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A Textbook of PUBLIC HEALTH DENTISTRY



CM Marya



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A Textbook of
Public Health Dentistry

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Public Health Dentistry

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To

My mother Veena Marya for making me what I am today,

My father Prof Dr RK Marya, a continuous motivational force in my life.

My wife Vandana for her constant encouragement and support.

My children for making life worthwhile.

—CM Marya

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Preface

This textbook is designed for undergraduate and postgraduate students in dentistry as well as health professionals with an interest in understanding and promoting oral health within communities. Although Public Health Dentistry is concerned with oral health of the population rather than dental needs of an individual patient, the ultimate beneficiary of public health programs is an individual.

As expected in a book of Public Health Dentistry, epidemiology, etiology, and preventive measures in context of dental caries, periodontal diseases and oral cancer have been discussed in detail. Extensive coverage has been given to the role of fluoride in the prevention of dental caries. The principal diseases of the mouth such as caries, periodontal disease and oral cancer are lifestyle dependent. A sound public health program can provide effective measures.

Some of the topics have been contributed by highly experienced colleagues from other dental colleges, bringing greater depth to the subject. The contribution of some chapters such as epidemiology, statistics, and nutrition, by senior teachers in Faculties of Medicine, Malaysia is gratefully acknowledged.

Forensic dentistry, Occupational hazards, Ergonomics in dentistry and Financial aspects of dental health practice are attracting greater attention these days. These topics have been included in this book.

The book incorporates the latest syllabus. The study of Public Health Dentistry also involves an appreciation of aspects of several disciplines including sociology, psychology and health-related behavior, health economics, health promotion and health service organizational methods in preventive dentistry. All these topics have been given adequate attention.

This textbook deliberately takes a broader international perspective of the dental preventive measures. Optimal solutions of health service provision are often hard one and one can often benefit from experiences in other countries.

An important aspect of this book is the large number of illustrations, mostly in color, as well as tables. Must-know information has been highlighted in a large number of boxes.

CM Marya

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My teacher and guide Dr BR Ashok Kumar is the base of my academic career in Public Health Dentistry, who has always inspired me in becoming a good academician.

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1 Section

Public Health

Chapter 1

Changing Concepts of Health and Prevention of Disease

CM Marya

Health is defined in the World Health Organization's Constitution as "a state of complete physical, social and mental well-being, and not merely the absence of disease or infirmity.

Thus health "is a positive concept emphasizing social and personal resources as well as physical capabilities".

To be healthy is to be in a state of homeostasis (balance) with one's surroundings. A healthy person, therefore, needs to maintain healthy habits such as taking regular exercise and adequate rest, adopting a high level of personal hygiene, eating a nutritionally balanced diet, abstaining from the abuse of drugs and alcohol, taking care of one's mental well-being and developing social skills to interact in a positive manner within society.

DETERMINANTS OF HEALTH

Many factors combine together to affect the health of individuals and communities. Whether people are healthy or not, is determined by their circumstances and environment. The factors which have been found to have the most significant influence – for better or worse – are widely known as the *determinants of health.* While health and social services make a contribution to health, most of the key determinants of health lie outside the direct influence of health and social care; for example, education, employment, housing, and environment. To a large extent, factors such as genetics, where we live, the state of our environment, our income and education level, and our relationships with friends and family all have considerable impacts on health, whereas the more commonly considered factors such as access and use of health care services often have less of an impact.

Public Health Agency of Canada and the *World Health Organization* has identified 12 determinants of health:

1. *Income and social status:* Health status improves at each step up the income and social hierarchy. High income determines living conditions such as safe housing and ability to buy sufficient good food. The healthiest populations are those in societies which are prosperous and have an equitable distribution of wealth.
2. *Employment:* Unemployment, underemployment and stressful work are associated with poorer health. People who have more control over their work circumstances and fewer stress related demands of the job are healthier and often live longer than those in more stressful or riskier work and activities
3. *Education:* Health status improves with level of education. Education increases opportunities for income and job security, and equips people with a sense of control over life circumstances-key factors that influence health. Low education levels are linked with poor health, more stress and lower self-confidence.
4. *Social environments:* The array of values and norms of a society, in varying ways, influence the health and well-being of individuals and populations. In addition, social stability, recognition of diversity, safety, good working relationships, and cohesive communities provide a supportive society that reduces or avoids many potential risks to good health. Studies have shown that low availability of emotional support and low social participation has a negative impact on health and well-being.
5. *Physical environments:* Physical factors in the natural environment (e.g., air, water quality) are key influences on health. Factors in the human-built environment such as housing, workplace safety and road design are also important influences.
6. *Healthy child development:* The effect of prenatal and early childhood experiences on subsequent health, well-being, coping skills and competence is very powerful. Children born in low-income families are more likely than those born to high-income families to have low birth weights, to eat less nutritious food, and to have more difficulty in school.
7. *Personal health practices and coping skills:* Balanced eating, keeping active, smoking, drinking, and how we deal with life's stresses and challenges, all affect health.
8. *Health services:* Access and use of services that prevent and treat disease influencing health.

9. *Social support networks:* Support from families, friends and communities is associated with better health. The importance of effective responses to stress and having the support of family and friends provides a caring and supportive relationship that seems to act as a buffer against health problems.
10. *Biology and genetic endowment:* Inheritance plays a part in determining lifespan, healthiness and the likelihood of developing certain illnesses.
11. *Gender:* Men and women suffer from different types of diseases at different ages.
12. *Culture:* Culture can be defined as all the ways of life including *arts, beliefs* and *institutions* of a population that are passed down from generation to generation. Culture includes codes of *manners, dress, language, religion, rituals,* norms of behavior such as law and morality, and systems of belief as well as the art. Customs and traditions, and the beliefs of the family and community, all affect health.

DETERMINANTS OF HEALTH

Public Health Agency of Canada and the *World Health Organization* have identified 12 determinants of health:

- Income and social status
- Employment
- Education
- Social environments
- Physical environments
- Healthy child development
- Personal health practices and coping skills
- Health services
- Social support networks
- Biology and genetic endowment
- Gender
- Culture

Dimensions of Health

Health is complex and involves the interaction of various factors. In 1948, the World Health Organization identified parameters to measure the functionality of an individual. The first three identified barometers include the physical, the social, and the mental constructs. Later, the emotional, spiritual, and environmental dimensions were added to the list.

(i) Physical

It is an ability of human body structure to function properly. Levels of physical fitness are determined by interacting genetic, environmental and individual factors. It is also affected by many interacting variables such as age, sex, diet, disease, stress, sleep, physical activity, medical and dental services, and by one's life cycle and lifestyle.

A physically fit person can carry out usual daily activities without undue fatigue and has enough energy to enjoy leisure time and to meet common emergencies.

(ii) Social

It is the ability to interact with other individuals. Social deprivation - intellectual, emotional, ethical, and spiritual - and prolonged exposure to social pathology and poverty may seriously impede the actualization of the individual's constructive potentialities.

(iii) Mental

Ability to process information and act properly.

(iv) Emotional

Ability to cope, adjust, and adapt.

(v) Spiritual

It is the belief in some force or dynamic other than humans. Human health involves a struggle to achieve a meaningful relationship with the universe and life. To ignore humankind's psychospiritual nature in developing models of health, would be to deal with a dehumanized caricature.

(vi) Environmental

It comprises of (i) External: one's surroundings, (e.g., habitat, occupation) and (ii) Internal: an individual's internal structure (e.g., genetics)

THEORIES OF DISEASE CAUSATION

i. *Germ theory of disease (monocausal):* Work of Koch and Pasteur revealed that the prevailing health problems of the time were the products of living organisms. Isolation of bacillus causing tuberculosis and identification of the organism responsible for 22 infectious diseases between 1880 to 1900, gave rise to the idea that each disease had a single and a specific cause. A set of rules was formulated by Koch (Koch postulates) for establishing causal relationship between a microorganism and a disease states. In brief, it was essential that to be ascribed a causal role, the agent must always be found with the disease in question and not with any other disease.

ii. *Epidemiological triad:* The germ theory could not explain why not all those exposed to pathogen become ill: an organism or other noxious agent is a necessary, but not a sufficient cause of disease. The epidemiological triangle approach sees disease as the product of an interaction between an agent, a host, and the environment. The epidemiological triangle is useful in understanding infectious disorders, but is less useful with respect to chronic and degenerative disorders such as stroke arthritis and heart disease.

iii. *Web of causation:* The web of causation considers all the predisposing factors of any type and their complex interrelationship with each other. This model is ideally suited for study of chronic diseases, where the disease agent is often not known. The disease is the outcome of the interaction of the multiple factors. It does not mean that to control a disease all or most of the factors need to be removed or controlled. The removal or elimination of even one factor may sometime be sufficient to control a disease provided that factor is sufficiently important.

iv. *The theory of general susceptibility:* This theory has emerged over the past 25 years and is different in important ways from monocausal and multicausal cause of disease. It is not concerned with identifying single or multiple risk factors associated with specific disorders. It seeks to understand why some social groups are more susceptible to disease and death in general.

v. *The socio-environmental approach:* During the 1980s, the theory of general susceptibility became more explicitly formulated as the socio-environm ental approach. This approach seeks to identify the factors which make and keep people healthy and is not much concerned with the cause of the disease. It focuses on the population rather than the individuals. It forms the basis for the health promotion strategies.

THEORIES OF DISEASE CAUSATION

Germ theory:
Disease is caused by transmissible agents.
A specific agent is responsible for one disease only (one-to-one relationship).

Epidemiological triad:
- Exposure to an agent does not necessarily lead to disease.
- Disease is the result of an interaction between agent, host and environment.
- Disease can be prevented by modifying the factors that influence the exposure and susceptibility.

Web of causation:
- Disease is a result of complex interaction of many risk factors.
- Any risk factor can be concerned in more than one disease.
- Disease can be prevented by modifying these risk factors.

General susceptibility:
- Some social groups have higher mortality and morbidity rates from all causes.
- It is an imperfectly understood general susceptibility to health problems.
- This is probably because of complex interaction of the environment, behavior and life-styles.

Socio-environmental approach:
- Health is strongly influenced by social and physical environment
- Risk conditions produced by such an environment affect health directly and through the physiological, behavioral and psychosocial risk factor that they create.
- Improving health requires modification of these environments.

Prevention of Disease

Definition

Prevention can be defined as 'the action of keeping from happening, or of rendering impossible, an anticipated event or act.'

This definition assumes that the thing being prevented is anticipated, but it does not mean that the extent, severity, or extent of the thing is always known. Prevention in health care means action to stop ill health before it begins.

Criteria for Disease Prevention

1. The disease and conditions are significant.
2. There is prevention that works.
3. Prevention is better than cure, repair, or doing nothing.
4. Sufficient resources are available to implement the preventive measures.
5. The economics can be calculated.
6. The process is ethical.

1. *Disease is significant:*
Significance of disease can be assessed in terms of three factors;
   - *Incidence and prevalence* (how much disease is there and how many people are affected).
   - *Mortality and morbidity* (what are the effects of disease – mild discomfort, disablement or death).
   - *Economics* (what is the cost of the disease to the individual or the nation).
2. *There is prevention that works:*
For an effective preventive strategy
   - The natural history of disease must be understood (etiology; determinants; predisposing, initiating, exciting, environmental factors; stages of disease progression etc.).
   - There should be an effective intervention available.
3. *Prevention is better than cure, repair, or doing nothing:*
Even if a preventive method is available, certain factors need to be considered:
   - Acceptability
   - Economics
   - Balance against process and outcome of disease.
   - Acceptable associated risk
4. *Availability of resources to implement the preventive measures:*
This includes all necessary and sufficient resources such as
   a. Manpower numbers.
   b. Manpower skills and ability
   c. Materials.
   d. Time.
   e. Political will.

   Often sufficient resources are available but priority for their utilization is not there.

5. *Economics:*
   Economics can be calculated by:
   a. Cost efficiency
   b. Cost benefit
   c. Cost utility
   To overcome the difficulty of comparing different health care approaches such as *cost effective analysis* (CEA) and *cost benefit analysis* (CBA) an approach termed *cost utility analysis* (CUA) has been developed where a universal currency, a single quantitative unit is constructed.

   The terms could be understood in terms of dentistry, as follows:

- Cost Efficiency (Effectiveness) — Cost of implementation / No. of tooth surfaces saved
- Cost Effectiveness (Efficiency) — Cost of implementation / Savings in cost of treatment
- Cost Benefit (Utility) — Cost of implementation / Benefits to quality of life

6. *Ethics*
   Ethics is concerned with what is right or what is wrong. Ethics in health care including prevention is as valid in preventing strategies as in any other element of health care provision.

An Ideal Public Health Measure Should Be

1. Of proven efficacy in the reduction of the targeted diseases.
2. Easily and efficiently implemented, using minimum quantity of materials and equipments.
3. Medically safe.
4. Readily administered by non-medical person.
5. Attainable by the beneficiaries regardless of their socio-economic, income, educational and occupational status.
6. Readily available and easily accessible to large number of individuals.
7. Inexpensive and hence affordable to majority of population.
8. Uncomplicated and easily learned by people.
9. Administered with maximum acceptance on the part of the patients.
10. Administered with minimum compliance on the part of the people.

Successful prevention depends upon:

- A knowledge of causation,
- Dynamics of transmission,
- Identification of risk factors and risk groups,
- Availability of prophylactic or early detection and treatment measures,
- An organization for applying these measures to appropriate persons or groups, and
- Continuous evaluation of development of procedures applied

LEVELS OR CATEGORIES OF PREVENTION

These can be studied under two main frameworks:

A. Levels of Prevention

i. Primordial prevention
ii. Primary prevention
iii. Secondary prevention
iv. Tertiary prevention.

B. Approaches of Prevention

- High risk (target) strategy
- Mass (whole population) strategy.

LEVELS OF PREVENTION

i. *Primordial prevention:* It is the prevention of emergence or development of risk factors in countries or population group in which they have not yet appeared. Individual and mass education is main intervention method in primordial prevention.

ii. *Primary prevention:* It is defined as 'action taken prior to the onset of the disease, which removes the possibility that a disease will even occur'. It is carried out on healthy populations. Information and / or public health measure to the whole population may be sufficient to maintain a disease free environment. It may be accomplished by measures designed to promote general health and well being or by specific protective measures.

iii. *Secondary prevention:* It can be defined as 'actions which halts the progress of a disease at its incipient stage and prevents complications'. It is carried out on targeted population identified by their being exposed to, or indulgence, in factors that place them 'at risk'. The individual or the population is required to change, either to take some new action, or to cease an established action, or both, in order to lower the levels of risk.

iv. *Tertiary prevention:* It provides a cure at an early stage in disease process, containing the disease or its effects on a long term basis and seeks to prevent a recurrence of the disease. It can be defined as 'all measures available to reduce or limit impairments and disabilities, minimizing suffering caused by existing departures from good health and to promote the patients adjustment to irremediable conditions'. The individual or population is aware of the disease, can see its effects and requires rehabilitation.

Modes of Intervention

Primary Prevention (Prepathogenesis)

Primary preventive services are those that prevent the initiation of disease.

a. *Health promotion:* It is process of enabling people to increase control over and to improve health. This can be achieved by
   i. Health education; instruction on proper plaque removal, daily tooth brushing and flossing
   ii. Environment modification such as safe water, control of insects and rodents.
   iii. Nutritional interventions: improvement of nutrition in vulnerable group.
   iv. Lifestyle and behavioural changes; which favor health
b. *Specific protection:* These are activities designed to protect against disease agents by decreasing the susceptibility of the host or by establishing barrier against agents in the environment. Methods include immunization, use of specific nutrition, avoidance of allergens, protection from carcinogens, ingestion of optimally fluoridated water and application of pit and fissure sealants.

Secondary Prevention

(Pathogenesis: Initial Stage of Pathogenesis)

It is defined as "action which halts the progress of a disease at its incipient stage and prevents complications."
These services intervene or prevent the progression and recurrence of disease.

a. *Early diagnosis:* WHO Expert Committee in 1973 defined early detection of health disorders as "the detection of disturbances of homeostatic and compensatory mechanism while biochemical, morphological and functional changes are still reversible."

   The earlier the disease is diagnosed and treated the better is its prognosis and helps to prevent the occurrence of more cases.

   Actions that detect and treat disease at an early stage thus hinder the progress of a disease and prevent complications. i.e. intervention in early pathogenesis phase.

   The methods (tools) employed for early diagnosis are:

   1. Screening for sub-clinical disease, either in screening surveys or in periodic medical examinations.
   2. Case finding (individual and community).

b. *Prompt treatment:* Secondary prevention attempts to arrest the disease process, restore health by seeking out unrecognized disease and treating it before irreversible pathological changes take place, and reverse communicability of infectious diseases.

Tertiary Prevention

(Pathogenesis: Late Stage of Pathogenesis)

Actions taken when the disease process has advanced beyond its early stages i.e. intervention in late pathogenesis phase.

It is defined as "all the measures available to reduce or limit impairments and disabilities, and to promote the patients' adjustment to irremediable conditions."

Intervention that should be accomplished in the stage of tertiary prevention is *disability limitation,* and *rehabilitation*.

The aim of tertiary prevention is to limit disability and prevent further complications or death.

a. *Disability limitation*

   The objective of this intervention is to prevent or stop the transition of the disease process from impairment to handicap (Fig. 1.1). The sequence is as follows:

   - Disease
   - Impairment
   - Disability
   - Handicap

   i. *Impairment*: It is "any loss or abnormality of psychological, physiological or anatomical structure or function."
   ii. *Disability*: It is "any restriction or lack of ability to perform an activity in the manner or within the range considered normal for the human being."

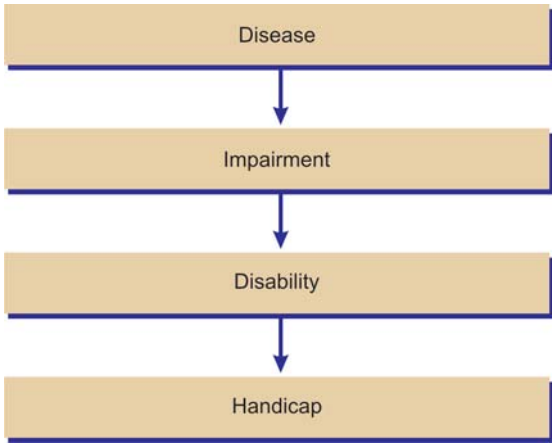


Fig. 1.1: Transition of disease process

Levels of prevention	*Primary*	*Secondary*	*Tertiary*
Concept of prevention	Prevention of disease initiation	Prevention of disease progression and recurrence	Prevention of loss of function
Modes of intervention	Health promotion specific protection	Early diagnosis and prompt treatment	Disability limitation rehabilitation

iii. *Handicap*: It is termed as "a disadvantage for a given individual, resulting from an impairment or disability that limits or prevents the fulfillment of a role in the community that is normal (depending on age, sex, and social and cultural factors) for that individual."

Tools for tertiary prevention include rehabilitation

b. *Rehabilitation:* It is defined as "the combined and coordinated use of medical, social, educational, and vocational measures for training and retraining the individual to the highest possible level of functional ability."

It is a measure to train the disable individuals to reach the highest level of functional ability by using combined coordinated medical, social, vocational, psychological and educational measures.

Rehabilitation comprises:

1. Medical rehabilitation: restoration of function or physical loss.
2. Educational rehabilitation: change of educational methods.
3. Vocational (occupational) rehabilitation: restoration of the capacity to earn a livelihood.
4. Social rehabilitation: restoration of family and social relationships.
5. Psychological rehabilitation: restoration of personal confidence

Examples of rehabilitation:

1. Special schools for blind pupils.
2. Provision of aids for crippled.
3. Reconstructive surgery for leprotics.
4. Modification of life for tuberculous or cardiac patients.

APPROACHES OF PREVENTION

High-risk Strategy

Here the population is classified in relation to the degree of risk which individuals or groups of individuals exhibit, or are exposed to. It aims to bring preventive care to individuals or a group at special risk, which will reduce their risk factors.

Advantages

a. Doctor-patient relationship.
b. Better motivation.
c. Cost benefits.
d. Individual appropriateness.

Disadvantages

a. Criteria for 'at risk' not clear.
b. Cost of screening.
c. Does not tackle cause of disease.
d. Misses transitional populations.

Mass Strategy

"Population strategy" is directed at the whole population irrespective of individual risk levels.

This approach does not differentiate between individuals in any defined population and is directed towards the whole population. It treats all individuals as at equal risk. Underlying factors which contribute to the etiology of the disease, or themselves are causative factors, are targeted for alteration. The population approach is directed towards socio-economic, behavioral and lifestyle changes.

Advantages

a. Easier.
b. Behaviorally appropriate for whole population.
c. Gets to the cause of the disease.
d. Reaches all who may become high risk / sufferers.

Disadvantages

a. Requires a lot of motivation.
b. Dilution of efforts.
c. Dilution of effects.
d. Less specific.
e. Higher rate of failure.
f. Lessened benefit to individuals.

Barriers (Challenges) to Preventive Strategies

1. *Diversity of population*
   A homogeneous message may not be appropriate for a heterogeneous population. Population varies in social status, age, ethnicity, differing attitudes, beliefs, expectations, knowledge, understanding and disease level etc.
2. *Inherent beliefs/mores*
   These include – fear of health/medical profession, confusion from previous message, erroneous message etc.
3. *Advertising*
   Propaganda produces pressure selling on children and blackmail on parents.
4. *Pressure groups*
   Many pressure groups base their opposition to health promoting moves on the basis of loss of autonomy and choice (seat belts, smoking in public places), and others on medical and epidemiological evidence (water fluoridation etc.).
5. *Access*
   Access to people to improve health is usually poorest to those who are in most need of intervention, e.g. Social class III, IV, V, kids, risk group.
6. *Resources*
   Although governments stress the importance of prevention, the major drain on health resources is the acute health care sector. Directing resources into prevention is still not completely addressed.

Chapter 2

Basic Epidemiology

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INTRODUCTION TO EPIDEMIOLOGY

Health and disease can be studied in 3 basic ways, (i) observation of effects on individuals (ii) laboratory experiments (iii) measuring their distribution in population (epidemiology).

The origin of the word epidemiology is from the Greek word 'epi' meaning upon, 'demos' meaning people and logos meaning 'doctrine'; the literal translation would be 'the doctrine of what is upon the people'.

The international epidemiological association defines epidemiology as "the study of the *distribution* and *determinants of* health related states and events in the populations and the application of this study to control of health problems". The primary unit of concern is groups of person not individuals.

Scope of Epidemiology

Epidemiology covers all major health problems in the community including:

- Communicable diseases
- Chronic degenerative, metabolic, neoplastic diseases
- Nutritional deficiencies
- Occupational health and injuries
- Mental and behavioral disorders
- Population issues and demographic trends.

Uses of Epidemiology

- The most important use of epidemiology is to increase the understanding of disease, shared with the other medical sciences, but looking at communities or populations
- Determine the cause of disease so that previously unavailable preventive or control measures may be successfully applied
- Epidemiology clarifies causative agents, the factors in web of causation, the populations at highest risk and environmental and other determinants
- Epidemiology is concerned with describing the natural history of disease, including not only the clinical stages seen in hospitals and medical practice but unapparent, sub clinical and carrier states and precursor states of chronic diseases
- Epidemiology is used to monitor the health of populations (surveillance) to chart changes over time, place and person and to determine which diseases are of most public health importance. By analyzing trends it is able to predict and devise methods of control
- The design, conduct and interpretation of field trials, vaccinations and control programs, therapeutic measures such as environmental modifications and dietary changes, concerned with populations not individuals
- It supplies information necessary for health planning and development and management of programs for disease prevention and control
- It supplies tools for evaluating health programs
- It provides a foundation for public policy and for making regulatory decisions relating to environmental problems.

Epidemiological Perspective

Epidemiology is about information, the information needed for health planning, supervision and evaluation of the health promotion and disease control activities. The key components of the data needed can be approached through a series of questions.

- Who? – Who is affected? - referring to age, sex, social class, ethnic group, occupation, heredity and personal habits. (These are person factors)
- Where? – Where did it happen? - in relation to place of residence, geographical distribution and place of exposure. (Place factors)
- When? – When did it happen? - in terms of months, season or year. (Time factors)
- What? – What is the disease or condition? - its clinical manifestation and diagnosis.
- How? – How did the disease occur? - in relation to the interplay of the specific agent, vector, source of infection, susceptible groups and other contributing factors.
- Why? – Why did it occur? - in terms of the reasons for the disease outbreak.

- What now? – The most important question - What action is now to be taken as a result of the information gained?

Epidemiological Concept

The concept which is sometimes called the ecological concept of disease or the concept of multiple causations is based on the three premises:

1. Disease results from an imbalance between the disease agent and the host.
2. The nature and the extent of the imbalance depends upon the nature and characteristics of the agent and the host.
3. The characteristics of the agent and the host and their interactions are directly related to and largely dependent on the nature of the physical, biological and social environment.

The epidemiological concept of disease holds that health and disease in an individual or community are outcomes of the dynamic relationship between the agent, the host and the environment (Fig. 2.1). A state of equilibrium between these factors indicates no disease; any disturbances of this equilibrium brought about by changes in the inherent characteristics of the agent the host and the environment results in disease.

Agents

The agent has been defined as an element, a substance or a force either animate or inanimate, the presence or the absence of which may, following effective contact with the susceptible human host and under proper environmental conditions, serve as a stimulus to initiate or perpetuate a disease process. The classifications of agents are:

- Biological agents – due to living agents. Viruses, bacteria, fungi, protozoa
- Nutritional factors – both excess and deficiencies such as calories, proteins, vitamins
- Chemical agents – e.g. lead, solvents
- Physical agents – humidity, vibration, heat, light, cold, radiation, etc
- Mechanical agents – explosives, bullets, knives, etc
- Social and psychological stressors – poverty, smoking, drug abuse, work stress, etc.

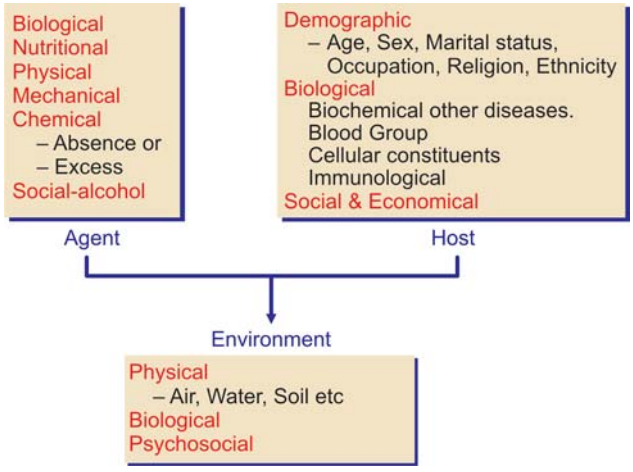


Fig. 2.1: Epidemiological triad and their interaction

Human Host

The factors which influence the exposure of response include:

- Age
- Sex
- Family size
- Marital status
- Religion
- Occupation
- Intercurrent disease
- Ethnic or racial factors
- Habits and customs
- Inherent immunity or non specific immunity
- Immunity – passive immunity, active immunity.

Environment

The environment is the sum total of all external conditions and influences that affect the life and development of an organism. It thus influences both the agent and the host.

- Biological environment – infectious agents of disease, reservoirs of infection, vectors that transmit disease, plants and animals.
- Social environment – the overall economic and political organization of a society and of the institutions by which individuals are integrated into the society at various stages in their lives.
- Physical environment – heat, light, air, water, radiation, gravity, chemical agents.

Risk Factors: The "Beings" Model

Epidemiological research has focused on life threatening diseases such as cancer. Majority of cancers were potentially preventable and were due to "extrinsic factors". However extrinsic or environmental factors have often been misinterpreted to mean "man made chemical" Hence the BEINGS is a helpful acronym to remember the major categories of risk factors.

Biological factors and behavioral factors: Gender, age, weight, smoking behavior, etc.

Environmental factors: Rainfall, season, housing, air-conditioning, etc.

Immunological factors: Immunity and Immunodeficiency.

Nutritional factors: Cholesterol in heart diseases

Genetic factors: Thalassemia, Hemophilia, etc.

Services, social factors and spiritual factors.

MEASURING HEALTH

There is a need for accurate information on illness (morbidity) and death (mortality) because of the high economic loss, social disturbances as well as the cost of medical care associated with them and to enable comparison within and between societies at a given point in time or over different time periods. Health is measured by morbidity and mortality statistics.

Numerator and Denominator

Epidemiology is concerned with either the presence of health problems in a population or the occurrence of new health events in a population. In both the cases an epidemiological measure (or expression) has at least two components: a numerator and a denominator.

The numerator in a disease ratio or rate for example is either existing (prevalent) cases as with measures of prevalence or new (incidence) cases as with incidence.

The denominator is the population at risk or the population in which cases exist or have occurred.

Ratio, Proportion and Rate

There are three basic classes of mathematical quantity used to measure health status and the occurrence of health events on populations.

- *Ratio* – is the general term that includes a number of more specific measures, such as proportion, percentage and rate. A ratio is obtained by dividing one quantity by another without implying any specific relationship between the numerator and the denominator. The value of a ratio can range from minus to plus infinity
- *Proportion* – is a type of ratio in which those who are included in the numerator must also be included in the denominator i.e. the numerator is a subset of the denominator. The magnitude of proportions is usually expressed as a percentage
- *Rate* – is a ratio in which there is a distinct relationship between the numerator and the denominator. A specified time period is an essential component of the denominator

Rates are used as a comparison of an observed rate with a target rate, a comparison of two different populations at the same time (the two population should be similar and are measured in exactly the same way), a comparison of the same population at two different time periods (used for studying time trends).

Categories of Rates

i. *Crude rates:* rates that apply to entire populations, without a reference to any characteristics of the individuals in it. They are valid rates but often misleading.
ii. *Specific rates:* rates that are used when a population is divided into more homogenous subgroups based on a particular characteristic of interest e.g., age.
iii. *Standard rates:* rates that are standardized to compare between two or more different populations.

Measures of Disease Frequency

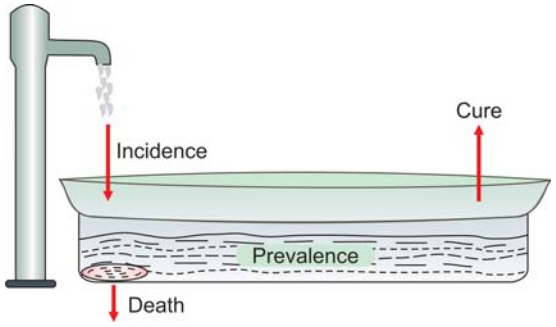


Fig. 2.2: Relationship between incidence and prevalence

Prevalence

Prevalence is an estimate of the proportion of individuals in the population with a given disease, disability or health state at a particular point in time. Prevalence is the measure of the existence of a particular condition i.e. prevalence measures the probability of people having a disease at a given point in time.

Prevalence is not strictly a rate although it is sometimes referred to as one. Prevalence is a proportion and should usually be reported as one. The major difference between incidence and prevalence is that knowledge of time of onset is not required in a prevalence study. Denominators in prevalence always include the entire population since the numerator contains old as well as new cases.

Prevalence depends on two factors (Fig. 2.2): the number of people who have been ill in the past (previous incidence) and the duration of their illness. P~ I × D, if incidence and duration have been stable over a long period of time then this formula becomes P = I × D (Table 2.1).

Table 2.1: Prevalence of disease over a period of time

Increased by	*Decreased by*
Longer duration of the disease	Shorter duration of the disease
Prolongation of life of patients without cure	High case fatality rate from disease
Increase in incidence	Decrease in incidence
In migration of susceptible people	Out migration of cases
Better reporting	Improved cure rate of cases

There are two types of prevalence rates point prevalence and period prevalence.

Point Prevalence:

Attempts to measure disease at one point in time,

$$\text{Prevalence} = \frac{\text{Number of existing cases of a disease at a point of time}}{\text{Total population at that point of time}} \times 1000$$

Point prevalence is preferred over period prevalence since it is more precise.

Period Prevalence:

It describes the prevalence of disease over a period of time.

$$\text{Period prevalence} = \frac{\text{Number of existing cases of a disease during a period or interval}}{\text{Average population during a period or interval (usually at mid point)}} \times 1000$$

Incidence

Incidence measures the number of new cases or new events of disease which develop on a given population during a specified time period. Incidence rates measure the probability that healthy people will develop a disease during a specified period of time. To determine incidence, it is necessary to follow prospectively a defined group of people and determine the rate at which new cases of disease appear.

Incidence may Change with the Following Factors

- Introduction of a new risk factor
- Changing habits
- Changing virulence of causative organism
- Changing potency of treatment of intervention programs
- Selective migration of susceptible persons to an endemic area, which increases the incidence of the disease.

Cumulative Incidence

CI is the proportion of people in a total population at risk and free of disease at the start of a particular time period who become diseased or develop the incident condition during the specified time period. CI provides an estimate of the probability (or risk) that an individual will become diseased in the specified time period

$$\text{CI} = \frac{\text{Number of new cases of a disease in a given period of time}}{\text{Total population at risk (Free from disease at beginning of period)}} \times 1000$$

Incidence Rate (Incidence Density)

Often every individual in the denominator is not followed for the specified period of time. For a variety of reasons including loss to follow-up, death or migration different individuals will be observed for different lengths of time. For differing periods of observation, person time denominator must be used.

IR is a true rate and is considered to be an instantaneous rate of development of disease in a population. The numerator is the number of new cases or incident cases in the population.

$$\text{Incidence rate} = \frac{\text{Number of new cases}}{\text{Person time of observation}} \times 1000$$

Mortality Statistics

Although mortality is far from being an ideal measure of the health of a population, thanks to vital registration systems, it is often the most easily available and accessible indicator that can be used by health agencies in the planning, implementation and evaluation of health services. Morbidity is of course a better indicator of health since it covers the whole spectrum of disease but there are numerous problems and errors associated with it. As most countries have a "vital events" registration system calculating mortality rates is easy. However, if deaths are not reported the rates will be artificially low.

The commonly used rates are crude death rate, standardized death rate, cause – specific death rate, age-specific death rate, case fatality rate, proportionate mortality rate, infant mortality rate (IMR), Neonatal mortality rate (NMR), postneonatal mortality rate (PNMR), prenatal mortality rate and maternal mortality rate (MMR).

Calculations for Common Mortality Rates

Crude death rate =

$$\frac{\text{Number of deaths among residents in an area in a calendar year}}{\text{Average population in the area in that year}} \times 100$$

Cause-specific death rate =

$$\frac{\text{Number of deaths from a stated cause in a year}}{\text{Average (mid-year) population}} \times 1000$$

Age-specific death rate =

$$\frac{\text{Number of deaths among persons of a given age group in a year}}{\text{Average (mid-year) population in the specified age group}} \times 1000$$

Case fatality rate =

$$\frac{\text{Number of deaths from a disease}}{\text{Number of clinical cases of that disease}} \times 100$$

Neonatal mortality rate (NMR) =

$$\frac{\text{Deaths in a year of children <28 days of age}}{\text{Number of five births in same year}} \times 1000$$

$$\text{Postneonatal mortality rate (PNMR)} = \frac{\text{Deaths in a year of children = 28 days of age upto 1 year}}{\text{Number of live births in the same year}} \times 1000$$

$$\text{Prenatal MR} = \frac{\text{Births (28 wks or more of gestation) + deaths in the first week of life}}{\text{Stillbirths + Number of live births in same year}} \times 1000$$

$$\text{Toddler MR} = \frac{\text{Deaths of children aged 1 to 4 years in a given year}}{\text{Mid year population of children aged 1 to 4 years for the same year}} \times 1000$$

$$\text{IMR} = \frac{\text{Number of deaths in a year of children less than 1 year of age}}{\text{Number of live births in same year}} \times 1000$$

$$\text{MMR} = \frac{\text{Number of deaths from pregnancy related causes in a year}}{\text{Number of live births in same year}} \times 100{,}000$$

EPIDEMIOLOGICAL STUDIES

Epidemiological studies are required to measure the rates of disease occurrence and the associated factors in a population, to make an unbiased comparison of those with or without a disease or risk factor and to make interventions. This is achieved by a good research design. Some research questions can be answered by more than one type of research design. The choice of design will depend on factors such as cost, speed and availability of data. Each design has advantages and disadvantages.

Design of Epidemiological Studies

The design of an epidemiological study serves the function of a measuring instrument. Though the design information is obtained from the population being studied, the researcher designs the study in such a way that valid estimates are obtained. A number of design options exist, each with their own purposes strengths and weaknesses.

The selection of the type of study is the core of a research design and is probably the single most important decision the investigator has to make. The strategy must include definition of variables, their levels and their relationships to one another.

The type of study design chosen depends on:

- The type of problem
- The knowledge already available about the problem and
- The resources available for the study.

Epidemiological studies are broadly classified as follows (Fig. 2.3):

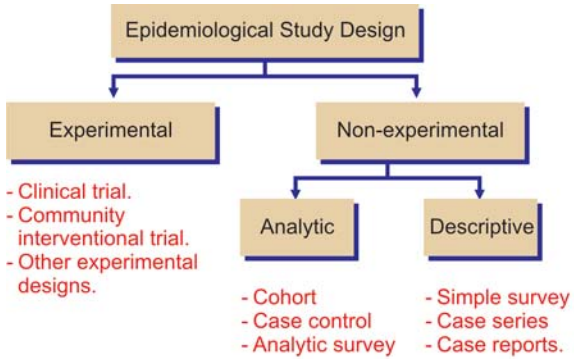


Fig. 2.3: Classification of epidemiological studies

Non-experimental (Observational)

In non-experimental studies, the assignment of subjects to exposure groups is not determined by the researcher, but rather by the study subjects themselves or by other factors. The possibility of bias in non-experimental studies is of constant concern.

There are two types of non-experimental designs.

- Analytical studies
- Descriptive studies.

Descriptive Studies (Who? What? Where? When?)

These studies involve the systematic collection, analysis and interpretation of data to give a clear picture of a particular situation. The wealth of data obtained in most descriptive studies allows the generation of hypothesis, which can then be tested by analytical experimental design. Both qualitative and quantitative techniques may be used.

In descriptive epidemiology we organize and summarize data according to *time, place and person*. These three characteristics are sometimes called the *epidemiologic variables.* This information provides important clues to the causes of the disease, and these clues can be turned into testable hypotheses.

Characteristics of Persons

- Age – overall the most important epidemiologic variable relating to exposure, susceptibility and pathogenesis. Age specific rates to make comparisons between populations must be determined. The population pyramid of the group studied must be considered
- Sex – anatomical, physiologic, psychological and behavioral characteristics account for many sex specific disease associations
- Ethnicity – genetic, physiologic, behavioral, environmental and socioeconomic characteristics of importance as determinants of disease
- Place of origin – genetic pool, environmental, cultural and behavioral and dietary factors

- Marital status – a selective process, and associated with differences in physical state, behavioral and socioeconomic determinants of health
- Occupation – reflects physical, mental, psychological, environmental and socioeconomic characteristics related to disease patterns
- Socioeconomic – determines many of the above characteristics.

Characteristics of Place (Geographic, Landscape Epidemiology)

- Biologic environment – climatic and ecologic characteristics that determine flora and fauna, including human factors
- Chemical and physical environment – quality of air, water and food
- Social environment – cultural, behavioral patterns that determine risks, perceptions and responses.

Characteristics of Time

- Endemics – diseases which are regularly and continuously present
- Epidemic – a significant excess over that expected on basis of past experience; an unusual clustering over time
- Short time variation – point epidemics
- Periodic variations – seasonal changes, cyclical variations, secular variations
- Dynamics of disease – refers to distribution in time, is concerned with trends, cyclic and secular changes, intervals between exposures, degrees of exposure, incubation periods, communicability periods.

Types of Descriptive Studies

1. *Case studies* – this kind of study is based on reports of a series of cases of a specific condition or a series of treated cases, with no specifically allocated control group. They represent the numerator of disease occurrence and should not be used to estimate risks.
2. *Community diagnosis or needs assessment* – entails collection of data on existing health problems, programs, achievements, constraints etc. Their purpose is to identify existing needs and to provide base line data for the design of further studies or action.
3. *Epidemiological description of disease occurrence* – entails the collection of data on the occurrence and distribution of disease in population according to specific characteristics of individuals, place, and time.
4. *Ecological descriptive studies* – when the unit of observation is an aggregate (e.g. a family, clan or school) or an ecological unit (a village, town or district), the study becomes a descriptive ecological study.
5. *Descriptive cross sectional studies or community (population) surveys* – entails the collection of data on a cross section of the population, which may comprise the whole population or a proportion (a sample). They provide a prevalence rate at a point in time (point prevalence) or over a period of time (period prevalence). The study population at risk is the denominator of these prevalence rates. Included in these studies are surveys in which the distribution of a disease, disability, pathological condition, immunological condition, nutritional status are studied.

   This design may also be used in health systems research to describe prevalence by certain characteristics – the pattern of health service utilization and compliance – or in opinion polls.
6. *Longitudinal studies* – use ongoing surveillance or frequent cross sectional studies to measure trends of disease over a period of time in a given population. By comparing these trends in disease rates with other changes in the society the impact of these changes on disease occurrence can be assessed. E.g: effect of introduction of vaccines, natural and manmade disasters economic change.

All the above studies can be the source of hypothesis generation. Both cross sectional and ecological studies can be used in hypothesis testing (i.e. are analytical.)

Analytical Studies (How? Why?)

Analytical strategies are observational means used in epidemiological investigations to test specific hypotheses. The term 'analytical' implies that the study is designed to establish the cause of a disease by looking for association between exposure to a risk factor and disease occurrence.

The basic approach in analytical studies is to develop a specific testable hypothesis and to design the study to control for extraneous variables that could potentially confound the observed relationship between the studied factors and the disease. The approach varies according the specific strategy used (Fig. 2.4).

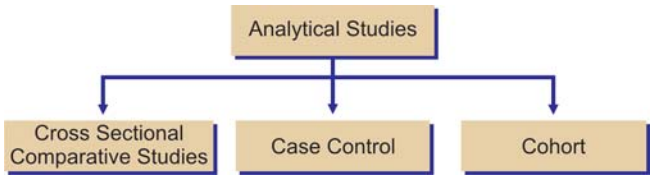


Fig. 2.4: Classification of analytical studies

Experimental (Interventional)

An experiment or an interventional trial is designed to evaluate the effect of an intervention in which the assignment of subjects to exposed and non exposed groups is designed by the researcher.

The researcher manipulates objects or situations and measures the outcome of his manipulations. Usually (but not always) two groups are compared, one in which the intervention takes place and another group that remains untouched.

There are two categories of interventional studies:

- Experimental studies
- Quasi-experimental studies.

Experimental Studies

An experimental design is the only type of study design that can actually prove causation. The classical study design has three characteristics.

- Manipulations – the researcher does something to one group of subjects in the study
- Control – the researcher introduces one or more control groups to compare with the experimental group
- Randomization – the researcher takes care to randomly assign the subjects to the control and experimental groups. (Each subject is given an equal chance of being assigned to either group.)

The strength of experimental studies is that by randomization the researcher eliminates the effects of confounding variables.

Quasi-experimental Studies

In this study at least one characteristic of a true experiment is missing, either randomization or the use of a separate control group. These studies, however, always include manipulation of an independent variable that serves as the intervention.

Common Study Designs in Epidemiology

Cross-sectional Survey

A cross-sectional survey is a survey of a population at a single point in time. Many methods like interview or mass screening can be used in these surveys. They are quick and relatively easy to perform and give a fair idea of the health status of the community. They can also estimate risk of developing diseases. Survey could be descriptive (hypothesis generating) or analytical (hypothesis testing).

i. Descriptive Cross-sectional Studies or Community (Population) Surveys

Many cross-sectional studies do not aim at testing a hypothesis about an association and are thus descriptive. They provide prevalence rate at a point in time (point prevalence) or over a period of time (period prevalence). Cross sectional survey provide a "snapshot" of the population at a certain point of time. Both exposure and disease outcomes are determined simultaneously. They are also called prevalence studies as prevalent cases are identified.

Included in this type of descriptive study are surveys in which the distribution of a disease, disability, nutritional status, pathologic condition, fitness, intelligence, etc. This design may also be used in health systems research to describe prevalence by certain characteristics, the pattern of health service utilization and compliance or opinions.

ii. Analytical Cross Sectional Studies

In analytical cross sectional study the investigator measures exposure and disease simultaneously in a representative sample of the population. By taking a representative sample it is possible to generalize the results obtained in the sample to the population as a whole.

Both exposure and disease outcome are determined simultaneously for each subject. In this type of approach the cases we identify are prevalent cases of the disease in question because we know that they existed at the time of the study but we do not know their duration. For this reason this study is called prevalence study.

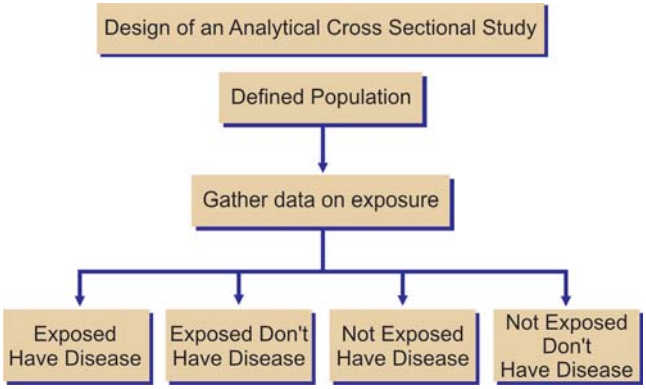


Fig. 2.5: Design of an analytical cross-sectional study

The data collected is examined by the prevalence of disease in different sub group and the presence of variables (or absence) in disease vs. non disease (Fig. 2.5). The data is tabulated in Table 2.2 thus

Table 2.2: Examined data by the prevalence of disease

	Disease	*No disease*	*Total*
Exposed	a	b	a+b
Not exposed	c	d	c+d
Total	a+c	b+d	a+b+c+d

The rates calculated are:

i. prevalence of disease:
In exposed compared to non exposed
= a / (a + b) vs. c / (c + d)

ii. prevalence of exposure:
In disease and non disease
= a /(a + c) vs. b /(b + d)

Advantages of Cross Sectional Studies

1. Can be done in a short time.
2. Are less costly.
3. Are a starting point in prospective cohort study for screening out already existing conditions.

4. Provide a wealth of data that can be used in health systems research.
5. Can be used for evaluating health safety services.
6. May be used in examining and identifying risk factors for acute diseases where the time between exposure and outcome is very short.
7. Useful for monitoring control programs for chronic conditions such as mental illness.
8. Periodic surveys useful in tracking changes in disease patterns over time (imp: repeated cross sectional surveys over time do not constitute a longitudinal study).

Disadvantages

1. They provide no direct estimate of risk (show association only).
2. They are prone to bias from selective survival.
3. It is not possible to establish temporality.
4. Even if an association of exposure and disease is observed the association may be due to survival.
5. Prone to selection bias, information bias, confounding bias.
6. Not suitable for rare diseases and remission.

Case Control Studies (Retrospective Study)

Case control study is useful as a first step when searching for a cause of an adverse health outcome. This hallmark of this type of study is it compares a case group (with disease) with a control group (not diseased) with reference to past exposure to possible risk factors. The cases and controls are selected from a dynamic population and then compared. It has become much more common in recent years (Fig. 2.6).

Selection of Cases and Controls

Cases can be selected from a variety of sources (hospitals, physician clinics, community registries and more), and assessed by interviews, questionnaires and direct measurement. The criteria for eligibility are carefully specified. Ideally incident (new) cases should be used but the problem with using the incident cases is that we must wait for new cases to develop and be diagnosed whereas a large number of prevalent (existing) cases are often available for study. Despite this practical advantage of using prevalent cases it is generally preferable to use incident cases as any risk factors identified by using prevalent cases may be related to the survival with the disease rather than to the development of the disease (incidence). Even if we use incident cases we will still be excluding patients who may have died before the diagnosis is made.

The controls should ideally be from the same population which gave rise to the cases, e.g. Non hospitalized persons living in the community (hospital patients differ to people in the community). However, most often, hospitalized patients admitted for diseases other than that for which the cases were admitted are chosen as controls. Multiple controls for each case are frequently used. Such controls may be of same or different type.

The controls can be either matched or unmatched and ideally selected from the same population. Matching is defined as the process of selecting the controls so that they are similar to the cases in certain characteristics such as sex, age, race, socioeconomic status and occupation. Matching removes the influence of that variable on the causation of the disease. Once we have matched controls to cases according to a given characteristics we cannot study that characteristics. We only match on variables that we are convinced are risk factors for the disease characteristics that we are not interested in investigating in this study. Matching on variables other than these is called overmatching.

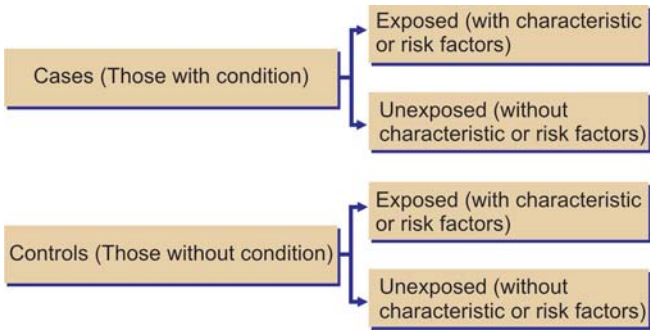


Fig. 2.6: Design of a case control study

Risk Measure in Case Control Study

Case control study yields odds ratio. It is the odds of exposure in diseased subjects and the odds of exposure in non diseased subjects.

Advantages of Case Control Studies

a. Suitable for rare as well as common diseases.
b. Usually less expensive.
c. Performed relatively quickly.
d. Many different exposures may be studied.
e. Fewer subjects required.

Disadvantages

a. Incomplete information.
b. Bias – selection bias, recall bias, information bias, non response bias, analysis bias, misclassification bias, confounding.
c. Problem in identifying control group and matching variables.
d. Yields only odds ratio.
e. Temporal relationship not clear.

Cohort Study (Longitudinal Study)

A cohort is a group of persons who share a common experience within a defined time period. In a cohort study the inves-

tigator defines a cohort of a naturally occurring non diseased, exposed individuals and another cohort of non diseased, non exposed individuals (the comparison population) and follows them over time to determine disease incidence. A definitive characteristic of a cohort (both retrospective and prospective) study is that the subjects at the beginning of the study are free of the disease outcome.

Types of Cohort Studies

There are two general types of cohort studies.

a. Prospective Cohort Studies (concurrent cohort/prospective study)

A cohort of individuals free from the disease are selected and grouped as per their exposure or non – exposure to a suspect causative factor and then monitored over a period of time for the development of disease (Fig. 2.7).

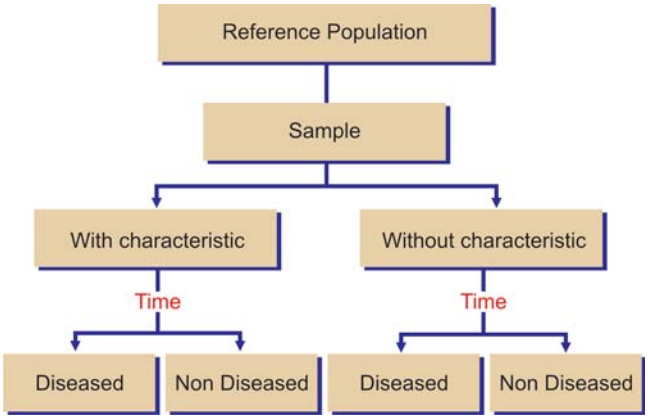


Fig. 2.7: Design of a prospective cohort study

b. Retrospective Cohort Studies (historical cohort / non concurrent prospective study)

In this type of study the investigator goes back in time to define the exposure and risk group and follows the members to the present to see the outcomes. A good health recording system is beneficial for this type of study as an estimate of exposure to relevant variables in the past must be made based upon these records. It can usually be conducted more quickly and cheaply. It is efficient for a cohort, whose investigation for a disease with a long latency period, will require many years of follow up to accrue sufficient end points. They depend on availability of relevant exposure data in adequate details from pre-existing records (data may be incomplete especially on confounding factors).

Selection of Exposed and Comparison Population

Cohort study is often conducted among groups specifically chosen, not only for their exposure status, but also for their ability to facilitate the collection of relevant information. Choice of a particular group to serve as the study population for any given study is related to both the hypothesis under investigation and specific features of the design. The groups being compared should be as similar as possible with respect to all other factors that may be related to the disease, except the determinant under investigation. An internal comparison group can be utilized, i.e. the experience of those cohort members classified as having a particular exposure is compared with that of members of the same cohort who are either non-exposed or exposed to a different degree.

It is important to obtain complete, comparable and unbiased information of the subsequent health experience of every study subject. Combination of various sources of the outcome data may be necessary to obtain complete follow-up information.

Collecting follow-up data on every person enrolled represents the major challenge of a cohort study as well as the major cost in terms of time, fiscal resources and ingenuity.

The basic analysis is the calculation of rate of the incidence of a specified outcome among the cohorts under investigation. Both relative and absolute measures of association can be calculated. Relative risk is the estimate of the association between exposure and disease and indicates the likelihood of developing disease among the exposed individuals relative to those not exposed i.e. how much more likely one group is to develop a disease than the other. Attributable risk is a method of attributing the occurrence of a disease to a specific exposure which may be contributing to the development of the disease. Its utility is that it represents the expected reduction in disease if the exposure could be removed or never existed. It is the difference between the frequency measures for the two populations.

Advantages

1. Suitable for rare as well as common exposure.
2. Exposure data are often more accurate.
3. Less information bias.
4. Examines multiple effects of a single exposure.
5. Provides absolute and relative effect measures.
6. Can elucidate temporal relationship between exposure and disease.
7. Allows direct measurement of incidence of disease in the exposed and non-exposed groups.

Disadvantages

1. Inefficient for the evaluation of rare diseases unless attributable risk present is high.
2. Expensive and time consuming (prospective).
3. Requires availability of adequate records (retrospective).
4. Validity can be seriously affected by losses to follow up (attrition).
5. Large number of subjects required.

6. Change over time – in criteria and methods.
7. Non response bias.

Measures of Risk in Cohort Studies

Relative and Attributable risk are calculated from cohort studies.

Relative Risk: Relative risk is the estimate of the association between exposure and disease and indicates the likelihood of developing disease among the exposed individuals relative to those not exposed, i.e. how much more likely one group is to develop a disease than the other.

Attributable Risk: Attributable risk is a method of attributing the occurrence of a disease to a specific exposure which may be contributing to the development of the disease. Its utility is that it represents the expected reduction in disease if the exposure could be removed or never existed. It is the difference between the frequency measures for the two populations.

Interventional Studies

In contrast to observational studies, where the epidemiologist takes no action but only observes the natural course of events or outcome, experimental studies involve some action, intervention or manipulation such as deliberate application or withdrawal of the suspected cause or changing one variable and the causative chain in the experimental group while making no change in the control group and observing and comparing the outcome of the experiment in both the groups.

The type of study can take one of three forms:

- Randomized Controlled trial
- Field trial
- Community trial.

The aim of experimental studies is:

- To provide scientific proof of etiological (or risk) factors which may permit the modification or control of those diseases
- To Provide a method of measuring the effectiveness and efficiency of health services for the prevention, control and treatment of disease and improve the health of community
- To evaluate the efficacy of medical management of disease in test and control groups. These are commonly called clinical trials.

i. *Field Trials*
Are experiments on people without the disease in question to determine the efficacy of a preventive or therapeutic agent or procedure. These trials involve people who are disease free but are presumed to be at risk, data collection takes place in the field usually among non institutionalized people in the general population.

ii. *Community Intervention Trials*
In this type of field trial the intervention is done on a community wide basis rather than individuals. Due to practical difficulties only a small number of communities are included. Random allocation of communities may not be feasible. These studies are appropriate for diseases that have origins in social conditions which can most easily be influenced by intervention directed at group behavior as well as at individuals.

iii. *Randomized Controlled Trails*
Randomized controlled trials (RCT's) are used for evaluating both the effectiveness and side effects of new types of intervention. Although the term randomized control clinical trial is often used, the design is used for new treatment modalities including new health and medical care technology and organizing and delivering health services. The design follows stringent norms to reduce bias (Fig 2.8).

Steps in a Randomized Control Study

i. *Randomization*
Participants are allocated into test and control groups at random. Random allocation permits chance to determine the assignment of subject to various groups. It eliminates selection bias and tends to create groups that are comparable in all factors. It gives validity.

ii. *Manipulation*
In this step the investigator intervenes or manipulates the study group by deliberate application or withdrawal or reduction of the suspected control factor. The control group may have a standard intervention, a placebo (an inert substance that produces no effect) or no intervention at all.

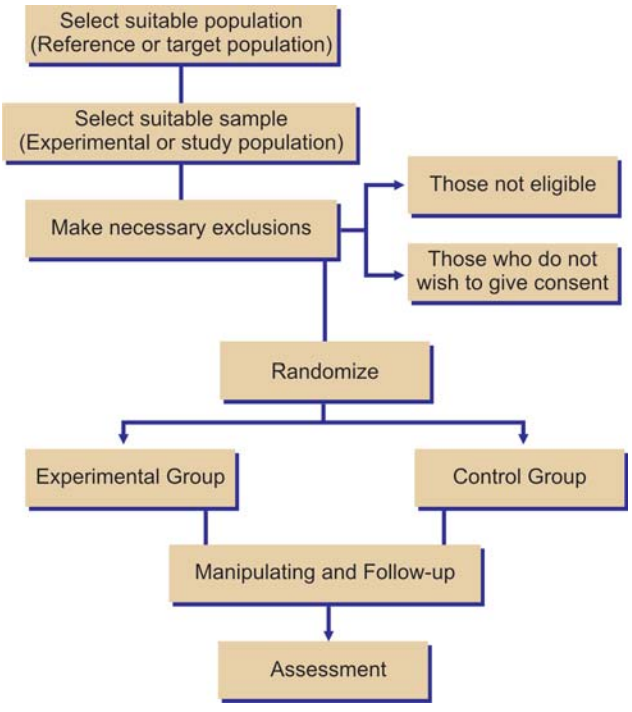


Fig. 2.8: Design of a randomized controlled trial

iii. *Blinding (Masking)*
The subjects need to participate without knowing which type of intervention is being done on them. Similarly this information can be withheld from the assessor and the person analyzing the data. This process is called blinding. The types of blinding are:
   a. Single blind trial – Participant not aware
   b. Double blind trial – Doctor nor participant aware
   c. Triple blind trial – Participant, investigator nor person analyzing the data are aware

iv. *Follow-up*
At defined intervals of time both the groups are assessed for outcome of the intervention. The follow up is done with the same intensity and quality. A problem of follow-up is attrition due to death or drop outs. All must be included in the analysis i.e. in the denominator when comparing the proportions of successes or failures.

v. *Assessment of outcome*
The outcome must be specified in advance and expressed in term of positive results which are the benefits to the subject. The negative or the severity and frequency of side effects and complications also need to be stated. The assessor ideally should not know to which group the subject belongs. The blinding process achieves this.

Clinical Trials

The randomized control design is used extensively for clinical trials. There are many types of clinical trials. They are

i.	Prophylactic trial	e.g.: immunization, contraception
ii.	Therapeutic trial	e.g.: drug treatment, surgical procedure
iii.	Safety trial	e.g.: side effect of oral contraceptive
iv.	Effectiveness trial	
v.	Risk factor trial,	e.g.: proving etiology of a disease by inducing putative agents In animals
vi.	Efficiency trial,	e.g.: efficiency of inserting IUCD

Phases of Clinical Trial

In the process of or development of a new drug or vaccine the trials in humans go through four phases:

Phase I

After considerable research in experimental animals, volunteers are institutionalized and receive a fraction of the anticipated dose of drug and are monitored for effects. This phase requires high technology and various medical expertise.

Phase II

The purpose this phase is to assess the effectiveness of the drug or device, to determine appropriate dose and to investigate its safety. It is conducted on volunteers based on strict criteria.

Phase III

This phase of the trial is on hospital in-patients who consent to participate. The randomized control design is used in this stage.

Phase IV

This phase is for assessing the post-launch effectiveness, safety, acceptability and continued use of the drugs or devices.

Non-randomized Trial

It is not always possible for ethical, administrative and other reasons, e.g. cost and logistics, to resort to a randomized control trial in human beings. In such situation we will depend on a non randomized trial. As there is no randomization the degree of comparability will be low and chances of spurious results are higher.

Natural Experiment

When a naturally occurring event or situation is exploited by a researcher to help answer a research question, it is called a natural experiment. The researcher has little or no control over the situation that is being observed. Hence they are called quasi – experiment. A good example of natural experiment is the prevention of scurvy among sailors by James Lind.

ERROR

Error occurs when an incorrect assumption or conclusion is made about data. This can be either random or systematic (Fig. 2.9).

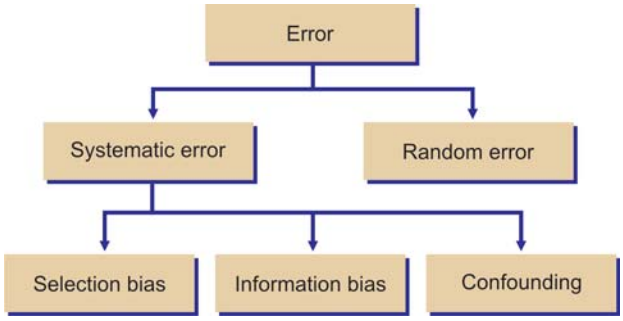


Fig. 2.9: Types of error

Random Error

Random error occurs because of chance and usually cannot be predicted. The random errors that can be predicted or determined are due to sampling error i.e. sampling of the population is not representative and not probabilistic. The size and design of a sample as well as the distribution of the variable of interest, determines the sampling error. As random error in-

creases the precision, i.e. the reproducibility or reliability of the study decreases. Random error can be decreased by increasing sample size or by making the study design more efficient so that the sample is representative.

Systematic Error or Bias

A systematic error occurs in epidemiology when there is a tendency to produce results that are different in a systematic manner from the true value such as a consistent error due to the malfunction of a measurement device. Systematic errors are also called bias. The source of systematic error can usually be determined. As systematic error increases, the validity i.e. its true intent, of the study decreases. Reduction of bias and confounding can only be achieved by a good study design. Once bias is introduced into the study it is difficult to correct the effects analytically.

Bias falls into three main categories *selection, information and confounding.* No study can completely eliminate bias.

Prevention of Bias

The degree to which an investigator is aware of the possible sources of selection bias in a proposed study determines the degree to which selection bias can be avoided through proper study design. Information biases are easier to prevent than selection biases. A case control design is affected by more sources of bias and less (likely to be defended against) as compared to cohort studies.

SCREENING

Screening is the practice of investigating apparently healthy individuals with the objective of detecting unrecognized disease or its precursors in order that measures can be taken to prevent or delay the development of disease or improve the prognosis.

In many diseases the pathological process is established long before the appearance of the symptoms and signs which alert people of the need to seek medical advice. By this time the disease process and the consequent damage may be irreversible or difficult to treat.

Screening is the process of testing for infection or diseases in populations or in individuals who are not seeking health care.

Uses of Screening

1. Case Detection (Prescriptive Screening)
   The presumptive identification of unrecognized disease which does not arise from a patient's request, i.e. people are screened for their own good.
2. Control of Disease (Prospective Screening)
   People are examined for the benefit of others.
3. Research Purposes
   For many chronic diseases whose natural history is not fully known. Participants should be informed that no follow-up therapy will be available.
4. Educational Opportunities
   Opportunity for creating public awareness and for educating health professionals.

Types of Screening

1. Mass Screening – is the screening of a whole population or a subgroup. There is no reference to risk and usually no follow-up. It is performed in a community setting.
2. High risk or Selective Screening – is done to detect a specific disease or predisposing condition in people who are known to be at high risk of having or developing the condition.
3. Multiphasic Screening – is the application of two or more screening tests in combination to a large number of people at one time.
4. Opportunistic Screening – is done only when the opportunity arises, it is usually done in a clinical setting.
5. Two Stage Screening – is conducted on those who screen positive the first time and are recalled for further testing. This process is less expensive as the less invasive and less uncomfortable test is done first.

Criteria for Screening

1. The condition should be an important health problem (high mortality, disability, discomfort, financial cost).
2. There should be an acceptable treatment for patients with recognized disease.
3. Facilities for the diagnosis and treatment should be available (adequate follow-up for positive cases).
4. There should be a recognizable latent or early symptomatic stage so that individuals benefit by early detection.
5. There should be a suitable test or examination (quick, easy, inexpensive, sensitivity, specificity).
6. The natural history of the condition, including development from latent to declared disease, should be adequately understood.
7. There should be an agreed policy concerning who to treat as patients.
8. The cost of case finding (including diagnosis and treatment of patients diagnosed) should be economically balanced in relation to possible expenditure on medical care as a whole.
9. The test should be acceptable to the population (safe and acceptable).
10. Case finding should be a continuous process and not a "one off" procedure.
11. There is a substantial burden of the disease in the community (not too rare).

Characteristics of a Screening Test

For a screening test to be useful it should have the following characteristics.

Validity

Validity is the ability of the test to measure what it intends to measure. It has two components, sensitivity and specificity. The validity of a test is affected not only by the characteristics of the test but by host factors such as stage of disease and presence of other conditions.

The sensitivity and specificity characteristics of the tests help in making the decisions on whether or not to use the test. They are generally regarded as independent of disease prevalence.

Sensitivity

It is defined as the ability of a test to identify correctly those who have the disease, i.e. the true positives. Sensitive tests are used in cases where there is an important penalty for missing a dangerous but treatable disease, e.g. TB, syphilis, and to rule out diseases in the early stages of diagnostic work up.

If the test is not sensitive it will fail to detect some of the people with the disease. These are called false negative. The importance of false negative is that serious diseases could be missed, and if the disease is curable in the early stages a false negative result may mean a virtual death sentence to the individual. The lower the sensitivity the larger will be the false negatives.

Specificity

It is defined as the ability of a test to identify correctly those who do not have the disease, i.e. the true negatives. It is useful to confirm the diagnosis that has been suggested by other data. If the test is not specific it will detect a large number of people who are false positive, i.e. they are shown to have disease when they do not have it. The disadvantage is that it causes a lot of anxiety and worry to the individual and in some diseases a stigma. Further, it puts a burden on the health care system.

ASSOCIATION AND CAUSATION

The essence of epidemiology is to determine the causation of disease, i.e. to find out the specific cause or causes of the disease and to assist in its prevention and control. In the quest for the cause we often encounter several factors which are not actually the causative factor but are only associated with the disease condition.

Association

An association is said to exist between two variables when a change in one variable parallels or coincides with a change in another. This is also called "covariation" or "correlation". An association or covariation may be positive or negative and may be proportionate or disproportionate.

An association is said to be causal when it can be proven that the presence of an independent variable (exposure) produces a change on the dependent variable (disease).

The association between two variables may be real or spurious.

Causation

A cause of a disease is an event, a condition, characteristic or a combination of these factors which plays an important role in producing the disease. A particular cause may be necessary, sufficient, neither or both. A cause is termed sufficient when it inevitably produces or initiates a disease and is termed necessary if a disease cannot develop in its absence. A cause is not usually a single factor but often comprises of several components.

Factors in Causation

Many factors are involved in causation of a disease. They may all be necessary but are rarely sufficient, independently, to cause a particular disease or state. Hence they can be classified as follows:

a. *Predisposing Factors* – like age, sex, previous illness, may create a state of susceptibility to a disease agent.
b. *Enabling Factors* – are the circumstances that assist in recovery from illness or in the maintenance of good health, e.g. low income, poor nutrition, bad housing.
c. *Precipitating Factors* – are exposures to a specific agent or a noxious agent.
d. *Reinforcing Factors* – such as repeated exposure and unduly hard work which may aggravate the disease.

Guidelines for Causation

Temporal Relation

Cause must precede the effect. (Essential)

Plausibility

Is the association consistent with current knowledge? For example evidence, from experimental animals. Lack of plausibility may simply reflect lack of medical knowledge.

Consistency

Have similar results been shown in other evidence especially when a variety of designs are used in different settings (meta analysis)? Lack of consistency does not exclude a causal association because different exposure levels and other conditions may reduce the impact of the causal factor in certain studies.

Strength

What is the strength of association between the cause and effect? This is measured by relative risk. Higher the relative risk

stronger is the likelihood of the factor being causative. A Relative Risk of greater than two can be considered strong.

Dose-Response Relationships

Is increased exposure to the possible cause associated with increased risk?

Reversibility

Does the removal of a possible cause lead to reduction of disease risk? If the cause leads to rapid irreversible changes that subsequently produce disease, whether or not there is continued exposure, then reversibility cannot be a condition for causality.

Study Design

It is the evidence-based on a strong study design?

Judging the Evidence

In judging the different aspects of causation the correct temporal relationship is essential, the greatest weight may be given to plausibility, strength of association, consistency and dose-response relationship.

The likelihood of a causal association is heightened when many different types of evidence lead to the same conclusion. Evidence from a well-designed study is particularly important especially if conducted in a variety of locations.

Randomized control studies provide the highest evidence of causality whereas ecological studies provide weak evidence.

Chapter 3

Biostatistics

KA Narayan, Abdul Rashid Khan

WHY LEARN STATISTICS?

Big or Confusing Numbers Require Statistics

Everyday we are faced with oceans of facts and figures. It is impossible to consider each fact individually, so we use "statistics" to describe, or summarize numbers, group them according to characteristics and compare with other groups.

Statistical methods can be used to summarize or describe a collection of data; this is called descriptive statistics. In addition, patterns in the data may be modeled in a way that accounts for randomness and uncertainty in the observations, and then used to draw inferences about the process or the population being studied; this is called inferential statistics. Both descriptive and inferential statistics comprise applied statistics.

Conceptual Overview

In applying statistics to a scientific, industrial, or societal problem, one begins with a process or population to be studied. This might be a population of people in a country, of crystal grains in a rock, or of goods manufactured by a particular factory during a given period. It may instead be a process observed at various times; data collected about this kind of "population" constitute what is called a time series.

KEY POINTS

- Purpose of Statistics
  - Assemble, Organize and Analyze Data
  - Draw Conclusions about Data
  - Form Predications
- Usually a subset of the population called a sample is studied in observational or experimental settings.
- Statistical analysis is descriptive or inferential
- Inferences drawn from the sample are extrapolated to the population

For practical reasons, rather than compiling data about an entire population, one instead usually studies a sample – a chosen subset of the population. Data are collected about the sample in an observational or experimental setting. The data are then subjected to statistical analysis, which serves two related purposes: description and inference.

- Descriptive statistics can be used to summarize the data, either numerically or graphically, to describe the sample. Basic examples of numerical descriptors include the mean and standard deviation. Graphical summarizations include various kinds of charts and graphs
- Inferential statistics is used to model patterns in the data, accounting for randomness and drawing inferences about the larger population. These inferences may take the form of answers to yes/no questions (hypothesis testing), estimates of numerical characteristics (estimation), descriptions of association (correlation), or modeling of relationships (regression). Other modeling techniques include ANOVA, time series, and data mining.

The concept of correlation is particularly noteworthy. Statistical analysis of a data set may reveal that two variables (that is, two properties of the population under consideration) tend to vary together, as if they are connected. For example, a study of annual income and age of death among people might find that poor people tend to have shorter lives than affluent people. The two variables are said to be correlated. However, one cannot immediately infer the existence of a causal relationship between the two variables. The correlated phenomena could be caused by a third, previously unconsidered phenomenon, called a lurking variable.

If the sample is representative of the population, then inferences and conclusions made from the sample can be extended to the population as a whole. A major problem lies in determining the extent to which the chosen sample is representative. Statistics offers methods to estimate and correct for randomness in the sample and in the data collection procedure, as well as methods for designing robust experiments in the first place.

The fundamental mathematical concept employed in understanding such randomness is probability. Mathematical statistics (also called statistical theory) is the branch of applied mathematics that uses probability theory and analysis to examine the theoretical basis of statistics.

The use of any statistical method is valid only when the system or population under consideration satisfies the basic mathematical assumptions of the method. Misuse of statistics can produce subtle but serious errors in description and interpretation — subtle in that even experienced professionals sometimes make such errors, and serious in that they may affect social policy, medical practice and the reliability of structures such as bridges and nuclear power plants.

Even when statistics is correctly applied, the results can be difficult to interpret for a non-expert. For example, the statistical significance of a trend in the data — which measures the extent to which the trend could be caused by random variation in the sample — may not agree with one's intuitive sense of its significance. The set of basic statistical skills (and skepticism) needed by people to deal with information in their everyday lives is referred to as statistical literacy.

HOW DATA IS COLLECTED?

The health sector generates a lot of data. These can be routine data such as patients' records or from special studies. Patients' data may be clinical information, images or lab reports. Valuable information can be generated from data thus collected.

For research studies, data collection is standardized and systematic. Studies are broadly classified as observational where the assignment of subjects to exposure groups is not determined by the researcher, but rather by the study subjects themselves, or by other factors, or experimental, where the researcher controls the exposure variable.

A variable is a factor that can take different values for individuals in a study. A variable may be quantitative, that is, it takes a numerical value; or it may be qualitative or categorical, in which case it describes an attribute. For example, changes in body weight after specific periods on a prescribed diet are quantitative because, for each subject, the observation takes a numerical value. In contrast, a child may or may not show evidence of dental caries at a particular moment in time. In this case the observation describes the presence or absence of a characteristic, and it is therefore qualitative rather than quantitative.

DATA DISPLAY AND SUMMARY

Types of Data

The first step, before summarizing or plotting of data, is to decide what type of data one is dealing with as that decides how it is to be summarized or depicted. Data can be classified in a number of ways. One is as described above i.e. qualitative and quantitative. Another way is to classify them as follows.

Nominal: Data is in the form of names, labels, or categories. The data cannot be ranked or grouped in any order at all. Examples: Gender, Race, Type of teeth etc.

Ordinal: There can be some sort of ordering but the differences are meaningless, e.g.: Large – Medium – Small; Good – Bad, Malnourished; Normal – Overweight – Obese, or Decayed – Missing – Filled.

Interval: There are meaningful differences between data points. However there is no true zero, e.g. Knoop Hardness for composites. However one data point cannot be divided by another to give a ratio. One cannot say 100°C is twice as hot as 50°C.

Ratio: This is similar to interval, but ratio has a true zero or starting point, e.g.: height, weight, length, distance traveled, etc. Each point value can be expressed as meaningful ratio to another e.g. – twice the weight (Table 3.1).

Table 3.1: Classification of data

Data is classified according to the highest level which it fits. Each additional level adds something the previous level didn't have.
• Nominal is the lowest level. Only names are meaningful here.
• Ordinal adds an order to the names.
• Interval adds meaningful differences
• Ratio adds a zero so that ratios are meaningful.

Nominal and ordinal variables are summarized by counts and proportions whereas interval and ratio variables by measures of central tendency such as mean and measures of variation such as standard deviation and range.

Generally it is easier to summarize nominal and ordinal variables. Hence, ratio variables are often converted to ordinal variables, e.g.: height to Tall – Medium – Short, Blood Pressure to Hypertensive – Non-hypertensive etc. However nominal data cannot be converted to interval. Hence at data collection it is advisable to retain data type instead of precoding it.

To make a clinical decision we usually do not need the exact value e.g.: serum potassium levels. It would suffice if it was within the normal range. Hence we often convert ratio scales to ordinal. However by converting a ratio value to an ordinal one, information is lost and the sensitivity of statistical interpretation is reduced. Further, the conversion is based on statistical principles rather than being done arbitrarily.

Examining Data

Even before the simplest statistical calculation is done on a data set it is wise to examine it by tabulating or plotting it. This will give us distortions and errors in the data and avoid misinterpretations later. Often in our anxiety to draw conclusions from our data this important step is missed or overlooked. If they are quantitative and relatively few, say up to about 30, they are conveniently written down in order of size. But numbers beyond 30 will need more complex tools. Computers and Statistical packages are very useful at this stage.

Stem and Leaf Plot (Fig. 3.1)

A data plot which uses part of the data value as the stem and the rest of the data value (the leaf) to form groups or classes.

Age (years) Stem-and-Leaf Plot
Frequency Stem & Leaf

```
  2.00  2 . and
  7.00  2 . 89
 31.00  3 . 00112223344
 59.00  3 . 555556677788888899999
 89.00  4 . 000000111111222223333333444444
116.00  4 . 55555556666667777777888888899999999999
106.00  5 . 00000001111111122222222233333344444
 94.00  5 . 5555555556667777777888888899999
110.00  6 . 000000000111222222222233333344444444
 99.00  6 . 55555556666666777777888888899999
 84.00  7 . 00000111111111222222233334444
 48.00  7 . 5555566666777899
 22.00  8 . 01112234
  7.00  8 . 5 and
```

Stem width: 10
Each leaf: 3 case(s) and denotes fractional leaves.

Fig. 3.1: Stem and Leaf plot of age of 874 women with cancer breast

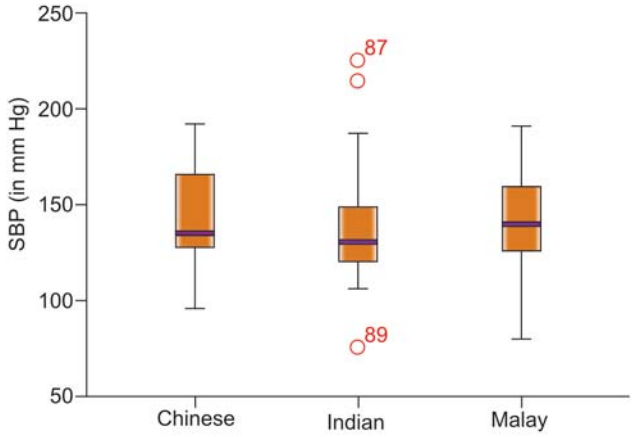


Fig. 3.2: Box and Whisker plot of systolic blood pressure by race

This is very useful for sorting data quickly and identifying the discrepancies in individual values.

Box and Whiskers Plot (Box Plot) (Fig. 3.2)

A graphical representation of the minimum, first Quartile, median, third Quartile, and maximum. This plot gives an idea of the distribution of the data. It is especially useful to identify differences in variability between groups and identify outliers.

Histogram

A graph for interval or ratio data collapsed into class intervals which displays the data by using vertical bars of various heights to represent frequencies in each class (Fig. 3.3).

Frequency Polygon

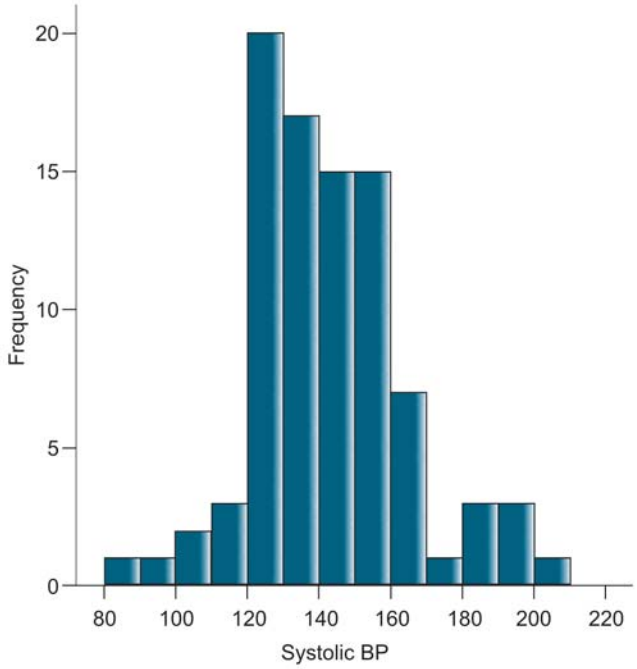


Fig. 3.3: Histogram of systolic blood pressure

A Line Graph

The frequency is placed along the vertical axis and the class midpoints are placed along the horizontal axis. These points are connected with lines.

The advantage of first setting the figures out in order of size and looking at their distribution before starting analysis is that the relation of each data point to the next can be looked at. Is there a steady progression, a noteworthy hump, a considerable gap? Simple inspection can disclose irregularities. Furthermore, a glance at the figures gives information on their range.

Graphical Data Summaries

Data can easily be summarized and displayed by a variety of diagrams. The choice of diagram is based on the type of data.

The general principle should be, as far as possible, to show the original data and to try not to obscure the design of a study in the display. Within the constraints of legibility, as much information as possible should be shown. Each graph should have a number for the graph a clear and concise title describing the data, variables described and place of study.

Bar Graph

A bar chart is similar to a histogram in appearance. However it is used for nominal and ordinal data. Unlike a histogram there

are gaps between the bars. The Y axis usually shows the counts or percentage of the total for each group. Two or more variables can be depicted in (Fig. 3.4) a multiple bar diagram.

Stacked Bar

A stacked bar is similar to bar graph, except that each series value is "stacked" on the value of previous series, instead of being set out side-by-side.

Pie Diagram

This is graphical depiction of data as slices of a pie. The total represents the complete pie. The central angle of each slice is proportional to the size of that part to the whole data. The male: female distribution, chewing habits of a group of individuals, or the types of cases attending an outpatient department can be depicted in a pie diagram (Fig. 3.5).

Scatterplot

The scatterplot visualizes a relation (correlation) between two variables X and Y (e.g., weight and height). Individual data points are represented in two-dimensional space where axes represent the variables X on the horizontal axis and Y on the vertical axis. The graph can show no relationship between the variables or a positive or negative association. The graph (Fig. 3.6) also shows whether the relationship is linear or non linear. When there is a linear relationship a "line of best fit can be drawn".

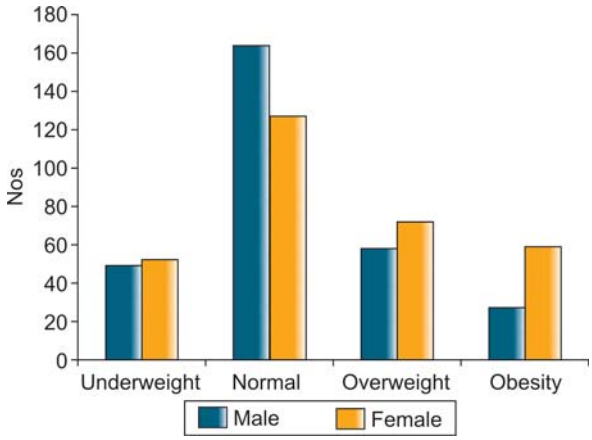


Fig. 3.4: Multiple Bar chart of BMI and Sex in a village

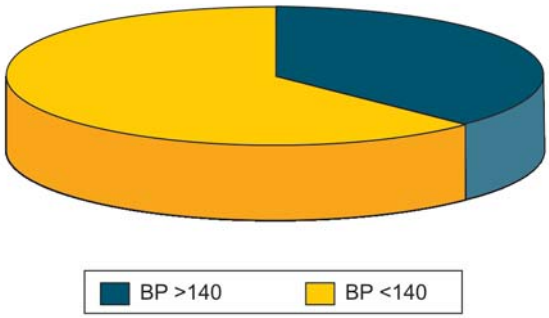


Fig. 3.5: Pie Chart

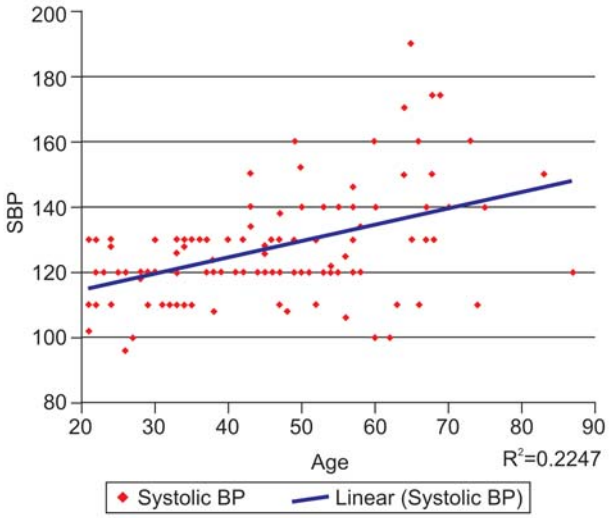


Fig. 3.6: Scatter plot of systolic blood pressure by age

DATA SUMMARY

Continuous or Interval Data

If we want to describe a data set by a single value a variety of summary measure are available.

Measures of Central Tendency

The Mean

The "arithmetic mean" is the most commonly calculated statistic and is a particularly informative measure of the "central tendency" of the variable especially when stated along with its confidence intervals. The mean is the sum of all values (Σx) divided by the number of values (n). In small samples, the mean can be affected by one or two extreme values. The larger the sample size, the more reliable its mean. The larger the variation of data values, the less reliable the mean.

Median

A measure of central tendency, the median of a sample is the value which, after ranking all the values, one-half (50%) of the observations will lie above that value and one-half will lie below that value. When the number of values in the sample is even, the median is computed as the average of the two middle values. The median is not affected by the extreme values like the mean.

Centiles

A percentile is the percent of a distribution that is equal to or below a particular number e.g. the 25th percentile, 0.25 or 25 percent of the data are below the cited value and 75 percent are above, the 75th percentile has 75 percent below and 25 percent above. Centiles are useful for dividing measurements into useful groups e.g. Weight and height distribution of children, grades in examination etc.

Mode

The value which occurs most commonly is called the mode.

Measure of Dispersion

Range

The range is the simplest measure of variation to find. It is simply the highest value minus the lowest value.

RANGE = MAXIMUM – MINIMUM

Since the range only uses the largest and smallest values, it is greatly affected by extreme values, that is - it is not resistant to change.

Variance

The range only involves the smallest and largest numbers, it would be desirable to have a statistic which involved all the data values.

The first attempt one might make at this is something they might call the average deviation from the mean. The problem is that this summation is always zero. So, the average deviation will always be zero. That is why the average deviation is never used.

So, to keep it from being zero, the deviation from the mean is squared and called the "squared deviation from the mean". This "average squared deviation from the mean" is called the variance.

Standard Deviation

To overcome the problem of squaring in variance to get the units back to the same as the original data values, the square root is taken. For small samples the sum of the squares is divided by the number of observations minus one instead of the number of observations. This is because "degrees of freedom" must be used. To explain this concept if we have a basket of apples every time we choose one, we have a choice till we reach the last apple. Then we have no choice. Hence we have n-1 choices.

Confidence Interval

A confidence interval gives an estimated range of values which is likely to include an unknown population parameter e.g. the mean of the population or the proportion with a characteristic. If we calculate confidence interval of the mean, in effect it is the standard deviation of the means of several samples. As it is impractical to draw several samples it is calculated from just one sample. It tells the range within which the true population mean will lie.

Frequency Tables (Table 3.2)

Frequency or one-way tables represent the simplest method for analyzing categorical (nominal and ordinal) data. Frequency tables are exploratory procedures and give an overview of how different categories of values are distributed in the sample. For example, the distribution of males and females in a survey could be summarized as follows.

Table 3.2: Sex distribution of survey population

Gender	Number	%
Females	44	58.6
Males	31	41.4
Total	75	100

Crosstabulation

Two (or more) variables can be looked at simultaneously such that each cell in the resulting table represents a unique combination of specific values of crosstabulated variables. Thus, crosstabulation allows us to examine frequencies of observations that belong to specific categories on more than one variable. By examining these frequencies, we can identify relations between crosstabulated variables. Only categorical (nominal) variables or variables with a relatively small number of different meaningful values should be crosstabulated. Continuous variable in a crosstabulation (e.g., income) can first be recoded into ranges (e.g., low, medium, high).

2x2 Table: The simplest form of crosstabulation is the 2 by 2 table where two variables are "crossed," and each variable has only two distinct values. For example, suppose we want to compare the differences in caries between boys and girls we could have (Table 3.3) a 2 by 2 table like this:

Table 3.3: Prevalence of caries among males and females (hypothetical data)

Gender	Caries	%	No Caries	%	Total
Females	30	68.2	14	31.8	44
Male	16	51.6	15	48.4	31
Total	46	61.3	29	38.7	75

The total values for each column and row are called the marginal frequencies. And are simply one-way (frequency) tables for all values in the table. They are important in that they help us to evaluate the arrangement of frequencies in individual columns or rows. For example, is the difference in frequencies of 51.6 percent and 68.2 percent of males and females (respectively) who have dental caries real or spurious.

Thus, the differences between the distributions of frequencies in individual rows (or columns) and in the respective margins informs us about the relationship between the crosstabulated variables.

Column, Row, and Total Percentages: The example in the previous paragraph demonstrates that in order to evaluate relationships between crosstabulated variables, we need to compare the proportions of marginal and individual column or row frequencies. Such comparisons are easiest to perform when the frequencies are presented as percentages.

Are the differences significant or due to chance: In the above example do a higher proportion of girls have caries as compared to boys. Often we have this dilemma. To overcome this we employ statistical tests. However before we do a statistical test need to understand how values are distributed in a sample.

STATISTICAL DISTRIBUTIONS

Normal Distribution

Many biological measurements that are ordinal or ratio conform to a normal distribution i.e. in a set of measurements most values will lie around the mean and the others will be equally distributed around the mean. For example, heights of adult men and women, blood pressures in a healthy population, random errors in many types of laboratory measurements and biochemical data. When plotted the distribution would have a smooth bell shape (Fig. 3.7). The Normal distribution is dependent on two parameters, the mean and the standard deviation of the population. The standard deviation is such a useful measure of scatter around the mean because a range

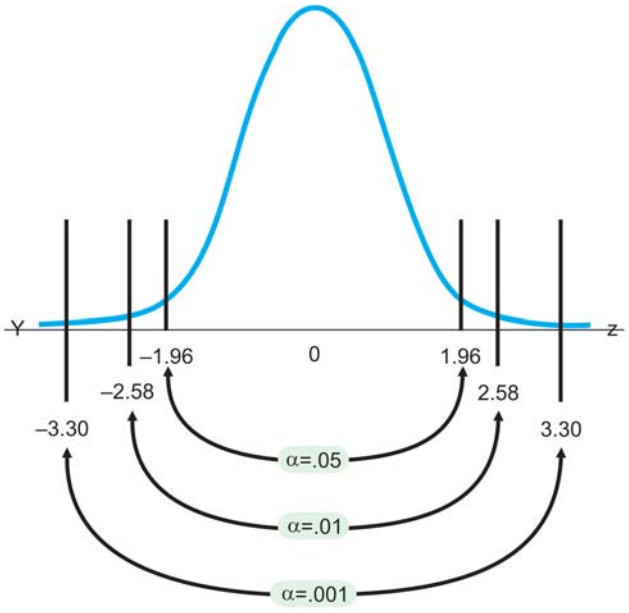
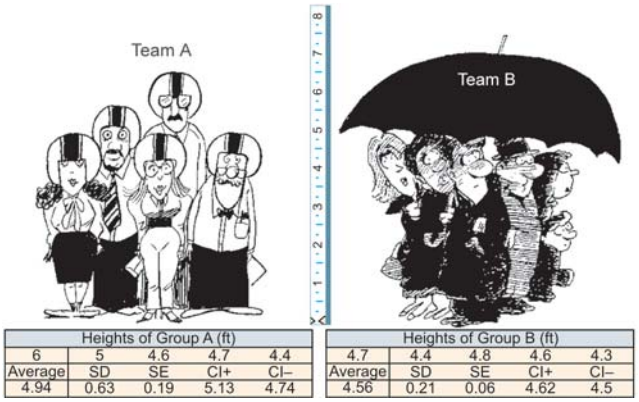


Fig. 3.7: Statistical distributions



Heights of Group A (ft)				
6	5	4.6	4.7	4.4
Average	SD	SE	CI+	CI–
4.94	0.63	0.19	5.13	4.74

Heights of Group B (ft)				
4.7	4.4	4.8	4.6	4.3
Average	SD	SE	CI+	CI–
4.56	0.21	0.06	4.62	4.5

Fig. 3.8 Comparison of heights of two groups

covered by one SD around the mean would include 68 percent of the observations, 2SD would include 95 percent and 3SD would include 99.7 percent of the observations. By putting one, two, or three standard deviations above and below the mean we can estimate the ranges that would be expected to include about 68 percent, 95 percent, and 99.7 percent of the observations.

Standard deviations set limits about which probability statements can be made. In the Figure 3.8, the mean heights would be approximately equal in both groups. However, the standard deviation in group A will be greater than in group B. We can use these values in three ways.

a. For each group what would be the lowest and highest possible values which would include 95 percent of the measurements?
b. Are the two groups means significantly different?
c. Given one individual measurement which group his he/she likely to belong?

The 95 percent limits are often referred to as a "reference range". For many biological variables, they define what is regarded as the normal (meaning standard or typical) range. Anything outside the range is regarded as abnormal.

Confidence Interval

The means and their standard errors can be treated in a similar fashion. If a series of samples are drawn from a population and the mean of each calculated, 95 percent of the means would be expected to fall within the range of two standard deviations above and two below the mean of these means. This common mean would be expected to lie very close to the mean of the population. So the standard error of a mean provides a statement of probability about the difference between the mean of the population and the mean of the sample.

In our example above if we estimate the population mean from group A we will be fairly confident (95%) that the population mean would lie between 4.7 and 5.1. If the same is made from Group B we would get slightly different values.

t-distribution

With small samples, where the chance of variation is more, the estimates of the standard error is different from those used for large samples, though the procedure does not differ greatly, but is preferable when the number of observations is less than 60, and certainly when they are 30 or less.

Standard Error of a Proportion or a Percentage

Just as we can calculate a standard error associated with a mean so can we also calculate a standard error associated with a percentage or a proportion. Here the size of the sample will affect the size of the standard error but the amount of variation is determined by the value of the percentage or proportion in the population itself. Hence we do not need an estimate of the standard deviation.

Binomial Distribution

The binomial distribution is the discrete probability distribution of the number of successes in a sequence of n independent yes/no experiments, each of which yields success with probability p. The binomial distribution is the basis for the popular binomial test of statistical significance. The probability that a person is diseased or not diseased will follow a binomial distribution.

CHI SQUARE DISTRIBUTION

In probability theory and statistics, the chi-square distribution is one of the most widely used theoretical probability distributions in inferential statistics, i.e. in statistical significance tests.

The best-known situations in which the chi-square distribution is used are the common chi-square tests for goodness of fit of an observed distribution to a theoretical one, and of the independence of two criteria of classification of qualitative data e.g. Table 3.2.

TESTS OF SIGNIFICANCE

In comparing the mean values or proportions of two groups we are testing the hypothesis that the two samples came from the same population. The hypothesis that there is "no difference" between the population from which the two groups is called the null hypothesis.

But what do we mean by "no difference"? Chance alone will almost certainly ensure that there is some difference between the sample means, for they are most unlikely to be identical. Consequently we set limits within which we shall regard the samples as not having any significant difference. If we set the limits at twice the standard error of the difference, and regard a mean outside this range as coming from another population, we shall on average be wrong about one time in 20 if the null hypothesis is in fact true. If we do obtain a mean difference bigger than two standard errors we are faced with two choices: either an unusual event has happened, or the null hypothesis is incorrect.

Pearson Chi-square

The Pearson Chi-square is the most common test for significance of the relationship between categorical variables. This measure is based on the fact that we can compute the expected frequencies in a two-way table (i.e., frequencies that we would expect if there was no relationship between the variables). For example in Table 3.2, we should expect that the rates of caries among males and females are approximately equal. if there is no relationship between gender and caries. The Chi-square test becomes increasingly significant as the numbers deviate further from this expected pattern.

The value of the Chi-square and its significance level depends on the overall number of observations and the number of cells in the table. If the number of observations is large even relatively small deviations of the relative frequencies across cells from the expected pattern will prove significant.

The only assumption underlying the use of the Chi-square is that the expected frequencies are not very small. The reason for this is that, actually, the Chi-square inherently tests the underlying probabilities in each cell; and when the expected cell frequencies fall, for example, below 5, those probabilities cannot be estimated with sufficient precision.

Yates Correction: When observed data in a 2×2 table are small the Chi Square statistic can be improved by reducing the absolute value of differences between expected and observed frequencies by 0.5 before squaring. It is generally applied when the expected frequency in a cell is less than 5.

Fisher Exact Test: This test is done only for 2×2 tables when the total numbers are small. It is based on the following rationale: how likely is it to obtain cell frequencies as uneven or worse than the ones that were observed given the observed frequencies in the table, and assuming that in the population the two factors studied are not related. This test is done when the number of observations are less than 5.

McNemar Chi-square: This test is applicable in situations where the frequencies in the 2×2 table represent dependent samples. For example, in a before-after design study, we may count the number of patients who improve after two modes of treatment.

Statistics Based on Ranks

In many cases the categories used in the crosstabulation contain meaningful rank-ordering information; that is, they measure some characteristic on an ordinal scale. Suppose we asked a sample of respondents to indicate frequency of chewing gum on a 4-point scale with the explicit labels (1) always, (2) usually, (3) sometimes, and (4) never. Obviously there is a ranking in the data. When categorical variables can be interpreted in this manner, there are several additional statistics that can be computed to express the relationship between variables. One such is the Spearman R.

t-test

The t-test is the most commonly used method to evaluate the differences in means between two groups. For example, the t-test can be used to test for a difference in test scores between a group of patients who were given a drug and a control group who received a placebo. Theoretically, the t-test can be used even if the sample sizes are very small (less than 30), as long as the variables are normally distributed within each group and the variation of scores in the two groups is not reliably different. There are three possible situations of comparison. a) when the sample mean is compared to the estimated population mean (One sample – t-test) b) When the means and standard deviations of two samples are compared (two sample or unpaired t-test) c) Paired observations are made on two samples (or in succession on one sample). Here the significance of the difference between the means of the two sets of observations is estimated. (paired t-test.) If the data is not normally distributed we should use other tests.

Example:

a. Suppose we calculated the oral hygiene index for a small group and wanted to find out if it differed significantly from that of the population we would use the one sample t-test.
b. If we wanted to find out the differences between males and females for the oral hygiene index in a sample group we would use the unpaired t-test.
c. If we want to compare the effect of two tooth pastes or two procedures on improvement in oral hygiene index we would do a paired t-test.

More Complex Group Comparisons: It often happens in research practice that you need to compare more than two groups (e.g., drug 1, drug 2, and placebo), or compare groups created by more than one independent variable while controlling for the separate influence of each of them (e.g., Gender, type of Drug, and size of Dose). It is not advisable to do multiple t-tests. Instead the analysis is done by using Analysis of Variance (ANOVA) which captures the within sample and between sample variance.

Comparing Proportions

Nominal data such as presence or absence of disease are usually expressed as proportions. For example in Table 3.2 the percentage of girls having caries is higher than boys. When sample sizes are large a test of proportions is done. This test is also used for comparing if the proportion affected in a study group is significantly different from the population proportion.

STATISTICAL SIGNIFICANCE

What is "statistical significance" (p-value). The statistical significance of a result is an estimated measure of the degree to which it is representative of the population. The higher the p-value, the less likely the observed relation between variables in the sample is indicative of the relation between the respective variables in the population. For example, a p-value of .05 (i.e.,1/20) indicates that there is a 5 percent probability that the relation between the variables found in the sample is due to chance.

Clinical vs Statistical Significance

In health sciences we often have this dilemma. For example the use of a toothpaste for plaque reduction may show a marginal reduction in prevalence. If samples size is large enough this may be shown as statistically significant. But is it clinically acceptable? This is for the clinician to decide (Fig. 3.9).

Type One and Type Two Errors (Fig. 3.10)

The Judges dilemma: The judge always starts with the premise "Not – guilty unless proved otherwise". In effect what the judge is doing is stating the null hypothesis. However, he can make an error sometimes and free the guilty or punish the innocent. He has committed an error. Similarly to reject the null hypothesis when it is true is to make what is known as a type I error. The level at which a result is declared significant is known as the type I error rate, often denoted by α. We try to show that a null hypothesis is unlikely ~, not that it is likely, so a difference which is greater than the limits we have set, and which we therefore regard as "significant", makes the null hypothesis unlikely.



Fig. 3.9 What decides significance?

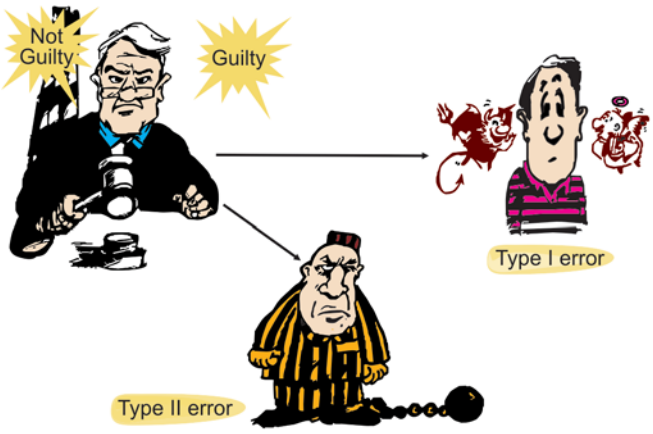


Fig. 3.10: Type one and type two errors

A range of not more than two standard errors is often taken as implying "no difference". However to reduce the chance of type I error higher standard error values could be chosen.

Alternative Hypothesis and Type II Error

When two groups have a non-significant result it does not mean that we have proved the two samples come from the same population. Instead we have failed to prove that they do not come from the population. It is important even while planning a study what are the likely differences that may arise between the groups. For example if we are testing a new antibiotic to test post extraction infections as compared to another drug we should make an estimate of the difference in reduction in infection rates to say the new drug is better than the old one. In this example if there is no difference in reduction in rates it means that the new drug is as good as the old one. Though statistically there is no difference the finding is still clinically significant.

If we do not reject the null hypothesis when in fact there is a difference between the groups we make what is known as a type II error. The type II error rate is often denoted as β. The power of a study is defined as 1 – β and is the probability of rejecting the null hypothesis when it is false. The most common reason for type II errors is that the study is too small.

Just like the judges decision, in statistics making a type I error is more grievous as one would highlight and publicize a non significant result.

SAMPLING

Why study a sample? Most often we are unable to study all members of a population due to constraints of time and money. Often the measurements made may be better and several type of biases can be avoided. However, the sample that we draw needs to be representative of the population from which it is drawn (Fig. 3.11).

The main objectives of sampling are estimation of population parameters from the sample statistics e.g.: mean, SD, SE,

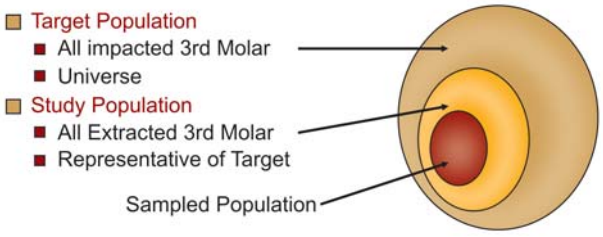


Fig. 3.11: Estimation of population parameters

proportion etc. and to test the hypothesis about the population from which the sample or samples are drawn.

Sampling Technique is the process or technique of selecting a sample of appropriate characteristics and adequate size. There are probabilistic and non-probalilistic sampling techniques (Table 3.4).

Table 3.4: Sampling techniques

Random sample (Probability sample)	Non-random sample (Non-probability sample)
Simple random sample	Convenience sample
Systematic sample	Consecutive sample
Stratified random sample	Quota sample
Cluster sample	Volunteer sample
Multistage sample	Snow ball sample

A few common techniques are described below:

Random sampling (Fig. 3.12) is similar to putting everyone's name into a hat and drawing out several names. Each element in the population has an equal chance of being included in the sample. While this is the preferred way of sampling, it is often difficult to do. It requires that a complete list of every element in the population be obtained. Random number tables or random number generators are used for this technique.

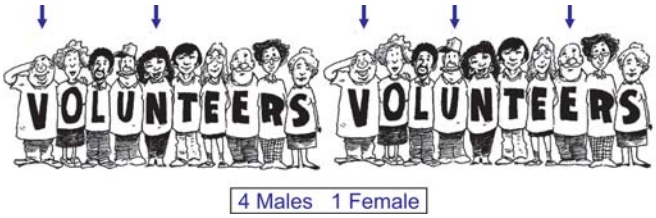


Fig. 3.12: Random sampling

Systematic sampling (Fig. 3.13) is easier to do than random sampling. It is a feasible method in hospital settings as patients come sequentially. The whole sampling frame need not be defined. In systematic sampling every nth element in the sample is selected. The list of elements is "counted off".

Stratified sampling (Fig. 3.14) also divides the population into groups called strata. However, this time it is by some characteristic, not geographically. For instance, the population might be separated into males and females. A sample is taken from each of these strata using either random, systematic, or convenience sampling.

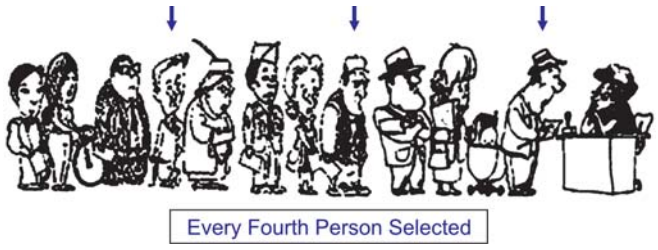


Fig. 3.13: Systematic sampling

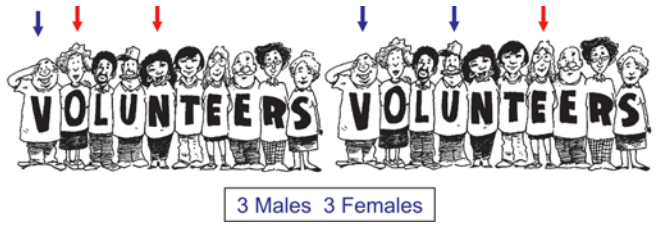


Fig. 3.14: Stratified sampling

Cluster sampling is accomplished by dividing the population into groups — usually geographically. These groups are called clusters or blocks. The clusters are randomly selected, and each element in the selected clusters are used. For example in a dental survey in schools each section in a class could be used as a cluster.

Convenience sampling is very easy to do and often used by health professionals, but it's probably the worst technique to use. It is non probabilistic sample. In convenience sampling, readily available data is used. That is, the first people the surveyor runs into are selected. However many novice researchers call this as random sampling which it is not.

Statistical Packages

Today a variety of packages are available for storing and analyzing data. Specialised statistical packages can help us do the analysis easily. Spreadsheets such as Excel can do a fair amount of statistical analysis. Statistical packages look like spreadsheets and there is a fair degree if interoperability between them. However there are subtle differences and some understanding is needed on how statistical packages look at data.

Most statistical packages and spreadsheets store data as columns and rows. By convention, in statistical packages, the columns are the variables and are called fields. Each variable, therefore, stores one type of information for all respondents.

The rows are called records or cases. A record therefore holds information on all the variables for one respondent. There is generally no limit to the number of records in a database but the number of variable cannot exceed 256. While entering data into a spreadsheet it is beneficial to adhere to these conventions.

Single vs Multiple Records: Statistical packages and spreadsheets permit only a sigle record per individual. Health records often do not adhere to this rule as one individual may have several sub records e.g. Number of visits to the clinic. In such situations the related data have to be stored in a separate file and each sub record related to its main record by a unique identifier field.

Variable Names and Labels: Statistical packages generally place restrictions on the variable name length. There can be no spaces and the length is limited to 8 characters. Further names need to be unique. Hence one needs to be creative in creating variable names. Eg: One cannot create a field called "Systolic Blood Pressure". Instead it will have to be created as "SBP" and a label of Systolic Blood Pressure" given.

Value and Value Names: As the data are to be entered as numeral it is important to label them as they are created. Eg 1 "Male" 2 " Female" etc. If the labels are not entered at the time of creation it may be impossible to decipher them later.

Data Type: Before starting data entry determine what is the data type. Data are classified as numeric, alphabet or string, alphanumeric, logical and date/time. Keep higher order data (ratio and interval) as they are during data collection and entry. They can be converted to ordinal data during analysis. Eg. Enter blood pressure data as they are. Do not classify as normotensive and hypertensive at time of collection or entry. Similarly age should be captured as "date/yr of birth"

Numbers not Text: All statistical packages handle data as numbers and not as text. Statistical calculations cannot be done with text. Hence nominal and ordinal data should be entered as numbers e.g. Gender as 1 and 2 and not as M and F.

A good package for handling data and doing statistical tests is Epi Info. It is a series of programs for Microsoft Windows for use by public health professionals in conducting outbreak investigations, managing databases for public health surveillance and other tasks, and general database and statistics applications. With Epi Info and a personal computer, physicians, epidemiologists, and other public health and medical workers can rapidly develop a questionnaire or form, customize the data entry process, and enter and analyze data.

WHAT NOT TO DO

Consulting the Statistician

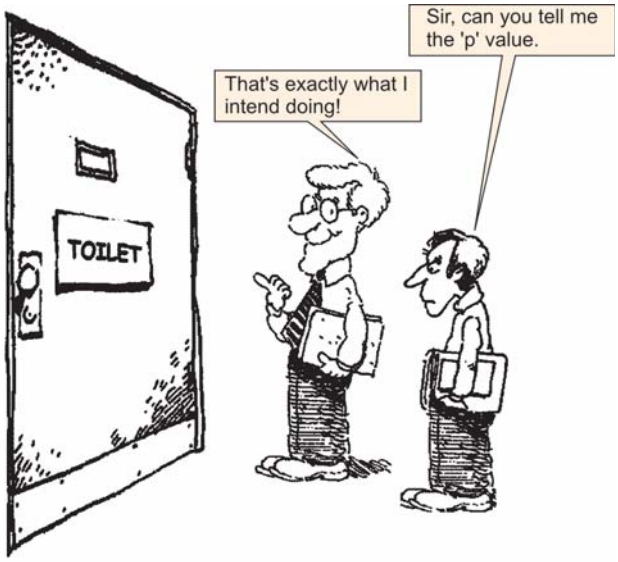


Fig. 3.15: What not to do

BOX 3.1: CALCULATING THE STANDARD DEVIATION

Following are the debris indices of 15 children from an urban area.
15 children scores
0.6, 2.6, 0.1, 1.1, 0.4, 2.0, 0.8, 1.3, 1.2, 1.5, 3.2, 1.7, 1.9, 1.9, 2.2
The mean debris index is 1.5
The standard deviation is calcuated by the formula

$$SD = \sqrt{\frac{\Sigma(x - \bar{x})^2}{n - 1}}$$

For the above data is calculated thus:

Sl No	*Debris Index*	*Differences from mean*	*Squared Differences*
1	0.1	–1.4	1.96
2	0.4	–1.1	1.21
3	0.6	–0.9	0.81
4	0.8	–0.7	0.49
5	1.1	–0.4	0.16
6	1.2	–0.3	0.09
7	1.3	–0.2	0.04
8	1.5	0	0
9	1.7	0.2	0.04
10	1.9	0.4	0.16
11	1.9	0.4	0.16
12	2.0	0.5	0.25
13	2.2	0.7	0.49
14	2.6	1.1	1.21
15	3.2	1.7	2.89
Total	22.5	0	9.96

n = 15, mean = 1.5

Each value in col (2) is subtrated from the mean and the absolute deviation obtained (col 3). This value is then squared (col 4). Tht total of the values in column 4 is then divided by the number of values minus 1 to obtain the variance (9.96/14). The square root of the variance gives the standard deviation (0.843).

How does this help us?

a. We can set the reference range for this population by adding or subtracting 1.96 times the standard deviation (1.96 × 0.843) from the mean which is 1.65. Adding and subtracting this value from the mean gives us the reference range. For this data set it is therefore 0 (–0.15) to 3.15. We interpret it like this.
b. We are certain that 95% of the value will lie between 0 and 3.15.
c. We can tell with a fair degree of certainly (95%) that observation 15 does not belong to this group.

We could also estimate what the population mean debris index score by the standard error of the mean. In this example the standard error of the mean is calculated by formula SD/√n which is 0.843/√15 = 0.21. When we add or subtract 1.96 times these value from the mean we get the confidence interval of the population mean. 1.5 + 1.96*0.21 = 1.91 and 1.5 – 1.96*0.021 = 1.09. We can be fairly sure that the population mean debris index for an urban population would lie between 1.09 and 1.91. In this example the sample size is small. With larger sample sizes the confidence intervals will become narrower.

We could compare the means and standard errors of another group, say rural children and determine if the mean debris indices are similar or different.

4 Environment and Health

CM Marya

The term environment implies all the external factors living and non-living, material and non-material which surround man.

Thirteen million deaths annually are due to preventable environmental causes. Preventing environmental risk, could save as many as four million lives a year, in children alone, mostly in developing countries.

Proper environmental management is the key to avoid the quarter of all preventable illnesses which are directly caused by environmental factors. The environment influences our health in many ways — through exposure to physical, chemical and biological risk factors, and through related changes in our behavior in response to those factors.

Environmental pollution in India results in a quarter of children's death. More than a million die every year due to water pollution.

Public Health Definition of "The Environment"
All that which is external to the individual host. It can be divided into physical, biological, social, and cultural factors, any or all of which can influence health status in populations. Last, JM (1995).

Environment can be divided into three components:

1. *Physical:* Water, air, soil, housing, wastes, radiation, etc.
2. *Biological:* Plant and animal life including bacteria, viruses, insects, and animals.
3. *Social:* Customs, culture, habit, income, occupation, religion, etc.

The term "*environmental sanitation*" has been defined by WHO as "the control of all those factors in man's physical environment which exercise or may exercise a deleterious effect on his physical development, health and survival". The term *environmental sanitation* is now replaced by *environmental health*.

The purpose of environmental health is to create and maintain ecological conditions that will promote health and thus prevent disease.

Much of the ill health in India is due to poor environmental sanitation, i.e, unsafe water, polluted soil, unhygienic disposal of human excreta and refuse, insects and rodents and poor housing. Air pollution is also a growing concern in many cities.

The environmental factors which are basic and fundamental to individual and community health are:

1. Water
2. Air
3. Noise
4. Housing
5. Disposal of wastes.
6. Radiation

WATER

Much of the ill health which affects humanity, especially in developing countries can be traced to lack of safe and wholesome water supply (free from pathogenic agents and harmful chemical substances).

Uses of Water

1. *Domestic use:* Drinking, cooking, washing, etc.
2. *Public purposes:* cleaning streets, fire protection etc
3. *Industrial purposes:* for processing and cooling.
4. *Agricultural purpose:* irrigation
5. Power production from hydro power and steam power
6. Carrying away waste from all manner of establishments and institutions

Sources of Water Supply

The water source must be sufficient to meet present and future requirement and the quality of water must be acceptable. Three main source of water supply are:

1. Rain
2. Surface water
   Impounding reservoirs
   Rivers and streams
   Tanks, ponds and lakes
3. Ground water
   Shallow wells
   Deep wells
   Springs

Pollution of Water

A more serious aspect of water pollution is that caused by human activity-urbanization and industrialization. The sources of pollution resulting from these are: sewage, industrial waste, agricultural pollutants, and physical pollutants.

Water Related Diseases

Ingestion of contaminated water either directly or through food may affect man's health by causing water related diseases. Such diseases may be classified as:

A. *Biological water-borne diseases*

1. Those caused by the presence of an infective agent:
   a. Viral : Viral hepatitis A, hepatitis E, poliomyelitis
   b. Bacterial : Typhoid and paratyphoid fever, bacillary dysentery
   c. Protozoal : Amoebiasis, giardiasis
   d. Helminthic: Roundworm, threadworm
   e. Leptospiral: Weil's disease
2. Those due to the presence of an aquatic host:
   a. Snail: Schistosomiasis
   b. Cyclops: Guinea worm, fish tapeworm

B. *Chemical*

These include industrial and agricultural wastes. Such pollutants include detergents solvents, cyanides, heavy metals, minerals and organic acids, nitrogenous substances, bleaching agents, dyes, pigments, sulfides, ammonia, toxic and biocidal organic compounds of great variety. These pollutants affect health, directly and indirectly by accumulating in foods which are consumed by human beings, e.g. fishes.

Purification of Water

It may be considered under two headings:

1. Purification of water on a large scale
2. Purification of water on a small scale

Purification of Water on A Large Scale

It comprise of one or more of the following measures:

1. Storage
2. Filtration
3. Disinfection

Storage

Water is drawn out from the source and impounded in natural or artificial reservoirs. As a result of storage, a very considerable amount of purification takes place. It can occur by three processes:

a. *Physical:* By mere storage, the quality of water improves. About 90 percent of the suspended impurities settle down in 24 hours by gravity.
b. *Chemical:* The aerobic bacteria oxidize the organic matter present in the water with the aid of dissolved oxygen. As a result, the content of free ammonia is reduced and a rise in nitrates occurs.
c. *Biological:* The pathogenic organisms gradually die out. Total bacterial count drops by as much as 90 percent in the first 5 to 7 days.

Filtration

By filtration apart other impurities, 98-99 percent of the bacteria are removed. Two types of filters used are:

1. Slow sand or biological filters
2. Rapid sand or mechanical filters

1. Slow sand filter

Slow sand filtration is a simple and reliable process. They are relatively inexpensive to build, but do require highly skilled operators. The process percolates untreated water slowly through a bed of porous sand, with the influent water introduced over the surface of the filter, and then drained from the bottom (Fig. 4.1).

Properly constructed, the filter consists of a tank, a bed of fine sand, a layer of gravel to support the sand, a system of under drains to collect the filtered water, and a flow regulator to control the filtration rate. No chemicals are added to aid the filtration process.

Elements of a slow sand filter

Supernatant water: The raw water flows into the upper tank region in such a manner as to avoid disturbing the scmutzdecke (defined below); flow near that surface must be very gentle. The water in this compartment must have sufficient depth to drive through the schmutzdecke, the filter bed and into the support gravel - and initially should be about 2 to 3 meters, or 7 to 10 feet. The lower limit of the depth is somewhat controversial but 1.5 meters, or about 4 feet, should be a reasonable value. There is waiting period of 3 to 12 hours for the raw water which helps it to undergo partial purification by sedimentation, oxidation, and particle agglomeration.

A bed of graded sand: The thickness of sand bed is approximately 1 meter. The effective diameter of sand grain should be 0.15 to 0.30 mm. The sand bed is supported by layer of graded gravel, 30 to 40 cm deep. This prevents the fine grains being carried into the drainage pipes.

The newly laid filter soon gets covered with a slimy growth. This layer is called as 'Schmutzdecke', vital or biological layer. It is the "heart" of slow sand filter. It removes the organic bacteria and holds back bacteria. It oxidizes ammoniacal nitrogen into nitrates and helps to yield bacteria free water (Fig. 4.2).

An under drainage system: It consists of perforated pipes through which filtered water is collected and it supports the filter medium above.

A system of filter control valves: The outlet pipe system is equipped with valves, which helps to maintain a constant rate of filtration.

A slow sand filter must be cleaned when the fine sand becomes clogged, which is measured by the head loss. The length of time between cleanings can range from several weeks to a year, depending on the raw water quality. The operator cleans the filter by scraping off the top layer of the filter bed. A ripen-

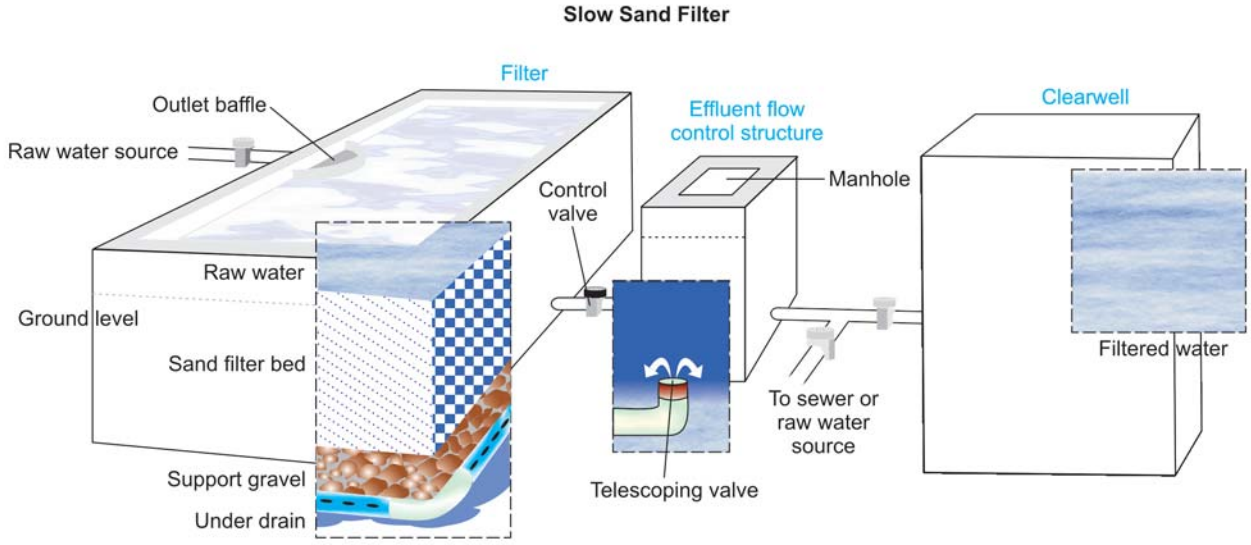


Fig. 4.1: Design of slow sand filter

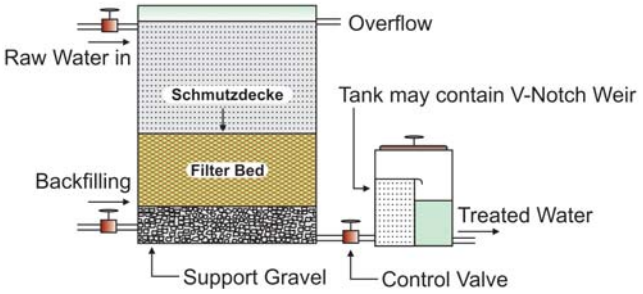


Fig. 4.2: Slow sand filter (Sketch)

ing period of one to two days is required for scraped sand to produce a functioning biological filter. The filtered water quality is poor during this time and should not be used.

Advantages

Design and operation simplicity—as well as minimal power and chemical requirements— make the slow sand filter an appropriate technique for removing suspended organic and inorganic matter. These filters also may remove pathogenic organisms.

Slow sand filtration reduces bacteria, cloudiness, and organic levels—thus reducing the need for disinfection and, consequently, the presence of disinfection byproducts in the finished water.

Other advantages include:

- Sludge handling problems are minimal.
- Close operator supervision is not necessary.
- Systems can make use of locally available materials and labor.

Slow sand filters also provide excellent treated water quality. Slow sand filters consistently demonstrate their effectiveness in removing suspended particles with effluent turbidities below 1.0 nephelometric turbidity units (NTU), achieving 90 to 99 + percent reductions in bacteria and viruses, and providing virtually complete *Giardia lamblia* cyst and *Cryptosporidium* oocyst removal.

Limitations

Slow sand filters do have certain limitations. They require a large land area, large quantities of filter media, and manual labor for cleaning. Water with high turbidity levels can quickly clog the fine sand in these filters.

Slow sand filters do not completely remove all organic chemicals, dissolved inorganic substances, such as heavy metals, or trihalomethane (THM) precursors—chemical compounds that may form THMs when mixed with chlorine. Also, water with very fine clays are not easily treated using slow sand filters. Slow sand filters are less effective at removing microorganisms from cold water because as temperature decreases, the biological activity within the filter bed declines.

2. Rapid sand or mechanical filters

The following steps are involved in this process (Fig. 4.3).

1. *Coagulation:* The raw water is first treated with a chemical coagulant such as alum.
2. *Rapid mixing:* The treated water is then subjected to violent agitation in a "mixing chamber" for a few minutes. This allows a quick and thorough dissemination of alum throughout the bulk of water.

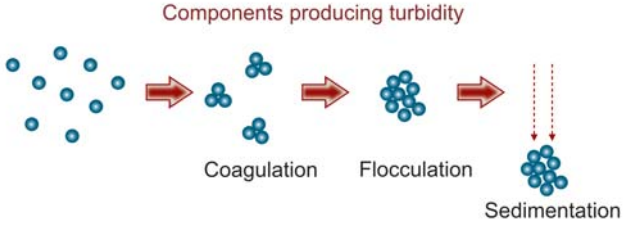


Fig. 4.3: Process of coagulation, flocculation, and sedimentation

3. *Flocculation:* It involves a slow and gentle stirring of the treated water in a flocculation chamber for about 30 minutes. This slow and gentle stirring results in the formation of a thick, copious, white flocculent precipitate of aluminium hydroxide.
4. *Sedimentation:* The coagulated water is now led into sedimentation tanks where it is detained for periods varying from 2 to 6 hours when the flocculent precipitate together with impurities and bacteria settle down in the tank.

Disinfection

Disinfection is accomplished both by filtering out harmful microbes and also by adding disinfectant chemicals in the last step in purifying drinking water. Water is disinfected to kill any *pathogens* which pass through the filters. Possible pathogens include *viruses, bacteria,* including *Escherichia coli, Campylobacter* and *Shigella,* and *protozoans*, including *G lamblia* and other *Cryptosporidia*. In most developed countries, public water supplies are required to maintain a residual disinfecting agent throughout the distribution system, in which water may remain for days before reaching the consumer. Following the introduction of any chemical disinfecting agent, the water is usually held in temporary storage - often called a *contact tank or clear well* to allow the disinfecting action to complete.

For a chemical or an agent to be potentially useful as a disinfectant in water supplies, it has to satisfy the following criteria:

a. It should be capable of destroying the pathogenic organisms present.
b. Should not leave products of reaction which render the water toxic.
c. Have ready and dependable availability at reasonable cost permitting convenient, safe and accurate application to water.
d. Possess the property of leaving residual concentration to deal with small possible recontamination.
e. Be amenable to detection by practical, rapid and simple analytical techniques in the small concentration ranges to permit the control of the efficiency of the disinfection process.

Chlorination

Chlorination is one of the greatest advances in water purification. Chlorine kills pathogenic bacteria, but it has no effect on spores and certain viruses except in high doses. It has limited effectiveness against protozoans that form cysts in water. (*Giardia lamblia* and *Cryptospo-ridium*, both of which are pathogenic).

When chlorine is added to water there is formation of hydrochloric and hypochlorous acids. The hydrochloric acid is neutralized by the alkalinity of water. The hypochlorous acid ionizes to form hydrogen ions and hypochlorite ions:

$$H_2O + Cl_2 \rightarrow HCl + HOCl$$

$$HOCl \rightarrow H + OCl$$

The disinfecting action of chlorine is mainly due to the hypochlorous acid and to a small extent due to the hypochlorite ions.

Chlorine acts best as a disinfectant when the pH of water is around seven because about 90 percent of the hypochlorous acid gets ionized to hypochlorite ions.

Method of chlorination

For disinfecting large bodies of water, chlorine is applied either as (1) Chlorine gas (2) Chloramines (3) Perchloron.

Chlorine gas is a toxic gas, hence there is a danger of a release associated with its use. This problem is avoided by the use of *sodium hypochlorite,* which is a relatively inexpensive solution that releases free chlorine when dissolved in water.

Chloramines are chlorine-based disinfectants. Although chloramine is not as strong of an oxidant, it does provide a long-lasting residual than free chlorine, and it does not form THMs or haloacetic acids. It is possible to convert chlorine to chloramine by adding ammonia to the water after addition of chlorine. The chlorine and ammonia react to form chloramine. Water distribution systems disinfected with chloramines may experience *nitrification,* wherein ammonia is used as nutrient for bacterial growth, with nitrates being generated as a byproduct.

Forms of chlorination:

1. *Plain chlorination:* When raw water is supplied to consumer by applying chlorine treatment only.
2. *Pre-chlorination:* When raw water is suspected to be highly contaminated, then a dose of chlorine is added to the raw water before it enters the sedimentation chamber.
3. *Post-chlorination:* When chlorine is added to water after all the treatment is over, just before it enters the distribution system to prevent contamination in the distribution line.
4. *Double chlorination:* When pre and post chlorination are both adopted.
5. *Break point chlorination:* The addition of chlorine to ammonia in water produces chloramines which do not have the same efficiency as free chlorine. If the chlorine dose in water is increased, a reduction in the residual chlorine occurs, due to the destruction of chloramines by the added chlorine. The end products do not represent any residual chlorine. This fall in residual chlorine will continue with further increase in chlorine dose and after a stage, the residual chlorine begins to increase in proportion to the added dose of chlorine. This point at which the residual chlorine appears and when all combined chlorines have been completely destroyed is the breakpoint and corresponding dosage is the breakpoint dosage.
6. *Superchlorination:* It is followed by dechlorination and comprises the addition of large doses of chlorine to the water, and removal of excess of chlorine after disinfection, this method is applicable to heavily polluted water whose quality fluctuates greatly.

All forms of chlorine are widely used despite their respective drawbacks. One drawback is that chlorine from

any source reacts with natural organic compounds in the water to form potentially harmful chemical byproducts *trihalomethanes* (THMs) and *haloacetic acids* (HAAs), both of which are *carcinogenic* in large quantities and regulated by the *United States Environmental Protection Agency* (EPA). The formation of THMs and haloacetic acids may be minimized by effective removal of as many organics from the water as possible prior to chlorine addition. Although chlorine is effective in killing bacteria, it has limited effectiveness against protozoans that form cysts in water. (*Giardia lamblia* and *Cryptosporidium*, both of which are pathogenic).

Methods of testing residual chlorine

Orthotoluidine (OT) Test

This test enables both free and combined chlorine in water to be determined with speed and accuracy.

Orthotoluidine-arsenite (OTA) Test

This is a modification of the OT test to determine the free and combined chlorine residuals separately

Other agents for disinfection

Ozone (O_3): Ozone is a relatively unstable molecule "free radical" of oxygen which readily gives up one atom of oxygen providing a powerful oxidizing agent which is toxic to most water borne organisms. It is a very strong, broad spectrum disinfectant that is widely used in Europe. It is an effective method to inactivate harmful protozoans that form cysts. It also works well against almost all other pathogens. Ozone is made by passing oxygen through ultraviolet light or a "cold" electrical discharge. To use ozone as a disinfectant, it must be created on site and added to the water by bubble contact. Some of the advantages of ozone include the production of relatively fewer dangerous byproducts (in comparison to *chlorination*) and the lack of taste and odor produced by ozonation. Although fewer byproducts are formed by ozonation, it has been discovered that the use of ozone produces a small amount of the suspected carcinogen *Bromate,* although little *Bromine* should be present in treated water. Another one of the main disadvantages of ozone, is that it leaves no disinfectant residual in the water. Ozone has been used in drinking water plants since 1906 where the first industrial ozonation plant was built in *Nice, France*. The US Food and Drug Administration has accepted ozone as being safe; and it is applied as an antimicrobiological agent for the treatment, storage, and processing of foods

Ultraviolet irradiation: UV irradiation is effective against most microorganisms known to contaminate water supplies including viruses. *UV radiation (light)* is very effective at inactivating cysts, as long as the water has a low level of color so the UV can pass through without being absorbed. The main disadvantage to the use of UV radiation is that, like ozone treatment, it leaves no residual disinfectant in the water. Because neither ozone nor UV radiation leaves a residual disinfectant in the water, it is sometimes necessary to add a residual disinfectant after they are used. This is often done through the addition of chloramines, discussed above as a primary disinfectant. When used in this manner, chloramines provide an effective residual disinfectant with very little of the negative aspects of chlorination.

Purification of Water on a Small Scale

a. Boiling
b. Chemical disinfection involves addition of
    1. Bleaching powder
    2. Chlorine solution
    3. High test hypochlorite
    4. Chlorine tablets
    5. Iodine
    6. Potassium permanganate

Other Water Purification Techniques

Boiling: Water is heated hot enough and long enough to inactivate or kill *microorganisms* that normally live in water at room temperature. At high altitudes (greater than two kilometers or 5000 feet) three minutes is recommended. In areas, where the water is "hard" (that is, containing significant dissolved calcium salts), boiling decomposes the *bicarbonate* ions, resulting in partial precipitation as *calcium carbonate*. This is the "fur" that builds up on kettle elements, etc. in hard water areas. With the exception of calcium, boiling does not remove solutes of higher boiling point than water and in fact increases their concentration (due to some water being lost as vapor). Boiling does not leave a residual disinfectant in the water. Therefore, water that has been boiled and then stored for any length of time may have acquired new pathogens.

Carbon filtering: Charcoal, a form of *carbon* with a high surface area, absorbs many compounds including some toxic compounds. Water passing through *activated charcoal* is common in household water filters. Household filters for drinking water sometimes contain *silver* which release silver ions which has an antibacterial effect.

Distillation: involves boiling the water to produce water *vapor*. When the vapors contacts a cool surface it condenses as a liquid. Because the solutes are not normally vaporized, they remain in the boiling solution. Even distillation does not completely purify water, because of contaminants with similar boiling points and droplets of unvaporized liquid carried with the steam. However, 99.9 percent pure water can be obtained by distillation. Distillation does not confer any residual disinfectant.

Reverse osmosis: Mechanical pressure is applied to an impure solution to force pure water through a *semi-permeable membrane.* Reverse osmosis is theoretically the most thorough method of large scale water purification, although perfect semipermeable membranes are difficult to create. Unless membranes are well-maintained, algae and other life forms can colonize the membranes.

Ion exchange: Common ion exchange systems use a *zeolite resin* bed to replace unwanted Ca^{2+} and Mg^{2+} ions with benign (soap friendly) Na^{+} or K^{+} ions. This is the common water softener.

Electrodeionization: Water is passed between a positive electrode and a negative electrode. Ion selective membranes allow the positive ions to separate from the water toward the negative electrode and the negative ions toward the positive electrode. High purity deionized water results. The water is usually passed through a *reverse osmosis* unit first to remove non-ionic organic contaminants.

Direct contact membrane distillation (DCMD): Applicable to desalination. Heated sea-water is passed along the surface of a *hydrophobic* polymer membrane. Evaporated water passes from the hot side through pores in the membrane into a stream of cold pure water on the other side. The difference in vapor pressure between the hot and cold side helps to push water molecules through.

WATER QUALITY—CRITERIA AND STANDARDS

The guidelines for drinking water quality recommended by WHO refer to following variables:

1. Acceptability aspects
2. Microbiological aspects
3. Chemical aspects
4. Radiological aspects

Acceptability Aspects

To a large extent, consumers have no means of judging the safety of their drinking-water themselves, but their attitude towards their drinking-water supply and their drinking-water suppliers will be affected to a considerable extent by the aspects of water quality that they are able to perceive with their own senses.

Physical Parameters

Taste, odor and appearance: Taste and odor can originate from natural inorganic and organic chemical contaminants and biological sources or processes (e.g. aquatic microorganisms), from contamination by synthetic chemicals, from corrosion or as a result of water treatment (e.g. chlorination). Taste and odor may also develop during storage and distribution due to microbial activity.

Taste and odor in drinking-water may be indicative of some form of pollution or of a malfunction during water treatment or distribution. It may therefore be an indication of the presence of potentially harmful substances.

Color, cloudiness, particulate matter and visible organisms may also be noticed by consumers and may create concerns about the quality and acceptability of a drinking-water supply.

Color: Drinking-water should ideally have no visible color. Color in drinking-water is usually due to the presence of colored organic matter (primarily humic and fulvic acids) associated with the humus fraction of soil. Color is also strongly influenced by the presence of iron and other metals, either as natural impurities or as corrosion products. It may also result from the contamination of the water source with industrial effluents and may be the first indication of a hazardous situation. No health-based guideline value is proposed for color in drinking-water.

Hardness: Hardness caused by calcium and magnesium is usually indicated by precipitation of soap scum and the need for excess use of soap to achieve cleaning. Public acceptability of the degree of hardness of water may vary considerably from one community to another, depending on local conditions. In particular, consumers are likely to notice changes in hardness. No health-based guideline value is proposed for hardness in drinking- water.

pH and corrosion: Although pH usually has no direct impact on people, it is one of the most important operational water quality parameters. Careful attention to pH control is necessary at all stages of water treatment to ensure satisfactory water clarification and disinfection For effective disinfection with chlorine, the pH should preferably be less than 8 however, lower pH water is likely to be corrosive and can cause corrosion of water mains and pipes in household water systems.

Synthetic detergents: The concentration of detergents in drinking-water should not be allowed to reach levels giving rise to either foaming or taste problems. The presence of any detergent may indicate sanitary contamination of source water.

Turbidity: Turbidity in drinking-water is caused by particulate matter that may be present from source water as a consequence of inadequate filtration or from resuspension of sediment in the distribution system. It may also be due to the presence of inorganic particulate matter in some groundwaters or sloughing of biofilm within the distribution system. The appearance of water with a turbidity of less than 5 NTU is usually acceptable. Particulates can protect microorganisms from the effects of disinfection and can stimulate bacterial growth. In all cases where water is disinfected, the turbidity must be low so that disinfection can be effective.

Temperature: Cool water is generally more palatable than warm water, and temperature will impact on the acceptability of a number of other inorganic constituents and chemical contaminants that may affect taste. High water temperature enhances the growth of microorganisms and may increase taste, odor, color and corrosion problems.

Inorganic Constituents

Copper: Copper is both an essential nutrient and a drinking-water contaminant. It has many commercial uses. It is used to make pipes, valves and fittings and is present in alloys and coatings. Copper sulfate pentahydrate is sometimes added to surface water for the control of algae.

Guideline value: 2 mg/liter

Iron: Iron is one of the most abundant metals in the Earth's crust. It is found in natural fresh waters at levels ranging from 0.5 to 50 mg/liter. Iron may also be present in drinking-water as a result of the use of iron coagulants or the corrosion of steel and cast iron pipes during water distribution. Iron is an essential element in human nutrition. Estimates of the minimum daily requirement for iron depends on age, sex, physiological status and iron bioavailability and range from about 10 to 50 mg/day.

Manganese: Manganese is one of the most abundant metals in the Earth's crust, usually occurring with iron. It is used principally in the manufacture of iron and steel alloys, as an oxidant for cleaning, bleaching and disinfection as potassium permanganate and as an ingredient in various products. Manganese is naturally occurring in many surface water and groundwater sources, particularly in anaerobic or low oxidation conditions, and this is the most important source for drinking-water. The greatest exposure to manganese is usually from food.

Guideline value: 0.4 mg/liter.

Mercury: Mercury is present in the inorganic form in surface water and groundwater at concentrations usually below 0.5 mg/liter, although local mineral deposits may produce higher levels in groundwater. Food is the main source of mercury in non-occupationally exposed populations; the mean dietary intake of mercury in various countries ranges from 2 to 20 mg/day per person.

Guideline value: 0.006 mg/liter for inorganic mercury

Sodium: Sodium salts (e.g., sodium chloride) are found in virtually all food (the main source of daily exposure) and drinking-water. Although concentrations of sodium in potable water are typically less than 20 mg/liter, they can greatly exceed this in some countries. Therefore, no health-based guideline value is proposed. However, concentrations in excess of 200 mg/liter may give rise to unacceptable taste

Total dissolved solids (TDS): TDS comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides and sulfates) and small amounts of organic matter that are dissolved in water. TDS in drinking-water originate from natural sources, sewage, urban runoff and industrial waste water. However, the presence of high levels of TDS in drinking-water (greater than 1200 mg/liter) may be objectionable to consumers. Water with extremely low concentrations of TDS may also be unacceptable because of its flat, insipid taste.

Zinc: Zinc is an essential trace element found in virtually all food and potable water in the form of salts or organic complexes. Although levels of zinc in surface water and groundwater normally do not exceed 0.01 and 0.05 mg/liter, respectively, concentrations in tap water can be much higher as a result of dissolution of zinc from pipes. The daily requirement for adult men is 15 to 20 mg/day. However, drinking-water containing zinc at levels above 3 mg/liter may not be acceptable to consumers

Microbiological Aspects

Infectious diseases caused by pathogenic bacteria, viruses and parasites (e.g. protozoa and helminths) are the most common and widespread health risk associated with drinking-water. For pathogens transmitted by the fecal–oral route, drinking-water is one of the main vehicles of transmission. Contamination of food, hands, utensils and clothing can also play a role, particularly when domestic sanitation and hygiene are poor. Improvements in the quality and availability of water, in excreta disposal and in general hygiene are all important in reducing fecal–oral disease transmission. Drinking-water safety is not related only to fecal contamination. Some organisms grow in piped water distribution systems (e.g. *Legionella*), whereas others occur in source waters (guinea worm *Dracunculus medinensis*) and may cause outbreaks and individual cases. Infectious diseases caused by pathogenic bacteria, viruses, protozoa and helminths are the most common and widespread health risk associated with drinking-water.

Failure to provide adequate protection, effective treatment and disinfection of drinking-water will expose the community to the risk outbreaks of intestinal and other infectious diseases. The potential consequences of microbial contamination are such that its control must always be of paramount importance and must never be compromised. The primary bacterial indicator recommended for this purpose is the coli form group of organisms as a whole.

The potential water-borne pathogens include (Table 4.1):

- Bacteria, viruses, protozoa and helminths with the exception of *Schistosoma*, which is primarily spread by contact with contaminated surface water during bathing and washing,
- Potentially emerging pathogens, including *Helicobacter pylori*, *Tsukamurella*, *Isospora belli* and *microsporidia*, for which waterborne transmission is plausible but unconfirmed,
- *Bacillus*, which includes the food borne pathogenic species *Bacillus cereus* but for which there is no evidence at this time of waterborne transmission, and
- Hazardous *cyanobacteria*.

Guideline Values for Verification of Microbial Quality (Table 4.2)

Recommended actions:

a. Immediate investigative action must be taken if *E. coli* are detected.
b. Although *E. coli* is the more precise indicator of fecal pollution, the count of thermotolerant coliform bacteria is an acceptable alternative. If necessary, proper confirmatory tests must be carried out. Total coliform bacteria are not acceptable indicators of the sanitary quality of water supplies, particularly in tropical areas, where many bacteria of no sanitary significance occur in almost all untreated supplies.

Table 4.1: Waterborne pathogens

Bacteria
Burkholderia pseudomallei
Campylobacter jejuni, C. coli
Escherichia coli – Pathogenic
E. coli – Enterohemorrhagic
Legionella spp.
Non-tuberculous mycobacteria
Pseudomonas aeruginosae
Salmonella typhi
Other *Salmonellae*
Shigella spp.
Vibrio cholerae
Yersinia enterocolitica
Viruses
Adenoviruses
Enteroviruses
Hepatitis A virus
Hepatitis E virus
Noroviruses and sapoviruses
Rotaviruses
Protozoa
Acanthamoeba spp.
Cryptosporidium parvum
Cyclospora cayetanensis
Entamoeba histolytica
Giardia intestinalis
Naegleria fowleri
Toxoplasma gondii
Helminths
Dracunculus medinensis
Schistosoma spp.

Table 4.2: Guideline values for coliform bacteria

Organisms	*Guideline value*
All water directly intended for drinking	
E. coli or thermotolerant coliform bacteria-sample	Must not be detectable in any 100 ml
Treated water entering the distribution system	
E. coli or thermotolerant coliform bacteria-sample	Must not be detectable in any 100 ml
Treated water in the distribution system	
E. coli or thermotolerant coliform bacteria-sample	Must not be detectable in any 100 ml

c. It is recognized that in the great majority of rural water supplies, especially in developing countries, fecal contamination is widespread. Especially under these conditions, medium-term targets for the progressive improvement of water supplies should be set.

Viral pathogens: Viruses associated with waterborne transmission are predominantly those that can infect the gastrointestinal tract and are excreted in the feces of infected humans (enteric viruses).

Chemical Aspects

A number of chemical contaminants have been shown to cause adverse health effects in humans as a consequence of prolonged exposure through drinking-water. However, this is only a very small proportion of the chemicals that may reach drinking-water from various sources.

The presence of certain chemicals in excess of prescribed limits may constitute ground for rejection of the water as a source of public water supply.

These are:

Arsenic: Levels in natural waters generally range between 1 and 2 mg/liter, although concentrations may be elevated (up to 12 mg/liter) in areas containing natural sources.

Provisional guideline: 0.01 mg/liter

Barium: Barium is present as a trace element in both igneous and sedimentary rocks, and barium compounds are used in a variety of industrial applications. However, barium in water comes primarily from natural sources.

Guideline value: 0.7 mg/liter

Benzene: Concentrations in drinking-water are generally less than 5 mg/liter. Benzene is used principally in the production of other organic chemicals. It is present in petrol, and vehicular emissions constitute the main source of benzene in the environment. Benzene may be introduced into water by industrial effluents and atmospheric pollution.

Guideline value: 0.01 mg/liter

Cadmium: Occurrence levels in drinking-water is usually less than 1 mg/liter. Cadmium metal is used in the steel industry and in plastics. Cadmium compounds are widely used in batteries. Cadmium is released to the environment in wastewater, and diffuse pollution is caused by contamination from fertilizers and local air pollution. Contamination in drinking-water may also be caused by impurities in the zinc of galvanized pipes and solders and some metal fittings. Food is the main source of daily exposure to cadmium. The daily oral intake is 10–35 mg. Smoking is a significant additional source of cadmium exposure.

Guideline value: 0.003 mg/liter

Chlorine: Chlorine is produced in large amounts and widely used both industrially and domestically as an important disinfectant and bleach. In particular, it is widely used in the disinfection of swimming pools and is the most commonly used disinfectant and oxidant in drinking-water treatment. Present in most disinfected drinking-water at concentrations of 0.2–1 mg/liter

Guideline value: 5 mg/liter

Chromium: Chromium is widely distributed in the Earth's crust. Total chromium concentrations in drinking-water are usually

less than 2 mg/liter, although concentrations as high as 120 mg/liter have been reported.

Provisional guideline value: 0.05 mg/liter for total chromium [provisional because of uncertainties in the toxicological database].

Cyanide: Cyanides can be found in some foods, particularly in some developing countries, and they are occasionally found in drinking-water, primarily as a consequence of industrial contamination.

Guideline value: 0.07 mg/liter

Fluoride: Fluoride accounts for about 0.3 g/kg of the Earth's crust and exists in the form of fluorides in a number of minerals. The most important source of fluoride in drinking-water is naturally occurring. Fluorosilicic acid, sodium hexafluorosilicate and sodium fluoride are used in municipal water fluoridation schemes. Daily exposure to fluoride depends mainly on the geographical area. In most circumstances, food seems to be the primary source of fluoride intake, with lesser contributions from drinking-water and from toothpaste. In groundwater, concentrations vary with the type of rock the water flows through but do not usually exceed 10 mg/liter; the highest natural level reported is 2800 mg/liter.

Guideline value: 1.5 mg/liter

Iron: Iron is one of the most abundant metals in the Earth's crust. It is found in natural fresh waters at levels ranging from 0.5 to 50 mg/liter. Iron may also be present in drinking-water as a result of the use of iron coagulants or the corrosion of steel and cast iron pipes during water distribution. Iron is an essential element in human nutrition. Estimates of the minimum daily requirement for iron depend on age, sex, physiological status and iron bioavailability and range from about 10 to 50 mg/day.

No guideline value for iron in drinking-water is proposed.

Lead: Lead is used principally in the production of lead-acid batteries, solder and alloys. Owing to the decreasing use of lead containing additives in petrol and of lead containing solder in the food processing industry, concentrations in air and food are declining, and intake from drinking-water constitutes a greater proportion of total intake. Lead is rarely present in tap water as a result of its dissolution from natural sources rather, its presence is primarily from household plumbing systems containing lead in pipes, solder, fittings or the service connections to homes. The amount of lead dissolved from the plumbing system depends on several factors, including pH, temperature, water hardness and standing time of the water. Concentrations in drinking-water are generally below 5 mg/liter, although much higher concentrations (above 100 mg/liter) have been measured where lead fittings are present.

Guideline value: 0.01 mg/liter

Mercury: Mercury is mainly used in the electrolytic production of chlorine, in electrical appliances, in dental amalgams and as a raw material for various mercury compounds. Mercury is present in the inorganic form in surface water and groundwater at concentrations usually below 0.5 mg/liter, although local mineral deposits may produce higher levels in groundwater. Food is the main source of mercury in non-occupationally exposed populations. The mean dietary intake of mercury in various countries ranges from 2 to 20 mg/day per person.

Guideline value: 0.006 mg/liter for inorganic mercury

Radiological Aspects

The effects of radiation exposure are called somatic if they become manifest in the exposed individual, and hereditary if they affect the descendants. Malignant diseases is the most important somatic effect.

Radiation exposure through drinking-water

Radioactive constituents of drinking-water can result from:

- Naturally occurring radioactive species (e.g. radionuclides of the thorium and uranium decay series in drinking-water sources), in particular radium-226/228 and a few others
- Technological processes involving naturally occurring radioactive materials (e.g. the mining and processing of mineral sands or phosphate fertilizer production)
- Radionuclides discharged from nuclear fuel cycle facilities
- Manufactured radionuclides (produced and used in unsealed form), which might enter drinking-water supplies as a result of regular discharges and, in particular, in case of improper medical or industrial use and disposal of radioactive materials
- Past releases of radionuclides into the environment, including water sources.

HARDNESS OF WATER

Hardness may be defined as the soap-destroying power of water. It is mainly caused by

1. Calcium bicarbonate
2. Magnesium bicarbonate
3. Calcium sulfate
4. Magnesium sulfate

Table 4.3: Classification of hardness in water

Classification	*Level of hardness (mg /liter)*
(a) Soft water	Less than 1(<50 mg/L)
(b) Moderately hard	1-3(50-150 mg/L)
(c) Hard water	3-6(150-300 mg/L)
(d) Very hard water	over 6 (>300 mg/L)

Hardness is classified as: (i) carbonate or "temporary" hardness and (ii) non-carbonate or "permanent" hardness. The carbonate hardness is due to the presence of calcium and magnesium bicarbonates. The noncarbonated hardness is due to calcium and magnesium sulfates, chlorides and nitrates (Table 4.3).

SPECIAL TREATMENT OF WATER

1. **Removal of hardness**
   Temporary hardness
   a. Boiling
   b. Addition of lime
   c. Addition of sodium carbonate
   d. Permutit process

   Permanent hardness
   a. Addition of sodium carbonate
   b. Base Exchange process
2. **Fluoridation of water**
   Water fluoridation is the practice of adding *fluoride* compounds to *water* with the intended purpose of reducing *tooth decay* in the general population. Many *North American* and *Australian* municipalities fluoridate their water supplies in the belief that this practice will reduce tooth decay at a low cost. Currently 66 percent of United States residents on public water supplies have fluoridated water.

   Typically fluoride is added in the form of sodium hexafluorosilicate or hexafluorosilicic acid, at a level between 0.7 and 1.2 ppm.
3. **Defluoridation**
   Fluoride, as a dissolved constituent of drinking water, is perhaps the only substance producing divergent health effects on the consumer depending upon their relative proportions. While a fluoride concentration in the range of 0.8 to 1.20 mg/liter is considered to be beneficial, concentration higher then 1.5 mg/liter are reported to be harmful to the teeth and bone structure of men and animals. The necessity of removal of excess fluoride has led to development of several defluoridation methods. Most of these methods are based upon ion exchange process, adsorption or addition of chemicals to water during treatment. Defluoridation is a process of removal of fluoride ion in drinking water. The different methods so far tried for the removal of excess fluoride from water can be broadly classified into four categories. Viz
   a. Adsorption method
   b. Ion Exchange method
   c. Precipitation method
   d. Miscellaneous method. (e.g. Reverse Osmosis)

AIR

The immediate environment of man comprises of air on which depends all forms of life. Apart from supplying the life giving oxygen, air and atmospheric conditions serve several functions.

Composition

Nitrogen	78.1 percent
Oxygen	20.93 percent
Carbon dioxide	0.03 percent

Other gases in traces: e.g. argon, neon, krypton, xenon and helium. In addition to these gases, air also contains water vapor, traces of ammonia and suspended matter such as dust, bacteria, spores and vegetable debris.

Air Pollution

The term Air Pollution signifies the presence in the ambient atmosphere of substances generated by the activities of man in concentrations that interfere with human health, safety or comfort,or injurious to vegetation and animals and other environmental media resulting in chemicals entering the food chain or being present in drinking water and thereby constituting additional source of human exposure.

Sources of Air Pollution

1. Automobiles
2. Industries
3. Domestic sources
4. Tobacco smoke
5. Miscellaneous: burning refuse, incinerators, etc.

Air Pollutants (Table 4.4)

1. Carbon monoxide
2. Sulfur dioxide
3. Lead
4. Carbon dioxide
5. Hydrocarbons
6. Cadmium
7. Hydrogen sulfide
8. Ozone
9. Particulate matter

Table 4.4: Air pollutant and their effects

Name of pollutant	*Health impacts*
RSPM*	Respiratory illness, including chronic bronchitis and asthma and heart diseases.
SO_2	Heart diseases; respiratory problems including pulmonary emphysema, cancer, eye burning, headache, etc.
NO_2	Lung irritation, viral infection, airway resistance, chest tightness, etc.
SPM	Pneumoconiosis, restrictive lung diseases, asthma, cancer, etc.
Benzene	Immunotoxicity, carcinogenicity, asthma, anemia, unconsciousness, etc.
Ozone	Impaired lung function, chest pains, coughing, irritation of eyes, nose, etc.
CO	CO poisoning cause cherry lips, unconsciousness, death by asphyxiation, etc.
Lead	It may cause decreased hemoglobin synthesis, anemia, damage the nervous and renal (kidney) systems, etc.

* Respirable Suspended Particulate Matter

Air Pollutants and their Effects on Health (See Table 4.4)

The *World Health Organization* states that 2.4 million people die each year from causes directly attributable to air pollution. Many of these mortalities are attributable to *indoor air pollution*. Worldwide more deaths per year are linked to air pollution than to *automobile* accidents.

Indoor Air Pollution

It refers to the physical, chemical, and biological characteristics of air in the indoor environment within a home, building, or an institution or commercial facility. Indoor air pollution can begin within the building or be drawn in from outdoors. Other than nitrogen dioxide, carbon monoxide, and lead, there are a number of other pollutants that affect the air quality in an enclosed space.

Causes of indoor air pollution:
Volatile organic compounds originate mainly from solvents and chemicals. The main indoor sources are perfumes, hair sprays, furniture polish, glues, air fresheners, moth repellents, wood preservatives, and many other products used in the house. The main health effect is the irritation of the eye, nose and throat. In more severe cases, there may be headaches, nausea and loss of coordination. In the long-term, some of the pollutants are suspected to damage to the liver and other parts of the body.

Tobacco smoke generates a wide range of harmful chemicals and is known to cause cancer. It is well known that passive smoking causes a wide range of problems to the passive smoker (the person who is in the same room with a smoker and is not himself/herself a smoker) ranging from burning eyes, nose, and throat irritation to cancer, bronchitis, severe asthma, and a decrease in lung function.

Pesticides, if used carefully and the manufacturer's instructions are followed, do not cause too much harm to the indoor air.

Biological pollutants include pollen from plants, mite, hair from pets, fungi, parasites, and some bacteria. Most of them are allergens and can cause asthma, hay fever, and other allergic diseases.

Formaldehyde is a gas that comes mainly from carpets, *particle* boards, and insulation foam. It causes irritation to the eyes and nose and may cause allergies in some people.

Asbestos is mainly a concern because it is suspected to cause cancer.

Radon is a gas that is emitted naturally by the soil. Due to modern houses having poor ventilation, it is confined inside the house causing harm to the dwellers.

Outdoor Air Pollution and its Effects
Smog is a type of large-scale outdoor pollution. It is caused by chemical reactions between pollutants derived from different sources, primarily automobile exhaust and industrial emissions

Temperature inversion occurs when air close to the earth is cooler than the air above it. Under these conditions, the pollution cannot rise and be dispersed. Cities surrounded by mountains also experience trapping of pollution. Inversion can happen in any season. Winter inversions are likely to cause particulate and carbon monoxide pollution

Acid rain: When a pollutant, such as sulfuric acid combines with droplets of water in the air, the water (or snow) can become *acidified.*

The Greenhouse Effect: Also referred to as global warming, is generally believed to come from the build up of carbon dioxide gas in the atmosphere. *Carbon dioxide* is produced when fuels are burned.

Ozone depletion is another result of pollution. Chemicals released by our activities affect the *stratosphere,* one of the atmospheric layers surrounding earth. The ozone layer in the stratosphere protects the earth from harmful *ultraviolet radiation* from the sun. Release of *chlorofluorocarbons* (CFC's) from aerosol cans, cooling systems and refrigerator equipment removes some of the ozone, causing "holes" to open up in this layer and allowing the radiation to reach the earth. Ultraviolet radiation is known to cause skin cancer and has damaging effects on plants and wildlife

Prevention of air pollution:
Scientific groups study the damaging effects on plant, animal and human life. *Legislative bodies* write laws to control emissions. *Educators* in schools and universities teach students, beginning at very young ages, about the effects of air pollution.

1. *Assessment*: is the first step to solve air pollution.
2. *Reduce exposure:* steps can be undertaken to reduce air pollution. These can be accomplished by regulation of man-made pollution through legislation. *Prevention* is another key to control air pollution.
3. *Adequate ventilation* is also a key to control exposure to indoor air pollution. Home and work environments should be monitored for adequate air flow and proper exhaust systems installed.
4. *Restricting smoking* is an important key to a healthier environment. Cigarette smoke is one of the most dangerous air pollutants.

NOISE

Definition: "wrong sound, in the wrong place, at the wrong time".
Sources: Automobiles, factories, industries, air crafts, loudspeakers, radios, T.V sets etc

Properties:

1. *Loudness*: Depends upon the amplitude of vibrations which initiated the noise. A daily exposure up to 85 dB is about the limit people can tolerate without substantial damage to their hearing.
2. *Frequency*: The human ear can hear frequencies from about 20 to 20,000 Hz, but this range is reduced with age

and other subjective factors. The range of vibrations below 20 Hz are infra-audible; and those above 20,000 Hz ultrasonic.

Effects of noise exposure:

1. *Auditory effect*:
   a. Auditory fatigue: It appears in the 90 dB region and at 4000 Hz. It may be associated with side effects such as whistling and buzzing in the ears.
   b. Deafness: Temporary or permanent.
2. *Non-auditory effect*:
   a. Interference with speech.
   b. Annoyance: This is primarily a psychological response. Neurotic people are more sensitive to noise than balanced people. Workmen exposed to higher intensity of noise in occupational capacities are often irritated, short tempered and impatient.
   c. Efficiency: Reduction in noise has been found to increase work output.
   d. Physiological changes: A rise in blood pressure, intracranial pressure, heart rate, increase in breathing and sweating. Giddiness, nausea, fatigue can also occur.

Control of noise:

1. Planning of cities:
   Division of city into zones, the separation of residential areas from the main streets by means of wide green belts, widening of main streets etc.
2. Control of vehicles.
3. By improving acoustic insulation of building.
4. Industries and railways should be outside the residential areas.
5. Protection of exposed persons:
   Workers must be regularly rotated from noisy areas to comparatively quiet posts in factories.
6. Legislation: Workers have the right to claim compensation if they suffered a loss of ability to understand speech.
7. Education about noise pollution should be given.

RADIATION

Radiation is energy, or emission of energy, in the form of waves or particles. Microscopic particles, called atoms, are the foundation on which all matter (all substances that exist as solids, liquids, or gas) is built. Each atom has a nucleus at its center. The nucleus contains smaller (nuclear) particles called protons and neutrons. If the number, position, or energy level of these nuclear particles changes, an atom becomes unstable, or radioactive. Unstable atoms, or atoms undergoing change, produce radiation.

Ionizing radiation has always been a part of the human environment. Along with natural radioactive sources present in the Earth's crust and cosmic radiation, man-made sources also contribute to our continuous exposure to ionizing radiation.

Environmental radioactive pollution has resulted from past nuclear weapons testing, nuclear waste disposal, accidents at nuclear power plants, as well as from transportation, storage, loss, and misuse of radioactive sources. *Ionizing radiation* is radiation with sufficient energy to eject electrons from atoms. This process is called ionization. *Non-ionizing radiation* is radiation without sufficient energy to produce ionization

Sources of Radiation Exposure

Natural Sources

Natural sources are those of natural origin that are unperturbed by human activities and those of natural origin affected by human activities *(enhanced* natural sources) Examples include the sun (UV and cosmic x-rays) and the soil (radon).

Man-made Sources

Man-made sources are those specifically produced by man. Examples include medical devices, consumer products, and nuclear power plants

a. Medical and dental X-rays, radioisotopes.
b. Occupational exposure.
c. Nuclear radioactive fallout.
d. Miscellaneous: television sets, radioactive dial watches, isotope tagged products, luminous marker.

Types of Radiation

Electromagnetic radiation
UV, visible light, x-rays, EMFs: Electric field and magnetic field traveling at right angles; no mass, no charge.

Particulate radiation
Alpha particle, beta particle, neutrons: Have mass and (alphas and betas) charge.

Ionizing radiation (~>14 eV) (Fig. 4.4)
Particulate: Alpha ($2p + 2n$), beta (e^-), positron (e^+).
Electromagnetic: X-rays, gamma rays.

Non-ionizing radiation(~<14 eV)
Electromagnetic: UV, microwaves, EMFs.

Biological Effects of Radiation

1. *Somatic effects:* A dose of 25 to 50 roentgens to the whole body was found to affect the WBCs and to produce mild lassitude and softening of muscles. Delayed effects are leukemia, malignant tumors and shortening of life.
2. *Genetic effects:* Chromosome mutations and *Point* mutations.

Radiation protection:

1. Use of lead shields and lead aprons.
2. Periodic medical examinations, regular working hours, recreation and holidays must be ensured to workers to maintain their state of health.

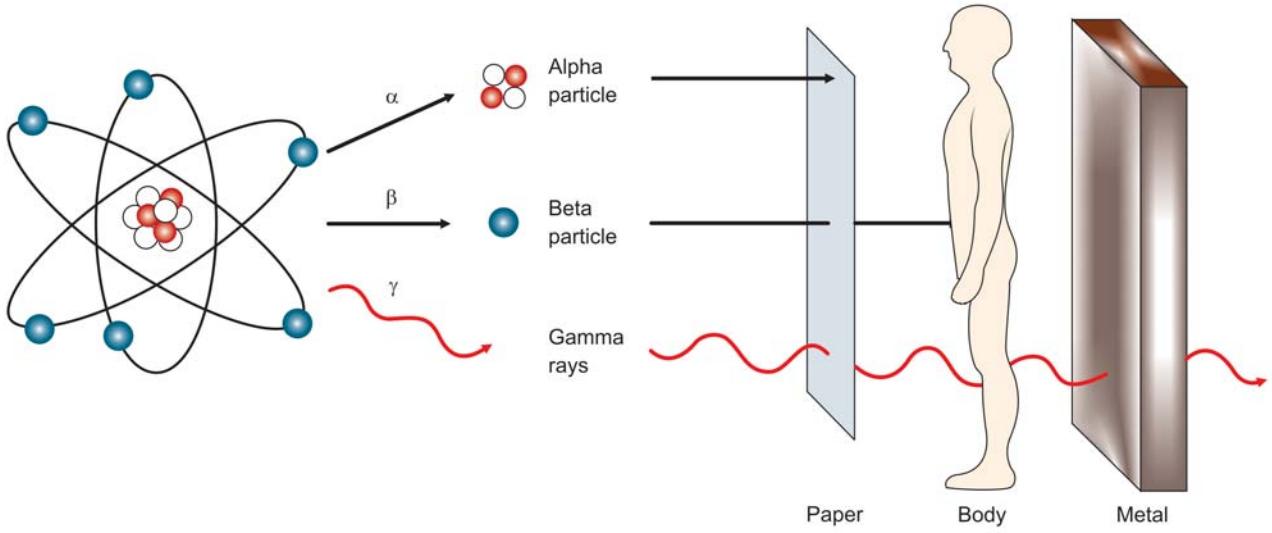


Fig. 4.4: Three types of ionizing radiation and their penetrating power

HOUSING

Healthy housing is a broad concept and WHO takes a holistic and interdisciplinary approach. There is no universally agreed definition of healthy housing, but it does not mean a specially designed visionary house, it simply means a home that provides an environment that is safe, comfortable and hygienic. Healthy housing is mostly a question of applying existing evidence, knowledge and proven principles. Over the centuries, housing standards and good practice have been developed to provide this, but these are often ignored. The following physical, social and mental factors all come into play.

A Committee on the Hygiene of Housing, appointed by American Public Health Association (APHA), created the Basic Principles of Healthful Housing, which provided guidance regarding the fundamental needs of humans as they relate to housing. These fundamental needs include physiological and psychological needs, protection against disease, protection against injury, protection against fire and electrical shock, and protection against toxic and explosive gases.

Fundamental Physiological Needs

Housing should provide for the following physiological needs:

1. Protection from the elements,
2. A thermal environment that will avoid undue heat loss,
3. A thermal environment that will permit adequate heat loss from the body,
4. An atmosphere of reasonable chemical purity,
5. Adequate *daylight* illumination and avoidance of undue daylight glare,
6. Direct sunlight,
7. Adequate *artificial* illumination and avoidance of glare,
8. Protection from excessive noise, and
9. Adequate space for exercise and for children to play.

Fundamental Psychological Needs

Seven fundamental psychological needs for healthy housing include the following:

1. Adequate privacy for the individual,
2. Opportunities for normal family life,
3. Opportunities for normal community life,
4. Facilities that make possible the performance of household tasks without undue physical and mental fatigue,
5. Facilities for maintenance of cleanliness of the dwelling and of the person,
6. Possibilities for aesthetic satisfaction in the home and its surroundings, and
7. Concordance with prevailing social standards of the local community.

Protection Against Disease

Eight ways to protect against contaminants include the following:

1. Provide a safe and sanitary water supply,
2. Protect the water supply system against pollution,
3. Provide toilet facilities that minimize the danger of transmitting disease,
4. Protect against sewage contamination of the interior surfaces of the dwelling,
5. Avoid unsanitary conditions near the dwelling,
6. Exclude vermin from the dwelling, which may play a part in transmitting disease,
7. Provide facilities for keeping milk and food fresh, and
8. Allow sufficient space in sleeping rooms to minimize the danger of contact infection.

Criteria for Healthful Housing

1. Healthful housing provides physical protection and shelters.

2. Provide adequately for cooking, eating, washing and excretory function.
3. Is designed, constructed, maintained and used in such a manner such as to prevent spread of communicable disease.
4. Provide protection from hazards of exposure to noise and pollution.
5. Is free from unsafe physical arrangement, toxic and harmful chemicals.
6. Encourage personal and community development.

Housing and Health

Some of the health hazards faced due to poor housing are:

a. Respiratory infections: Common cold, tuberculosis, whooping cough and diphtheria.
b. Skin infections: Leprosy, impetigo, ringworm infection.
c. Rat infestation: Plague.
d. Accident caused by some defect in house.
e. Psychological effects: Feeling of isolation, quarrels, behavioral disorders, and crimes, etc.

WASTE MANAGEMENT

Waste can be divided into many different types.

Classification

One important classification is by their consistency:
Solid wastes are waste materials that contain less than 70 percent water. This class includes such materials as household garbage, some industrial wastes, some mining wastes, and oilfield wastes such as drill cuttings.

Liquid wastes are usually wastewater's that contain less than 1 percent solids. Such wastes may contain high concentrations of dissolved salts and metals.

Sludge is a class of waste between liquid and solid. They usually contain between 3 percent and 25 percent solids, while the rest of the material is water dissolved materials.

Federal regulations classify wastes into three different categories.

i. *Non-hazardous* are those that pose no immediate threat to human health and the environment. Household garbage is included into this category.
ii. *Hazardous wastes* are of two types:
   a. Those that have common hazardous properties such as ignitability or reactivity, and
   b. Those that contain leakable toxic components.
iii. *Special Wastes* is very specific in nature. They are regulated with specific guidelines. Some examples would be radioactive wastes and medical wastes.

Methods of Disposal of Waste (Table 4.5)

Incineration:
This process of burning waste in large furnaces is known as incineration. In these plants, the recyclable material is segregated and the rest of the material is burnt. At the end of the process, all that is left behind is ash. Refuse can be disposed of hygienically by burning or incineration. Hospital waste is best disposed of by this method. It is more expensive but a safer method of disposal than landfills. Modern incinerators are designed to destroy at least 99.9 percent of the organic waste material they handle. Burning garbage is not a clean process as it produces tonnes of toxic ash and pollutes the air and water. A large amount of the waste that is burnt here can be recovered and recycled. In fact, at present, incineration is kept as

Table 4.5: Advantages and disadvantages of various methods of waste disposal

Advantages	*Disadvantages*
OCEAN DUMPING	
• Convenient • Inexpensive • Source of nutrients, shelter and breeding • Killing of plankton	• Ocean overburdened • Destruction of food sources • Desalination
SANITARY LANDFILL	
• Volume can increase with little addition of people/equipment • Filled land can be reused for other community purposes	• Completed landfill areas can settle and requires maintenance • Requires proper planning, design, and operation
INCINERATION	
• Requires minimum land • Can be operated in any weather • Produces stable odor-free residue • Refuse volume is reduced by half	• Expensive to build and operate • High energy requirement • Requires skilled personnel and continuous maintenance • Unsightly - smell, waste, vermin
OPEN DUMPING	
• Inexpensive	• Health-hazard - insects, rodents etc. • Damage due to air pollution • Ground water and run-off pollution
RECYCLING	
• Key to provide a liviable environment for the future	• Expensive • Some wastes cannot be recycled • Technological push needed • Separation of useful material from waste difficult

the last resort and is used mainly for treating the infectious waste.

Dumping: Refuse is dumped in low lying areas partly as a method of reclamation of land but mainly as an easy method of disposal of dry refuse. As a result of bacterial action, refuse decreases considerably in volume and is converted gradually into humus

Open dumps: Open dumps refer to uncovered areas that are used to dump solid waste of all kinds. The waste is untreated, uncovered, and not segregated. It is the breeding ground for flies, rats, and other insects that spread disease. The rainwater run-off from these dumps contaminates nearby land and water thereby spreading disease. In some countries, open dumps are being phased out.

Controlled tipping or landfill: It differs from ordinary dumping, in that the material is placed in a trench or other prepared area, adequately compacted, and covered with earth at the end of the working day. Landfills are generally located in urban areas where a large amount of waste is generated and has to be dumped in a common place. Unlike an open dump, it is a pit that is dug in the ground. The garbage is dumped and the pit is covered thus preventing the breeding of flies and rats. At the end of each day, a layer of soil is scattered on top of it and some mechanism, usually an earth-moving equipment is used to compress the garbage, which now forms a cell. Thus, every day, garbage is dumped and becomes a cell. After the landfill is full, the area is covered with a thick layer of mud and the site can thereafter be developed as a parking lot or a park.

Sanitary landfills: An alternative to landfills which solves the problem of *leaching* to some extent is a sanitary landfill which is more hygienic and built in a methodical manner. These are lined with materials that are impermeable such as plastics and clay, and are also built over impermeable soil. Constructing sanitary landfills is very costly and they are having their own problems. Some authorities claim that often the plastic liner develops cracks as it reacts with various chemical solvents present in the waste.

Composting: Is a method of combined disposal of refuse and night soil or sludge. It is a process of nature whereby organic matter breaks down under bacterial action resulting in the formation of relatively stable humus-like material, called the *compost* which has considerable manurial value for the soil. Composting can be carried out in two ways, i.e. aerobically and anaerobically. During aerobic composting aerobic microorganisms oxidize organic compounds to Carbon dioxide, Nitrite and Nitrate. Carbon from organic compounds is used as a source of energy while nitrogen is recycled. Due to exothermic reaction, temperature of the mass rises. During anaerobic process, the anaerobic microorganisms, while metabolizing the nutrients, breakdown the organic compounds through a process of reduction. A very small amount of energy is released during the process and the temperature of composting mass does not rise much. The gases evolved are mainly Methane and Carbon di oxide. An anaerobic process is a reduction process and the final product is subjected to some minor oxidation when applied to land.

1. *Bangalore method* (Hot fermentation process):
   It is an anaerobic process. The Indian Council of Agricultural Research at the Indian Institute of Science, Bangalore, developed a system of anaerobic composting known as Bangalore method. It has been recommended as a satisfactory method of disposal of town wastes and night soil.

   In this method, three feet deep trenches are dug. Trenches deeper than three feet (90 cm) are not recommended because of slower decomposition. First a layer of refuse about 15 cm thick is spread at the bottom of the trench. Over this, nightsoil is added corresponding to a thickness of 5 cm. Then alternate layers of refuse and nightsoil are added in the proportion of 15 cm and 5 cm respectively, till the heap rises to one feet (30 cm) above the ground level. The top layer should be of refuse, at least 25 cm thickness. Then the heap is covered with excavated earth.
   Within a week as a result of bacterial action considerable heat (over 60)
2. Mechanical composting: In this, compost is literally manufactured on a large scale by processing raw materials and turning out a finished product.
   Manure pits: The garbage cattle dung, straw, and leaves should be dumped into the manure pits and covered with earth after each day's dumping. In 5 to 6 month's time, the refuse is converted into manure which can be returned to the field.
   Burial: This method is suitable for small camps.

Other methods of sewage disposal are:

a. Sea outfall
b. River outfall
c. Land treatment
d. Oxidation ponds
e. Oxidation ditches

Chapter 5

Organization of the Health System in India

CM Marya

ORGANIZATION OF THE HEALTH SYSTEM IN INDIA

The health care services organization in the country extends from the national level to village level. The total structure of health care system is functioning at national, state, district, community, PHC and subcenter levels. Apart from the modern system of medicine, traditional and indigenous medicinal systems like *Ayurvedic* and *Unani* systems are in practice throughout the country

National Level

The organization at the national level consists of the Union Ministry of Health and Family Welfare. The Ministry has three departments, viz. Health, Family Welfare, and Indian System of Medicine and Homeopathy, headed by two Secretaries, one for Health and Family Welfare and the other for Indian System of Medicine and Homeopathy. The department of Health is supported by a technical wing, the Directorate General of Health Services, headed by Director General of Health Services (DGHS).

Some Functions of Union Health Ministry:

1. International health relation and quarantine.
2. Promotion of research through research center.
3. Regulation and development of medical, pharmaceutical, dental and nursing professions.
4. Establishment and maintenance of drug standards.
5. Census.

State Level

The organization at State level is under the State Department of Health and Family Welfare in each State headed by Minister and with a Secretariat under the charge of Secretary/ Commissioner (Health and Family Welfare) belonging to the cadre of Indian Administrative Service (IAS). By and large, the organizational Structure adopted by the State is in conformity with the pattern of the Central Government. The State Directorate of Health Services, as the technical wing, is an attached office of the State Department of Health and Family Welfare and is headed by a Director of Health Services. However, the organizational structure of the State Directorate of Health Services is not uniform throughout the country. For example, in some states, the Program Officers below the rank of Director of Health Services are called as Additional Director of Health Services while in other states they are called as Joint/ Deputy Director, Health Services. But regardless of the job title, each program officer below the Director of Health Services deals with one or more subject(s). Every State Directorate has supportive categories comprising of both technical and administrative staff.

The area of medical education which was integrated with the Directorate of Health Services at the State, now maintain a separate identity in some states as Directorate of Medical Education and Research. This Directorate is under the charge of Director of Medical Education, who is answerable directly to the Health Secretary/Commissioner of the State. Some states have created the posts of Director (Ayurveda) and Director (Homeopathy).

District Level

In the recent past, states have reorganized their health services structures in order to bring all health care programs in a district under unified control. The district level structure of health services is a middle level management organization and it is a link between the State as well as regional structure on one side and the peripheral level structures such as Primary Health Center (PHC) as well as subcenter on the other side. It receives information from the State level and transmits the same to the periphery by suitable modifications to meet the local needs. In doing so, it adopts the functions of a manager and brings out various issues of general, organizational and administrative types in relation to the management of health services. The district officer with the overall control is designated as the Chief Medical and Health Officer (CM and HO) or as the District Medical and Health Officer (DM and HO). These officers are popularly known as CMOs or DMOs, and are overall in-charge of the health and family welfare programs in the district. They

are responsible for implementing the programs according to policies laid down and finalized at higher levels, i.e. State and Center. These CMOs and DMOs are assisted by Deputy (Dy.) CMOs and program officers.

Subdivisional/Taluka Level

At the Taluka level, health care services are rendered through the office of Assistant District Health and Family Welfare Officer (ADHO). Some specialties are made available at the taluka hospital. The ADHO is assisted by Medical Officers of Health, Lady Medical Officers and Medical Officers of general hospital. These hospitals are being gradually converted into Community Health Centers (CHCs).

Community Level (CHC)

For a successful primary health care program, effective referral support is to be provided. For this purpose one Community Health Center (CHC) has been established for every 80,000 to 1, 20,000 population, and this center provides the basic specialty services in general medicine, pediatrics, surgery, obstetrics and gynecology. The CHCs are established by upgrading the sub-district/taluka hospitals or some of the block level Primary Health Centers (PHCs) or by creating a new center wherever absolutely needed.

PHC Level

At present there is one Primary Health Center covering about 30,000 (20,000 in hilly, desert and difficult terrains) or more population. Many rural dispensaries have been upgraded to create these PHCs. Each PHC has one medical officer, two health assistants – one male and one female, and the health workers and supporting staff.

Subcenter Level

The most peripheral health institutional facility is the subcenter manned by one male and one female multi-purpose health worker. At present, in most places there is one subcenter for about 5,000 populations (3,000 in hilly and desert areas and in difficult terrain).

The 73rd and 74th constitutional amendments have given the powers to the local bodies in some states of India. In the process, different states have adopted different stakeholders for the benefit of health services, with the help of community participation, which gives stress on safe drinking water and sanitation at village level. The Panchayats are given the power to look after the welfare of the people.

VOLUNTARY HEALTH AGENCIES IN INDIA

Voluntary Organization

A voluntary organization is a non-governmental, autonomous, non- profit making organization supported mainly by voluntary contributions in cash and kind from the general public or certain segments of the public, specialized to carry out a number of functions related to development, aid and emergency relief.

The main characteristics of voluntary agencies would be that they should:

- Be established by a group of private individuals or NGOs
- Be autonomous
- Be managed by an independent, volunteer board of directors elected periodically by the members
- Have a clearly defined constitution and be accountable to that constitution
- Be financially independent
- Have a formal legal status, permanent headquarters and employ professional or volunteer staff
- Have humanitarian objectives and programs.

Names of Few Voluntary Health Agencies In India

Voluntarism is a phenomenon of ancient Indian society, where people shared skills, expertise, services, resources and knowledge among the members of communities living together. In the present era, voluntarism manifests through organizations, associations, organized structures such as Community Based Organizations, Voluntary Organizations (VOs), Non-Governmental Organizations (NGOs), etc. From charity, relief and welfare oriented activities; voluntarism has suitably moulded itself to undertake development activities in keeping with the needs of the time and society. Following are the names of certain voluntary organizations of which a few have been discussed:

1. Indian Council of Child Welfare.
2. Family Planning Association of India.
3. Nutrition Foundation of India.
4. The Voluntary Health Association of India.
5. The Kasturba Gandhi Trust.
6. Action for Autism.
7. Ajit Foundation.
8. Chethana.
9. The All India Women's Conference.
10. Pragati.
11. Hind Kusht Nivaran Sangh.
12. Tuberculosis Association of India.
13. The Indian Cancer Society.
14. The Indian Blind Relief Society.
15. The Red Cross Society of India.
16. The Central Social Welfare Board.

INDIAN COUNCIL FOR CHILD WELFARE (ICCW)

Main focus: Child welfare, Education

Aim/Objective: ICCW aims at initiating and undertaking services for child welfare and development in India. It also aims at promoting enactment of legislation and reforms for the benefit of the children, to cooperate and collaborate with governmental, non-governmental, national and international organizations to meet the needs of the children and promote dissemination of

knowledge and information. It also strives to educate the community about the needs of children.

FAMILY PLANNING ASSOCIATION OF INDIA

Vision

FPA of India envisions health, particularly sexual and reproductive health for all, especially marginalized and young people, in the broad context of sustainable development leading towards the alleviation of poverty, stabilization of population, gender equality, and human rights.

Mission

FPA of India strengthens a voluntary and non-governmental commitment to promote sexual and reproductive health and rights including family planning. It supports the rights of individuals to reproductive choices, including legal and safe abortion, works towards reducing the spread and the impact of STIs /HIV/AIDS and increasing access to gender sensitive SRH information, education and services to all especially the young and marginalized and eliminating violence, discrimination, and abuse.

FPA of India is contributing towards:

- Population Stabilization
- Prevention of Unsafe Abortion and Sex Selective Abortions
- Reduction in Infant Mortality Rate
- Reduction in Maternal Mortality Rate
- Reduction in Reproductive Morbidity of Men and Women
- Reduction in Sexually Transmitted Infections including HIV
- Gender Equity and Gender Equality
- Meeting the SRH Needs of Youth.

NUTRITION FOUNDATION OF INDIA

The scope of functions of the Foundation, at the time it was set up, was spelt out as follows:

- To highlight and focus public and government attention on national problems connected with malnutrition, assess their causation, magnitude and implications, and offer short-term as well as long-term action plans,
- To initiate, conduct and support coordinated action-oriented studies and research on these problems through existing institutes, university centers and other suitable bodies in order to evolve appropriate solutions capable of application in the current context,
- To investigate means to offset existing deficiencies in the pattern of predilection and distribution of foods and to ensure the wholesomeness and nutritive value of foods sold for public consumption,
- To disseminate information on diet and nutrition, promote nutrition education in schools and through mass media; publish periodically a bulletin in order to disseminate information on important facets of nutrition, and
- To interact with the Planning Commission and governmental and non-governmental agencies in facilitating the formulation, implementation and evaluation of nutrition programs.

VOLUNTARY HEALTH ASSOCIATION OF INDIA (VHAI)

It is a non-profit, registered society formed in the year 1970. It is a federation of 27 State Voluntary Health Associations, linking together more than 4500 health and development institutions across the country. They are one of the largest health and development networks in the world.

Objectives

VHAI's primary objective is to make health a reality for the people of India by promoting community health, social justice and human rights related to the provision and distribution of health services in India.

VHAI tries to achieve these goals through campaigns, policy research, and advocacy, need based training, media and parliament interventions, publications and audio visuals, dissemination of information and running of health and development projects in difficult areas. *VHAI* works for people centered policies and their effective implementation. It sensitizes the general public on important health and development issues for evolving a sustainable health movement in the country with due emphasis on its rich health and cultural heritage.

Goals

To ensure social justice, equity and human rights in the provision and distribution of health services to all, with emphasis on the less privileged millions.

To promote and strengthen a medically rational, culturally acceptable and economically sustainable Health Care System in the country.

To develop sustainable and innovative strategies to ensure health and overall community development in remote and vulnerable areas through various grass root level initiatives.

To provide relief and rehabilitation in areas affected by disasters and calamities and help the affected to rebuild a better life for themselves.

THE KASTURBA GANDHI TRUST

The Kasturba Gandhi National Memorial Trust was established in 1945 as a result of the national endeavor, led by Mahatma Gandhi, to address the issues of women in rural India

Activities involve:

- Village Service Centers (Gram Seva Kendra)
- Health Centers (Arogya Kendra)

- Children welfare (Bal seva Kendra)
- Creches (Jhulaghar)
- Basic Schools (from 1st to 8th standard)
- Higher Secondary school for Girls (Kasturba Kanya Vidya Mandir, Banwasi Kanya Ashram
- Girls College (Kanya Mahavidyalaya)
- Nursing training
- Training for Block Workers (Gram Karyakarta Prashikshan)

ACTION FOR AUTISM

Action for Autism was started in 1991 to provide support and services to persons with autism and their families, and to create an environment in India in which people with Autism are able to grow to their full potential

AFA is a non-profit organization whose mission is to:

- Facilitate a barrier free environment - informational, attitudinal and physical – to create opportunities for education, employment and socialization for persons with Autism Spectrum Disorders (ASD)
- Empower families of individuals with ASD
- Act as a catalyst for change and build community responsibility for mainstreaming of all persons with ASD.

AJIT FOUNDATION

Ajit Foundation is a voluntary organization committed to the idea of working with youths. Its mission is to walk with them in their search for knowledge. The knowledge that nurture's their creativity. The knowledge that informs them of their responsibility to the community of which they are part of.

CHETHANA

The Chethana trust is a non-profit organization floated by a team of dedicated and wholly committed professionals specializing in the area of vital social contribution. The trust aims to provide comprehensive mental health care for the needy and deserving, and also undertake programs to educate society about the attitudinal changes required regarding mental health.

ALL INDIA WOMEN'S CONFERENCE (AIWC)

AIWC was founded in 1927 "to function as an organization dedicated to the upliftment and betterment of women and children". The organization is continuing its mission. AIWC today has over 1, 56,000 members in more than 500 branches of AIWC across the country. It is recognized as a premier organization working for women's development and empowerment.

The main objectives of the organization are:

- To work for a society based on the principle of social justice, personal integrity and equal rights and opportunities for all.
- To secure recognition of the inherent right of every human being to work and to achieve the essentials of life, which should not be determined by accident of birth or sex but by planned social distribution
- To support the claim of every citizen to the right to enjoy basic civil liberties
- To stand against all separatist tendencies and to promote greater national integration and unity
- To work actively for the general progress and welfare of women and children and to help women utilize to the fullest, the Fundamental Right conferred on them by the Constitution of India
- To work for permanent international amity and world peace

PRAGATI

Pragati is a voluntary organization devoted primarily to education of urban children, the jhuggi-jhopri dwellers. It also looks after healthcare and general upliftment of these children and their environment. Pragati teaches children through loving care and help with books, food, school uniform and all.

THE HIND KUSHT NIVARAN SANGH

Objectives

- To eradicate and control the disease and assist the leprosy affected persons in their social and economic rehabilitation.
- To establish co-ordination amongst all the organizations working in the field of leprosy in Delhi, and to render them necessary help whenever desired.
- To provide services for the treatment of leprosy and conduct research on the socio, psycho and economic conditions of the patients.
- To educate the patients and students in particular and the public at large about the various aspects of the disease and the plight of leprosy affected persons
- To establish institutions, clinics and hospitals for the control and treatment of leprosy.
- To provide information and treatment of leprosy from India.
- To provide clinical treatment of leprosy.

National Health Programs

Government of India has undertaken several measures to improve the health of the people, prominent among these are the National Health Programs. The Ministry of Health and Family Welfare has been facilitating health needs in India by establishing various schemes and organizations.

List of National Health Programs of India

1. National Vector Borne Disease Control Program (NVBDCP).

2. National Iodine Deficiency Disorders Control Program.
3. National Leprosy Eradication Program.
4. National Program for Control of Blindness.
5. National Filaria Control Program.
6. National Program for Prevention and Control of Deafness.
7. National Cancer Control Program.
8. National Aids Control Program.
9. Universal Immunization Program.
10. Revised National TB Control Program.
11. National Mental Health Program.
12. Reproduction and Child Health Program.
13. National Guinea Worm Eradication Program.
14. National Diabetes Control Program.
15. National Surveillance Program for Communicable Diseases.
16. National Family Welfare Program.
17. National Water Supply and Sanitation Program.
18. Minimum Needs Program.
19. 20-Point Program.
20. National Tobacco Control Program.
21. Pilot Program on Prevention and Control of Diabetes, CVD and Stroke.

National Program for Control of Blindness

National Program for Control of Blindness was launched in the year 1976 as a 100 percent centrally sponsored scheme with the goal to reduce the prevalence of blindness from 1.4 percent to 0.3 percent.

Program Objectives

a. Develop Eye Care infrastructure throughout the country.
b. Increase institutional capacity for eye care.
c. Expand coverage to underserved areas.
d. Decentralization to district level.
e. Human Resource Development for Eye Care at all levels.
f. Improvement in quality of eye care for better visual outcome.
g. Secure participation of non-government and private sector.

National Aids Control Program

National AIDS Control Organization is a division of the Ministry of Health and Family Welfare that provides leadership to HIV/AIDS control program in India through 35 HIV/AIDS Prevention and Control Societies. In 1986, following the detection of the first AIDS case in the country, the National AIDS Committee was constituted in the Ministry of Health and Family Welfare. In 1992 India's first National AIDS Control Program (1992-1999) was launched, and National AIDS Control Organization (NACO) was constituted to implement the program. The objective of NACP-I (1992-1999) was to control the spread of HIV infection National AIDS Control Program - II has two key objectives namely:

1. To reduce spread of HIV infection in India, and
2. Strengthen India's capacity to respond to HIV/AIDS on a long term basis.

National Cancer Control Program

In 1975-76 National Cancer Control Program was launched with priorities given for equipping the premier cancer hospital/institutions.

Goals and Objectives of NCCP

1. Primary prevention of cancers by health education especially regarding hazards of tobacco consumption and necessity of genital hygiene for prevention of cervical cancer.
2. Secondary prevention i.e. early detection and diagnosis of cancers, for example, cancer of cervix, breast and of the oro-pharyngeal cancer by screening methods and patient's education on self-examination methods.
3. Strengthening of existing cancer treatment facilities, which are woefully inadequate.
4. Palliative care in terminal stage of the cancer.

National Leprosy Eradication Program

Government of India launched the **National Leprosy Control Program** in 1955 based on Dapsone mono therapy. Multi Drug Therapy (MDT) came into wide use from 1982 and the Program was re-designated the **National Leprosy Eradication Program** (NLEP) in 1983. The program was expanded with World Bank assistance and the 1st phase of the World Bank supported National Leprosy Elimination Project started from 1993-94 and ended in March 2000. The 2nd phase of World Bank supported National Leprosy Elimination Project started from April 2001 and ended successfully in December 2004

National Iodine Deficiency Disorders Control Program

National Iodine Deficiency Disorders control program aims at bringing down the prevalence of Iodine Deficiency Disorders (IDD) to below 10 percent in all the districts of the country.

Iodine deficiency results in abortion, stillbirth, mental retardation, deaf-mutism, squint, dwarfism, goiter, neuromotor defects, etc. More than 1.5 billion population of the World are at the risk from Iodine Deficiency Disorders (IDD) out of which about 200 million people are in India.

The Government had launched a 100 percent centrally assisted National Goiter Control Program (NGCP) in 1962 with the following objectives:-

i .Surveys to assess the magnitude of the Iodine Deficiency Disorders.
ii. Supply of iodated salt in place of common salt.

iii. Resurveys to assess iodine deficiency disorders and the impact of iodated salt after every five years.
iv. Laboratory monitoring of iodated salt and urinary iodine excretion.
v. Health Education and Publicity.

The National Goiter control program (NGCP) was renamed **as National Iodine Deficiency Disorders Control Program** (NIDCCP) in August, 1992 with a view of wide spectrum of Iodine Deficiency Disorders.

National Mental Health Program

To mitigate the hardship of mentally ill patients the National Mental Health Program was started in 1982.

As decided in the meeting of the Central Council of Health in 1995 and as recommended by the workshop of all the Health Administrators of the Country held in February, 1996, the District Mental Health Program was launched in 1996-97 in four districts, one each in Andhra Pradesh, Assam, Rajasthan and Tamil Nadu.

The program envisages a Community based approach to the problem, which includes:-

i. Training of the mental health team at the identified nodal institutes within the State,
ii. Increase awareness about mental health problems,
iii. Provide services for early detection and treatment of mental illness in the community itself with both OPD and indoor treatment and follow-up of discharge cases, and
iv. Provide valuable data and experience at the level of community in the State and Center for future planning, improvement in service and research.

Oral Health Care System in India

The oral health care system is intended to deliver the oral health care services in India.

These are

Public health sectors
- Government Dental Colleges
- Government Medical Colleges with Dental wings
- District hospitals
- Community Health Centers
- Primary Health Centers

Non-governmental organizations
- Private Dental Colleges
- Private Medical Colleges with Dental wings
- Corporate Hospitals with Dental Department
- Charitable Hospital with Dental Units

Private practice
- Private Dental Practitioners
- Private Dental Hospitals
- Private Medical Hospital with Dental Units

Indigenous system
- Ayurveda
- Sidda
- Unani
- Homeopathy

Chapter 6

Primary Health Care

CM Marya

CONCEPT OF PRIMARY HEALTH CARE

The conventional health model based on symptoms and diseases and treatment and cure, which incurred substantial cost, was questioned by as many as social, political, economical, educational and psychological determinants of health, were not considered. There was a rise in chronic diseases like drug addiction, alcoholism, cardiovascular diseases, etc. Hence issues like dependency, poverty and lifestyles were linked with health status. Primary health care is hence described as "health by the people and placing people's health in people's hands". It is not merely the first level of contact by individual, the family and community with the national health system. Primary health care approach integrates at the community level all the factors required for improving the health status of the population. The concept of primary health care came into existence in 1978 following a joint WHO-UNICEF international conference of Alma-Ata in the former Soviet-Union. The conference called for acceptance of the WHO goal of "health for all by 2000AD" and primary health care was accepted as the key to achieve the goal of Health for all by 2000 AD.

The existing gross inequalities in the health status of people particularly between developed and developing countries as well as within the countries was politically , socially and economically unacceptable. It is based on the principles of equity, wider coverage, individual and community involvement and intersectoral coordination.

The proportion of primary care physicians varies by country—for example, in Great Britain, it is 80 percent, in the United States, it is 32 percent. Primary care physicians in the United States consist of family or general practice physicians, general internists, and general pediatricians. Some primary care may be delivered by specialists, especially obstetricians, gynecologists, but it is not the focus of their practice. In the United States, primary care is also delivered by nurse practitioners and physician assistants. Considering all sources of primary care, there is still a lack of primary care providers in many areas of the country, particularly in the inner city and rural areas. Primary care clinicians may be physicians, nurses, or various other health workers trained for the purpose. Countries with better provision of primary health care have greater patient satisfaction at lower costs and better health indicators. Primary health care should be available to all people without the barriers of geography, cost, language, or culture. In primary care, all types of problems, at all ages and for both genders, are considered, including care for acute self-limited problems or injuries, the care of chronic diseases such as diabetes or AIDS (acquired immunodeficiency syndrome), the provision of preventive care services such as immunizations and family planning, and health education.

ORIGIN OF PRIMARY HEALTH CARE

From the late 1960s, there was an increase in WHO projects related to the development of "basic health services" (from 85 in 1965 to 156 in 1971). These projects were the institutional predecessors of the primary health care programs that would later appear. Another important inspiration for primary health care was the global popularity that the massive expansion of rural medical services in Communist China experienced, especially the "barefoot doctors." This visibility coincided with China's entrance into the United Nations (UN) system (including the WHO). The "barefoot doctors," whose numbers increased dramatically between the early 1960s and the Cultural Revolution (1964-1976), were a diverse array of village health workers who lived in the community they served, stressed rural rather than urban health care and preventive rather than curative services, and combined Western and traditional medicines.

The agreement produced in 1975 a joint WHO-UNICEF report, *Alternative Approaches to Meeting Basic Health Needs in Developing Countries* that was widely discussed by these agencies. The term "alternative" underlined the shortcomings of traditional vertical programs concentrating on specific diseases. In addition, the assumption that the expansion of "Western" medical systems would meet the needs of the common people was again highly criticized. According to the document, the principal causes of morbidity in developing countries were

malnutrition and vector-borne, respiratory, and diarrheal diseases, which were "themselves the results of poverty, squalor and ignorance". The report also examined successful primary health care experiences in Bangladesh, China, Cuba, India, Niger, Nigeria, Tanzania, Venezuela, and Yugoslavia to identify the key factors in their success.

This report shaped WHO ideas on primary health care. The 28th World Health Assembly in 1975 reinforced the trend, declaring the construction of "National Programs in primary health care" a matter "of urgent priority". The report *Alternative Approaches* became the basis for a worldwide debate. In the 1976 World Health Assembly, proposed the goal of "Health for All by the Year 2000". The slogan became an integral part of primary health care.

ALMA-ATA

The landmark event for primary health care was the International Conference on Primary Health Care that book place at Alma-Ata from September 6 to 12, 1978. Alma-Ata was the capital of the Soviet Republic of Kazakhistan, located in the Asiatic region of the Soviet Union. The conference's main document, the Declaration of Alma-Ata, which was already known by many participants, was approved by acclamation. The term "declaration" suggested high importance, like other great declarations of independence and human rights. The intention was to create a universal and bold statement. This was certainly unusual for a health agency used to compromise resolutions. The slogan "Health for All by the Year 2000" was included as a prospective view.

Three key ideas permeate the declaration: "appropriate technology," opposition to medical elitism, and the concept of health as a tool for socioeconomic development.

Criticism of Alam-Ata Declaration

The Alma-Ata Declaration was criticized for being too broad and idealistic and having an unrealistic timetable. A common criticism was that the slogan "Health for all by 2000" was not reasible.

Concept of Primary Health Care in India

The concept and guidelines for national health planning were provided by a number of committees appointed by the government of India from time to time to review the existing health measure and to recommend measures for further action.

The government of India in 1943 appointed the Health Survey and development committee with Sir Joseph Bhore as its chairman, to survey and assess the existing health conditions and health care facilities and to make recommendations for future development. The committee met regularly for 2 years and submitted its report in 1946 which is famously known as **Bhore Committee Report.**

The committee conceptualized the development of primary health centers in 2 stages. (a) as short-term measure—it was proposed to have each primary health centers in rural areas to cater to a population of about 40,000 with a secondary health center to serve as a supervisory, coordination and referral center. (b) a long-term program of setting up primary health units with 75-bedded hospitals for each 10,000 to 20,000 population and secondary units with 650 bedded hospitals.

Although the Bhore committees recommendations did not form part of a comprehensive plan for national socioeconomic development, the committee's report continues to be a guideline for national planning in India.

The Alma-Ata declaration on primary health care and the national policy of the government gave a new direction to health planning in India, making the primary health care a central function and main focus of its national health system. The goal of national health planning in India was to attain Health for All by the year 2000.

Definition

Primary health care [PHC] is essential health care based on practical, scientifically sound and socially acceptable methods and technology made universally accessible to individuals and families in the community through their full participation and at a cost that the community and country can afford to maintain at every stage of their development in the spirit of self reliance and self determination. (WHO/ UNICEF 1978)

COMPONENTS OF PRIMARY HEALTH CARE

The Alma-Ata declaration has outlined a number of activities which are essential.

1. Education is about prevailing health problems and the methods of preventing and controlling them.
2. Promotion of food supply and proper nutrition.
3. Adequate supply of safe water and basic sanitation.
4. Maternal and child health care, including family planning.
5. Immunization against the major infectious diseases.
6. Appropriate treatment of common diseases and injuries.
7. Provision of essential drugs.
8. Prevention and control of locally endemic diseases.

Principles of Primary Health Care (Fig. 6.1)

1. *Equitable distribution*
   Government must endeavor to distribute equitably those variables which influence health. *Inequity* refers to difference that are unnecessary and unavoidable and that are also unfair and unjust. *Equity* is concerned with creating equal opportunities for health and bringing health differentials down to the lowest possible levels.

   Health services must be shared equally by all people irrespective of their ability to pay, and all people either rich or poor, urban or rural must have access to health services. Bringing these services to as near as possible to people could help in achieving these goals.

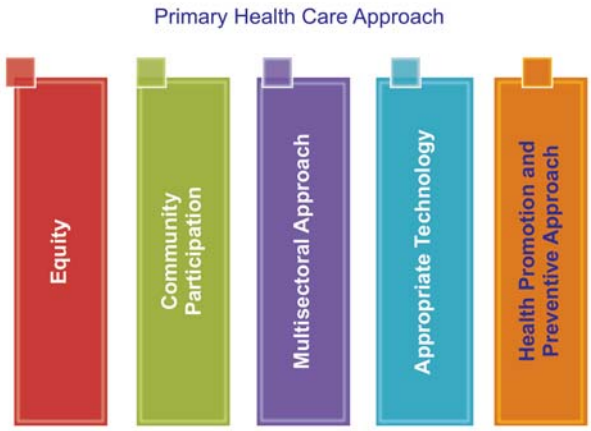


Fig. 6.1: The 5 pillars of primary health care

2. *Community involvement/participation*
   A fundamental element of PHC is input by non-professional community members. Failing to involve communities in ways that are based on their own cultures, values and experiences has doomed many health initiatives. For programs to be appreciated and used, they have to be relevant. It is more effective to begin work in a community, dealing with the issues which community members have identified as important, rather than beginning with predetermined services. It is better to make use of local resources such as manpower, money, materials and involve local community in planning and implementation of health services. Village health guides and dais are being used effectively in rendering primary health care in India.
3. *Focus on prevention and health promotion*
   The focus of health planners and funding must shift from medical/dental care to prevention and health promotion. At the heart of health promotion is empowerment, which is achieved when people are enabled to set their priorities, make decisions, plan and implement their own strategies for achieving health.

   Not being in control is recognized as a risk factor for disease, whereas empowerment has shown to be an important promoter of health.
4. *Appropriate technology*
   Emphasis should be on the most appropriate technology and personnel to deal with problems. *Appropriate technology* has been defined as "technology that is scientifically sound, adaptable to local needs and acceptable to those who apply it and those for whom it is used, and that can be maintained by the people themselves in keeping with the principle of self reliance with the resources, the community and country can afford". Appropriate refers to not making use of costly equipment, procedures, techniques and infrastructure when cheaper scientifically valid and acceptable ones are available.

   Atraumatic Restorative Treatment [ART] technique offers a minimal threatening treatment for caries at an early stage and at low cost, as it can be provided where electricity is not available or where it is not possible to afford and maintain expensive dental equipments. Use of neem stick is used in rural areas of India and Africa.
5. *Multisectoral approach*
   A major reason for the lack of success of many oral health programs is the fact that they operate in isolation, i.e. separate from the general health care structure. Solution to ill-health cannot be solved only by the health sector. Social, economical, agriculture and educational sector must coordinate policies that affect health.

   Oral health can be better integrated into general health programs by tackling common causes, by including oral health in general health education. For example, smoking effects heart disease, respiratory disease and oral disease, hence dental and medical health workers should both support and compliment each other in programs aimed at reducing tobacco smoking.

Implications

Four implications are proposed:

1. *Pursue Partnership*
   Equity cannot be achieved by dentists and related personnel in isolation. Cooperation with other sector that influences oral health like education, nutrition, environment, social welfare, etc. is needed. For dental personnel really to pursue Primary Oral Health Care [POHC] they need to make partnership with people and hence contribute to the overall development of the community.
2. *Evaluation and Research*
   Evaluation and research with local people helps in gaining important information which helps in taking appropriate actions. This makes the dental personnel to work on their own with the community and hence accountable to the community. Also it helps to accept responsibility and evaluate the progress made time to time and make wise decisions for future course of action.
3. *Reform Existing Pedagogy*
   The basic concept that "health is something to be delivered" has to be changed to "it is something to be achieved". It is usually believed that change in attitude in lay people is difficult to accomplish. But it is seen that it is more difficult to modify the attitudes and approaches of the professionals. Probably because their training does not prepare them to easily adopt or work with people. So for POHC, the training for the dental personnel has to be modified and preparation has to be radically different.
4. *Begin With Self*
   Time, temperament and trust are the ingredients for initiating and sustaining community work. Time is needed for community empowerment. Necessary also is an orientation that one can learn from community people and

that power to the people is desirable. Trust means believing, over time and with support people are capable of analyzing their own situations and deciding what is best for them. So a professional needs to take the initiative or the first step if he really wants to pursue equity and promote oral health in community.

DECLARATION OF ALMA-ATA

International Conference on Primary Health Care, Alma-Ata, USSR, 6-12 September 1978.

The International Conference on Primary Health Care, meeting in Alma-Ata this twelfth day of September in the year Nineteen hundred and seventy eight, expressing the need for urgent action by all governments, all health and development workers, and the world community to protect and promote the health of all the people of the world, hereby makes the following.

Declaration

i. The Conference strongly reaffirms that health, which is a state of complete physical, mental and social wellbeing, and not merely the absence of disease or infirmity, is a fundamental human right and that the attainment of the highest possible level of health is a most important worldwide social goal whose realization requires the action of many other social and economic sectors in addition to the health sector.

ii. The existing gross inequality in the health status of the people particularly between developed and developing countries as well as within countries is politically, socially and economically unacceptable and is, therefore, of common concern to all countries.

iii. Economic and social development, based on a New International Economic Order, is of basic importance to the fullest attainment of health for all and to the reduction of the gap between the health status of the developing and developed countries. 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.

iv. The people have the right and duty to participate individually and collectively in the planning and implementation of their health care.

v. Governments have a responsibility for the health of their people which can be fulfilled only by the provision of adequate health and social measures. A main social target of governments, international organizations and the whole world community in the coming decades should be the attainment by all peoples of the world by the year 2000 of a level of health that will permit them to lead a socially and economically productive life. Primary health care is the key to attain this target as part of development in the spirit of social justice.

vi. Primary health care is essential health care based on practical, scientifically sound and socially acceptable methods and technology made universally accessible to individuals and families in the community through their full participation and at a cost that the community and country can afford to maintain at every stage of their development in the spirit of self-reliance and self-determination. It forms an integral part both of the country's health system, of which it is the central function and main focus, and of the overall social and economic development of the community. It is the first level of contact of individuals, the family and community with the national health system bringing health care as close as possible to where people live and work, and constitutes the first element of a continuing health care process.

vii. Primary health care:
   1. Reflects and evolves from the economic conditions and sociocultural and political characteristics of the country and its communities and is based on the application of the relevant results of social, biomedical and health services research and public health experience.
   2. Addresses the main health problems in the community, providing promotive, preventive, curative and rehabilitative services accordingly.
   3. Includes at least education concerning prevailing health problems and the methods of 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, and provision of essential drugs.
   4. Involves, in addition to the health sector, all related sectors and aspects of national and community development, in particular agriculture, animal husbandry, food industry, education, housing, public works, communications and other sectors, and demands the coordinated efforts of all those sectors.
   5. Requires and promotes maximum community and individual self-reliance and participation in the planning, organization, operation and control of primary health care, making fullest use of local, national and other available resources, and to this end develops through appropriate education the ability of communities to participate.
   6. Should be sustained by integrated, functional and mutually supportive referral systems, leading to the progressive improvement of comprehensive health care for all, and giving priority to those most in need.
   7. Relies, at local and referral levels, on health workers, including physicians, nurses, midwives, auxiliaries and community workers as applicable, as well as traditional practitioners as needed, suitably trained socially

and technically to work as a health team and to respond to the expressed health needs of the community.

viii. All governments should formulate national policies, strategies and plan of action to launch and sustain primary health care as part of a comprehensive national health system and in coordination with other sectors. To this end, it will be necessary to exercise political will, to mobilize the country's resources and to use available external resources rationally.

ix. All countries should cooperate in a spirit of partnership and service to ensure primary health care for all people since the attainment of health by people in any one country directly concerns and benefits every other country. In this context the joint WHO/UNICEF report on primary health care constitutes a solid basis for the further development and operation of primary health care throughout the world.

x. An acceptable level of health for all the people of the world by the year 2000 can be attained through a fuller and better use of the world's resources, a considerable part of which is now spent on armaments and military conflicts. A genuine policy of independence, peace, détente and disarmament could and should release additional resources that could well be devoted to peaceful aims and in particular to the acceleration of social and economic development of which primary health care, as an essential part, should be allotted its proper share.

The International Conference on Primary Health Care calls for urgent and effective national and international action to develop and implement primary health care throughout the world and particularly in developing countries in a spirit of technical cooperation and in keeping with a New International Economic Order. It urges governments, WHO and UNICEF, and other international organizations, as well as multilateral and bilateral agencies, nongovernmental organizations, funding agencies, all health workers and the whole world community to support national and international commitment to primary health care and to channel increased technical and financial support to it, particularly in developing countries.

The Conference calls on all the aforementioned to collaborate in introducing, developing and maintaining primary health care in accordance with the spirit and content of this Declaration.

Primary Health Care System In India

The Primary Health Care Infrastructure has been developed as a three tier system with Subcenter, Primary Health Center (PHC) and Community Health Center (CHC) being the three pillars of Primary Health Care System. Progress of Subcenters, which is the most peripheral contact point between the Primary Health Care System and the community, is a prerequisite for the overall progress of the entire system

The health care infrastructure in rural areas has been developed as a three tier system (Table 6.1) and each health center is based on the following population norms:

Type of center population norms

Table 6.1: Distribution of health centers based on population

	Plain area	*Hilly/tribal/ difficult area*
Subcenter	5000	3000
Primary health center	30,000	20,000
Community health center	1,20,000	80,000

Rural Health Care System in India

It is based on three tier system, which includes a subcenter as the 1st point of contact, the primary health center and community health center (Fig. 6.2).

Subcenters (SCs)

The subcenter is the most peripheral and first contact point between the primary health care system and the community. Each subcenter is manned by one Auxiliary Nurse Midwife (ANM) and one Male Health Worker/ MPW(M) (for details of staffing pattern (Box 6.1). One Lady Health Worker (LHV) is entrusted with the task of supervision of six subcenters. Subcenters are assigned tasks relating to interpersonal communication in order to bring about behavioral change and provide services in relation to maternal and child health, family welfare, nutrition, immunization, diarrhea control and control of communicable diseases programs. The subcenters are provided with basic drugs for minor ailments needed for taking care of essential health needs of men, women and children.

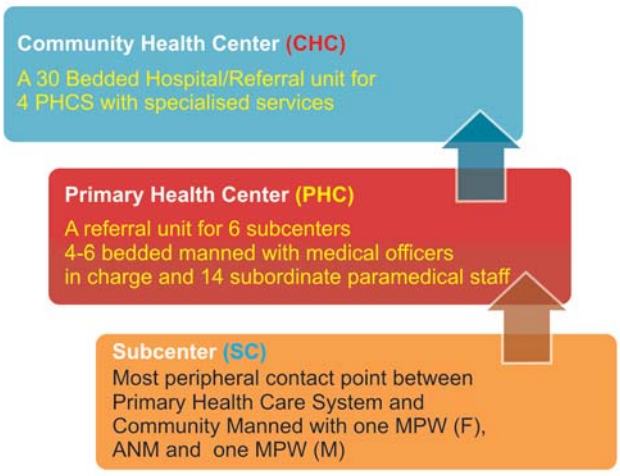


Fig. 6.2: Rural health care system in India

Primary Health Centers (PHCs)

PHC is the first contact point between village community and the Medical Officer. The PHCs were envisaged to provide an integrated curative and preventive health care to the rural population with emphasis on preventive and promotive aspects of health care. The PHCs are established and maintained by the State Governments under the Minimum Needs Program (MNP)/ Basic Minimum Services Program (BMS). At present, a PHC is manned by a Medical Officer supported by 14 paramedical and other staff (Box 6.1). It acts as a referral unit for 6 Subcenters. It has 4-6 beds for patients. The activities of PHC involve curative, preventive, primitive and Family Welfare Services. There are 22,370 PHCs functioning as on March 2007 in the country.

Community Health Centers (CHCs)

CHCs are being established and maintained by the State Government. It is manned by four medical specialists, i.e. Surgeon, Physician, Gynecologist and Pediatrician supported by 21 paramedical and other staff. It has 30 in-door beds with one OT, X-ray, Labor Room and Laboratory facilities. It serves as a referral center for 4 PHCs and also provides facilities for obstetric care and specialist consultations. As on March, 2007, there are 4,045 CHCs functioning in the country.

Functions of PHc:

1. Medical care.
2. MCH including family planning.
3. Safe water supply and basic sanitation.
4. Prevention and control of locally endemic diseases.
5. Collection and reporting of vital statistics.
6. Education about health.
7. National health programs.
8. Referral services.
9. Training of health guides, health workers, local dais and health assistants.
10. Basic laboratory services.

BOX 6.1: STAFFING PATTERN IN VARIOUS HEALTH CENTERS

A. STAFF FOR SUBCENTER: NUMBER OF POSTS

1.	Health Worker (Female)/ ANM	1
2.	Health Worker (male)	1
3.	Voluntary Worker (Paid @Rs. 100/-p.m. as honorarium)	1
	Total	**3**

B. STAFF FOR NEW PRIMARY HEALTH CENTER

1.	Medical Officer	1
2.	Pharmacist	1
3.	Nurse Mid- Wife (Staff Nurse)	1
4.	Health Worker (Female)/ ANM	1
5.	Health Educator	1
6.	Health Assistant (Male)	1
7.	Health Assistant (Female)/LHV	1
8.	Upper Division Clerk	1
9.	Lower Division Clerk	1
10.	Laboratory Technician	1
11.	Driver (Subject to availability of Vehicle)	1
12.	Class IV	4
	Total	**15**

C. STAFF FOR COMMUNITY HEALTH CENTER

1.	Medical Officer #	4
2.	Nurse Mid-wife (Staff Nurse)	7
3.	Dresser	1
4.	Pharmacist/ Compounder	1
5.	Laboratory Technician	1
6.	Radiographer	1
7.	Ward Boys	2
8.	Dhobi	1
9.	Sweepers	3
10.	Mali	1
11.	Chowkidar	1
12.	Aya	1
13.	Peon	1
	Total	**25**

#: Either qualified or specially trained to work as surgeon, Obstetrician, Physician and Pediatrician. One of the existing Medical Officers similarly should be either qualified or specially trained in Public Health.

Chapter 7

Health Agencies of the World

CM Marya

INTRODUCTION

Almost the entire cost of health care in the developing world is borne by the developing countries themselves. According to two separate estimates, aid from International Health Organizations in the developed countries pays for less than 5 percent of the total health care costs in the developing world. The estimates do not specify exactly what they include as health aid, but they probably exclude the value of food relief and other health-related disaster relief, as well as money spent on water supply and sanitation projects, although these activities have important health benefits. Nor do they seem to include the work done in the home offices of international health organizations, e.g. the publication of manuals for health care workers in developing countries, the development of model health care systems, the strategic planning for campaigns against tropical diseases.

Finally these estimates omit the monetary value of the following: the labor of volunteer health workers, research in tropical diseases done at medical institutions in the industrialized countries, drug development for tropical diseases by major pharmaceutical firms, and the development of equipment by international companies for use in poor countries. Even if all these items were counted, however, the total value of the aid from abroad would still account for much less than 10 percent of the total health expenditures in the developing world.

Nevertheless, it is important to note that, in the very poorest countries, the percentage of health care costs donated by the developed world is considerably greater than the 5 percent average.

Although, the aid given to the developing world as a whole is relatively small in financial terms, it can be of crucial importance. Research and pilot programs sponsored by agencies from the industrial nations have generated many of the best ideas for improving health in developing countries. Also, the international health organizations are a major source of expert technical advice and training for local health professionals. These organizations produce the key textbooks in tropical health, as well as the most important manuals for health care workers.

A large number of organizations of various sizes provide international health aid. The exact roles played by these organizations can be confusing at times, even to professionals in this field. What follows is a description of the functions of the largest International Health Organizations. After a look at the major organizations providing long-term health care, the focus shifts to those that specialize in giving aids to victims of war, famines and natural disasters.

Organizations Providing Long-term Health Care

International Health Organizations are usually divided into three groups: Multilateral organizations, bilateral organizations, *and* Nongovernmental Organizations (NGOs).

Multilateral Organizations

The term multilateral means that funding comes from multiple governments (as well as from nongovernmental sources) and is distributed to many different countries. The major multilateral organizations are all part of the United Nations.

The World Health Organization (WHO) is the premier International Health Organization. Technically it is an "intergovernmental agency related to the United Nations". WHO and other such intergovernmental agencies are "separate, autonomous organizations which, by special agreements, work with the UN and each other through the coordinating machinery of the Economic and Social Council". According to its constitution (1948) its principal goal is "the attainment by all peoples of the highest possible level of health".

The principal work of WHO is directing and coordinating international health activities and supplying technical assistance to countries. It develops norms and standards, disseminates health information, promotes research, provides training in international health, collects and analyzes epidemiologic data, and develops systems for monitoring and evaluating health programs.

The Pan-American Health Organization (PAHO) serves as the regional field office for WHO in America and, since it

predates WHO, carries on some additional autonomous activities.

The World Bank is the other major "intergovernmental agency related to the UN" heavily involved in international health. The World Bank loans money to poor countries on advantageous terms not available in commercial markets. The amount of money loaned to developing countries for human resources development, i.e. health and education, has increased steadily over the past 10 years.

Three subsidiary agencies of the UN Economic and Social Council are heavily committed to international health programs.

The United Nation Children's Fund (UNICEF) spends the majority of its program (non-administrative) budget on health care. UNICEF makes the world's most vulnerable children its top priority, so it devotes most of its resources to the poorest countries and to children younger than 5. UNICEF runs many of the child health programs in cooperation with WHO.

The United Nations Population Fund (UNFPA) concerned with family planning programs. Priority is based on rate of population growth and poverty.

The United Nation Development Program (UNDP) focus is on health, education, employment. Its major health concerns are AIDS, maternal and child nutrition, and excessive maternal mortality. In conjunction with WHO and the World Bank it sponsors the special program for Research and Training in Tropical Diseases (TDR).

Bilateral Agencies

Bilateral agencies are governmental agencies in a single country which provide aid to developing countries. The largest of these is the United States Agency for International Development (USAID). Most of the industrialized nations have a similar governmental agency. Political and historical reasons often determine which countries receive donations from bilateral agencies and how much they receive. For example, France concentrates on its former colonies and Japan gives mostly to developing countries in Asia. USAID channels most of this aid through "cooperating agencies"—private international health agencies which contract with USAID.

Nongovernmental Organizations

Nongovernmental Organizations (NGOs), also known as private voluntary organizations (PVOs), provide approximately 20 percent of all external health aid to developing countries. Most of these organizations are quite small; many are church-affiliated. In the very poorest countries, hospitals and clinics run by missionary societies are especially important. The largest NGO devoted to international health in the United States is Project Hope, with an annual budget exceeding $100 million. Worldwide, the most important NGO in long-term international health is probably Oxfam International. Founded in the United Kingdom in 1943, it now affiliates in 10 other countries, including the United States.

INTERNATIONAL RED CROSS AND RED CRESCENT MOVEMENT

The International Red Cross and Red Crescent Movement is the largest and most prestigious of the world's humanitarian NGOs. It has three components: The International Committee of the Red Cross (ICRC); the International Federation of Red Cross and Red Crescent Societies; the Individual National Red Cross societies, e.g. the American Red Cross. The seven fundamental principles of the movement are: Humanity; impartiality; neutrality; independence, i.e. autonomy vis-à-vis national governments; voluntary service; unity, i.e. for each country only one national society, open to all and serving the entire country; universality.

The ICRC is a Swiss organization, founded in 1863 and mandated by the Geneva conventions to protect and assist prisoners of war and civilians in international armed conflicts. It may also offer its services in civil wars. Its functions include: Visiting and treating prisoners of war and political detainees and providing them with a communication service with the outside world; setting up surgical hospitals or providing expatriate teams to work in existing hospitals; providing other types of medical assistance and relief, especially rehabilitation of war-disabled patients; development and dissemination of educational materials concerning health care of prisoners and victims of war. In regard to this last function, the book "Surgery for Victims of War" is especially well-known.

The International Federation of Red Cross and Red Crescent Societies receive its principal support from the individual national societies. Its main mission is to provide disaster relief. It works closely with the national Red Cross Societies in the affected countries. In addition, it issues international appeals for emergency aid and often serves as the organizing agency for the relief efforts of smaller organizations.

Medecins Sans Frontieres (MSF)

Like the Red Cross, Medecins Sans Frontieres (MSF) provides health aid to victims of war and natural disasters. Differences between Red Cross and MSF are that unlike the Red Cross, MSF is willing to enter war-torn areas without the permission of authorities. Another difference is that MSF, considers one of its functions to be speaking out on human rights abuses. Usually, this speaking out consists of drawing attention to cases of human rights violations that MSF considers under-reported. Founded in 1971 in France, MSF now has six operational centers in Europe and 13 delegate offices throughout the developed world. In addition to aiding in acute disasters, MSF also provides aid in "chronic emergencies" (e.g. Somalia, Sudan), assists in several long-term health projects, and publishes a series of field manuals/texts on disaster medicine.

CARE USA

Founded in 1946 to provide aid to war-devastated Europe, CARE USA is best known for providing food relief in the form

of "care-packages", but the activities of CARE have expanded greatly over the past 50 years. CARE focuses on emergency aid and on a variety of development projects in the fields of small business support, population, agriculture and environment , and health and nutrition. In disasters, CARE has special expertize in transportation of supplies and logistics. Since 1980, affiliated CARE agencies have been established in 10 countries, leading to the creation of CARE International, headquartered in Brussels.

Catholic Relief Services (CRS)

It specializes in providing food relief. It spends its revenue mainly on food and ocean freight, disaster relief, development assistance, general welfare, and refugee relief and resettlement. CRS works closely with Caritas, the international organization of Catholic charities.

REFUGEE AND DISASTER RELIEF ORGANIZATIONS

In most natural disasters, e.g. earthquakes, floods, volcanic eruptions, the majority of deaths occur in the first few hours or days, and likewise most of the lives that are saved early and saved by local efforts at disaster relief. A major disaster, however, can overwhelm the resources of a poor country and, by destruction of an already somewhat tenuous economic and social infrastructure, set the stage for famines and epidemics. The aid provided by international relief organizations in the days immediately following the disaster can play a major role in averting health crises and re-establishing a functioning society.

In contrast to natural disasters, famines and refugee crises tend to develop slowly, often preceded by warning signs of the impending emergency, so that international agencies can coordinate relief efforts with national agencies in a timely fashion. The United Nations agencies are probably the most important of the international relief organizations, but there are several very large NGOs active in refugee and disaster relief. Two of these, the International Committee of the Red Cross (ICRC) and Medecins Sans Frontieres, perform special functions.

World Food Program (WFP)

The World Food Program (WFP) supplies food relief in disasters and coordinates the activities of NGOs involved in food relief, as well as assisting them with transportation and logistics.

UN High Commissioner for Refugees (UNHCR)

The office of the UN High Commissioner for Refugees (UNHCR) provides international protection to refugees and also attempts to find long-lasting solutions to their problems. UNHCR is the major international organization for the world's 20 million refugees. It aids refugees directly and coordinates the work of NGOs involved in refugee relief. Although, it has no formal authority over displaced persons, upon request of the UN General Assembly and the Secretary General, UNHCR has provided assistance to displaced persons in such countries as Bosnia and Herzegovina, Somalia, and Rwanda in recent years.

Food and Agriculture Organization (FAO)

Another UN organizations involved in relief work is the Food and Agriculture Organization (FAO). Like the World Bank and WHO it is technically an "intergovernmental agency related to the UN". It helps developing countries prepare for famine through its global information and early warning system and its food security assistance scheme, which helps developing countries set up national food reserves. In disasters its principal role is to assist in the re-establishment of agricultural production.

International Organizations

- World Health Organization
- Pan-American Health Organization
- Food and Agriculture Organization
- The United Nations Development Program
- The Pan American Health and Education Foundation
- International Committee of the Red Cross
- The World Bank
- United Nations Population Fund
- Cooperative for American Relief Everywhere
- The Rockefeller Foundation
- The Ford Foundation
- World Trade Organization

WHO [WORLD HEALTH ORGANIZATION]

WHO is the directing and coordinating authority for health within the United Nations system. It is responsible for providing leadership on global health matters, shaping the health research agenda, setting norms and standards, articulating evidence-based policy options, providing technical support to countries and monitoring and assessing health trends.

The WHO Agenda

WHO operates in an increasingly complex and rapidly changing landscape. The boundaries of public health action have become blurred, extending into other sectors that influence health opportunities and outcomes. WHO responds to these challenges using a six-point agenda. The six-points address two health objectives, two strategic needs, and two operational approaches.

1. *Promoting development:* During the past decade, health has achieved unprecedented prominence as a key driver of socioeconomic progress, and more resources than ever

are being invested in health. Yet poverty continues to contribute to poor health, and poor health anchors large populations in poverty. Health development is directed by the ethical principle of equity: Access to life-saving or health-promoting interventions should not be denied for unfair reasons, including those with economic or social roots. Commitment to this principle ensures that WHO activities aimed at health development give priority to health outcomes in poor, disadvantaged or vulnerable groups. Attainment of the health-related millennium development goals, preventing and treating chronic diseases and addressing the neglected tropical diseases are the cornerstones of the health and development agenda.

2. *Fostering health security:* Shared vulnerability to health security threats demands collective action. One of the greatest threats to international health security arises from outbreaks of emerging and epidemic-prone diseases. Such outbreaks are occurring in increasing numbers, fuelled by such factors as rapid urbanization, environmental mismanagement, the way food is produced and traded, and the way antibiotics are used and misused. The world's ability to defend itself collectively against outbreaks has been strengthened since June 2007, when the revised international health regulations came into force.
3. *Strengthening health systems:* For health improvement to operate as a poverty reduction strategy, health services must reach poor and underserved populations. Health systems in many parts of the world are unable to do so, making the strengthening of health systems a high priority for WHO. Areas being addressed include the provision of adequate numbers of appropriately trained staff, sufficient financing, suitable systems for collecting vital statistics, and access to appropriate technology including essential drugs.
4. *Harnessing research, information and evidence:* Evidence provides the foundation for setting priorities, defining strategies, and measuring results. WHO generates authoritative health information, in consultation with leading experts, to set norms and standards, articulate evidence-based policy options and monitor the evolving global heath situation.
5. *Enhancing partnerships:* WHO carries out its work with the support and collaboration of many partners, including UN agencies and other international organizations, donors, civil society and the private sector. WHO uses the strategic power of evidence to encourage partners implementing programs within countries to align their activities with best technical guidelines and practices, as well as with the priorities established by countries.
6. *Improving performance:* WHO participates in ongoing reforms aimed at improving its efficiency and effectiveness, both at the international level and within countries. WHO aims to ensure that its strongest asset, its staff, works in an environment that is motivating and rewarding. WHO plans its budget and activities through results-based management, with clear expected results to measure performance at country, regional and international levels.

Member Countries

All countries which are members of the United Nations may become members of WHO by accepting its constitution. Other countries may be admitted as members when their application has been approved by a simple majority vote of the World Health Assembly. Territories which are not responsible for the conduct of their international relations may be admitted as associate members upon application made on their behalf by the member or other authority responsible for their international relations. Members of WHO are grouped according to regional distribution (193 member states).

Governance

WHO has three main divisions. The governing body, the World Health Assembly, meets once a year to approve the budget and decide on major matters of health policy. All the 190 or so member nations send delegations. The World Health Assembly elects 31 member nations to designate health experts for the executive board, which meets twice a year and serves as the liaison between the assembly and the secretariat, which carries on the day-to-day work of the WHO. The secretariat has a staff of about 4,500, with 30 percent of the employees at headquarters in Geneva, 30 percent in six regional field offices (Table 7.1), and 40 percent in individual countries, either as country-wide WHO representatives or as representatives of special WHO programs (Fig. 7.1).

The principal work of WHO is directing and coordinating international health activities and supplying technical assistance to countries. It develops norms and standards, disseminates health information, promotes research, provides training in international health, collects and analyzes epidemiologic data, and develops systems for monitoring and evaluating health programs. The Pan-American Health Organization (PAHO) serves as the regional field office for WHO in the Americas and, since it predates WHO, carries on some additional autonomous activities.

The executive board is composed of 34 members technically qualified in the field of health. Members are elected for three-year terms. The main board meeting, at which the agenda for the forthcoming health assembly is agreed upon and resolutions for forwarding to the health assembly are adopted, is held in January, with a second shorter meeting in May, immediately after the health assembly, for more administrative matters. The main functions of the board are to give effect to the decisions and policies of the Health Assembly, to advise it and generally to facilitate its work.

The secretariat of WHO is staffed by some 8000 health and other experts and support staff on fixed-term appointments, working at headquarters, in the six regional offices, and in countries.

The organization is headed by the Director-General, who is appointed by the Health Assembly on the nomination of the executive board.

Principles

The states parties to this constitution declare, in conformity with the charter of the United Nations, that the following principles are basic to the happiness, harmonious relations and security of all peoples:

Health is defined as, "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, and 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 and control of disease, especially communicable disease, is a common danger.
- Healthy 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.

Accepting these principles, and for the purpose of cooperation among themselves and with others to promote and protect the health of all peoples, the contracting parties agree to the present constitution and hereby establish the World Health Organization as a specialized agency within the terms of Article 57 of the Charter of the United Nations.

Objective

The objective of the World Health Organization (hereinafter called the organization) shall be the attainment by all peoples of the highest possible level of health.

Functions

In order to achieve its objective, the functions of the organization shall be:

1. To act as the directing and coordinating authority on international health work.
2. To establish and maintain effective collaboration with the United Nations, specialized agencies, governmental health administrations, professional groups and such other organizations as may be deemed appropriate.
3. To assist governments, upon request, in strengthening health services.
4. To furnish appropriate technical assistance and, in emergencies, necessary aid upon the request or acceptance of governments.
5. To provide or assist in providing, upon the request of the United Nations, health services and facilities to special groups, such as the peoples of trust territories.
6. To establish and maintain such administrative and technical services as may be required, including epidemiological and statistical services.
7. To stimulate and advance work to eradicate epidemic, endemic and other diseases.
8. To promote, in cooperation with other specialized agencies where necessary, the prevention of accidental injuries.
9. To promote, in cooperation with other specialized agencies where necessary, the improvement of nutrition, housing, sanitation, recreation, economic or working conditions and other aspects of environmental hygiene.
10. To promote cooperation among scientific and professional groups which contribute to the advancement of health.
11. To propose conventions, agreements and regulations, and make recommendations with respect to international health matters and to perform such duties as may be assigned thereby to the organization and are consistent with its objective.
12. To promote maternal and child health and welfare and to foster the ability to live harmoniously in a changing total environment.
13. To foster activities in the field of mental health, especially those affecting the harmony of human relations.
14. To promote and conduct research in the field of health.
15. To promote improved standards of teaching and training in the health, medical and related professions.
16. To study and report on, in cooperation with other specialized agencies where necessary, administrative and social techniques affecting public health and medical care from preventive and curative points of view, including hospital services and social security.
17. To provide information, counsel and assistance in the field of health.
18. To assist in developing an informed public opinion among all peoples on matters of health.
19. To establish and revise as necessary international nomenclatures of diseases, of causes of death and of public health practices.
20. To standardize diagnostic procedures as necessary.
21. To develop, establish and promote international standards with respect to food, biological, pharmaceutical and similar products.

22. Generally to take all necessary action to attain the objective of the organization.

The Health Assembly has the authority to adopt regulations concerning:

- Sanitary and quarantine requirements and other procedures designed to prevent the international spread of disease.
- Nomenclatures with respect to diseases, causes of death and public health practices.
- Standards with respect to diagnostic procedures for international use.
- Standards with respect to the safety, purity and potency of biological, pharmaceutical and similar products moving in international commerce.
- Advertizing and labeling of biological, pharmaceutical and similar products moving in international commerce.

Table 7.1: WHO Regional offices

Regional Office for Africa—Brazzaville Congo
Regional Office for the Americas—Washington, DC USA
Regional Office for South-East Asia—New Delhi, India
Regional Office for Europe—Copenhagen, Denmark
Regional Office for the Eastern Mediterranean—Nasr City, Cairo
Regional Office for the Western Pacific—Manila, Philippines

PAHO [THE PAN, AMERICAN HEALTH ORGANIZATION]

The Pan American Health Organization (PAHO) is an international public health agency with over 100 years of experience working to improve health and living standards of the people of the America. It enjoys international recognition as part of the United Nations system, serving as the regional office for the America of the World Health Organization, and as the health organization of the inter-American system.

PAHO is based in Washington DC, and has scientific and technical experts at its headquarters, in its 27 country offices, and its nine scientific centers, all working with the countries of Latin America and the Caribbean in dealing with priority health issues. The health authorities of PAHO's member states set PAHO's technical and administrative policies through its governing bodies.

PAHO Member States and Associates

These include all 35 countries in the America; Puerto Rico is an associate member. France, the Kingdom of the Netherlands, and the United Kingdom of Great Britain and Northern Ireland are participating states, and Portugal and Spain are observer states.

Mission

The Organization's essential mission is to strengthen national and local health systems and improve the health of the peoples of the America, in collaboration with ministries of health, other government and international agencies, nongovernmental organizations, universities, social security agencies, community groups, and many others.

PAHO promotes primary health care strategies, which reach people in their communities, to extend health services to all and to increase efficiency in the use of scarce resources. It

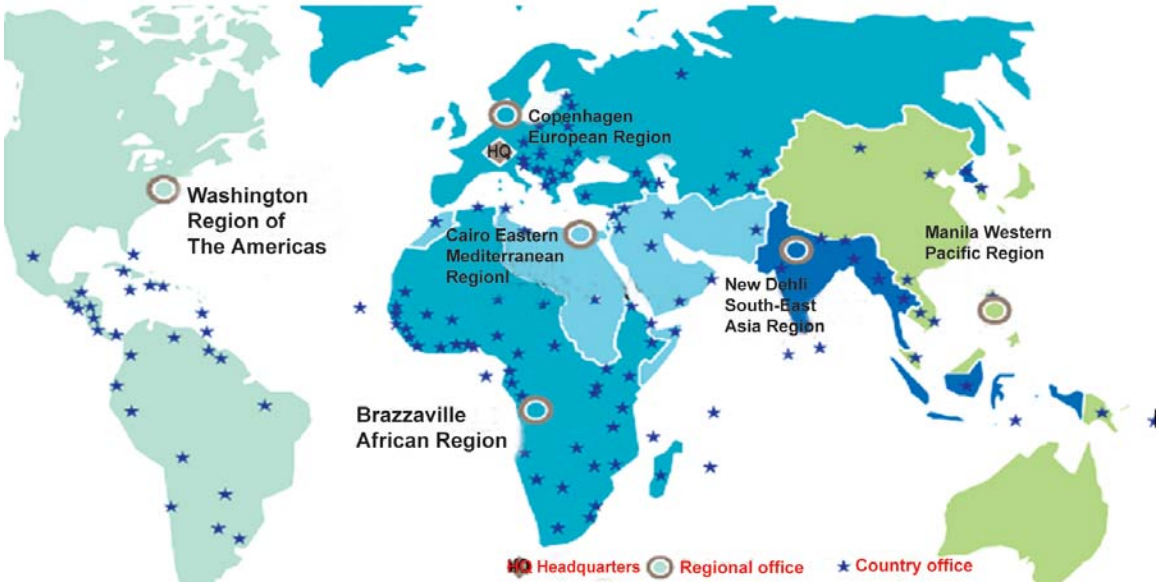


Fig. 7.1: Location of WHO regional offices

assists countries in fighting old diseases that have re-emerged, such as cholera, dengue and tuberculosis, and new diseases such as the spreading AIDS epidemic, providing technical cooperation including education and social communications support, promoting work with nongovernmental organizations, and support for programs to prevent transmission of communicable diseases. The Organization is also involved in prevention of chronic diseases such as diabetes and cancer, which are increasingly affecting the populations of developing countries in the America.

In its efforts to improve health, PAHO targets the most vulnerable groups including mothers and children, workers, the poor, the elderly, and refugees and displaced persons. It focuses on issues related to equity for those who lack access to health, and on a Pan-American approach encouraging countries to work together on common issues.

PAHO and its member countries are committed to improving the safety of blood in the Americas, launching a blood safety initiative designed to ensure that all blood for transfusion is free of disease and to increase the number of volunteer blood donors.

A major priority for the Americas is cutting infant mortality, and PAHO is mobilizing new political, institutional and financial resources to prevent infant deaths every year through application of the integrated management of childhood illness strategy.

It is involved aggressively in the fight to reduce the use of tobacco, emphasizing the health aspects and the high cost to the countries of tobacco use. It also continues to emphasize the approach of health promotion as applied to people and not an abstract construct.

Improvement of drinking water supplies, adequate sanitation, and increased access to health care for the poor is top priorities for PAHO, with a focus on equity.

A major effort committing the Americas to embark on polio eradication in 1985 succeeded in September 1994, when a distinguished international commission declared the Americas officially polio-free. The last case of polio in the Americas was identified August 23, 1991 in a young boy named Luis Fermín Tenorio Cortez, in Junín, Peru. Since then, despite intensive surveillance, no cases of polio have been detected anywhere in the Americas, and the World Health Organization is now working toward the goal of eradicating polio globally.

PAHO assists the countries in mobilizing the necessary resources to provide immunization and treatment services for all vaccine-preventable diseases

PAHO disseminates scientific and technical information through its publications program, its Internet site, and a network of academic libraries, documentation centers, and local health care libraries.

The organization provides technical collaboration in a variety of specialized public health fields, and organizes emergency preparedness and disaster relief coordination. It supports efforts to control malaria, Chagas' disease, urban rabies, leprosy, and other diseases that affect the people of the Americas.

PAHO collaborates with governments, other agencies, and private groups to address major nutritional problems including protein-energy malnutrition, and is now working to eliminate iodine and vitamin A deficiencies.

It expedites health promotion to help countries deal with health problems typical of development and urbanization, such as cardiovascular diseases, cancer, accidents, smoking, addiction to drugs and alcohol, and others.

PAHO strengthens the health sector capacity in the countries to advance their priority programs through intersectoral action, promoting an integral approach to health problems. It also works to improve women's health, promoting the greater integration of women in society, as well as awareness of their importance as both recipients and providers of health services.

PAHO trains health workers at all levels, through fellowships, courses and seminars, and the strengthening of national training institutions

The organization recognizes the role of the private sector in the delivery of services, and fosters dialogue and partnerships with the ministries of health.

FAO [THE FOOD AND AGRICULTURE ORGANIZATION]

The Food and Agriculture Organization of the United Nations leads international efforts to defeat hunger. Serving both developed and developing countries, FAO acts as a neutral forum where all nations meet as equals to negotiate agreements and debate policy. FAO is also a source of knowledge and information. We help developing countries and countries in transition modernize and improve agriculture, forestry and fisheries practices and ensure good nutrition for all. Since our founding in 1945, we have focused special attention on developing rural areas, home to 70 percent of the world's poor and hungry people. FAO's activities comprise four main areas:

– Putting information within reach.
– Sharing policy expertise.
– Providing a meeting place for nations.
– Bringing knowledge to the field.

FAO activities comprise four main areas:

Putting information within reach: FAO serves as a knowledge network. We use the expertise of our staff —agronomists, foresters, fisheries and livestock specialists, nutritionists, social scientists, economists, statisticians and other professionals— to collect, analyze and disseminate data that aid development. A million times a month, someone visits the FAO Internet site to consult a technical document or read about our work with farmers. We also publish hundreds of newsletters, reports and books, distribute several magazines, create numerous CD-ROMS and host dozens of electronic fora.

Sharing policy expertise: FAO lends its years of experience to member countries in devising agricultural policy, supporting planning, drafting effective legislation and creating national strategies to achieve rural development and hunger alleviation goals.

Providing a meeting place for nations. On any given day, dozens of policy-makers and experts from around the globe convene at headquarters or in our field offices to forge agreements on major food and agriculture issues. As a neutral forum, FAO provides the setting where rich and poor nations can come together to build common understanding.

Bringing knowledge to the field: Our breadth of knowledge is put to the test in thousands of field projects throughout the world. FAO mobilizes and manages millions of dollars provided by industrialized countries, development banks and other sources to make sure the projects achieve their goals. FAO provides the technical know-how and in a few cases is a limited source of funds. In crisis situations, we work side-by-side with the World Food Program and other humanitarian agencies to protect rural livelihoods and help people rebuild their lives.

UNDP [THE UNITED NATIONS DEVELOPMENT PROGRAM]

UNDP is the UN's global development network, an organization advocating for change and connecting countries to knowledge, experience and resources to help people build a better life. UNDP is working in 166 countries. It is working with them on their own solutions to global and national development challenges.

World leaders have pledged to achieve the millennium development goals, including the overarching goal of cutting poverty in half by 2015. UNDP's network links and coordinates global and national efforts to reach these goals.

Focus is on helping countries build and share solutions to the challenges of:

- *Democratic governance:* More countries than ever before are working to build democratic governance. UNDP brings people together within nations and around the world, building partnerships and sharing ways to promote participation, accountability and effectiveness at all levels.
- *Poverty reduction:* Developing countries are working to create their own national poverty eradication strategies based on local needs and priorities. UNDP helps to make them effective through ensuring a greater voice for poor people, expanding access to productive assets and economic opportunities, and linking poverty programs with countries international economic and financial policies.
- *Crisis prevention and recovery:* UNDP's approach to conflict assessment seeks to operationalize conflict prevention into strategy development and programming.
- *Energy and environment:* Energy and environment are essential for sustainable development. The poor are disproportionately affected by environmental degradation and lack of access to clean, affordable energy services. These issues are also global, as climate change, loss of biodiversity and ozone layer depletion cannot be addressed by countries acting alone.
- *HIV/AIDS:* To prevent the spread of HIV/AIDS and reduce its impact, developing countries need to mobilize all levels of government and civil society. UNDP advocates for placing HIV/AIDS at the center of national planning and budgets; helps build national capacity to manage initiatives that include people and institutions not usually involved with public health; and promotes decentralized responses that support community level action.

UNDP helps developing countries attract and use aid effectively. It encourages the protection of human rights and the empowerment of women.

In each country office, the UNDP resident representative normally also serves as the resident coordinator of development activities for the United Nations system. Through such coordination, UNDP seeks to ensure the most effective use of UN and international aid resources.

Millennium Development Goals (MDGs)

UNDP, as the UN's global development network, links and coordinates global and national efforts to reach the millennium goals.

Guided by the UN core strategy, UNDP's work on the MDGs focuses on coordinating global and local efforts that:

- Campaign and mobilize for the MDGs through advocacy.
- Share the best strategies for meeting the MDGs in terms of innovative practices, policy and institutional reforms, means of policy implementation, and evaluation of financing options.
- Monitor and report progress towards the MDGs.
- Support governments in tailoring the MDGs to local circumstances and challenges.

PAHEF [THE PAN-AMERICAN HEALTH AND EDUCATION FOUNDATION]

The Pan-American Health and Education Foundation (PAHEF) is a public philanthropic organization working to combat disease, lengthen life, improve health care services, foster health research, and enhance the capacities of health care workers primarily in the Americas through grant-making and direct program implementation.

It is a United States not-for-profit organization that enjoys a unique relationship with the Pan-American Health Organization (PAHO) an international public health agency that also acts as the regional office of the World Health Organization (WHO). The foundation has valuable experience in administering health-related grants and in cross-border grant-making.

In addition to its experience in grant-making, PAHEF presents five international awards that recognize excellence in inter-American health, community service, health literature, veterinary public health, and bioethics. The Expanded Textbook and Instructional Materials Program (PALTEX), a joint program of the foundation and the PAHO, provides affordable medical and health science books and basic diagnostic instruments to students and health workers throughout Latin America and the Caribbean.

AIM

The aim is to achieve the highest possible level of health for all, to reduce the health disparities among and within the countries of the western hemisphere, and to promote philanthropy as a core social value.

Mission

The foundation is an independent philanthropic organization working to combat disease, lengthen life, improve health care services, foster health research, and enhance the capacities of health care workers in the Americas through grant-making and direct program implementation. The foundation works to promote philanthropy as a core social value, and shares the Pan-American Health Organization's vision of health for all.

For more than 30 years, PAHEF has worked in partnership with intergovernmental organizations, civil society organizations, universities, industry, foundations, and caring individuals to reduce inequities in health status reduce maternal and child mortality, increase access to treatment and medicines for indigenous communities, and provide better health education for students entering the medical, dental and nursing professions. A healthy future for the people of the Americas depends on this joining of strengths.

Over the past six years, the Pan-American Health and Education Foundation has made more than 64 grants to improve the health of children and families, to support medical and nursing education, to strengthen the capacities of health workers, and to advance research.

PAHEF has supported activities to:

- Improve blood safety and establish quality control standards for laboratory workers.
- Vaccinate thousands of children against life-threatening preventable diseases.
- Train epidemiologists to use a worldwide database for early warning of disease outbreaks.
- Test cost-effective methods for early cervical cancer diagnosis.
- Make medical and nursing textbooks more affordable through a partnership program with over 500 universities in 18 Spanish-speaking countries.
- Develop distance learning modules to train rural doctors.
- Provide nursing scholarships for women from indigenous communities.
- Work to eliminate intestinal parasites, the leading cause of morbidity in children in developing countries.
- Test a new method for the delivery of malaria drugs.
- Through the generosity of donors, foundation grants have saved lives and improved the quality of life for millions of people.

Foundation Strengths

- PAHEF is independent, non-partisan and knowledgeable about the spectrum of public health needs.
- In collaboration with its primary partner, the Pan-American Health Organization, which serves as the World Health Organization office for the region of the Americas (PAHO/WHO) and, with public health practitioners, non-profit agencies, business and industry, and governments, it identifies and fund programs to act effectively for the common good.

ICRC [INTERNATIONAL COMMITTEE OF THE RED CROSS]

The creation of the Red Cross was spurred by the publication of Un Souvenir de Solférino (1862), an account by Jean Henri Dunant of the suffering endured by the wounded at the battle of Solferino in 1859. Dunant, a Swiss citizen, urged the formation of voluntary aid societies for relief of such war victims. He also asked that service to military sick and wounded be neutral.

The Société genovoise d'Utilité publique, a Swiss welfare agency, actively seconded Dunant's suggestion, the result being the formation (1863) of the organization that became known as the Red Cross. The next year, delegates from 16 nations met in Switzerland, and the Geneva convention of 1864, for the amelioration of the condition of the wounded and sick of armies in the field was adopted and signed by 12 of the nations represented. It provided for the neutrality of the medical personnel of armed forces, the humane treatment of the wounded, the neutrality of civilians who voluntarily assisted them, and the use of an international emblem to mark medical personnel and supplies. In honor of Dunant's nationality, a red cross on a white background—the Swiss flag with colors reversed was chosen as this symbol.

The original Geneva convention, its subsequent revisions, and allied treaties such as the Hague convention for naval forces and the Prisoners of war convention have been signed (although not always ratified) by almost all countries and their dependencies. The international committee of the Red Cross was awarded the Nobel Peace Prize in 1917, 1944, and, with the League of Red Cross Societies, in 1963.

The Red Crescent, which was first used by the Ottoman empire in 1876, was formally recognized by the League of Red Cross Societies in 1929. Iran used the Red Lion and Sun, formally recognized in 1949, until 1980. The adoption of the Red Crystal symbol in 2005 (effective in 2007), although occurring primarily as a means to provide an emblem under which Israel's Magen David Adom could become a full member (2006) of the international movement, also established a neutral emblem that could be used by any national society that preferred to avoid using the Christian cross or Islamic crescent.

The Seven Fundamental Principles of Red Cross

Humanity

The International Red Cross and Red Crescent Movement, born of a desire to bring assistance without discrimination to the

wounded on the battlefield, endeavors, in its international and national capacity, to prevent and alleviate human suffering wherever it may be found. Its purpose is to protect human life and health and to ensure respect for the human being. It promotes mutual understanding, friendship, cooperation and lasting peace amongst all people.

Impartiality

It makes no discrimination as to nationality, race, religious beliefs, class or political opinions. It endeavors to relieve the suffering of individuals, being guided solely by their needs, and to give priority to the most urgent cases of distress.

Neutrality

In order to continue to enjoy the confidence of all, the movement may not take sides in hostilities or engage at any time in controversies of a political, racial, religious or ideological nature.

Independence

The movement is independent. The national societies, while auxiliaries in the humanitarian services of their governments and subject to the laws of their respective countries, must always maintain their autonomy so that, they may be able at all times to act in accordance with the principles of the movement.

Voluntary Service

It is a voluntary relief movement not prompted in any manner by desire for gain.

Unity

There can be only one Red Cross or one Red Crescent Society in any one country. It must be open to all. It must carry its humanitarian work throughout its territory.

Universality

The International Red Cross and Red Crescent Movement, in which all societies have equal status and share equal responsibilities and duties in helping each other, is worldwide.

THE WORLD BANK

The World Bank is one of the three Bretton Woods Institution which was created in 1944 to rebuild the destroyed Europe after World War II. Later, after the economic revival of Europe, the World Bank's activities became focused on developing countries. By financing infrastructure projects, poverty should be reduced. Today, the focus is on the achievement of the millennium development goals (MDGs), goals calling for the elimination of poverty and the implementation of sustainable development. The constituent parts of the bank, the IBRD and the IDA, achieve their aims through the provision of low or no interest loans and grants to countries with little or no access to international credit markets. The bank is a market based non-profit organization, using its high credit rating to make-up for the low interest rate of loans.

The bank's mission is to aid developing countries and their inhabitants achieve the MDGs, through the alleviation of poverty, by developing an environment for investment, jobs and sustainable growth, thus promoting economical growth and through investment in and empowerment of the poor to enable them to participate in development.

The World Bank sees the following key factors necessary for economic growth and the creation of a business environment as:

1. *Capacity building*—Strengthening governments and educating government officials.
2. *Infrastructure creation*—Implementation of legal and judicial systems for the encouragement of business, the protection of individual and property rights and the honoring of contracts.
3. *Development of financial systems*—The establishment of strong systems capable of supporting endeavors from micro credit to the financing of larger corporate ventures.
4. *Combating corruption*—Eradicating corruption to ensure optimal effect of actions.
5. *Research, consultancy and training*—World Bank provide platform for research on development issues, consultancy and conduct training programs (web based, online, video/teleconferencing and classroom based) open for those who are interested from academia, students, government and NGO officers, etc.

UNFPA [UNITED NATIONS POPULATION FUND]

Mission

UNFPA, the United Nations Population Fund, is an international development agency that promotes the right of every woman, man and child to enjoy a life of health and equal opportunity. UNFPA supports countries in using population data for policies and programs to reduce poverty and to ensure that every pregnancy is wanted, every birth is safe, every young person is free of HIV/AIDS, and every girl and woman is treated with dignity and respect.

UNFPA seeks to improve the lives and expand the choices of individuals and couples. Over the time, the reproductive choices they make, multiplied across communities and countries, alter population structures and trends.

UNFPA helps governments, at their request, to formulate policies and strategies to reduce poverty and support sustainable development. The fund also assists countries to collect and analyze population data that can help them understand population trends. And it encourages governments

to take into account the needs of future generations, as well as those alive today.

The close links between sustainable development and reproductive health and gender equality, the other main areas of UNFPA's work, were affirmed at the 1994 International Conference on Population and Development (ICPD), in Cairo. UNFPA is guided in its work by the program of action adopted there. At the conference, 179 countries agreed that meeting needs for education and health, including reproductive health, is a prerequisite for sustainable development over the long-term. They also agreed on a roadmap for progress with the following goals:

- Universal access to reproductive health services by 2015
- Universal primary education and closing the gender gap in education by 2015
- Reducing maternal mortality by 75 per cent by 2015
- Reducing infant mortality
- Increasing life-expectancy
- Reducing HIV infection rates

Reaching the goals of the program of action is also essential for achieving the millennium development goals. These eight goals, which are fully aligned with the ICPD roadmap, have the overarching aim of reducing extreme poverty by half by 2015. UNFPA brings its special expertise in reproductive health and population issues to the worldwide collaborative effort of meeting the millennium development goals.

Improving Reproductive Health

The critical importance of reproductive health to achieving international development goals was affirmed at the highest level at the 2005 World Summit. Reproductive health is also a human right. UNFPA seeks to improve the lives and expand the choices of individuals and couples. Overtime, the reproductive choices they make, multiplied across communities and countries, alter population structures and trends.

Preventing HIV/AIDS

The AIDS epidemic is a global catastrophe responsible for over 20 million deaths worldwide. As one of ten co-sponsors of UNAIDS, UNFPA works to intensify and scale up HIV prevention efforts using rights-based and evidence-informed strategies, including attention to the gender inequalities that add fuel to the epidemic.

Promoting Gender Equality

Women can and must play a powerful role in sustainable development and poverty eradication. When women are educated and healthy, their families, communities and countries benefit. Yet gender-based discrimination and violence pervade almost every aspect of life, undermining the opportunities of women and denying them the ability to fully exercise their basic human rights.

Gender equality is one of the eight millennium development goals as well as a human right.

Using Culturally Sensitive Approaches

UNFPA's activities touch on the most sensitive and intimate spheres of human existence, including reproductive health and rights, gender relations and population issues. Attitudes about these subjects vary widely between and among different cultures.

Protecting Human Rights

All individuals are entitled to equal rights and protections. This idea is fundamental to UNFPA's mission and to its way of working.

A strong emphasis on the rights of individual women and men underpins the 1994 Cairo consensus that guides UNFPA's work. At that meeting, it was agreed by all that reproductive health is a basic human right and that individuals should be able to freely choose the number, timing and spacing of their children.

Numerous international agreements affirm the human rights principles that underpin UNFPA's work in reproductive health, gender equality and population and development.

Securing Reproductive Health Supplies

Without essential commodities, from contraceptives to testing kits to equipment for emergency obstetric care, people cannot fully exercise the right to reproductive health. In many places, male and female condoms are urgently needed to prevent the further spread of HIV. UNFPA's mandate in this area is to provide the right quantities of the right products in the right condition in the right place at the right time for the right price. This complex logistical process involves many actors from both the public and private sectors. UNFPA takes a lead role in reproductive health commodity security, by forecasting needs, mobilizing support, building logistical capacity at the country level and coordinating the whole process.

Assisting in Emergencies

Humanitarian crises are reproductive health disasters. In times of upheaval, pregnancy-related deaths and sexual violence soar. Reproductive health services—including prenatal care, assisted delivery, and emergency obstetric care—often become unavailable. Young people become more vulnerable to HIV infection and sexual exploitation. And many women lose access to family planning services, exposing them to unwanted pregnancy in perilous conditions.

Within the coordinated, interagency response to disasters, UNFPA takes the lead in providing supplies and services to protect reproductive health, with an emphasis on the special needs and vulnerabilities of women and young people. Priority areas include safe motherhood; prevention of sexually transmitted infections, including HIV; adolescent health; and gender-based violence. The fund also supports various data collection activities, including censuses to provide detailed

information for planning and rapid health assessments to allow for appropriate, effective and efficient relief. UNFPA encourages the full participation of women and young people in efforts to rebuild their societies.

Building Support

As the world's leading multilateral agency on population, UNFPA is the most prominent international advocate for reproductive health and rights, including the right to choose the number, timing and spacing of one's children.

Working in partnership with other United Nations agencies, governments, communities, NGOs, foundations and the private sector, the fund raises awareness and mobilizes the support and resources needed to reach the targets set forth at the International Conference on Population and Development and in the millennium development goals. In 2007, UNFPA received a record high in voluntary contributions for its core resources from 181 countries, also a record number.

UNFPA'S Regions

UNFPA supports programs in four regions: Arab States, Europe and Central Asia; Asia and the Pacific; Latin America and the Caribbean; and sub-Saharan Africa. UNFPA work in over 140 countries, areas and territories through nine country technical services teams and 112 country offices. Three-quarters of UNFPA staff work in the field.

CARE [COOPERATIVE FOR AMERICAN RELIEF EVERYWHERE]

Activities

1. *Agriculture and natural resources:* CARE helps families produce more food and increase their income while managing their natural resources and preserving the environment for future generations
2. *Cross-cutting initiatives*: CARE's cross-cutting initiatives span across the breadth of their program sectors to tackle the underlying causes of poverty, and place special emphasis on working with women and girls to create lasting social change.
3. *Economic development*: CARE's economic development programs assist impoverished families by supporting moneymaking activities, especially those operated by women.
4. *Education:* CARE is dedicated to promoting basic education for all. Experience shows that educated people have healthier families and greater earning potential.
5. *Emergency relief:* CARE projects directly assist survivors of natural disasters and conflict through both immediate relief and long-term community rehabilitation, including food, temporary shelter, clean water, sanitation services, medical care, family planning and reproductive health services, and seeds and tools.
6. *Health:* A family cannot be economically healthy if it is not physically healthy. CARE's health projects focus on mothers and children, who often are the most vulnerable to disease and malnutrition. This includes training local health volunteers as counselors, mentors and monitors of community health.
7. *HIV/AIDS:* CARE's HIV/AIDS programs link with other sectors, including health, education and economic development. Through HIV/AIDS programs, CARE help communities care for children who have become orphaned and vulnerable by HIV/AIDS, develop peer education and outreach in communities, and increase access to services such as condoms, voluntary counseling and testing, antiretroviral treatment, and sexually transmitted infections (STI) prevention and treatment.
8. *Nutrition:* Proper nutrition is vital to a child's healthy development and an adult's ability to work and care for his or her family. CARE's projects focus on teaching techniques and practices that help prevent malnutrition
9. *Water, sanitation and environmental health and irrigation:* CARE helps communities to build and maintain clean water systems and latrines. The goal of these projects is to reduce the health risks of water-related diseases. Both directly and through local organizations, CARE provides training and subsidizes construction, but communities make significant contributions and pay the cost of operation and maintenance.

THE ROCKEFELLER FOUNDATION [RF]

The Rockefeller Foundation (RF) was established in 1913 by John D Rockefeller Sr, who amassed a vast fortune as the founder and developer of the Standard Oil Company. According to the Foundation's current President, Gordon Conway, "Mr Rockefeller gave us a broad mandate to further "well-being of mankind throughout the world".

RF's philanthropy is directed toward five main program areas:

a. *Creativity and culture:* This program seeks "to give full expression to the creative impulses of individuals and communities in order to enhance the well-being of societies and better equip them to interact in a global and dynamic world". Toward this end, the foundation supports "new art forms, including dance, theatre, music, film and digital media, which promote cultural diversity, innovation and understanding across cultures".
b. *Food security:* This program works to "improve the food security of the rural poor through the generation of agricultural technologies, institutions and policies that sustain livelihoods in areas of sub- Saharan Africa and Asia bypassed by the Green Revolution [a term used to describe the dramatic increases in the agricultural production of developing nations between the 1940s and 1960s]". According to RF, a root cause of food shortages worldwide is the "corporate dominance" that "limits access to agricultural technologies".

In September 2006, RF collaborated with the Bill and Melinda Gates Foundation on a "Green Revolution Project" in Africa, aiming to "dramatically increase the productivity of small farms, moving tens of millions of people out of extreme poverty and significantly reducing hunger". In pursuit of this objective, the project addresses such issues as soil fertility, irrigation, farmer management practices, and farmer access to markets and financing.

c. *Health equity:* Founded on the premise that America values the well-being of minorities less than that of whites, this program seeks to "reduce avoidable and unfair differences in the health status of populations" within the US It similarly aims to reduce such disparities internationally.
d. *Working communities:* The goal of this program is to "transform poor urban neighbourhoods into working communities—safe, healthy and effective neighbourhoods, by increasing the amount and quality of employment, improving the quality of all urban schools, and revitalizing poor neighbourhoods through mixed-income community development". In RF's view, a principal "root cause" of poverty and violence is that "low-income and minority children attend schools that possess inadequate resources to ensure equal educational opportunity".
e. *Global inclusion:* This program is intended to "help broaden the benefits and reduce the negative impacts of globalization on vulnerable communities, families and individuals around the world. RF "works around the world to expand opportunities for poor or vulnerable people and to help ensure that globalization's benefits are more widely shared".

THE FORD FOUNDATION

The Ford Foundation was established on January 15, 1936. Goals:

- Strengthen democratic values
- Reduce poverty and injustice
- Promote international cooperation
- Advance human achievement

The Ford Foundation's three major program areas:

a. *The asset building and community development program:* "It helps strengthen and increase the effectiveness of people and organizations working to find solutions to problems of poverty and injustice". Grants in this area, "support vibrant social movements, institutions and partnerships that analyze contemporary social and economic opportunities and devise responses to them".
b. *The peace and social justice program:* It is founded on the premise that "armed conflict destroys not only human lives but also livelihoods, governments, civil institutions, trust—in short, everything in its wake" and that "social justice is the aspiration of all healthy societies and the only long-term guarantee for sustaining peace".
c. *The knowledge, creativity and freedom program works:* It globally to advance achievement in the arts, education and scholarship and to advance a positive understanding of sexuality. … It also affirms the importance of freedom to think and act critically, originally and responsibly in facilitating the building of more just and pluralistic societies.

WORLD HEALTH DAYS

In 1948, the First World Health Assembly called for the creation of a "World Health Day" to mark the founding of the World Health Organization. Since 1950, World Health Day has been celebrated on the 7th of April annually. Each year a theme is selected for World Health Day that highlights a priority area of concern for WHO.

World Health Day is a worldwide opportunity to focus on key public health issues that affect the international community. World Health Day launches long-term advocacy programs that continue well beyond 7th April.

Year	World health day theme
1950	Know your own health services
1951	Health for your child and the world's children
1952	Healthy sorroundings make healthy people
1953	Health is wealth
1954	The nurse: Pioneer of health
1955	Clean water means better health
1956	Destroy disease carrying insects
1957	Food and health
1958	Ten years of health progress
1959	Mental illness and mental health today
1960	Malaria eradication – A world challenge
1961	Accidents need not happen
1962	Preserve sight: Prevent blindness
1963	Hunger: Disease of millions
1964	No trace of tuberculosis
1965	Smallpox: Constant Alert
1966	Man and his cities
1967	Partners in life
1968	Health in the world of tomorrow
1969	Health, labor and productivity
1970	Early detection of cancer saves life
1971	A full life despite diabetes
1972	Your heart is your health
1973	Health begins at home
1974	Better food for a healthier world
1975	Smallpox: Point of no return
1976	Foresight prevents blindness
1977	Immunize and protect your child
1978	Down with high blood pressure
1979	A healthy child: A sure future
1980	Smoking or health: The choice is yours
1981	Health for all by the year 2000
1982	Add life to years
1983	Health for all by 2000: The count down has begun

1984	Children's health: Tomorrow's wealth
1985	Healthy youth: Our best resources
1986	Healthy living: Everyone a winner
1987	Immunization a chance for every child
1988	Health for all: All for health
1989	Let's talk health
1990	Our Planet: Our health—Think gobally, act locally
1991	Should disaster strike: Be prepared
1992	Heartbeat: The rhythm of life
1993	Handle life with care: Prevent violence and negligence
1994	Oral health for a healthy life
1995	Global Polio Eradication
1996	Healthy cities for better life: A challenge
1997	Emerging infectious diseases: Global alert and global response
1998	Safe motherhood: Pregnancy is precious, let's make it special
1999	Healthy aging, healthy living, start now
2000	Safe blood start with me: Blood saves lives
2001	Mental health: Stop exclusion—dare to care
2002	Move for Health
2003	Shape the future of life: Healthy environments for children
2004	Road safety
2005	Make every mother and child count
2006	Working together for health
2007	International health security
2008	Protecting health from climate change
2009	Save lives: Make hospitals safe in emergencies
2010	Urbanization and Health
2011	Antimicrobial resistance and its global spread

IMPORTANT DATES – WORLD HEALTH

1.	National Youth Day	12th January
2.	International Women's Day	8th March
3.	World Health Day	07th April
4.	World Red Cross Day	08th May
5.	World Environment Day	05th June
6.	World Blood Donation Day	14th June
7.	World Day to Combat Desertification and Drought	17th June
8.	World Refugee Day	20th June
9.	International Day against Drug Abuse and illicit Trafficking	26th June
10.	World Population Day	11th July
11.	Geneva Conventions Day	12th August
12.	International Literacy Day	08th September
13.	International First Aid Day	13th September
14.	International Day of Peace	21th September
15.	Voluntary Blood Donation Day	01st October
16.	World Disaster Reduction Day	13th October
17.	ICRC Foundation Day	29th October
18.	Children's Day	14th November
19.	International Day for the Elimination of Violence against women	25th November
20.	World AIDS Day	01st December
21.	World Disabled Day	3rd December
22.	Human Rights Day	10th Dec
23.	Antileprosy Day	30th January
24.	World Health Day	7th April
25.	World Habitat Day	22nd April
26.	World No-Tobacco Day	31st May
27.	Doctor's Day	1st July
28.	World Population Day	11th July
29.	Antidrug Addiction Day	2nd October
30.	Anti-natural Disaster Day	13th October
31.	Anti-AIDS Day	1st December
32.	UNICEF Day	11th December
33.	World Oral Health Day	12th September

8 Nutrition and Health

RK Marya

All living organisms require energy for maintenance of vital functions of the body. Energy is required for cardiac muscle contraction. It is required for conduction of nerve impulses and for various active transport mechanisms involved in different absorptive and secretory processes. Synthetic reactions involved in growth and development are also energy dependent. The energy is provided by the oxidation of food stuffs like carbohydrates, fats and proteins. The energy so liberated is trapped in the body as high energy phosphate bonds. If the energy intake is more than the immediate requirement, it is stored in the body as glycogen or fat which can be broken down to yield ATPs whenever required. Ultimately, all the energy required for various metabolic processes is obtained in the form of ATP only.

The energy requirements of an individual depend upon (i) the basal energy requirement and (ii) amount of physical work done.

THE BASAL ENERGY REQUIREMENT

Energy is required for various metabolic processes in the body occurring even at rest, e.g. cardiac contraction, conduction of nerve impulse, hepatic metabolism, active transport mechanism in the body, etc. This energy requirement has been called basal metabolic rate, which is fairly constant.

PHYSICAL WORK

Physical work may vary from simple standing or even sitting to heavy manual labor, e.g. carrying load upstairs. The energy requirement for this purpose varies according to the degree of work performed.

TOTAL CALORIC REQUIREMENTS

Total caloric requirements of an individual can be calculated by adding the basal metabolic requirements to the energy required for the nature of his profession and other recreational/household activities. A sedentary worker, like a bureaucrat, requires much less energy than a farm-laborer or a rickshaw-puller. According to ICMR (Indian Council of Medical Research), an average sedentary male requires 2400 kilocalories per day. A sedentary female requires 80 percent of this value.

If the caloric requirement of a sedentary male (2400 kcal/day) is taken as a unit, the caloric requirements of other type of male and female workers may be calculated as follows:

- Adult male (sedentary work) 1.0
- Adult male (moderate work) 1.2
- Adult male (heavy work) 1.6
- Adult female (sedentary work) 0.8
- Adult female (moderate work) 0.9
- Adult female (heavy work) 1.2

Balanced Diet

Our diet must contain carbohydrates, fats, proteins, vitamins, minerals and water. These constituents of diet provide energy for basal metabolism and physical work and materials for growth and development as well as for repair of the tissues. A diet is said to be balanced when the various nutrients are present in proper proportion and in sufficient amount to meet all the needs of the body.

Table 8.1 shows the recommended dietary allowances (RDA) of calories and other nutrients for Indian population. The figures given for adult males and females are for those involved in moderate type of work. Figures for pregnant and lactating women and children of various age groups are also given in the Table.

The constituents of some of the important foodstuffs are shown in Table 8.2.

Carbohydrates

Carbohydrates constitute the cheapest dietary source of energy. They fulfill over 50 percent of the total caloric requirement (the rest of the caloric requirement is provided by oxidation of fats and proteins). Although, carbohydrates can be synthesized in the body, yet a minimum intake of 50 to 100 g of carbohydrates

Table 8.1: Recommended dietary allowance (RDA) for Indian population (Indian Council of Medical Research, 1992)

	Energy (kcal)	*Protein (g)*	*Calcium (mg)*	*Iron (mg)*	*Vit.A (µg)*	*Vit.C (mg)*	*Folic Acid (µg)*	*Vit. B12 (µg)*
Men (Adult)	2875	60	400	28	600	40	100	1.0
Women (Adult)	2225	50	400	30	600	40	100	1.0
Pregnancy	2525	65	1000	38	600	40	400	1.0
Lactation	2775	75	1000	30	950	80	150	1.5
Infants								
0-6 m	108 kcal/kg	2.05 g/kg	500	-	350	25	25	0.2
6-12 m	98 kcal/kg	1.65 g/kg	500	-	350	25	25	0.2
Children								
1-3 Y	1240	22	400	12	400	40	30	1.0
3-6 Y	1690	30	400	18	400	40	40	1.0
6-9 Y	1950	41	400	26	600	40	60	1.0
Boys								
10-12 Y	2190	54	600	19	600	40	70	1.0
13-15 Y	2450	70	600	28	600	40	100	1.0
16-18 Y	2640	78	500	30	600	40	100	1.0
Girls								
10-12 Y	1970	57	600	34	600	40	70	1.0
13-15 Y	2060	65	600	41	600	40	100	1.0
16-18 Y	2060	63	500	50	600	40	100	1.0

Table 8.2: Important components of some common foodstuffs in 100 g of each

	Protein (g)	*Fat (g)*	*Carbohydrate (g)*	*Energy (kcal)*	*Minerals (g)*	*Calcium (mg)*	*Phosphorus (mg)*	*Iron (mg)*
Cereals								
Rice	7.5	1.0	76.7	346	0.9	10	190	3.2
Wheat flour	12.1	1.7	69.4	341	2.7	48	355	4.9
Pulses								
Bengal gram	17.1	5.3	60.9	360	3.0	202	312	4.6
Green gram	24.0	1.3	56.7	334	3.5	124	326	4.4
Peas (dry)	19.7	1.1	56.5	315	2.2	75	298	7.0
Rajmah	22.9	1.3	60.6	346	3.2	260	410	5.1
Soyabean	43.2	19.5	20.9	432	4.6	240	690	10.4
Leafy vegetables								
Cabbage	1.8	0.1	4.6	27	0.6	39	44	0.8
Cauliflower	5.9	1.3	7.6	66	3.2	626	107	40.8
Mustard leaves	4.0	0.6	3.2	3.2	1.6	155	26	16.3
Spinach	2.0	0.7	3.8	46	2.1	53	91	10.9
Roots and tubers								
Carrot	0.9	0.2	10.6	48	1.1	80	530	1.03
Onion	1.2	0.1	11.1	50	0.4	46.9	50	0.6
Potato	1.6	0.1	22.6	97	0.6	10	40	0.48
Nuts								
Almonds	20.8	58.9	10.5	655	2.9	230	490	5.09
Coconut dry	6.8	62.3	18.4	662	1.6	400	210	7.8
Groundnut	25.3	40.1	26.1	567	2.4	90	350	2.5
Cashew nut	21.2	46.9	22.3	596	2.6	50	450	5.81
Fruits								
Apple	0.2	0.5	13.4	59	0.3	10	14	0.66
Banana	1.2	0.3	27.2	116	0.8	17	36	0.3
Grapes	0.6	0.4	13.1	58	0.9	20	23	0.5
Mango	0.6	0.4	16.9	74	0.4	14	16	1.3
Tomato	0.9	0.2	3.6	20	0.5	48	20	0.6

Contd...

Contd...

	Protein (g)	*Fat (g)*	*Carbohydrate (g)*	*Energy (kcal)*	*Minerals (g)*	*Calcium (mg)*	*Phosphorus (mg)*	*Iron (mg)*
Meat and poultry								
Fish	20.9	3.1	13.9	167	1.1	98	152	1.8
Goat meat (lean)	21.4	3.6	–	118	1.1	12	193	–
Chicken meat	25.9	0.6	–	109	1.3	25	245	–
Egg	13.3	13.3	–	173	1.0	60	220	2.1
Milk and milk products								
Milk cow's	3.2	4.1	4.4	67	0.8	120	90	0.2
Milk buffalo's	4.3	6.5	5.0	117	0.8	210	130	0.2
Cheese	24.1	25.1	6.3	348	4.2	790	520	2.1

per day is essential to prevent the development of ketosis and loss of muscle protein.

Moreover, in the absence of dietary carbohydrates excessive ingestion of fats is required to provide energy which may expose the individual to the risk of atherosclerosis and coronary heart disease.

In general, in the Indian diet, most of the carbohydrates are ingested in the form of starch. However, in the western diet, approximately 50 percent of the carbohydrate calories are derived from sucrose, e.g. candies, ice cream, colas, pastries, chocolate, etc. Such foods are consumed in large amounts by children of the more affluent segment of the Indian population also. The ingestion of sucrose in large quantities is harmful in a variety of ways:

1. Sucrose rich foods are tastier than starch rich food. It predisposes to obesity.
2. The digestion of sucrose is quicker than that of starch. Therefore, ingestion of sucrose causes greater hyperglycemic effect than that of starch, causing a greater load on the beta cells of the Islets of Langerhans. This factor predisposes to diabetes mellitus.
3. Sucrose is a suitable substrate for the metabolism of a number of bacteria in the oral cavity. Ingestion of sucrose rich foods, especially that stick to the teeth, e.g. chocolates promote the bacterial growth in the oral cavity. The acids produced by bacterial metabolism of sucrose have a corrosive action on the dental enamel, leading to the development of dental caries. Thorough rinsing of the oral cavity immediately after consumption of sweets can provide protection against dental caries.

Dietary Fiber

This term denotes all the plant cell wall components consisting mainly of nonstarch polysaccharides, which cannot be digested in the human gastrointestinal tract. It includes cellulose, hemicellulose, pectins, gums, etc. These polysaccharides are made up of β-glycosidic linkages which cannot be broken down by α-amylase present in the human gastrointestinal secretions. In herbivorous animals, intestinal microorganisms breakdown these polysaccharides into acetate, propionate and butyrate, which are absorbed into portal blood and utilized for energy production.

Even though not a source of energy, the dietary fiber serves many useful functions in the human body:

1. By adding bulk to the food, it slows down gastric emptying. Therefore, the postprandial rise of blood sugar is attenuated, decreasing the insulin requirement in the body.
2. It retains water and therefore makes feces larger in bulk and softer. Consequently, the colonic movements are stronger and constipation does not occur.
3. It has cholesterol lowering action by interfering with its absorption by adsorbing the dietary cholesterol.
4. Many epidemiological studies have demonstrated that intake of dietary fiber rich diet is associated with reduced incidence of diabetes mellitus, coronary artery disease, cancer of colon, diverticulosis of colon, and gallstones.

On the negative side, dietary fiber may reduce the bioavailability of some vitamins and minerals (iron) by binding with them.

Fats

Fats are the most compact form of food. One gram of fat, on oxidation, yields 9 kcal as compared to 4.5 kcal in case of carbohydrates and proteins. However, fats are far more expensive source of energy than carbohydrates. The value of dietary fat lies not only in the supply of essential fatty acids but also in increasing the palatability of food and producing sense of satiety after intake of food. Moreover, dietary fats act as a vehicle for the supply and absorption of fat soluble vitamins.

Vegetable Fat vs Animal Fat

In India, the use of animal fat like butter and ghee is considered a valuable and essential component of food in most of the households. Animal fat is the only source of essential fatty acids like linoleic acid, linolenic acid and arachidonic acid. Essential fatty acids are a component of cell architecture as well as precursors of prostaglandins. However, since animal fat chiefly consists of saturated fatty acids, its heavy consumption has been shown to promote increase in plasma cholesterol level leading to increased

risk of atherosclerosis and associated disorders like coronary artery disease and cerebral strokes. Even if the animal fat constitutes only 1 to 2 percent of total fat intake, it is sufficient to provide the essential fatty acids. In India, till recently only poor people were using vegetable oils in the form of hydrogenated vanaspati ghee.

Vegetable oils are not only cholesterol free but also contain a large percentage of polyunsaturated fatty acids, which have a plasma cholesterol lowering action. Coconut oil is an exception to this statement, since it contains saturated fatty acids only. The percentage of saturated and unsaturated fatty acids in various types of edible oils is given in the Table 8.3. The cholesterol lowering action of vegetable fats is lost after hydrogenation. Hydrogenation of vegetable oils raises the melting point to give the consistency of ghee (animal fat) at room temperature. However, hydrogenation converts all the unsaturated fatty acids present in the vegetable oils into saturated fatty acids. Therefore, to obtain any benefit, only nonhydrogenated vegetable oils should be consumed.

Table 8.3: Concentration of polyunsaturated fatty acids in various types of edible fats

Edible fats	*Percent polyunsaturated fatty acids*
Coconut oil	≤ 1
Corn oil	57
Cotton seed oil	47
Ground nut oil	30
Mustard oil	29
Rapeseed oil	33
Palm oil	9
Palmolin	11
Rice bran oil	33
Sunflower oil	79
Butter	2

Eggs and organ meat are rich sources of dietary cholesterol. The cholesterol content of eggs (500 mg/100 gm) may be compared with that of liver (440 mg/100 gm), kidney (800 mg/100 gm) and brain (200 mg/100 gm).

Recommended Intake

Fats are basically used as a source of energy and hence can be replaced by carbohydrates. Except for the provision of essential fatty acids, and fat soluble vitamins, intake of fats is not necessary. Fat intake is also important for the sake of palatability. It has been estimated that fat intake of about 20 gm animal fat/day is sufficient in an adult.

Proteins

Proteins are indispensable constituent of diet. Proteins constitute most of the exocrine and endocrine secretions (except steroid hormones). Plasma proteins and hemoglobin synthesis also require proteins. Proteins are required for growth during childhood and during pregnancy. The normal wear and tear of the tissues is repaired with the help of dietary proteins. The importance of dietary protein intake lies in the fact that almost 50 percent of the amino acids cannot be synthesized in the body, i.e. leucine, isoleucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine, hidtidine, and arginine. These amino acids, called essential amino acids, have to be provided in the diet. Proteins are available from both animal and vegetable sources. Some of the vegetables, e.g. soyabeans have greater protein content (43%) than meat (21-26%).

Animal proteins like egg, fish, meat and milk have amino acid composition almost similar to that of human tissues. Hence, when ingested, they can be economically used in the body. Such proteins are said to have high biological value. Individual proteins of vegetable origin are deficient in one or more of the essential amino acids and hence cannot be used economically in the body. Such proteins are said to have low biological value. The biological value of a protein is expressed as follows:

$$BV = \frac{\text{Nitrogen retained in the body}}{\text{Nitrogen absorbed}} \times 100$$

The biological value of milk protein (casein) or egg albumin is 100 percent. Biological values of proteins of some of the common foods is compared in Table 8.4.

Table 8.4: Biological values of some of the dietary proteins

Food	*Biological value*
Egg	100
Milk	100
Meat	74
Wheat	66
Rice	80
Bengal gram	74
Fish	80
Soyabeans	90

However, vegetable proteins, though of lower biological value than animal proteins are seldom consumed individually. When a mixture of vegetable proteins is ingested, it usually provides all the essential amino acids. A classical example is the consumption of a meal consisting of cereals and pulses. The lysine deficiency of cereals is made up by the pulses, whereas methionine deficiency of pulses is made up by the cereals. Another problem of vegetable proteins is regarding its efficiency of utilization. Since, the efficiency of utilization of vegetable proteins is about 65 percent of the efficiency of animal proteins (see Table 8.2), the amount of vegetable protein intake has to be proportionately greater than those who consume animal proteins.

Daily protein intake should be spread over all the major 2-3 meals of the day. Amino acids that are not incorporated into tissues are deaminated and excreted as urea. Therefore, occasional intake of high protein diet is not as beneficial as regular intake of moderate amount of protein.

Recommended Intake

According to the Indian Council of Medical Research, the protein intake in an adult, in terms of mixed vegetable proteins should be at least 1 gm/kg body weight/day. If the protein intake is in the form of animal proteins, in view of better bioavailability, protein intake of 0.6 gm/kg body weight/day would be sufficient. Greater intake of proteins is required in infants and children in view of the protein requirement for growth.

MINERALS

Calcium

Total body calcium content is about 1 kg of which, approximately 99 percent is present in the skeleton. Plasma calcium level is maintained within a very narrow normal range of 9 to 11 mg percent, of which approxi-mately 50 percent is in ionic form. Ionic plasma calcium has notable effects on neuromuscular excitability and myocardial function. In addition, ionic calcium is involved in numerous intracellular biochemical reactions, excitation- contraction coupling in the skeletal and cardiac muscles and in coagulation of blood.

ICMR has recommended an intake of 400 mg calcium/day. It should be increased to 1 gm/day in pregnancy and lactation. Traditionally, in the western literature, an intake of 1 gm calcium/day for adults and 1.5 gm/day in pregnant and lactating women is recommended. The lower recommended daily allowance (RDA) by ICMR is based on the knowledge that chronically low intake of dietary calcium induces adaptive changes in the body in the form of increased production of 1, 25-dihydroxy vitamin D_3.

Sources

Main dietary sources of calcium include milk and milk products, egg, fish, green leafy vegetables and cereals. Rice is a poor source of calcium. The presence of phytic acid and oxalates in cereals and in some leafy vegetables decreases the bioavailability of calcium by forming insoluble nonabsorbable calcium phytate and calcium oxalate.

Rickets in babies and osteomalacia in adults (usually women) are the disorders of bone metabolism primarily related to vitamin D deficiency rather than deficiency of dietary calcium.

Iron

Iron is an important component of hemoglobin (in RBCs), myoglobin (in skeletal muscle) and a number of enzymes involved in cellular oxidative reactions.

Sources

Two groups of sources of dietary iron may be recognized. The iron present in meat and eggs is called heme iron as compared to nonheme iron present in green leafy vegetables, pulses and cereals. The bioavailability of heme iron (about 20%) is almost twice that of nonheme iron. Ingestion of vitamin C helps in the absorption of dietary iron. The recommended daily intake of iron is 28 mg for men, 30 mg for nonpregnant adult women and 38 mg for pregnant women. Iron deficiency produces microcytic hypochromic type of anemia.

Iodine

Iodine is an essential component of thyroxin, the important hormone regulating the basal metabolic rate of the body. Sea fish and other sea foods are very rich sources of iodine. Meat, eggs, some green leafy vegetables and cereals are other sources (Table 8.5). Recommended intake of iodine is about 150 μg / day.

Table 8.5: Iodine content of foods

Food	*Iodine content (microgram/kg weight)*
Sea fish	832
Fresh water fish	30
Meat	50
Eggs	93
Cereals	47
Legumes	29
Green vegetables	29
Fruits	18

Thyroxine has a crucial role in the growth and development of nervous tissue. In view of widespread prevalence of iodine deficiency goiter, only iodinated salt is allowed to be sold in India.

Vitamins

Vitamins are organic compounds needed in minute amounts but are essential for normal health. They are named as alphabet letters in the order they were discovered, e.g. A, B, C, D, etc. Vitamins are classified as water soluble vitamins (vitamin B complex, and C), and fat soluble vitamins (vitamins A, D, E, and K). Factors initially called vitamins F, G, H, I, and J were dropped from the list of vitamins because some of them were listed as components of vitamin B complex while others were found to be not essential for normal health.

The sources, their role in the body and disorders caused by their deficiency are summarized in Table 8.6.

FAT SOLUBLE VITAMINS

Vitamin A

It is essential for proper body growth and integrity of epithelial tissues. As a component of visual purple, the photopigment of retinal rods, vitamin A is essential for dim light vision.

Table 8.6: Vitamins, their sources, role in body and deficiency disorders

Vitamin	*Sources*	*Actions*	*Deficiency disorders*
Fat soluble			
A	Fish liver oil, liver, butter, egg, cheese, carrot, amaranth, spinach, mango, papaya, tomato	• Constituents of retinal photo-pigments • Maintenance of the integrity of glandular and epithelial tissues specially of the skin and eyes • Supports growth	• Night blindness • Conjunctival xerosis (dryness) • Bitot's spot • Corneal xerosis • Keratomalacia
D	Cutaneous synthesis, animal food like liver, egg yolk, butter, cheese and fish liver and fortified vanaspati ghee	Intestine: Promotes calcium absorption Bone: Stimulates mineralization Kidney: Increase calcium resorption	Rickets in children, osteomalacia in adults
E	Vegetable oils, sunflower seed, egg yolk and butter	An important antioxidant in cellular and subcellular membrane, phospholipids	Anemia in pregnancy and neurological disorders
K	Green vegetables, synthesized by intestinal bacteria	Synthesis of clotting factors; II, VII, IX and X	Clotting disorders
Water soluble			
B_1 Thiamine	Whole grain cereals, wheat germ, pulses, ground nut	Coenzyme for oxidative decarboxylation and transketolase reaction, HMP shunt	Beriberi Dry: Neuropathy Wet: Cardiovascular degeneration
B_2 Riboflavin	Milk, eggs, liver, green vegetables	As cofactor in cellular oxidation in energy metabolism	Stomatitis, glossitis, cheilosis
Niacin	Liver, meat, eggs, fish, groundnut	Coenzyme in NAD-linked dehydrogenases	Pellagra: Weight loss, diarrhea, dermititis and dementia
B_6 pyridoxine	Milk, egg yolk, meat, cereals and vegetables	Role in metabolism of carbohydrate, fat and amino acids	Rare; because of wide distribution in foods
Pantothenic acid	All foods	Present in cells as coenzyme-A	Deficiency never occurs
Folic acid	Leafy vegetables, meat, egg, milk, cereals	Role in nucleic acid synthesis	Megaloblastic anemia, glossitis, diarrhea
B_{12} Cyanocobalamine	Liver, meat, fish, eggs, milk and cheese, also synthesized by colonic bacteria	DNA synthesis	Pernicious anemia, megaloblastic anemia and subacute combined degeneration of spinal cord
Vitamin C	Citrus food and green leafy vegetables, amla, guava	Role in tissue oxidation, collagen synthesis and absorption of iron	Scurvy, bleeding from gums, local hemorrhages, increased capillary fragility

Sources

1. Animal fat is a rich source of vitamin A, e.g. butter, ghee, milk, egg yellow, liver, fish. Fish liver oil contains the highest concentration of vitamin A.
2. Many green vegetables contain a yellow pigment called carotene. Carotene is a provitamin A, i.e. in the body it is converted to vitamin A. Carotene rich fruits and vegetables include mangoes, papaya, tomato, orange, yellow pumpkin, spinach, radish, cabbage, lettuce.

Requirement

Recommended daily allowances of Vitamin A is 600 µg of retinol for an adult and 950 µg for a lactating mother.

Deficiency Disorders

Vitamin A deficiency is widely prevalent in India. The symptoms include:

1. Growth retardation
2. Keratomalacia (softening and ulceration of the cornea leading to blindness), xerophthalmia (dryness of the conjunctiva) and Bitot's spots (pearly-white foamy spots in the bulbar conjunctiva).
3. Night blindness: This disorder results from impairment of dark adaptation in the retina. The patient has fairly normal vision in daylight but cannot see at dusk or in a dimly lit room.
4. Dryness and roughness of skin and mucous membranes.

Vitamin D

Vitamin D is essential for normal calcium and phosphate metabolism in the body. Thus, it helps in calcification of bones and teeth. Vitamin D deficiency produces rickets in children and osteomalacia in adults.

Sources

1. Animal fat is a good source of vitamin D, e.g. milk, eggs, butter, ghee. Vitamin D is not found in fruits and vegetables.
2. Solar exposure can provide all the vitamin D required by the body in adults as well children. That is why vitamin D is also known as sunshine vitamin. Ultraviolet rays in the sunlight activate 7-dehydrocholesterol, a lipid normally presents in the skin into cholecalciferol (vitamin D). Vitamin D deficiency occurs in those who do not get adequate solar exposure because of living in dark dingy houses, or those women who observe purdah, or those who live in highly industrialized cities where pollutants like smoke and fog obstruct the ultraviolet rays from reaching the earth (skin).

Requirement

The ICMR has suggested no RDA for vitamin D since solar exposure of hands and face for ten minutes a day is sufficient to synthesize sufficient cholecalciferol in the skin. If due to any of the reasons mentioned above, the solar exposure is inadequate, an intake of 400 IU vitamin D in the diet per day is required.

Fat soluble vitamins once ingested cannot be excreted. Therefore, unnecessary dietary supplements with high concentrations of vitamin A and D should be avoided.

Deficiency Disorders

1. Rickets: This disorder results from deficiency of vitamin D in young children, below 2-3 years age. The disease is characterized by growth failure, bone deformities, and muscular hypotonia. Severe hypocalcemia may lead to tetany and convulsions. The bony deformities may include curved legs (knock-knees or bowlegs), deformed pelvis, pigeon chest or kyphoscoliosis.
2. Osteomalacia: This disorder results from vitamin D deficiency in adults. Osteomalacia typically occurs in purdah observing Muslim women. The condition becomes worse during each pregnancy and lactation, when requirements of vitamin D are increased. The bones of the spine and pelvis become soft, extremely painful and deformed. Deformities of the pelvis may make vaginal delivery difficult.

Vitamin E

The role of vitamin E in the human body is not clear. It is believed to prevent sterility and helps in the embedding of the fertilized ovum. It possesses antioxidant properties also.

The richest natural sources of vitamin E are vegetable oils, e.g. cotton seed oil, sunflower oil as well as butter, and egg yolk. There is no well defined vitamin E deficiency disorder known in humans.

Vitamin K

Though a fat soluble vitamin, it is widely distributed in green leafy vegetables, especially cauliflower. Cow's milk is also a good source. The natural flora of the large gut also produce vitamin K. Therefore in normal individuals, deficiency of vitamin K does not occur. Administration of broad spectrum antibiotics for more than a week results in suppression of colonic bacteria and may result in deficiency of vitamin K. Chronic fatty diarrhea results in vitamin K deficiency by interfering with its intestinal absorption. Newborn infants are usually vitamin K deficient because the intestinal bacterial flora is not well established.

Vitamin K is essential for the hepatic synthesis of prothrombin and some other clotting factors. That is why vitamin K deficiency results in clotting disorder.

WATER SOLUBLE VITAMINS

Vitamin B Complex

Vitamin B complex is the name given to a group of water soluble vitamins with diverse composition, metabolic functions and deficiency symptoms.

Thiamine (Vitamin B_1)

Thiamine is a constituent of a coenzyme essential for the metabolism of carbohydrates in the citric acid cycle. Since, nervous tissue is dependent purely on the carbohydrates for its energy needs, nervous symptoms are most noticeable feature of thiamine deficiency.

Sources: Thiamine is present in large amounts in the wheat and rice germ, outer layers of cereals, yeast, pulses and nuts, especially groundnuts. Meat, fish, eggs, milk vegetables and fruits are poor sources of vitamin B_1.

RDA for thiamine is 1-2 mg per day.

Deficiency of thiamine results in the disorder called beriberi. Two forms of beriberi have been recognized. In dry beriberi, peripheral neuritis is the dominant clinical feature. In wet beriberi, cardiac enlargement and edema are the dominant clinical features. About 50 years ago, beriberi used to be endemic in communities whose staple diet was polished rice. With the improvement in health education and nutritional status of the population, beriberi is not a serious clinical problem nowadays.

Riboflavin (Vitamin B_2)

Riboflavin is an essential component of oxidative enzymes involved in biological oxidation (energy metabolism).

Sources: Green leafy vegetables, milk and eggs are good sources of riboflavin. Cereals and pulses are poor sources of riboflavin. RDA of riboflavin is 0.6 mg.

Riboflavin deficiency, in mild form, is fairly common in Indian population particularly in communities whose staple staple diet is rice. The disorder (ariboflavinosis) is characterized by angular stomatitis, glossitis, nasolabial dermatitis and vascularization of the cornea.

Niacin or Nicotinic Acid (Vitamin B_4)

Niacin is a component of the respiratory enzyme NAD and therefore, involved in energy metabolism.

Sources: Particularly rich sources of niacin include meat, fish, cereals and pulses. Maize contains niacin but it is not biologically available since it is present in bound form. RDA of niacin is 16 mg.

Deficiency of niacin results in a disorder known as pellagra. Pellagra is characterized by 3 Ds—diarrhea, dermatitis and dementia. Glossitis is often seen. Dermatitis is prominent on parts of the skin exposed to sunlight like face, back of the neck, back of the hands and legs. Pellagra used to be common in districts of Maharashtra where maize was the staple diet.

Folic Acid (Vitamin B_{11})

Folic acid is essential for synthesis of deoxyribonucleic acid (DNA). Deficiency of folic acid results in defective development of rapidly multiplying cells like RBCs and WBCs, and intestinal mucosal epithelial cells.

Sources: Pulses, green leafy vegetables, milk, liver and kidney are rich sources of folic acid.

RDA of folic acid is 100 μg in adults and 400 μg in pregnant women.

Deficiency of folic acid is fairly common during pregnancy because the usual diet cannot provide the enhanced body requirement of the vitamin. Folic acid deficiency manifests as megaloblastic anemia, glossitis, and gastrointestinal disturbances such as diarrhea, distention and flatulence.

Cyanocobalamin (Vitamin B_{12})

Vitamin B_{12} is involved in the metabolism of folic acid and therefore essential for DNA synthesis. Deficiency of vitamin B_{12} also results in a defect in the development of rapidly multiplying cells in the bone marrow and gastrointestinal epithelium. Thus, deficiency of vitamin B_{12}, like that of folic acid, results in megaloblastic anemia and gastrointestinal disturbance. In addition, deficiency of cyanocobalamin is associated with neurological symptoms since it acts as a coenzyme in amino acid metabolism involved in myelin synthesis.

Sources: Vitamin B_{12} is totally absent in vegetables and fruits. Good sources of cyanocobalamin include liver, kidney, meat, eggs, milk and cheese. RDA for cyanocobalamin is 1 μg.

Thus theoretically, deficiency of vitamin B_{12} may be expected to be widespread in vegetarians. Actually dietary deficiency of this vitamin is rare, partly because most of the vegetarians consume milk and also because cyanocobalamin is synthesized by colonic bacteria. Pernicious anemia, due to deficiency of vitamin B_{12} is due to an autoimmune gastric atrophy leading to decreased secretion of intrinsic factor essential for absorption of the vitamin in the intestine.

Vitamin C (Ascorbic Acid)

Ascorbic acid is essential for the synthesis of intercellular cement substance and collagen. As a reducing agent, it helps in absorption of iron in the gut.

Sources: Citrus fruits, tomatoes, cabbage, green leafy vegetables, fresh fruits, and germinating pulses are good sources of vitamin C.

RDA for vitamin C is 40 mg (80 mg during lactation).

Deficiency of ascorbic acid causes scurvy—delayed wound healing, bleeding gums and hemorrhages from mucous membranes. About 200 years ago scurvy was a serious problem for those who lived on the ships for months and did not take fresh fruits and vegetables.

DISORDERS OF MALNUTRITION (UNDERNUTRITION)

Generalized Undernutrition

1. *Starvation:* The effects of complete starvation may be studied in individuals who undertake fast unto death, the nonviolent method of protest initially used by Gandhiji against the British rule. Complete starvation may also occur in some psychiatric patients, or patients with later stages of cancer of esophagus, or very old bed-ridden individuals neglected by the family. Partial starvation used to be more common due to famines in India but even now it is not rare.

   The body stores of glycogen are so little (200 g) that they are unable to maintain blood sugar level for more than 24 hours. After this, tissue fat and proteins are uti-

lized to provide energy and maintain blood glucose level (gluconeogenesis). Free fatty acids released by lipolysis can be utilized as fuel by most of the tissues specially skeletal muscle and cardiac muscle. However, tissues like brain, retina, germinal epithelium, and RBCs are purely glucose dependent for their energy requirements. Whereas lipolysis has glucose sparing action, enhanced breakdown of proteins helps in neoglucogenesis and maintenance of blood glucose level. Within 3-4 weeks of complete starvation over 25 percent of the body weight may be lost. Of this, loss of fat is 5-6 kg, loss of protein 2.5-3 kg, and loss of body water about 5 kg. Loss of body water occurs mainly from intracellular compartment. Decreased plasma protein concentration leads to edema specially in elderly individuals.

Deficiency of TSH secretion leads to marked atrophy of thyroid gland. Hence BMR falls. Decreased secretion of gonadotropins leads to loss of libido in males and menstrual disturbances in the female.

2. *Severe malnutrition:* Severe malnutrition is not uncommon in India. It may be seen in extremely poor population of rural and urban India. It results in deficiency diseases like protein energy malnutrition, nutritional anemias, vitamin deficiency disorders, goiter and nutritional edema, etc.
3. *Chronic undernutrition*: Chronic undernutrition is a national health problem in India and other under-developed countries. According to a recent study by WHO (1998), about 50 percent of the population of India is underweight (as compared to only 2 percent in the UK).

Specific Nutritional Deficiency States

Protein Energy Malnutrition (PEM)

This condition was recognized in the middle of the last century and attributed to dietary deficiency of proteins as well as total caloric intake. By 1970s it came to be recognized that the disorder is primarily due to deficient caloric intake, protein intake is usually adequate. Childhood PEM is fairly common in the underprivileged sections of the Indian population.

Classification of Malnutrition

Classification of malnutrition is usually based on the anthropometric criteria. The three measurements commonly used are weight, height and midarm circumference. The most accepted international classification of childhood malnutrition is as follows:

Nutritional Status	*Percent RWA (weight as percent of reference weight for age)*
Normal	≥ 80%
Grade I malnutrition	70-79.9%
Grade II malnutrition	60-69.9%
Grade III malnutrition	Less than 60%

Clinically, malnutrition may present as a part of spectrum with Kwashiorkor at one extreme and Marasmus at the other. 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". The most characteristic feature of Kwashiorkor is edema, giving rise to "moonface", usually accompanied by skin lesions, irritability and lack of interest in surroundings. Loss of weight may not be apparent because of edema. Kwashiorkor is much less frequently seen than marasmus, but it is a more serious form of malnutrition, which may be fatal within days to weeks.

According to UNICEF, 53 percent of Indian children below 4 years age are suffering from moderate to severe malnourishment. India alone accounts for 40 percent of total malnourished children in the world. Equally common are deficiencies of vitamins A, B, C, and D as well as iodine and iron deficiencies. Subnormal body weight, without any positive sign of illness is an indication of mild chronic undernutrition. Chronic undernutrition in childhood leads to physical and possibly mental growth retardation and more susceptibility to infections leading to greater childhood mortality. In adults, chronic undernutrition produces a significant reduction in work capacity, easy fatigability, greater susceptibility to infections and premature ageing.

Iron Deficiency

Iron deficiency is the most common nutritional deficiency, especially in India. According to a WHO estimate, the prevalence of nutritional anemia in India is 76 percent in preschool children, 50 percent in school children, 15-25 percent in men, 50-80 percent in women, and 70-90 percent in pregnant women. Though classified as nutritional anemia, it practically means iron deficiency anemia, because the other two types, folic acid and vitamin B_{12} deficiency anemia are not common.

Anemia is not the only manifestation of iron deficiency. As a component of tissue oxidative enzymes, iron deficiency affects all tissues. Thus besides anemia, there may be other functional impairments such as impaired cell mediated immunity, reduced resistance to infections, increased morbidity and mortality, diminished work performance. Chronic iron deficiency may be responsible for scholastic underachievement and behavioral disturbances in children.

Vitamin A Deficiency

Surveys in India have revealed widespread low intake of vitamin A. Below the age of 5 years, 2-3 percent of Indian children show Bitot's spots, the tell-tale sign of vitamin A deficiency. Other signs such as xerophthalmia and night blindness are also common. Xerophthalmia has been observed in about 2-10 percent of preschool children. It has been estimated that 13,000 Indian children become blind every year due to vitamin A deficiency. It is all the more tragic that preventive measures against

deficiency of vitamin A are very simple (intake of green vegetables) and cheap.

Iodine Deficiency

Iodine deficiency results in impaired synthesis of thyroxine. This manifests more commonly as goiter, seen in the form of a diffuse or nodular enlargement of the thyroid gland. Symptoms and signs of hypothyroidism may also be present. During the last few decades, it is being increasingly recognized that iodine deficiency during intrauterine life and childhood has serious health and psychological implications, especially because of its effects on neural development. Goiter is endemic in most of the sub-Himalayan regions of North India, though it has been reported even in Maharashtra. In some parts of Uttar Pradesh, prevalence rate of 36 percent goiter and 15 percent rate of congenital hypothyroidism has been reported. To overcome the wide spread iodide deficiency, Government of India has allowed the sale of only iodide- fortified common salt throughout the country.

Nutritional deficiency and its oral clinical manifestations

Area/Oral cavity	*Clinical manifestation*	*Nutrient deficiencies*
Face	Malar pigmentation	Niacin, B Vitamins,
	Bitemporal wasting	Protein-energy malnutrition
	Nasolabial seborrhea	Niacin, riboflavin, B_6
	Edema	Protein deficiency,
	Lack of color	Iron, malnutrition
Lips	Cheilosis	Niacin, B_6, riboflavin
	Angular fissures	Niacin, B_6, riboflavin, iron
Gingiva	Spongy, bleeding abnormal redness	Vitamin C
Tongue	Glossitis (red, raw, fissured)	Folate, niacin, iron, B_6, B_{12}
	Pale, atropic, smooth slick (filiform papillary) atrophy)	Iron, folate
	Magenta color	Riboflavin

DISORDERS OF OVERNUTRITION

Obesity

Obesity is a fairly common problem in the affluent members of the society. Although, there is an internal regulation of body weight and long-term intake of food, these individuals tend to be obese due to some genetic factors. Obesity attributable to endocrine disorders is relatively less common.

Even though the exact cause of obesity is not known, the basic fact remains that their energy intake exceeds the energy expenditure. Moreover, excess energy input needs to be present only when obesity is developing. Once a person has become obese, his energy intake is usually not more than that of a lean individual. Obesity is associated with increased incidence of diabetes mellitus, atherosclerosis, coronary artery disease, hypertension, joint pains especially in knees, and psychological disturbances. A person is said to be obese if his body weight is 20 percent greater than the desirable weight for his age and sex. Body Mass Index (BMI) has been considered a better index of obesity assessment. BMI is calculated as follows:

BMI = Body weight (kg)/(height) square (meters)

The normal values of BMI are depicted below:

BMI

Normal: 18.5 - 24.9
Overweight: 25 - 29.9
Obese: 30 and over

Although, undernutrition is the major public health problem in most of the Indian population, obesity is gradually emerging as an area of concern in the affluent segments of urban population. In a small study carried out in Delhi, 20 percent men and 27 percent women were found to be overweight or obese.

In the treatment of obesity, dieting is commonly resorted to. Most often dieting can reduce the body weight only transiently. Moreover, prolonged and severe dieting may lead to vitamin and mineral deficiency disorders. Moderate decrease in food intake especially of fats coupled with increased physical activity, constitute a more effective regimen for the reduction of body weight. Increased physical activity should not be taken to mean paddling a bicycle for a few minutes every day. A change of life style involving willingness to engage in physical activity at every available opportunity is required. In principle, the aim should be to increase the energy expenditure so that it exceeds the energy intake.

Hypervitaminosis

Due to self-medication, excessive intake of vitamins is a common occurrence. Rapid urinary excretion prevents any toxic effects of water soluble vitamins. In contrast, fat soluble vitamins tend to be stored in the liver and adipose tissue and cannot be excreted. Hypervitaminosis A and D are well recognized clinical disorders.



Section

Dental Public Health

Chapter 9

Introduction to Public Health Dentistry

CM Marya

BACKGROUND

Public health is not a new subject. It has long and interesting history which is linked to many of the social, economic and political changes that have occurred in world's history in the last so many years. The public health movement originally arose in response to the appalling living and working conditions that affected a high proportion of the working classes in nineteenth century.

Rapid industrialization and urban growth created industrial town in which overcrowding, extreme poverty, poor, and filthy physical conditions and diseases were common place. Pioneering social reformers such as Southwood Smith, Edwin Chadwick and John Snow identified the need to improve the living and working conditions of the poor in UK, to promote the public health. Municipal reforms and improvements in the environment then resulted from passing legislation such as Public Health Act, 1875.

Every society irrespective of its values has one common feature that it requires a collective arrangement for health care provision at some minimal level.

Definition of Health (1948)

WHO defines health as 'a state of complete physical, mental and social well being and not merely the absence of disease or infirmity'.

DEFINITIONS OF PUBLIC HEALTH

Winslow (1920)

The art and science of preventing disease, prolonging life and promoting physical and mental efficiency, through organized community efforts; for the sanitation of the environment, the control of communicable infections, the education of the individuals in personal hygiene, the organization of medical and nursing services for the early diagnosis and preventive treatment of disease and the development of the social machinery to ensure everyone a standard of living adequate for the maintenance of health, so organizing these benefits as to enable every citizen to realize his birthright of health and longevity.

Downer (1984)

Defined public health as 'The science and art of preventing oral disease, promoting oral health and improving the quality of life through organized efforts of the society'.

Ten Great Public Health Achievements of the 20th Century

- Vaccination
- Motor-vehicle safety
- Safer workplaces
- Control of infectious diseases
- Decline in deaths from coronary heart disease and stroke
- Safer and healthier foods
- Healthier mothers and babies
- Family planning
- Fluoridation of drinking water
- Recognition of tobacco use as a health hazard.

Role of Public Health

- Prevent epidemics and the spread of disease
- Protects against environmental hazards
- Prevents injuries
- Promotes and encourages healthy behaviors
- Responds to disasters and assists communities in recovery
- Assures the quality and accessibility of health services.

When we move beyond the definitions and concepts, perhaps the easiest way to understand what public health is by comparison to that which it often times confused, medical treatment or health care. Though it's not really fair to characterize the two as adversaries, since they are really best when working together, as Box 9.1 indicates, there are some key differences that go to the core of what public health is, particularly its focus on populations rather than individual patients, and on prevention rather than diagnosis and treatment.

BOX 9.1: DIFFERENCES BETWEEN PUBLIC HEALTH AND MEDICAL TREATMENT

	Public Health	*Medical Treatment*
1.	Focus on health status of populations	Focus on clinical improvement of individuals patients
2.	Public services ethic, tempered by concerns for the individual	Personal service ethic, conditioned by awareness of social responsibilities
3.	Emphasis on prevention and health promotion	Emphasis on diagnosis and cure
4.	Activated all of the time	Activated when a person is injured or ill

ESSENTIAL PUBLIC HEALTH SERVICES

Ten Essential Public Health Services These services fall under the three core functions of public health, which are "Assessment", "Policy Development and Planning", and "Assurance".

Assessment Function

1. Monitor health status to identify community health problems.
2. Diagnose and investigate health problems and health hazards in the community.

Policy Development and Planning Function

3. Inform, educate, and empower people about health issues.
4. Mobilize community partnerships to identify and solve health problems.
5. Develop policies and plans that support individual and community health efforts.

Assurance Function

6. Enforce laws and regulations that protect health and ensure safety.
7. Link people to needed personal health services and assure the provision of health care when otherwise unavailable.
8. Ensure a competent public health and personal health care workforce.
9. Evaluate effectiveness, accessibility, and quality of personal and population-based health services.
10. Research for new insights and innovative solutions to health problems.

Some essential public health services fit under more than one of the three major functions of Assessment, Policy Development/Planning, and Assurance.

CONCEPTS OF PUBLIC HEALTH

1. Disease control phase: (1880-1920)
   It was characterized by industrialization and rapid urbanization leading to desperate living conditions for the poor. Public health achievements were mainly those of sanitary reforms. During this phase medical and epidemiological approaches were targeted towards detecting causal relationship involving malnutrition, unhygienic conditions and infectious diseases and not towards the control of any specific disease. John Snow's classic study of the cholera epidemic of 1854 is one of the best examples.
2. Health promotional phase: (1920-1960)
   Advances in bacteriology and immunization were made during this phase bringing personal prevention and health promotion on a population basis, which included maternal and child welfare, school and industrial health services, provision for basic health services through the medium of primary health centers and subcenters for the rural and urban areas.
3. Social engineering phase: (1960-1980)
   This was characterized by shifting of focus towards complexities of medical treatments and less emphasis on public health. This coincided with the disappearance of the major infectious diseases. There was emergence of chronic diseases eg cancer, diabetes, drug addiction, alcoholism etc. specially in the developed world. These diseases could not be explained on the basis of germ theory of disease so a new concept of 'RISK FACTORS' came into existence.
4. Health for all phase: (1980-2000)
   Also called as 'New Public health' phase. There was a noticeable difference seen between developed and developing countries. All members of WHO in 1981 pledged to provide Health For All by 2000, i.e. attainment of a level of health that will permit all people to lead a socially and economically productive life. Aim was to bring health within reach of every one in a given community.

PUBLIC HEALTH PROBLEM

It is well recognized now that demands on health care system will always be greater than the resources available to meet these needs. This creates a need to direct the available resources to particular problem areas or the most important problem.

Table 9.1 shows the similarities and dissimilarities between individual and public health practice.

Criteria for a Public Health Problem

- Prevalence of the condition – what percentage of population effected.
- Impact of the condition on an individual level.- how serious are effects of disease to the patient
- Impact on wider society.
- Condition is preventable and effective treatments are available.

IMPACT OF ORAL DISEASE

Oral health is an integral part of general health. Oral diseases directly affect quality of life by having a serious impact on an

Table 9.1: Similarities and dissimilarities between clinical and public health practice

Individual Care	*Public Health Practice*
Examination	*Survey*
Medical history	Assessment of disease rates
Clinical examination	Community support
Patient's interviews	Available services
Diagnostic tests	Barriers to services
Diagnosis	*Analysis*
Based on examination information	Interpretation of statistics, opportunities and threats to implementation, and community support
Treatment Planning	*Program Planning*
Many factors must be balanced: Professional judgment, patient's interest, cost of treatment	Community's desire for intervention, cost, availability of proven interventions
Informed Consent	*Ethics and Planning Approval*
Treatment	*Program Operation*
Schedule for care is determined, referral may be necessary for complex procedures	A varied group of disciplines may be needed for implementation
Payment	*Funding*
Self pay, third party, HMO	May be federal, state, local or funded by grants
Evaluation	*Program Appraisal and Review*
At subsequent visits, the patient's health is reassessed	Data collected at the initial assessment serve as a baseline for the appraisal. Public health workers are accountable to the community for a periodic appraisal of performance.

individual's well being and the ability to fulfill desired functions in the social and economic context. Appropriate nutritional intake can also be influenced by incapacity to masticate or persisting pain due to oral diseases. The consequences of conditions like oropharyngeal cancer and noma on the individual are even worse. They can be life-threatening and often result in lifelong functional impairment or disfigurement. Oral appearance affects self-esteem and the willingness to interact with others.

The economic costs of oral diseases are also considerable, although difficult to quantify. They result from direct costs of treatment within the health care systems and out-of-pocket co-payments from patients, and from indirect costs such as work-loss, absenteeism from school, travel expenses, and the total societal burden through loss of economic productivity.

Oral diseases are major public health problems on a global level. Their most common effects, oro-facial pain and tooth loss, are known to almost every human being. Budget limitations, lack of infrastructure, resources and knowledge, lack of capacity, different priorities, or even unwillingness to act, are some of the reasons for the widening gap between need, services provided, and effective policies that address oral health problems.

The world oral health report 2003 presents oral diseases as a major public health problem owing to their high prevalence and incidence in all regions of the world, and as for all diseases, the greatest burden of oral diseases is on disadvantaged and socially marginalized populations. The severe impact in terms of pain and suffering, impairment of function and effect on quality of life must also be considered. Traditional treatment of oral diseases is extremely costly in several industrialized countries, and not feasible in most low-income and middle-income countries. The WHO Global Strategy for Prevention and Control of Non communicable Diseases, added to the common risk factor approach is a new strategy for managing prevention and control of oral diseases.

The following factors (Table 9.2) necessitate considering oral diseases to be of public health importance *(Sheiham A, Watt RG)*.

Table 9.2: Public health importance of oral diseases

High prevalence
High cost of treatment
Considerable impact on individuals
Affects quality of life-handicapping
Causes are known - diet and dirt
Easy and cheap to prevent
Diagnosis is easy
Easy to evaluate treatment
Treatment relatively unsuccessful

Definition of Dental Public Health

American board of dental public health defines dental public health as:

Dental public health is the science and art of preventing and controlling dental diseases and promoting dental health through organized community efforts. It is that form of dental practice that serves the community as a patient rather than the individual. It is concerned with the dental health education of the public, with applied dental research, and with the administration of group dental care programs, as well as the prevention and control of dental diseases on a community basis. Implicit in this definition is the requirement that the specialist have broad knowledge and skills in public health administration, research methodology, the prevention and control of oral diseases, and the delivery and financing of oral health care.

MILESTONES IN DENTAL PUBLIC HEALTH

Introduction

Dental ailments have remained remarkably similar throughout history. Decay, toothaches, periodontal disease and premature tooth loss were documented in ancient chronicles. The exact time that dental art made its appearance isn't known; however, there is ample proof of its existence among the civilizations of Egypt, Etruscans of Central Italy, Assyrians, China, etc.

HISTORICAL OVERVIEW

The Early Times

The Egyptians

- The first known dentist was an Egyptian named Hesi-Re (3000 BC). He was the chief toothist to the Pharaohs. He was also a physician, indicating an association between medicine and dentistry.
- The first evidence of a surgical operation was found in Egypt. A mandible with two perforations just below the root of the first molar indicated the establishment of drainage of an abscessed tooth. The approximate date is 2750 BC. The splinting of teeth also was practiced by Egyptians; evidence by a specimen from Cizeh, 2500 B.C. It shows two molars fastened with heavy gold wire.
- Egyptian pharaohs were known to have suffered from periodontal (gum) disease. Radiographs of mummies confirm this fact.
- 3000 BC, Babylonians and Assyrians used to have gum problems for which they used gingival message combined with various herbal medicines, as per legend written on a clay tablet.

The Chinese

- The Chinese were known to have treated dental ills with knife, cautery, and acupuncture, a technique whereby they punctured different areas of the body with a needle.
- There is no evidence of mechanical dentistry at that time, 2700 BC, however. Marco Polo stated that the Chinese did cover-teeth with thin gold leafs only as decorations, 1280 AD.
- The modern toothbrush was invented by Chinese in 959 BC.

The Greeks

- *Aesculapius* (1300-1200 BC) originated the art of bandaging and use of purgatives. He also advocated cleaning of teeth and extractions.
- *Hippocrates* (500 BC) Hippocrates raised the art of medicine to a high level. Also in one of his texts (Peri-Arthron) he devoted 32 paragraphs to the dentition. He appreciated the importance of teeth. He accurately described the technique for reducing a fracture of the jaw and also for replacing dislocated mandible.
- *Aristotle* (384 B.C.) - who follows Hippocrates, accurately described extraction forceps.

  The Etruscans (100-400 BC)
- *Etruscans* (100 - 400 BC) in the hills of Central Italy made the greatest contribution in restorative dentistry.
- In Italian museums there are numerous specimens of crowns and bridges which were the equal of many made in Europe and America up until 1870 when the dental engine was invented.

The Romans

- Several Roman physicians wrote extensively about dentistry. Many people still believed in the theory of the 'tooth worm' being responsible for toothaches. Romans were skilled in restoring decayed teeth with gold crowns. They had a high regard for oral hygiene.

  Celsus (25 BC - 50 AD) believed that General Physical deterioration caused dental diseases. For toothaches he prescribed:
  - Hot water fomentation
  - Narcotics
  - Use of the cautery
  - Alum for soft tissue disease
  - Extraction of badly broken down teeth. He recommended filling the cavity with lead prior to extraction as a means of lessening the chance of fracturing the crown.
  - Gave the technique for reducing fractures
  - Gave first technique for tooth straightening or positioning.

  Archigenus (100 AD)

  a. Recognized pulpitis

  b. Invented the dental drill to open into pulp chamber

  Galen (200 AD) considered the greatest physician since Hippocrates, was the first to recognize that a toothache could be:

  a. Pulpitis (inflammation of the pulp)

b. Pericementitis (inflammation of radicular portion of the tooth)

He classified teeth into centrals, cuspids and molars.

The Romans were not especially gifted in their dental art. They borrowed their medicine from the Greeks and restorative dentistry from the Etruscans.

The Renaissance

- Le Chirurgien Dentiste described the basic oral anatomy and function, sign and symptoms of oral pathology, operative methods for removing decay and restoring teeth, periodontal disease (pyorrhea), orthodontics, replacements of missing teeth and tooth transplantation.
- Pierre Fauchard was the founder of modern dentistry. He developed dentistry as an independent profession from medicine.

The Arabians

- Arabian physicians gave great importance to clean teeth. They describe various procedures to scrape teeth and designed a set of instruments to accomplish the task.
- Mouth washes and dentifrices were applied by the Arabians using a toothbrush (a small polishing stick that was beaten and soften at one end), instrument they used for scaling was called a siwak.
- Abulcasis described extraction, scaling, reduction of fractures and treatment of dislocated jaw.
- He designed 14 different kinds of scrapers and suggested the binding together of sound teeth and filling the existing gap with a bone substitute.
- Rhazes (850-923), a Persian physician, wrote a treatment on how to fill the cavities with alum and mastic.

Some Dental History Highlights in Chronological Order

- 1308-1745 AD France, Guild of Barber-Surgeons founded and remained active until 1745.
- 1363 AD. In two manuscripts in the Vatican Library there was earliest use of the term dentist.
- 1452-1519 AD *Leonardo da Vinci*, who inspired the work of *Vesalius*, was an anatomist and original dissector of the human body. His manuscript presented the earliest accurate drawings of the skull, teeth, associated structures and maxillary sinus.
- 1498 AD Chinese invented the modern toothbrush on june 24th.
- 1542 AD *Amroise Pare*, famous military surgeon, revived the old method of compression of nerve trunks to produce local anesthesia. Mentions transplantation and filling of teeth and ligation of teeth with gold wire. Described obturators.
- 1543 AD *Andreas Vesalius*. Made important observations on the development of teeth.
- 1561 AD *Gabriel Fallopius* wrote about the dental follicle and development of teeth.
- 1683 AD *Anton van Leeuwenhoek* discovered by use of microscope (1673) microorganisms (animalcules) in teeth and describes their tubular construction. 1728 AD. First edition of Pierre Fauchard (founder of modern dentistry) textbook on "The Surgeon Dentist".

The Indian Civilization

- Sushrutha samhita – numerous description of severe periodontal disease with loose teeth and purulent discharge.
- Charaka samhita – tooth brushing with a Neem twigs which is bitter, pungent and astringent.
- Adequate proof of community health measures adopted during Harappa Civilization as far as 5000 years back has been found in the old excavations at Mohenjo- Daro and at Lothal near Ahmedabad.

Middle Civilization

16th Century AD and After

Albucasis, a Spanish moor of Cordova (1013 A.D.). He is considered the great Exponent of Dental Surgery in the middle ages. In his book we find what is perhaps the first illustration of dental instruments. They are as follows:

1. 14 scalers
2. Elevators for surgery
3. Cautery
4. Forceps for surgery
5. Dental saws and files for removal of caries. He was also a great teacher. He insisted on arriving at an accurate diagnosis. He accurately described technique for extractions and believed in the refferred pain theory. He also described treatment for partially luxated teeth.

- *Peter Foreest*, a Dutch physician concentrated on the harmful effect of sugar and all sweet things.
- *Le Chirurgien Dentiste* emphasized on cleaning teeth to prevent diseases.
- *Barber* dentists were sent from England to US
- In 1640: toothbrush was introduced into the western world.
- In 1791: in New York City, first dispensary for the treatment of poor was established by Skinner.
- 1728: *Pierre Fauchard's* great work "Le Chirurgien Dentiste"
- 1733-1735: *James* Reading and *James Mills* became the first tooth-drawers in New York and perhaps in America.
- 1756: *Philipp Pfaff* made plaster models and described taking the bite. Practiced capping the pulp.
- 1763: *John Baker*, *M.D. Surgeon Dentist*. The earliest qualified dentist to practice in Boston and in America.
- 1771: *John Hunter*, comparative anatomist and surgeon, published his classic description of the anatomy of the

human teeth. In transplanting teeth, he demanded the removal of the pulp before filling the teeth.
- 1826: *M Taveace* in Paris introduced the first form of amalgam
- 1840: *Baltimore College* of dental surgery marks the official birth of formal dental education.
- 1844: *H Wells* Discovered use of nitrous oxide anesthesia.
- 1861: Dental services become part of charity hospitals in Philadelphia.
- 1864: small dental clinics were opened for low income group in Boston.
- 1870: American Dental Association passed a resolution in Nashville, Tennessee, passed a resolution calling for "a committee to correspond to the publishers of American school books and ascertain if some plan can be devised to have short plain statements inserted of name, form, and arrangement of several teeth".
- 1872: *Morrison* invented First foot-engine.
- 1884: *ML Rhein* of NY City urged the dentists to teach their patients proper brushing method. It was only true campaign to prevent caries before First World War and got famous by term 'oral hygiene'.
- 1890: *WD Miller* described microorganism of the human mouth.
- 1893: *Dr GV Black* gave system of dental nomenclature.
- 1896: *Dr GV Black* modified the composition of silver amalgam.

Early 20th Century

- 1901: *Dr Fredrick McKay* discovered and coined the term Colarado stains, in Colombo springs, USA
- 1903 AD Four years course in dental colleges established
- 1905: *Dr Alfred C Fones* trained *Mrs. Irene Newman* (1st dental surgery assistant) to undertake oral prophylaxis
- 1907: Connecticut State Legislature passed a law prohibiting employment of unlicensed dental assistants. But *Dr Fones* was able to insert a law which permitted the trained assistants to perform oral prophylaxis under the direct supervision of a registered dentist
- 1908: *Dr Black and Dr McKay* and associates studied colarado stains and termed it as dental fluorosis
- 1910: Establishment of Rochester Dental clinic later endowed by George Eastman and in corporation of Forsyth dental infirmary for children of Boston
- 1911: *Dr Ebersole* organized a large hygiene meeting in Cleveland, Ohio at which he exhibited the mental and physical improvement of 27 children who had been brought from the state of great dental neglect to the state of full dental health
- 1915 AD *McKay and Black* publish results of investigation of fluoride in drinking water
- 1919: Founding of dental department of US public health services
- 1920: By and large the period following the World War I was characterized by a broadening of the scientific basis for the preventive dentistry and many factors predisposing to dental caries
- 1921: The first training school for the dental nurses came in to existence in New Zealand, in Willington, started by TA Hunter
- 1921: Dentist act passed in England. Over 7000 previously unregistered dentists registered themselves
- 1923: The first batches of school dental nurses from Willington were sent to the Govt. school system to provide dental care
- 1929: White house conference on the child health and protection held in Washington DC. There was a discussion on dental health care also
- 1931: Churchill identified the element 'fluoride'
- 1933: dentists were employed in FERA (Federal Emergency Relief Administration) so that establishment of large clinics in which relief client could receive proper care
- In 1945, two water fluoridation plants were launched on trial basis in Grand Rapids, Michigan and Newburgh, New York
- 1945: The start of voluntary prepaid comprehensive dental care in St. Louis, USA
- 1948: England Established National Insurance Scheme including comprehensive dental care
- 1954: Formation of Washington state dental services corporation by Washington state dental council to help administer prepayment dental care plan for children of International Longshoremen's and Ware house men's union pacific maritime association
- 1966: Medicare brought medical care to the aged of the US without regard to income. They did not include dentistry but Medicaid
- 1973: Health maintenance organization act provided government support for organization providing standardized comprehensive care to individuals in enrolled groups
- 1973: WHO established WHO epidemiological data bank which collect data on dental health and needs in various countries around the globe

AIMS OF DENTAL PUBLIC HEALTH

FDI aims related to Public Health (Adopted by General Assembly in 2001, Kuala Lumpur, Malaysia)

To develop, support and promote programs aimed at the prevention of oral diseases and the improvement of general and oral health.

To provide expertise and advice on (oral) health promotion programs, suitable for various situations.

To develop collaboration with Member Associations, inter-governmental, governmental and voluntary organizations involved in the promotion of general and oral health.

To promote the delivery of best possible oral health care.

To provide a world forum to exchange knowledge and experience in all aspects of oral health and oral health care.

To analyse trends and developments of importance to oral health and oral health care world-wide.

To develop, adopt and encourage pro-active programs to progressively develop oral health care world-wide.

To provide a comprehensive information and communication system for making relevant information available to members, the media and governments.

The aim of public health is to enhance the health of population. The study of the oral health in the community will require an appreciation of other disciplines like:

Sociology and psychology,
Epidemiology,
Health economics,
Health promotion,
Health education,
Health service organizational methods
Medical statistics.

TOOLS OF DENTAL PUBLIC HEALTH

1. Epidemiology
2. Biostatistics
3. Social sciences
4. Principles of administration
5. Preventive dentistry

1. Epidemiology
   Defined as 'the study of the distribution and determinants of health related states or events in specified populations and the application of this study to control health problems'. [Last 1988]
   Uses
   1. Concerned with course and outcome [natural history] of disease in individuals and groups.
   2. Causation of disease.
   3. Used to describe the health status of the population group
   4. Helps in evaluating effectiveness and efficiency of health services [intervention]
2. Biostatistics
   It is the method of collection, organizing, analyzing, tabulating and interpretation of datas related to living organisms and human beings.
   Uses
   1. To test whether the difference between two populations, regarding a particular attribute is real or a chance occurrence.
   2. To define normalcy.
   3. To study the association between two or more attribute in the same population.
   4. To evaluate the efficacy of vaccines by controlled studies.
   5. To evaluate the progress of public health programs.
   6. To define and measure the extent of morbidity and mortality in the community.
3. Social Science
   It includes sociology, cultural anthropology and psychology. Sociology is the study of human groups. Sociology is not concerned with behavior unique to individuals but patterned human relationship.
4. Principles of administration
   Sound administration is essential for the success of any public health program whether on the national, intermediate or the local level.
   Administration is defined as "the art and science of guidance, leadership, and control of the efforts of a group of individuals towards some common goal".
   Management is the operational part of administration.
   It is defined as: "It is a set of interactive processes through which the utilization of resources results in the accomplishment of organization objectives."
   It is a "conversion mechanism".
   It is through "management" that the objectives of the health care organization are achieved by gathering and positioning of resources.

   Elements of Administration:
   Planning
   Organization
   Staffing
   Directing
   Coordinating
   Reporting
   Budgeting
   Supervising
   Evaluation
5. Preventive dentistry
   Prevention is defined as "actions aimed at eradicating, eliminating or minimizing the impact of diseases and disability. The concept of prevention is best defined in the context of levels, traditionally called, primary, secondary and tertiary prevention".

PROCEDURAL STEPS IN DENTAL PUBLIC HEALTH

1. Survey
2. Analysis
3. Program planning
4. Ethics and planning approval
5. Program operation
6. Financing
7. Program appraisal

Stages of Clinical and Public Health Practice

1. *Examination/survey*
   A clinical dentist carries out a thorough and careful examination on the 1st visit of the patient which includes

a history and clinical assessment. This helps in future treatment planning for patient. Survey is 1st step in public health practice. It means clinical assessment of the extent and severity of disease in a population. Here the public health dentist examines the population to assess the oral health problem unlike a single patient by clinical dentist.

2. *Diagnosis/analysis*
   A clinical dentist makes a diagnosis of the problem based on the examination. In public health the information collected by survey is analyzed. The analysis of data is done to make the obtained data more meaningful. Statistician and computers aid in compilation of data.
3. *Treatment planning/program planning*
   Treatment planning includes both dentist and patient participation. Dentist's professional judgment of treatment, patient interest in treatment and cost factor etc. are involved. The patient may accept the treatment in full or partially or may reject it completely.
   In program planning similarly the people may accept the ideal program with enthusiasm or may reject it or accept only a part of it. The decision reflects the community's relative value solving the particular health problem.
4. *Informed consent/ethics and planning approval*
   Informed consent of the patient is taken before starting any treatment. Patient is explained all aspect of treatment planned. Similarly all ethical clearance and approval from all the concerned persons and authorities is taken before implementing a public health program.
5. *Treatment/program operation*
   After taking consent the treatment schedule is arranged. Complex treatment may require services of various specialists for different procedures, which is coordinated by the primary dentist.
   Similarly once a community public health program has been adopted, a varied group of discipline which constitutes a public health team may be utilized for execution of the program.
6. *Payment/finance*
   Payment for treatment in a clinical setup is informed to the patient and mode of payment acceptable to both the dentist and patient is arranged.
   Funds for community public health program are arranged by local, state or federal grants. The public health professional is expected to know how to secure and manage the funds. Local or voluntary organization may also contribute towards the program. Differences have been shown in the following Table 9.3.
7. *Evaluation/program appraisal*
   Patient is evaluated by the dentist regularly during the course of treatment. Recording of initial condition helps to compare with later observations.
   Similarly data collected in initial surveys serves as a baseline against which effectiveness of an oral health program can be evaluated or assessed. Public health team is accountable to the community for a periodic appraisal of their program.

Role of a Public Health Dentist

A public health dentist can play a role in community or field based programs like:

Dental public health professionals work with the school-based fluoride mouth rinse program.

Suggestion and guidance on Community and school water fluoridation program.

Classroom-based education for elementary school children on dental health, plaque awareness, and tobacco use prevention.

Community oral health education and prevention initiatives in partnership with private dentists and other health care groups.

Spit Tobacco Education Program activities

Community dental sealant, dental screening, early childhood caries, and baby bottle tooth decay education programs.

Prevent abuse and neglect through Dental Awareness program.

Table 9.3: Differences between personal/private practitioner and community health dentist

Private	*Community health dentist*
1. Works more or less alone	1. Works in a team
2. Focus on individual patient	2. Focus is on community
3. Independent decision maker regarding line of treatment	3. Decision taken by governing body or advisory council
4. Higher take home pay but less fringe benefits	4. Salaried with fringe benefits like pension plan etc.
5. Priorties of individual care may be coincidentally related to social goals. Private care seeks to maximize the chance of best possible outcome	5. Goals are socially determined, and seeks to minimize the chance of worst outcome
6. Patient consent and cooperation required	6. Requires community participation
7. Intervention includes appropriate dental procedure	7. Promotive and preventive measures at individual and community levels are carried out
8. Payment for treatment by individual	8. Funding by government authorities
9. Emphasis on curative and restorative care	9. Emphasis on promotive and preventive care

FUNCTIONS OF PUBLIC HEALTH DENTISTRY

The services provided to the community by public health dentist include:

1. *Preventive Services*
   a. Application of topical fluorides
   b. Pit and fissure sealants application
   c. Promotion of water fluoridation
   d. Defluoridation
2. *Public Health Training*
   a. School teacher training program.
   b. Training of the health care worker about dental health and oral hygiene measures.
3. *School Dental Health Program*
   a. Topical fluoride application.
   b. School mouth rinsing program.
   c. Teaching of oral hygiene methods and importance of dental health to children.
   d. Education about safe play areas for children to school authorities.
   e. Knowledge about junk foods and effects of cold drinks to children.
4. *Dental Public Health Program*
   a. Examination and treatment of community through dental health program.
   b. Screening program for oral cancer.
   c. Dental health check up and treatment like extraction, filling, oral prophylaxis of industrial workers through camps.
5. *Dental Health Education*
   a. Education about dental health and its importance to community, industrial workers and social organizations.
   b. Imparting knowledge about oral health to expectant mothers.
   c. Knowledge about injury to teeth and importance of mouth guards.
   d. Education to geriatric population about oral health.
   e. Informing people about ill effects of tobacco and smoking.
   f. Educating public about methods of prevention of dental diseases like dental caries, periodontal disease and oral cancer.
   g. educating care takers about maintenance of oral health in special needs patients.
   h. parent counseling for pre school and school children.
6. *Program Administration and Promotion*
   a. Helping the State / Central agency in conducting epidemiological studies regarding oral diseases.
   b. Conducting surveys to determine dental needs of the population.
   c. Providing dental health knowledge to state agencies or education department.

The economic costs of oral diseases are also considerable, although difficult to quantify. They result from direct costs of treatment within the health care systems and out-of-pocket co-payments from patients, and from indirect costs such as work-loss, absenteeism from school, travel expenses, and the total societal burden through loss of economic productivity.

Besides dental decay, in a number of countries oral cancers, trauma to teeth and craniofacial trauma, oral manifestations of HIV-infection and noma (cancrum oris) are also important oral public health problems. Oral cancer is one of the ten most frequent cancers worldwide with great variability between different regions. In some countries in Asia, oral cancer accounts for up to 50 percent of all cancers. Three quarters of oral cancer cases occur in developing countries. Noma shows the strongest links to poverty and general medical and social deprivation and has a large impact on the affected individuals.

Oral diseases are major public health problems on a global level. Their most common effects, orofacial pain and tooth loss, are known to almost every human being. Budget limitations, lack of infrastructure, resources and knowledge, lack of capacity, different priorities, or even unwillingness to act, are some of the reasons for the widening gap between need, services provided, and effective policies that address oral health problems.

PUBLIC HEALTH MILESTONES IN INDEPENDENT INDIA

- 1947: Ministries of health and Director-General of Health Services established at the Center and States. The Indian Nursing Council Act passed
- 1948: India joined the World Health Organization and the Employees State Insurance Act passed. The Dental Council of India established under the Dentist Act
- 1949: The Registrar-General India appointed in the Ministry of Home Affairs. WHO opened its South East Asia Regional Office in New Delhi. The Indian Pharmacy Council and Family Planning Association of India established
- 1950: India became a Republic in the Commonwealth. The Planning Commission was set up by the Government of India
- 1951: The beginning of the first Five Year Plan. The BCG vaccination programme launched in the country
- 1952: The Community Development Programme launched for the all-round rural development. The Central Council of Health constituted. First Primary Health Center set up
- 1953: The National Malaria Control Programme and National Extension Service Programme for rural development started. A nation-wide family planning program started. A committee appointed to draft a Model Public Health Act for the country
- 1954: The Contributory Health Service Scheme (Central Government Health Scheme), the Central Social Welfare

Board, the National Water Supply and Sanitation Programme and the National Leprosy Control Programme started. The Prevention of Food Adulteration Act passed by Parliament

- 1955: The National Filaria Control Programme commenced. The National TB sample survey conducted.
- 1956: The Second Five Year Plan started. The Model Public Health Act published and the Central Health Education Bureau established in the Union Health Ministry. The Indian Medical Council established
- 1957: Influenza pandemic swept the country. The Demographic Research Centres established in Calcutta, Delhi and Trivandrum
- 1958: The National Malaria Control Programme converted into National Malaria Eradication Programme. The National Development Council endorses Panchayati Raj. The National TB survey completed
- 1959: The Mudaliar Committee appointed. A Central Expert Committee recommended eradication of small pox and cholera. Rajasthan introduces Panchayati Raj. National Tuberculosis Institute at Bangalore established
- 1960: The School Health Committee and the National Nutrition Advisory Committee constituted
- 1961: The Third Five Year Plan launched. The Mudaliar Committee report published. The Central Bureau of Health Intelligence established
- 1962: The Central Family Planning Institute established in Delhi. The National Smallpox eradication Programme and the School Health Programme initiated, the National Goitre Control Programme and the District Tuberculosis Programme launched
- 1963: The Applied Nutrition Programme was launched with aid from UNICEF, FAO and WHO. The National Institute of Communicable Diseases (formerly Malaria Institute of India) inaugurated and the National Trachoma Control Programme started. A Drinking Water Board and the Chadah Committee established
- 1964: The National Institute of Health Administration and Education opened
- 1965: Reinforced Extended Family Planning Programme launched. The Mukherjee Committee set up
- 1966: A separate department of Family Planning created under the Health Ministry. The Population Council's International Postpartum Family Planning program started in Delhi and Trivandrum
- 1967: The Central Council of Health recommended levy of health cess on patients. The Jungalwalla Committee set up
- 1968: The Small Family Committee's Report submitted. Govt. appointed the Medical Education Committee
- 1969: The Fourth Five Year Plan launched. The Nutrition Research Laboratories became the National Institute of Nutrition. The Central Births and Deaths Registration Act promulgated
- 1970: The Drugs (Price Control) Order promulgated. All India Hospital (Post-partum) Family Planning Programme started. The Population Council of India and the Central Council of Indian Medicine (Ayurveda, Unani and Siddha) formed. VHAI (Voluntary Health Agency of India)comes into being.
- 1971: The Family Pension Scheme (FPS) for industrial workers came into force. The Medical Termination of Pregnancy Bill passed by the Parliament. Uni-purpose Health Workers converted into Multi-purpose workers.
- 1972: National Service Bill passed. The National Nutrition Monitoring Bureau set up
- 1973: National Programme of Minimum Needs was incorporated in the Fifth Five Year Plan. The Government envisaged a scheme for setting up 30-bedded rural hospitals; one such hospital for every 4 primary health centres. The Kartar Singh Committee recommended a new cadre of health workers called "Multi-purpose Health Workers". The Central Council of Homeopathy was set up. The Kartar Singh Committee was established
- 1974: The Fifth Five Year Plan launched. Parliament enacted the Water (Prevention and Control of Pollution) Act
- 1975: India became smallpox-free. A Revised strategy for NMEP accepted. The "Integrated Child Development" scheme launched. The National Children's Welfare Board set up. The Cigarettes Regulation (Production, Supply and Distribution) Act passed by the Parliament. The Srivastava Committee set up
- 1976: The Equal Remuneration Act promulgated providing for equal wages for men and women for equal work. A new Population Policy introduced. A National Programme for Prevention of Blindness formulated. The Central Council for Yoga and Naturopathy established. In 1975-76 National Cancer Control Programme was launched.
- 1977: The National Institute of Health and Family Planning formed. The Rural Health Scheme launched. Community Health Volunteers (Guides) scheme taken up. "Population Control and Family Planning" was put in the concurrent list. WHO adopted the goal of 'Health for All by 2000 AD'
- 1978: A Bill on Air Pollution introduced in the Lok Sabha. The Parliament approved the Child Marriage Restraint (Amendment Bill fixing the minimum age of marriage 21 years for boys and 18 years for girls
- 1979: The World Health Assembly endorsed the Declaration of 'Alma Ata' on primary health care

- 1980: Smallpox officially declared eradicated from the entire world by the World Health Assembly. The Sixth Five Year Plan launched
- 1981: The census taken. WHO and Member countries adopted the global strategy for 'Health For All'. The Report of the Working Group on Health for All, set up by the Planning Commission, published.
- 1982: The Govt. of India announced the National Health Policy. Amendment done on the Drugs and Cosmetics Act of 1940. National Mental Health Programme was started
- 1983: India launched a national plan of action against avoidable disablement, known as "IMPACT India". The National Leprosy Control Programme became the National Leprosy Eradication Programme. Guinea-worm Eradication Programme launched
- 1984: The Bhopal Gas tragedy, the worst ever industrial accident killing at least 2500 people and no fewer than 50,000 affected. The ESI (Amendment) Bill approved by Parliament and the Workmen's Compensation (Amendment) Act came into force
- 1985: The Seventh Five year Plan launched. The Universal Immunisation Programme started. The Lepers Act, 1898 was repealed by the Parliament. A separate Department of Women and Child development set up under the newly created Ministry of Human Resource Development
- 1986: The Environment (Protection) Act and the Consumer Protection Act were promulgated. National Drug Policy announced. 1st AIDS case detected in country (India).
- 1987: The New 20 Point Programme launched. A worldwide "safe motherhood" campaign was launched by World Bank. National Diabetes Control Programme and National AIDS Control Programme initiated. The Mental Health Act passed. The Drugs (Price Control) Order released
- 1988: Hospitals and Other Institutions (Redressal of Grievances of Employees) Bill passed
- 1989: Blood Safety Programme was launched. The ESI (Amendment) Act modified
- 1990: Control of Acute Respiratory Infection (ARI) Program initiated as a pilot project in 14 districts
- 1991: India stages the last decadal Census of the Century. Population of India was 844.32 million. Pre-natal Diagnostic Techniques (regulation and prevention of misuse) Act enacted
- 1992: Eighth Five Year Plan launched. Child Survival and Safe Motherhood Programme (CSSM) launched in the country. The Infant Milk Substitute, Feeding Bottles and Infant Foods (Regulation of Production, Supply and Distribution) Act passed. The State of India's Health Report by VHAI released. India's first National AIDS Control Programme (1992-1999) was launched, and National AIDS Control Organization (NACO) was constituted to implement the program
- 1993: The dentists (amendment) act, 1993 [2nd April, 1993]. An Act further to amend the Dentists Act, 1948. The Indian Association of Public health Dentistry established
- 1994: Return of Plague after 28 years of silence in few parts of the country. The Transplantation of Human Organs Bill passed. The first Heart Transplantation Surgery in the country done at AIIMS, New Delhi. Malaria epidemic strikes Rajasthan. Swaminathan Committee Report submitted
- 1995: The revised Rational Drug Policy announced. Malaria epidemic strikes Assam. The Persons with Disabilities (Equal Opportunities, Protection of Rights and Full Participation) Act passed
- 1996: Dengue epidemic in Delhi. Malaria strikes again many northern States of India. The Central Govt. publishes the 'list of essential drugs'. The Revised National TB Control Programme initiated. The Supreme Court orders the government to set up the National Council of Blood Transfusion
- 1997: The National Illness Assistance Fund launched. Delhi government enacts Anti-Smoking Bill
- 2003: 1st National oral health survey and fluoride mapping was published
- 2008: Ban on tobacco smoking act. Smoking in public places banned.

10 Epidemiology of Dental Caries

CM Marya

Dental caries is a disease of civilization, i.e. the more developed a country the greater the incidence of caries. Caries is a Latin word meaning *rottenness*. In ancient humans, caries was located mainly at cementoenamel junction or in the cementum, in contrast to modern times where dental caries is primarily located in pits, fissures and in smooth surfaces of teeth.

DEFINITION

It is defined as progressive, irreversible microbial disease of multifactorial nature affecting the calcified tissue of the teeth, characterized by demineralization of the inorganic portion and destruction of the organic portion the tooth.

EPIDEMIOLOGY

Studies have shown that dental caries remained low until the 17th century. Skeletal data shows that skulls of men from Pre Neolithic period [12000 BC] did not exhibit dental caries but skulls from Neo-lithic period [12000-3000 BC] contained carious teeth. The prevalence of dental caries increased dramatically towards the end of 17th century, and continued to increase until the early 1970. The only break in this increase came during the mid 40 and early 50s and this coincided with the reduced availability of sucrose as a result of food rationing imposed during the World War II.

Dental caries is a universal disease affecting all geographic regions, races, both the sexes and all age groups. The prevalence of dental caries is generally estimated at the ages of 5, 12, 15, 35 to 44 and 65 to 74 years for global monitoring of trends and international comparisons. The prevalence is expressed in terms of point prevalence (percentage of population affected at any given point in time) as well as DMFT index (number of decayed, missing and filled teeth in an individual and in a population).

Since the mid 1970s reports from developed countries world wide have shown that the prevalence of dental caries in children and adolescent has declined. WHO global data bank confirms a decline in the prevalence of dental caries in children and adolescents in developed countries, and there is an increase in dental caries in some developing countries (Fig. 10.1).

There is now increasing evidence that incidence of caries levels has declined in developed countries in the past 20 years. Dental caries is now largely a disease affecting the deprived section of society. Recent reports also confirm that in many communities, 80 percent of dental caries is occurring in 20 percent of the population.

The incidence of dental caries has been studied in American white populations. The results show dental caries to be most prevalent chronic disease in this population. The disease affects all regardless of location, sex, age, or social stratum. The disease starts in young people just as soon as teeth erupt. About 90 percent of youngsters are affected by age 14. As mentioned earlier however, the incidence of caries is decreasing in this young population in the U.S. and in other Western countries. This downward trend is explained by increased fluoridation of community water supplies and by increased attention to regular care at dental offices and at home.

Caries Incidence is Tied to Soft, Sugar-laden Western Diets

Isolated populations who have not adopted eating habits of the West have long been known to have decreased incidence of dental caries. Eskimos, some African natives, and inhabitants of rural India are examples of such "immune" populations. Examination of teeth shows considerable abrasion of the occlusal surfaces indicating consumption of a coarse, abrasive diet. It is not uncommon to observe teeth abraded down to the contact points between adjacent teeth. There is no doubt to explain the fact that dental caries in these "primitive" populations is restricted to the interproximal areas below contact areas where food impaction may occur.

TRENDS IN DENTAL CARIES

Dental caries afflicts humans of all ages and in all regions of the world. It is a disease that may never be eradicated because

of complex interplay of social, behavioral, cultural, dietary and biological risk factors that are associated with its initiation and progression.

When we evaluate global distribution of caries in the twentieth century, three patterns evolve:

The first is seen mainly in rural China, and Africa and remote areas of South America. In these societies, there is still high mortality rate, there is poor infrastructure roads are nonexistent or poorly maintained. Water sources are not protected and medical care is available only in cities (Sugar is available in the cities and caries is a problem as people age). The prevalence and severity of dental caries are usually higher in urban areas compared with the lower socioeconomic groups living in rural communities as shown in Table 10.1.

Sado-Infirri in a World Health Organization report commented that Zaire and Malavi had low caries rate and little tooth loss. Countries such as Tanzania, Ethiopia and Ghana can be included into this group (Table 10.1). Many persons from rural Africa and China have little access to dental care and several studies have reported higher caries experience in urban as opposed to rural areas.

The second pattern of dental caries is found in newly industrialized countries such as Taiwan, India, Chile, Uganda and Thailand as given in Table 10.2. In these countries, there is evidence of an increasing caries rate in children and in adults. There is also an increasing rate of edentulousness in the older population.

The relationship between increased industrialization, consumerism, consumption of refined carbohydrates and sugars and caries rates is well known with increasing urbanization, people are switching from traditional starchy staple foods to refined carbohydrates. The caries rate in each of these individual countries also depends on the individual's current socioeconomic status. The sophistication and development of dental services depends on access and availability of dentists. For most of these countries in rural areas dental care if available consists of palliative services and extraction, while replacement of lost teeth with a prosthesis is exceptional. Populations in urban areas have greatest access to care, but the quality and sophistication of care depends on the socioeconomic status of the individual seeking care.

The urbanized nations of Asia and Central and South America need to develop national preventive programs to combat the rising caries rate. These preventive programs must not only present known scientific facts, but also confront the deep seated beliefs of the people that have been handed down from folk lore.

The third pattern is found in North America, Australasia, Europe and Japan where the people's oral status is characterized by a decreasing caries rate in children and increasing number of retained teeth in older adults.

This change is a relatively new phenomenon, however, because at the turn of the century, most people regard dental care as a luxury rather than a health service, and individuals used dentists only when they were experiencing pain.

There are several factors that have attributed to decline in dental caries in these industrialized countries Table 10.3. These include the availability of fluorides especially fluoride dentifrices, a demand for dental care associated with a changed attitude towards preserving natural teeth and preventive approach by general dentist.

However, there are still substantial amount of caries in the population, but these high rates are found only in some high risk group as follows;

- Developmentally disabled
- Mentally retarded
- Immigrant groups
- Low socioeconomic group individuals

The World Health Organization Global Data Bank (1995) shows that out of 178 countries for which data is available 25 percent were categorized as having very low levels of dental caries (DMFT 0.0 to 1.1), 42 percent as low (DMFT 1.2 to 2.6), 30 percent as moderate (DMFT 2.7 to 4.4) and 13 percent as high (DMFT 4.5 to 6.5) and 2.1 percent countries as very high, i.e. 6.6 as shown below in Table 10.3.

Table 10.1: Caries rate in 12-year-old

Year	*Country*	DMFT
1987	Sudan (Rural)	0.2
1994	Sudan (Urban)	1.7
1991	Nigeria	0.7
1987	Zaire	0.4
1981	Botswana	0.5
1986	Kenya	0.9
1997	China	0.8
1986	Tanzania	0.7

Table 10.2: Increase in caries rate in 12-year-old

Year	*Country*	*DMFT*	*Change*
1979-1992	Taiwan	0.9 – 4.3	+ 477%
1972-1994	Thailand	0.9 – 1.6	+ 177%
1960-1991	Chile	2.8 – 5.3	+ 189%
1972-1992	Mexico	2.5 – 5.1	+ 204%
1961-1993	Lebanon	1.2 – 5.7	+ 475%
1962-1995	Jordan	0.2-3.3	+1650%
1965-1983	Peru	3.2-5.9	+184%
1967-1993	India	1.2–3.8	+316%
1966-1972	Uganda	0.4-2.4	+600%

Table 10.3: Decrease in caries rate in 12 years

Year	*Country*	DMFT
1973 - 1992	England	4.8 – 1.2
1975 – 1993	Japan	5.9 – 3.64
1971 – 1994	USA	6.65 – 3.08
1960 – 1992	Switzerland	7.67 – 1.12

REASONS FOR CARIES DECLINE AND RISE

Common Factors Contributing to the Decline of Dental Caries

1. Fluoridation of water supplies
2. Use of fluoride supplements
3. Use of fluoride dentifrices
4. Availability of dental resources
5. Increased dental awareness
6. Adoption of preventive approach by the practitioner
7. Changes in diagnostic criteria
8. Widespread use of antibiotics
9. Herd immunity
10. Decrease in sugar consumption.

Reasons for Rise in Dental Caries

1. Increase in sugar consumption in underdeveloped countries
2. Lack of dental resources
3. Socio economic factor
4. Lack of water fluoridation
5. Lack of preventive dental health programs

DENTAL CARIES PANDEMIC

Caries is both diet-dependent and fluoride-mediated and is amenable to prevention and management at both the individual and population levels. It is also readily treatable through conventional surgical interventions and dental repair. Therefore, the extent and severity of its consequence for individuals, communities, and nations varies by the availability and balance of these factors. As a result, there are marked disparities in caries experience, treatment experience, and disease consequences both between countries and within countries. BL Edelstein (2006) justifies that term 'pandemic' is fitting because those who are affected by caries and have little or no access to care number in the hundreds of millions, reside on all continents and in most societies, and experience significant consequences of pain and dysfunction that impair their most basic functions of eating, sleeping, speaking, being productive and enjoying general health as defined by the World Health Organization.

CARIES INCIDENCE IN EUROPE

Caries is as old as mankind, and the prevalence of caries is reported to increase temporarily in relatively affluent periods. In Europe, for example, there was an increase in caries during the Roman occupation, probably as a result of increased use of cooked foods. These early increases were minor compared to the dramatic increase that started from the time that sucrose was imported from the Caribbean islands to Europe. This increase continued until the 1960s, by which time dental caries was considered rampant. At that time, in non-fluoridated European countries like the Netherlands, 5- to 6-year-old children had 18 DMFS and 12-year-old children had 8 DMFT.

Since the 1970s, a dramatic decrease in the prevalence of dental caries has occurred in developed countries. During the 1990s in the Netherlands, the mean DMFS in 5-year-old children was only 4, whereas > 50 percent of these children were cavity free.

In this same population, the DMFT for the 12-year-old children was only 1.1 percent and 55 percent of the children were cavity free. The distribution of the children according to their caries experience is skewed, and 60 to 80 percent of the decay is found in 20 percent of the population in both Europe and the United States. However, evidence indicates that the favorable trends in dental caries have stabilized.

CARIES INCIDENCE IN THE UNITED STATES

Dental caries is one of the most common childhood diseases in the United States. Studies have shown that in children aged 5 to 9 year, 51.6 percent have had 1 filling or caries lesion; of those aged 17 year, the proportion is 77.9 percent; 85 percent of adults aged >18 year have had caries. However, in the last quarter of the 20th century, the percentage of adults with no decay or fillings increased slightly from 15.7 to 19.6 percent in that aged 18 to 34 year and from 12 to 13.5 percent in those aged 35 to 54 year. Reasons for the decline can be partly attributed to increased use and availability of fluoride. These trends, however, were not found in older adults during this period; in the older adult population, the percentage of teeth free of caries and restorations declined from 10.6 to 7.9 percent in that aged 55 to 64 year and from 9.6 to 6.5 percent in those aged 65 to 74 years.

US findings by the Centers for Disease Control and Prevention (CDC) released in August 2005 reveal high ongoing prevalence of dental caries in children, with 27 percent of preschoolers, 42 percent of school-age children, and 91 percent of dentate adults having caries experience.

Caries is increasing in the Third World and in the US elderly. While decreased incidence has been observed in the US young, caries rates are increasing in Third World countries as they adopt Western diets. It is also increasing in the US elderly. In this population, retention of teeth into old age with accompanying exposure of root surfaces, has led to an increase in "cemental caries".

INDIAN SCENARIO

Dental Caries has been consistently increasing both in prevalence and severity since last five decades. In the year 1941, its prevalence was reported between 40 to 50 percent with an average DMFT of 1.5 (Table 10.4). In 1980s the point prevalence increased to about 80 percent in children with an average DMFT of 2 to 6 at the age of 16 years in different regions of the country. The point prevalence in 10 to 15-year-old children of Delhi was found to be 39.2 percent and DMFT was 2.61 in the year 1992

Table 10.4: Prevalence of dental caries in India

Author	*Year*	*Age*	*Place*	*Prevalence of caries (%)*
Shourie K L	1941	12	Delhi (urban)	54.8
Kokil et al	1951		Gujrat	68.7
Sehgal	1960	4-18	Bombay	90.0
Dutta	1965	Less than 12	Dumdum	67.1
Gill et al	1968	12	Lucknow	99.0
Tiwari and Chawla	1977	15	Chandigarh	86.6
Damle et al	1982	15	Naraingarh (Rural)	77.2
Tiwari et al	1985	15	Bombay (Urban)	96.0
Mehta et al	1987	15	Dehradun	45.0
Thaper et al	1989	12	Rajasthan (Rural)	31.4
Gupta et al	1993	12	New Delhi	87.0
Chopra et al	1995	15	Delhi (Urban)	20.9
Gopinath et al	1999	12	Tamil Nadu	61.2
Singh et al	1999	12	Faridabad (rural)	33.1
Goel et al	2000	12	Puttur	59.6
Kulkarni and Deshpande	2002	11-15	Belgaum	45.12
Sudha P	2005	5-7	Mangalore	94.3
		11-13		82.5
Joshi N	2005	6-12	Kanyakumari	77
Goyal A	2007	6 years	Chandigarh	79.74
		12		80
		15		87

(Prakash et al, 1992). As per the WHO Oral Health Surveillance 1992, the DMFT index in 12-year-old Indian was 0.89 while in 1996 the point prevalence was 89 percent with DMFT ranging between 1.2 to 3.8. In India, different investigators have studied various age groups.

DENTAL CARIES IN UNDERDEVELOPED COUNTRIES

The pattern of dental caries in underdeveloped countries is following the pattern of the disease which was observed in Europe in the 18th and 19th centuries. An increase in the prevalence and severity, first in the upper income groups then in the urbanized populations followed by changes in disease prevalence in the rural groups. The influence of social class is strong. In Ethiopia, children from more affluent high social class families had four times more caries in primary teeth than poorer children and twice as many permanent teeth with caries.

Urbanized populations in underdeveloped countries are more likely to consume refined sugars than those in rural areas. Therefore, it is not surprising that caries rates are higher in urban populations. In the Sudan, 15 to 19-year-old urban children had seven times more caries than children in rural areas where the sugar consumption was below 5 lbs/person/year.

Deteriorating dental health is seen as a necessary consequence of a certain kind of economic growth because a change to a more refined high-sugar diet is associated with economic growth. Sugar consumption in underdeveloped countries is rising; consumption is predicted to be higher than in industrialized countries where consumption is falling.

The potential for promoting the consumption of sugar is greater in underdeveloped countries because they are low sugar consumers and most developed countries have either reached saturation levels of sugar consumption or switched to sugar substitutes.

PROBABLE REASONS FOR THE MARKED DECLINE IN DENTAL CARIES IN MOST WESTERN INDUSTRIALIZED COUNTRIES

No single factor has been found to account for the decline and the most likely explanation is that a combination of factors is responsible. Dental caries is a sugar-dependent infective disease. The demineralizing effect of the cariogenic challenge can be prevented or reduced depending on the strength of the challenge and the availability of fluoride at the site of attack. Fluoride reduces the enamel's solubility in acid and it influences the remineralization of lesions as well as the metabolism of the oral bacteria. Some authors believe that the main mechanism whereby fluoride acts in caries prevention is in promoting remineralization. The factors to consider in relation to the decline in caries are sugar consumption, fluorides in toothpaste, fluoride-rinsing, systemic fluoride, improved oral hygiene and the use of antibiotics.

Globally, WHO reports caries prevalence in school-age children at 60 to 90 percent and as virtually universal among adults in the majority of countries. Because so few countries are spared high levels of this disease, caries maps typically display disease severity rather than prevalence. Global data by WHO (National oral health surveys) shows caries distribution

among 12 year olds by average numbers of teeth affected, using the Decayed, Missing, and Filled Teeth (DMFT) index of severity. The map shows a clear pattern of higher disease experience in North and South America, Western Europe, and much of Africa; more moderate disease experience in much of South America, Russia, and the former Soviet Republics; and low levels of disease in Eastern Africa, China, Australia and Greenland. While the correlation between caries rates and national development is not tight, WHO has observed that developed countries have higher rates of caries experience, while developing countries have lower rates. (Fig. 10.1) WHO has attributed these differences to the relative availability of simple sugars in diets, to fluoride, and to dental treatment (World Oral Health Report 2003). Figure 10.2 shows the situation for the ages 35 to 44 years.

THE CARIES PROCESS (PATHOGENESIS)

Bacterial Plaque and Acid Production

The mechanism of dental caries formation is essentially straightforward. Plaque on the surface of the tooth consists of a bacterial film that produces acids as a byproduct of its metabolism. To be specific, certain bacteria within the plaque are acidogenic—that is, they produce acids when they metabolize fermentable carbohydrates. These acids can dissolve the calcium phosphate mineral of the tooth enamel or dentine in a process known as demineralization. If this process is not halted or reversed via remineralization (the redeposition of mineral via saliva) it eventually becomes a frank cavity.

Dental caries of the enamel typically is first observed clinically as a so-called "white-spot lesion". This is a small area of subsurface demineralization beneath the dental plaque. The body of the subsurface lesion may have lost as much as 50 percent of its original mineral content and often is covered by an "apparently intact surface layer". The surface layer forms by remineralization. The process of demineralization continues each time there is carbohydrate taken into the mouth that is metabolized by the bacteria. The saliva has numerous roles, including buffering (neutralizing) the acid and remineralization by providing minerals that can replace those dissolved from the tooth during demineralization.

The critical pH value for demineralization varies among individuals, but it is in the approximate range of 5.2 to 5.5. Conversely, tooth remineralization can occur if the pH of the environment adjacent to the tooth is high due to: (1) lack of substrate for bacterial metabolism; (2) low percentage of cariogenic bacteria in the plaque; (3) elevated secretion rate of saliva; (4) strong buffering capacity of saliva; (5) presence of inorganic ions in saliva; (6) fluoride; and (7) rapid food clearance times. Whether dental caries progresses, stops, or reverses is dependent on a balance between demineralization and remineralization.

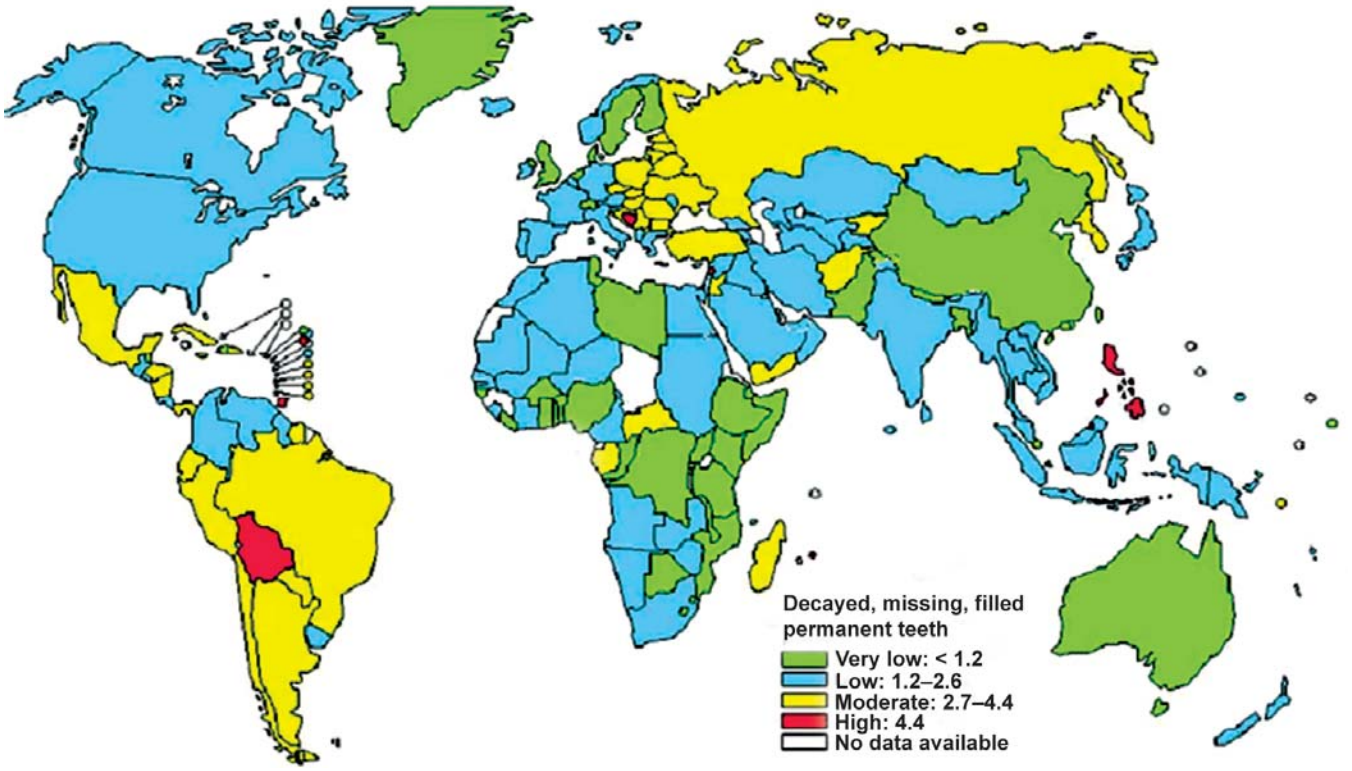


Fig. 10.1: World map on dental caries 2003 (12 years old)

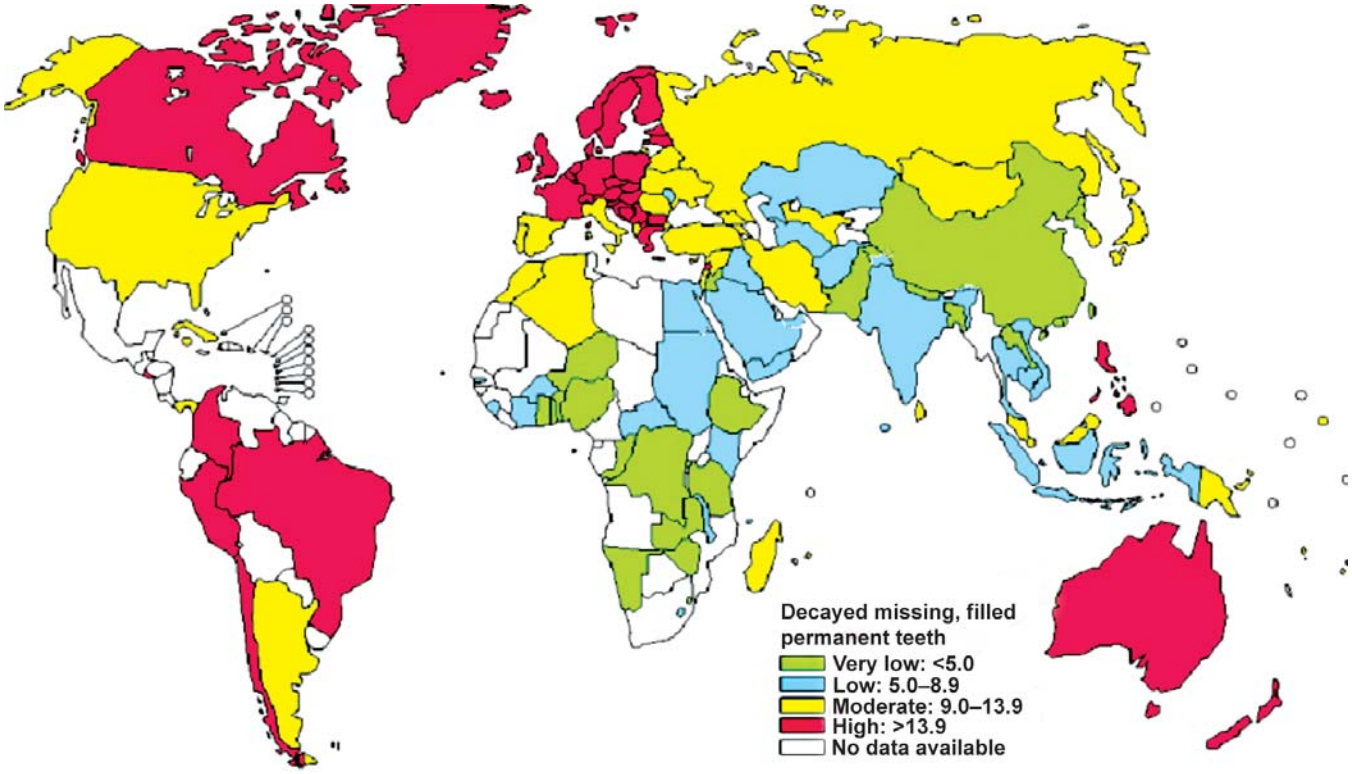


Fig. 10.2: World map on dental caries 2003 (35-44 years old) (with permission from WHO)

However, if demineralization overtime exceeds remineralization, an initial carious lesion (the so-called "white spot" lesion) can develop and may further progress to a frank cavity.

Demineralization can be reversed in its early stages through uptake of calcium, phosphate, and fluoride. Fluoride acts as a catalyst for the diffusion of calcium and phosphate into the tooth, which remineralizes the crystalline structures in the lesion. The rebuilt crystalline surfaces, composed of fluoridated hydroxyapatite and fluorapatite, are much more resistant to acid attack than is the original structure. Bacterial enzymes can also be involved in the development of caries.

The cause of dental caries is the consumption of fermentable carbohydrates (sugars). There is a dose- response relationship between the quantity of the sugar consumed and the development of dental caries. It is suggested, at levels below 10 kg/person per year dental caries will not develop. [15 kg/person per year in fluoridated areas].

THEORIES OF DENTAL CARIES

The Legend of the Worm

Ancient Sumerian text known as 'The legend of the worm' gives reference of the tooth decay and tooth pain. It was obtained from the Mesopotamian areas which date back to about 5000 BC. According to the legend, toothache was caused by a worm that drank the blood of teeth and fed on the root of the jaws.

Endogenous Theories

Humoral Theory

The ancient Greek believed that a person's physical and mental constitution was determined by four elemental humors of the body: blood, phlegm, black bile and yellow bile. An imbalance in these humors is the cause of all diseases including dental caries.

According to *Galen*, the ancient greek physician and philosopher, "dental caries is produced by internal action of acrid and corroding humors". Hippocrates referred to accumulated debris around teeth and to their corroding action. He also stated that stagnation of juices in the teeth was the cause of tooth ache.

Vital Theory [Proposed during 18th Century]

According to this theory, the tooth decay originated like bone gangrene, from within the tooth itself.

Exogenous Theories

Chemical Theory

Parmly (1819) proposed that an unidentified "chemical agent" was responsible for caries. According to this theory, teeth are destroyed by the acids formed in the oral cavity by the putrefaction of protein which produced ammonia and was subsequently oxidized to nitric acid. Robertson (1895) proposed that dental decay was caused by acids formed by fermentation of food particles around teeth.

Parasitic or Septic Theory

Dr Miles and Underwood proposed the so-called "septic theory". They claimed that dental caries is caused by direct action of microorganisms that penetrate the dental tubules and destroy the organic component of the dentine leaving the inorganic parts to be broken down and washed away in fluids of the mouth.

Chemoparasitic Theory (WD Miller)

It is a blend of chemical and parasitic theory, because it states that caries is caused by acids produced by microorganisms of the mouth. According to this theory, microorganisms of the mouth, by secretion of enzymes or by their own metabolism, degrade fermentable carbohydrate food materials to form acids which demineralize the enamel and the disintegrated enamel is subsequently mechanically removed by force of mastication. Miller summarized his theory as follows.- Dental decay is a chemoparasitic process consisting of two stages- decalcification or softening of the tissue and dissolution of the softened residue.

Proteolytic Theory (Gottileb- 1947)

According to this theory, microorganisms invade the organic pathways (lamellae) of the enamel and initiate caries by proteolytic action. Subsequently, the inorganic salts are dissolved by acidogenic bacteria. Pincus (1950) stated that initial caries process in dental caries was due to the proteolytic breakdown of the dental cuticle.

Proteolysis Chelation Theory

This theory proposed by Shalz et al implies a simultaneous microbial degradation of the organic components (proteolysis) and the dissolution of the minerals of the tooth by the process of chelation. According to this theory, dental caries results from an initial bacterial and enzymatic proteolytic action on the organic matter of enamel without preliminary demineralization. This causes the release of a variety of complexing agents, such as amino acids, polyphosphates and organic acids which then dissolves the crystalline apatite.

AREAS PRONE TO DENTAL CARIES

Bacterial plaque is the essential precursor of caries. Hence, sites on the tooth surface which encourage plaque retention and stagnation are particularly prone to progression of lesions. These sites are:

- Enamel in pits and fissures on occlusal surfaces of molars and premolars, buccal pits of molars, and palatal pits of maxillary incisors
- Tooth surfaces adjacent to dentures and bridges which make cleaning more difficult, thus encouraging plaque stagnation
- Approximal enamel smooth surfaces just cervical to the contact point
- In patients where periodontal disease has resulted in gingival recession, caries occur on the exposed root surface
- The enamel of the cervical margin of the tooth just coronal to the gingival margin
- The margins of restorations, particularly those that are deficient or overhanging.

IMPORTANCE OF DIAGNOSIS OF DENTAL CARIES

1. It forms the basis for treatment decision. Active lesion require some form of active management whereas arrested lesions does not.
2. Informing the patient: patient will control the process
3. Advising the health planners: epidemiological surveys inform the health agency (Central /State) about the state of health and disease of the population. These surveys assist them to take necessary action.

CLASSIFICATION OF DENTAL CARIES

Various Clinical Classification Systems for Caries

i. According to location
   (*a*) Pit and fissure
   (*b*) Smooth surface
   (*c*) Root surface
ii. According to clinical appearance
   (*a*) Incipient
   (*b*) Cavitation
   (*c*) Gross destruction
iii. According to rate of disease progression
   (*a*) Acute
   (*b*) Chronic
   (*c*) Arrested
   (*d*) Rampant
iv. According to history
   (*a*) Primary
   (*b*) Secondary or recurrent

Lesions can be classified according to their anatomical (location) site. Thus, lesions may be found in pits and fissures

or on smooth surfaces. Lesions may start on enamel (enamel caries) or on exposed root cementum and dentine (root caries).

Primary caries denotes lesions on unrestored surfaces. Lesions developing adjacent to fillings are referred to as either recurrent or secondary caries. Residual caries is demineralized tissue left in place before a filling is placed.

Primary lesion: Begins on a surface with no previous lesion or restoration.

Secondary lesion: Begins on a surface which has already had a lesion, i.e. around an existing restoration. May also be a new lesion on a remaining part of an inadequately excavated and filled lesion.

Rampant caries is the name given to multiple active carious lesions occurring in the same patient, frequently involving surfaces of teeth that are usually caries-free.

Early childhood caries is a term used to describe dental caries presenting in the primary dentition of young children.

Bottle caries or nursing caries are names used to describe a particular form of rampant caries in the primary dentition of infants and young children. The problem is found in an infant or toddler who falls asleep sucking a bottle (called a nursing bottle) which has been filled with sweetened fluids (including milk).

ENAMEL CHANGES DURING EARLY CARIES LESION DEVELOPMENT

Dental caries develops where microbial deposits are allowed to form biofilms that are not frequently removed or disturbed by mechanical wear (mastication, attrition, abrasion, from brushing, flossing or toothpicks). Caries of the enamel is preceded by the formation of microbial dental plaque.

CHANGES RECORDED IN ENAMEL COVERED BY DENTAL PLAQUE

After One Week

Macroscopically no changes can be seen.

At the Ultrastructural Level

- There are distinct signs of direct dissolution of outer enamel surface.
- The intercrystalline spaces are wider, indicating a partial dissolution of the crystal surfaces.

Histological Examination

Histological examination in polarized light shows slight increase in enamel porosity, indicating an extremely modest loss of mineral to a depth of 20 to 100 micrometer from the outer surface.

After 14 Days

With completely undisturbed plaque, the enamel changes are visible after air drying as whitish opaque changes.

- Smooth chalky white area.
- A subsurface lesion starts forming.

After 3 and 4 Weeks

The outermost surface exhibits complete dissolution of thin perikymate overlappings and more marked dissolution corresponding to larger developmental irregularities such as pits of tomes processes and focal holes.

HISTOPATHOLOGY OF DENTAL CARIES

Dental caries can involve enamel, dentine and root (Fig. 10.3).

CARIES OF THE ENAMEL

Smooth Surface Caries

Incipient caries is the appearance of smooth chalky white area. The overlying enamel surface is smooth, hard and shiny.

Early lesion in enamel caries is conical in shape with its apex towards the dentine and base toward the surface of the tooth.

Four zones are present with differing translucency.

The early enamel lesion consists of four zones of alternating levels of mineralization. It illustrates the dynamic nature of the caries process (Fig. 10.4). The surface zone blocks the passage of calcium ions into the body of the lesion and may have to be removed to allow the lesion to become arrested.

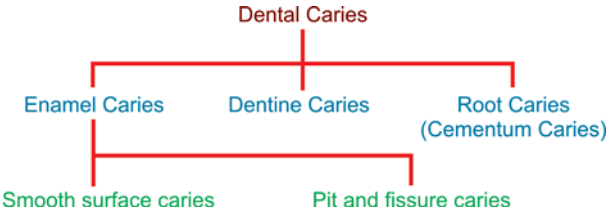


Fig. 10.3: Histopathology of dental caries

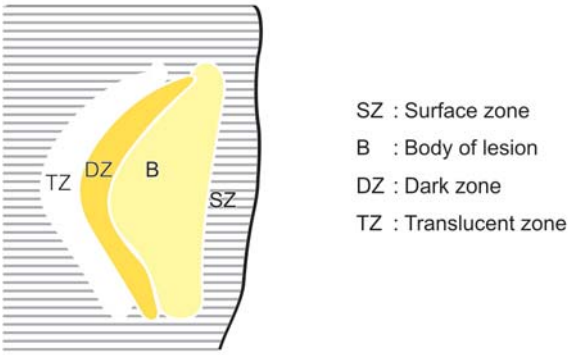


Fig. 10.4: Various zones in enamel caries

Four zones are clearly distinguishable starting from the inner advancing front of the lesion:

1. Translucent zone
2. Dark zone
3. Body of lesion
4. Surface zone

Translucent Zone

- Lies at the advancing front of enamel lesion (not always present)
- This is the first recognizable zone of alteration from the normal enamel.
- In transmitted light the zone appears structure less.
- This zone may vary from 5 to 10 micrometer in width.
- Pore volume – slightly more than one percent [in sound enamel: 0.1%]
- Slight loss of mineral; Mainly the minerals are lost from this zone and not organic material
- *Translucent appearance:* Initial dissolution of the enamel mainly occurs along the gaps between the rods and interrod enamel in the tissue; thus on examining ground sections imbibed in clearing agent, Quinolone (suitable since refractive index is similar to that of enamel). Quinolone is assumed to penetrate more easily into these enlarged pores, the final result looks like a structureless zone.
- No evidence of protein loss seen.

Dark Zone

- Lies adjacent and superficial to the translucent zone.
- This zone is formed as a result of demineralization and appears dark brown
- Under polarized light the dark zone has a pore volume of 2 to 4 percent
- Occurs in 90 to 95 percent of lesions
- Represents a result of multitude of demineralization and reprecipitation processes
- When examined in transmitted light, after inhibition with Quinolone, appears dark brown in ground sections, thus called '*Dark zone*'; and shows positive birefringence in contrast to negative of that of sound enamel. Therefore, *Positive zone*.
- The appearance of dark zone is due to remineralization occurring at the advancing front of the lesion. It is broader in arrested or remineralized lesion.

Body of Lesion

- Lies between the relatively unaffected surface layer and dark zone.
- It is the area of greatest demineralization.
- In polarized light- pore volume is five percent in spaces near the periphery and nearly equals to 25 percent in the outer of the intact lesion.
- On examination, the ground section in Quinolone with transmitted light, the body of the lesion appears relatively translucent compared to sound enamel.
- It forms the bulk of the lesion and extends from just beneath the surface zone to dark zone
- *Striae of retzius* are well marked.
- Reduction of 24 percent in mineral per unit volume as compared to sound enamel.
- Increase in unbound water and organic content due to ingress of bacteria and saliva.

Surface Zone

- It represents the most important change in enamel caries in terms of prevention and management
- Partial demineralization 1 to 10 percent loss of mineral salts has taken place. Pore volume is less than five percent of spaces.
- Surface zone retains a negative birefringence.
- The surface is resistant due to greater degree of mineralization and concentration of fluoride in the surface enamel. It remains intact and well mineralized because it is a site where calcium and phosphate ions, released by subsurface dissolution become precipitated. This is called remineralization.
- Cavitation is due to loss of this layer which allows the bacteria to enter the lesion. It is of relatively constant width, a little thicker in arrested or remineralizing lesions.

Pit and Fissure Caries

Carious lesion starts at both sides of the fissure, not at the base. The enamel is thin in fissures so there is early dentine involvement. The carious lesion forms a triangular or cone-shaped lesion with its apex at the outer surface and base towards the dentinoenamel junction (DEJ).

- Lesion begins beneath plaque, with decalcification of enamel.
- Pit and fissures are often deep, with food stagnation,
- Enamel in the bottom of pit or fissure is very thin, so early dentine involvement frequently occurs.
- Here the caries follows the direction of the enamel rods. In pit and fissure the enamel rods are said to flare laterally at the bottom of the pit and caries is said to follow the path of enamel rods hence a characteristic angular/inverted 'V' shaped lesion is formed.
- It is triangular in shape with the apex facing the surface of tooth and the base towards the DEJ.
- When reaches DEJ, greater number of dentinal tubules are involved.
- It produces greater cavitation than the smooth surface caries and there is more undermining of enamel.

CARIES OF THE DENTINE

The caries process in dentine involves the demineralization of the mineral component and breakdown of the organic

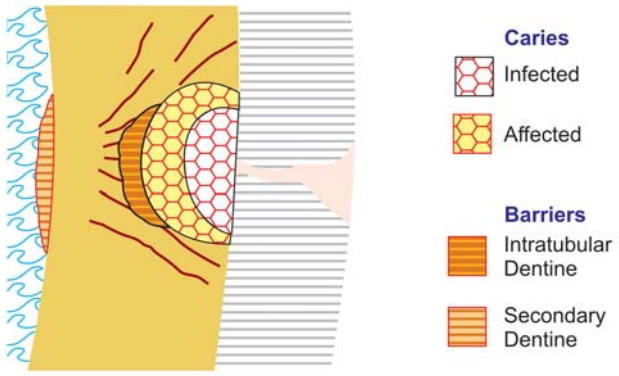


Fig.10.5: Infected and affected layers in dentine

component of collagen fibers. The caries process in dentine is approximately twice as rapid as in enamel. Spread of caries is more in dentine compared to enamel because of:

1. Decreased calcification (mineralization).
2. Existence of pathways (dentinal tubules).

Advanced carious lesions in dentine consist of two distinct layers having different microscopic and chemical structures. The outer layer is heavily infected by bacteria which are mainly located in the tubule spaces. The collagen fibers are denatured and the organic matrix is not being remineralized. The inner layer is scarcely *infected*, but *affected* by plaque acid (Fig. 10.5). It still contains high concentrations of mineral salts and can be remineralized.

The initial dentinal changes are known as dentinal sclerosis or transparent dentine. The dentinal sclerosis is due to calcification of dentinal tubules. The change is minimal in progressing caries and more in slow caries. In transmitted light the dentine appear transparent. In reflected light sclerotic dentine appear dark. In advanced lesions tiny liquefaction foci are formed.

In secondary dentine the dentinal tubules are fewer and irregular. Caries spread laterally at the junction of primary and secondary dentine separating both.

Various zones are distinguished assuming the shape of triangle with the apex toward the pulp and the base toward the enamel.

VARIOUS ZONES OF CARIES OF DENTINE

Zone of Fatty Degeneration

1. Firstly the fatty degeneration of the tomes dentinal fibres resulting in deposition of fat globules in the further end of dentinal tubules.
   - It has been suggested that this fatty degeneration contributes to the:
     1. Impermeability of the dentinal tubule.
     2. Also sclerosis of dentinal tubule.

Zone of Dentinal Sclerosis

The sclerotic zone is located beneath and at the sides of the carious lesion. It is almost invariably present, being broader beneath the lesion than at the sides and is regarded as a vital reaction of odontoblasts to irritation. Sclerosed dentine has a higher mineral content. Dead tracts may be seen running through the zone of sclerosis. They are the result of death of odontoblasts at an earlier stage in carious process. The early dentinal tubules contain air and the remains of dead odontoblastic process and such tubules cannot undergo sclerosis. However, they provide ready access of bacteria and their products to the pulp.

Zone of Demineralization

In the demineralized zone the intertubular matrix is mainly affected by a wave of acid produced by bacteria in the zone of bacterial invasion, which diffuses ahead of the bacterial front. The softened dentine in the base of a cavity is therefore sterile (affected dentine) but it cannot be distinguished from softened infected dentine. It may be stained yellowish-brown as a result of the diffusion of other bacterial products interacting with proteins in dentine.

Zone of Bacterial Invasion

In this zone the bacteria extend down and multiply within the dentinal tubules, some of which may become occluded by bacteria. There are always, however, many empty tubules lying among those tubules containing bacteria. The bacterial invasion probably occurs in two waves: the first wave consisting of acidogenic organisms, mainly, lactobacilli produce acid which diffuses ahead into the demineralized zone. A second wave of mixed acidogenic and proteolytic organisms then attack the demineralized matrix.

The walls of the tubules are softened by the proteolytic activity and some may then be distended by the increasing mass of multiplying bacteria. The peritubular dentine is first compressed, followed by the intertubular dentine, resulting in elliptical areas of proteolysis-*LIQUEFACTION FOCI*. Liquefaction foci run parallel to the direction of the tubules and may be multiple, giving the tubule a beaded appearance.

Zone of Decomposed Dentine

In this zone the liquefaction foci enlarge and increase in number. Cracks or clefts containing bacteria and necrotic tissue also appear at right angles to the course of the dentinal tubules forming *TRANSVERSE CLEFTS*. Bacteria are no longer confined to the tubules and invade both the peritubular and intertubular dentine. In acute, rapidly progressing caries the necrotic dentine is very soft and yellowish-white; in chronic caries it has a brownish-black color and is of leathery consistency.

CARIES IN DENTINE

Zone 1: Zone of fatty degeneration of tomes fibers (next to pulp)—due to degeneration of the odontoblastic process. This occurs before sclerotic dentine is formed and makes the tubules impermeable.

Zone 2: Zone of dentinal sclerosis characterized by deposition of calcium salts in the tubule.

Zone 3: Zone of decalcification of dentine, a narrow zone preceding bacterial invasion.

Zone 4: Zone of bacterial invasion of decalcified zone but intact dentine.

Zone 5: Zone of decomposed dentine due to acids and enzymes.

ROOT CARIES

Root caries as defined by *HAZEN*, is a soft, progressive lesion that is found anywhere on the root surface that has lost its connective tissue attachment and is exposed to the environment.

- The root surface must be exposed to the oral environment before caries can develop here.
- Plaque and microorganisms are essential for the cause and progression of the lesion, mostly Actinomyces.
- Microorganisms invade the cementum either along the Sharpey's fibers or between the bundles of fibers.
- Spread laterally, since cementum is formed in concentric layers.
- After decalcification of cementum, destruction of matrix occurs similar to dentine with ultimate softening and destruction of this tissue.
- Invasion of microorganisms into the dentinal tubules, finally leading to pulp involvement.
- The rate is slower due to fewer dentinal tubules than in crown area.

SUSCEPTIBILITY OF DIFFERENT TEETH

The Hagerstown Study ranks the order of susceptibility of teeth to caries as:

1. Mandibular 1st and 2nd molars.
2. Maxillary 1st and 2nd molars.
3. Mandibular 2nd bicuspids, maxillary 1st and 2nd bicuspids, maxillary central and lateral incisors.
4. Maxillary canines and mandibular 1st bicuspids.
5. Mandibular central and lateral incisors, mandibular canines. Third molar had not erupted in the children studied.

PATHOGENIC PROPERTIES OF CARIOGENIC BACTERIA

These cariogenic bacteria can:

- Transport sugars and convert them to acid (*acidogenic*)
- Produce extracellular and intracellular polysaccharides which contribute to the plaque matrix. The intracellular polysaccharides can be used for energy production and converted to acid when sugars are not available
- Thrive at low pH (*aciduric*).

FACTORS AFFECTING THE EPIDEMIOLOGY OF DENTAL CARIES

In the 1960s, the caries theory was depicted as three circles representing the three prerequisites for dental caries **(Keyes Triad).** Three indispensable factors for development of caries were: (1) carbohydrate (diet), (2) bacteria (dental plaque), and (3) susceptible teeth (the host) (Keyes and Jordan, 1963).

Since then, many modifying factors have been recognized, resulting in a more complex model that includes saliva, the immune system, time, socioeconomic status, level of education, lifestyle behaviors, and the use of fluorides. An important breakthrough in the understanding of dental caries was the recognition of the remineralization process as a result of plaque fluid and saliva at pH levels above a critical value being highly saturated with calcium and phosphates. The caries process can be described as loss of mineral (demineralization) when the pH of plaque drops below the critical pH value of 5.5; the critical value for enamel dissolution is 5 to 6, and an average pH of 5.5 is the generally accepted value. Redeposition of mineral (remineralization) occurs when the pH of plaque rises. The presence of fluoride reduces the critical pH by 0.5 pH units, thus exerting its protective effect.

It is now established that dental caries is a multifactorial disease and results from a combination of four principal factors (Fig. 10.6) (Newbrun).

1. Host and teeth factors:
2. Microorganism in dental plaque
3. Substrate [diet]
4. Time

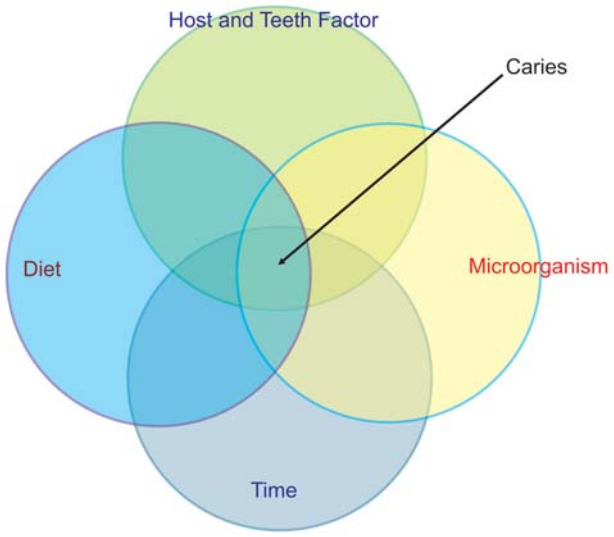


Fig.10.6: Four principal factors in dental caries (Adapted from Newbrun)

FACTORS AFFECTING DEVELOPMENT OF DENTAL CARIES (FIG. 10.7)

Host and Teeth Factors

A. *Tooth*
- Composition
- Morphology
- Position.

B. *Saliva*
- Composition
- Buffering capacity of saliva
- Quantity.

C. *Sex*
D. *Age*
E. *Race and ethnicity*
F. *Socioeconomic status*
G. *Heredity*
H. *Emotional disturbances*

Agent Factors

A. *Microorganism*
B. *Plaque*

Environmental Factors

A. *Diet*
- Total consumption of carbohydrate
- Frequency and form of carbohydrate

B. *Geographic variation*
C. *Climate*
D. *Oral hygiene*
E. *Soil*
F. *Fluoride*

I. HOST AND TEETH FACTOR

A. Tooth

i. *Composition:* Number of studies on the relation of caries to the chemical composition have shown that there was no difference found in the calcium, phosphorus, magnesium and carbonate content of enamel from sound and carious teeth. But there was a significant difference in fluoride content of teeth, i.e. more in sound teeth.

It was also noted that surface enamel is more resistant to caries than subsurface enamel. Surface enamel is more highly mineralized and tends to accumulate greater quantities of fluoride, zinc, lead and iron than the underlying enamel. The surface is lower in carbon dioxide, dissolves at a slower rate in acids and has more organic material than subsurface enamel. These factors contribute to caries resistance.

ii. *Morphology:* Morphologic features which may pre dispose to the development of caries are the presence of deep, narrow occlusal fissure or buccal or lingual pits. These fissure trap food, bacteria and debris leading to development of caries.

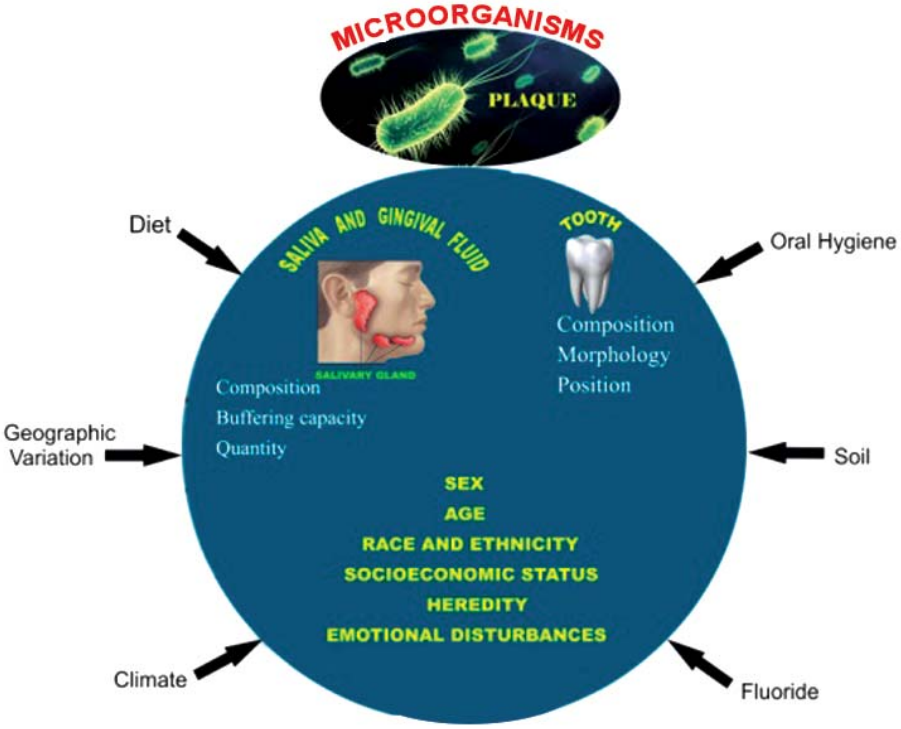


Fig.10.7: Factors affecting development of dental caries

Attrition on other hand makes the tooth flattened, hence less food entrapment in fissures, so less caries.

iii. *Position:* Malaligned, out of position, rotated teeth are difficult to clean, favoring the accumulation of food and debris. This may predispose to the development of caries.

B. Saliva

It can be considered as an environmental factor also as teeth are constantly bathed by it. This influences the process of dental caries. Saliva has a flushing action on teeth.

i. *Composition:* varies from person to person. Saliva is dilute fluid; over 99 percent being made up of water.
   1. *Proteins:* They include enzymes, immunoglobins and other antibacterial factors, mucous glycoproteins and certain polypeptides.
   2. *Enzymes:* α-Amylase
   3. Immunoglobulins – secretary IgA
   4. Antibacterial proteins –Lysozyme, Lactoferrin, Sialoperoxidase.
   5. Glycoproteins.
   6. Polypeptides – Statherin, Sialin (helps to regulate pH of plaque).
   7. Other Organic Compounds:
      - Free Amino Acids
      - Urea (it is hydrolysed by many bacteria with release of Ammonia, leading to rise in pH).
      - Glucose
   8. *In Organic Constituents:*
      - Major Ions [Sodium, Potassium, and Chloride and Bicarbonate] contribute to osmolarity of saliva.
      - *Bicarbonates:* Principal buffer in saliva.
      - *Thiocyanate:* Has antibacterial action.
      - *Fluoride:* Has anticaries action.

i. Saliva: It has a critical role to play in the development of caries or its prevention. Saliva provides calcium, phosphate, proteins, lipids and antibacterial substances and buffers. Saliva buffering can reverse the low pH in plaque.

ii. *Buffering and neutralization:* pH of saliva depends on the bicarbonate concentration. Saliva is alkaline and is an effective buffer system. These properties protect the oral tissues against acids and plaque. After eating a sugary food if saliva is stimulated by chewing substances such as wax or sugar free chewing gum, the drop in pH in plaque which would have occurred is reduced or even eliminated. This salivary neutralization and buffering effect markedly reduces the cariogenic potential of foods.

iii. *Quantity:* Rate of flow of saliva may be an additional factor which helps contribute to caries susceptibility or caries resistance. Mild increase or decrease in flow may be of little significance, near total reduction in salivary flow adversely affects dental caries. There is an inverse relation between salivary flow and dental caries.

C. Sex

In young people caries has been seen to higher in the females but some studies show no significant difference between the sexes. Root caries is seen more in males. Girls may be more prone to caries due to early eruption of teeth and hormonal changes (puberty and pregnancy).

D. Age

Although present in all ages, it was believed that dental caries was disease of childhood. WHO global data bank has shown a decline in DMFT values in 12-year-old children. Some studies indicate greatest intensity of dental caries occurs in 15 to 25 years of age.

Root caries is seen in over 60 years age group people, mainly due to denuded root surface because of gingival recession.

E. Race and Ethinicity

A number of studies indicate that blacks [Negroes] of comparable age and sex have a lower caries scores than Caucasians. Chinese population has shown to have a lower caries rate than corresponding white population. These differences are probably more due to environmental factors.

F. Socioeconomic Status

There is an inverse relationship between socioeconomic status and dental caries experience in primary dentition. The relation has not been established in adults, though some studies suggest so.

G. Heredity

Environmental factors have a greater influence than genetic factors but latter also contributes to the causation of caries.

H. Emotional Disturbances

Emotional disturbances, particularly transitory anxiety states tend to increase the incidence of dental caries.

II. AGENT FACTORS

A. Microorganisms

The mouth has a diverse resident microbial flora. The normal inhabitants become established early in life. There have been a few epidemiological studies to investigate the link between oral flora and dental caries. *Streptococcus mutans* was first identified in 1924 by Clarke and subsequently *Lactobacillus acidophilus* by Bunting (1930). These acid producing bacteria were found to be associated with the formation of dental caries. *Streptococcus mutans* is of interest because it has the ability to

form an extracellular polymer of glucose, mutans from sucrose, which aids the microorganism in adhering to the enamel surface and in establishing a stable relationship there.

The absolute demonstration of a specific microorganism as the causative agent of dental caries in man may be impossible because of diverse organisms being always present in the oral cavity and on the teeth.

L. acidophillus and other acidogenic microorganism in plaque and carious lesion may be capable of producing caries by themselves, or they may be able to act synergistically with *Streptococcus mutans* in caries initiation.

Actinomyces are Gram-positive pleomorphic rods (GPPR) which form a large proportion of the oral microflora of all mammals. *Actinomyces* are also among the earliest colonizers of dental surfaces and may constitute up to 27 % of the pioneer bacteria. They have been implicated in root caries, although their role in dental caries initiation and progression is not well-understood.

B. Dental Plaque

Bacterial plaque is a dense non-mineralized, highly organized mass of bacterial colonies in a gel-like intermicrobial, enclosed matrix or slime layer. It is a transparent film that can be *supra-gingival*, coronal to the gingival margin on the clinical crown of the tooth and *subsgingival*, apical to the margin of the gingiva.

III. ENVIRONMENTAL FACTORS

A. Diet

According to acidogenic or chemoparasitic theory, dental caries occurs when acid is produced by bacteria in dental plaque when refined carbohydrates are eaten. The presence of refined carbohydrate as sugar is essential for the majority of caries development and sucrose is the most cariogenic of all sugars. In human consumption, sucrose accounts for 60 percent of all sugars eaten.

B. Geographic Variation

It is well documented that dental caries experience has been decreasing in children in developed western [1973–1983] countries. But this decrease is beginning to level out. Gradual increase in caries in 5 years old have been found in some areas. [Palmer & Pitts 1994].

C. Climate

Sunshine and high temperature areas seems to have lower dental caries [inverse relationship]. Whereas areas with more relative humidity and rainfall have shown increase dental caries.

D. Oral Hygiene

Inverse relationship has been seen between oral hygiene and dental caries. Poor oral hygiene increases the rate of dental caries.

E. Soil

Trace elements in soil have shown a relation with caries. An increase in dental caries is seen in areas where selenium is present in soil, whereas molybdenum and vanadium are said to decrease dental caries.

F. Fluoride

Fluoride in water and soil decreases incidence of dental caries.

EARLY CHILDHOOD CARIES

Early childhood dental caries has been reported by the Centers for Disease Control and Prevention to be perhaps the most prevalent infectious disease of our nation's children. Early childhood dental caries occurs in all racial and socioeconomic groups; however, it tends to be more prevalent in low-income children, in whom it occurs in epidemic proportions. Human dental flora is site specific, and an infant is not colonized until the eruption of the primary dentition at approximately 6 to 30 months of age. The most likely source of inoculation of an infant's dental flora is the mother or another intimate care provider, through shared utensils, etc. Decreasing the level of cariogenic organisms in the mother's dental flora at the time of colonization can significantly impact the child's predisposition to caries. To prevent caries in children, high-risk individuals must be identified at an early age (preferably high-risk mothers during prenatal care), and aggressive strategies should be adopted, including anticipatory guidance, behavior modifications (oral hygiene and feeding practices), and establishment of a dental home by 1 year of age for children deemed at risk.

ROOT CARIES

Root caries can be defined as a lesion which is initiated or extends onto the part of the tooth apical to the cementoenamel junction.

The term "primary" as it is used with root caries refers to new dental caries occurring in the absence of a restoration. Secondary (recurrent) root caries refers to caries occurring adjacent to an existing restoration. There is general agreement on this terminology.

Root caries most often occurs supragingivally, at or close to (within 2 mm) the cemento-enamel junction.

This phenomenon has been attributed to the location of the gingival margin at the time conditions were favorable for caries to occur. The location of root caries has been positively associated with age and gingival recession. This is consistent with the concept that root caries occurs in a location adjacent to the crest of the gingiva where dental plaque accumulates. Root caries occurs predominantly on the proximal (mesial and distal) surfaces, followed by the facial surface.

Early root caries tends to be diffused (spread out) and track along the cementoenamel junction or the root surface. More advanced root lesions enlarge toward the pulp.

Epidemiology

The true prevalence of root caries is difficult to assess. Interpretation of data from prevalence and incidence studies is complicated due to differences in diagnostic criteria, treatment decisions, and lack of homogeneity of the observed population. Nevertheless, it has been definitely established that the prevalence of root caries increases with age and is greater in the elderly population than in younger adults.

Although root caries affects younger age groups as well, the disease has become more prevalent in the geriatric population due to the increased retention of natural teeth.

Root caries research studies have found that about one-third of the population up to sixty years of age experiences root caries. The prevalence of root caries in patients over sixty years of age ranges from 30 to 63 percent, depending upon the type of individuals studied and where the study took place.

There are certain teeth and surfaces that are more susceptible to the development of root caries. Molars are the most susceptible, followed in decreasing order by the premolars, canines, and incisor. It has also been found that the mandibular molars have the most root surface caries and the mandibular incisors the least.

Root caries is generally more prevalent and severe among males than female. Root caries also seems to be a problem among older people of lower socioeconomic status, those who have lost some teeth, do not maintain good oral hygiene, and do not visit the dentist on a regular basis.

Risk Factors

Clinical studies suggest that only those root surfaces where the crest of the gingival margin is apical to the cernentoenamel junction are considered to be at risk for root decay.

In a cross-sectional study of healthy Boston elderly, root caries was positively correlated with a high daily intake of slow-dissolving fermentable foods.

In another study, older adults developing root caries had a higher intake of sugary liquids and solid fermentable carbohydrates and starches than did subjects without root caries.

Recent studies show that microflora differ on healthy and diseased root surfaces. A higher number of *Actinomyces* species was found on healthy root surfaces than on diseased root surfaces. Also, high numbers of mutans streptococci were found in initial and advanced root lesions.

Root surface caries seems to be more prevalent on teeth already afflicted with coronal caries.

Another risk factor for root surface caries in the elderly is xerostomia. Adults aged 65 and over, and especially those residing in nursing homes, use hyposalivatory medications more than any other age group. Salivary flow rates depressed by medications may increase the risk of dental caries as shown in Box 10.1.

BOX 10.1: RISK FACTORS ASSOCIATED WITH THE DEVELOPMENT OF ROOT CARIES IN OLDER PERSONS

- Poor oral hygiene
- Microbial plaque
- Periodontal disease
- Sex - gender (male)
- Coronal caries
- Dietary habits
- Xerostomia
- Low socioeconomic status
- Infrequent dental visits

Etiology

Root caries is initiated when bacteria and fermentable carbohydrates attack the root surface.

Since the 1970's, studies have been conducted to identify the microflora responsible for root caries, and *Streptococcus mutans* was found to be the primary initiating microorganism and *Lactobacillus* and *Actinobacillus* are believed to have adjunctive roles has been identified in soft lesions but it is not considered to have a role in initiating these lesions. *Candida albicans* has been identified in soft lesions but it is not considered to have a role in initiating these lesions.

THE FOLLOWING FACTORS PLAY A ROLE IN THE DEVELOPMENT OF ROOT CARIES

1. Exposure of the enamel-cementum junction and the root
   May be caused by Scaling and root planing, periodontal surgery.
2. Restorations on or near the root surface
   Which may be Leaking or plaque-retaining can lead to root caries.
3. Diet
   Frequent sugar intake increases the chances of developing root caries.
4. Partial dentures
5. Impaired salivary gland function
   e.g. high blood pressure, rheumatoid arthritis uncontrolled diabetes, medication
6. Delayed oral sugar clearance due to old age and illness
   Reduced unstimulated saliva secretion (<0.1 ml/min)
   - Cardiovascular disease
   - Rheumatic diseases (e.g. Sjögren's syndrome)
   - Depression, stress
   - Medications

   Impaired oral muscular activity
   - Stroke, paralyses, Parkinson's
   - Very old age
7. Insufficient use of fluorides

8. Poor oral hygiene
   Poor motor skills following stroke
   Illness

FACTORS ASSOCIATED WITH ROOT CARIES

Intraoral Factors

1. Low salivary flow resulting in xerostomia. Low salivary buffer capacity.
2. Poor oral hygiene resulting in high plaque score and calculus deposition.
3. Periodontal disease and periodontal surgery.
4. Attachment loss and gingival recession.
5. Elevated salivary levels of microorganisms.
6. Frequency of carbohydrate intake and percentage of tooth surfaces harboring plaque.
7. Unrestored and restored coronal and root caries.
8. Overdenture abutments and removable partial dentures, since clamps and connectors contribute to food retention.
9. Malocclusion, abfraction, drifting, and tipping, which makes areas of teeth inaccessible for patients to maintain proper oral hygiene.

Extraoral Factors

1. Advanced age, since the incidence of root caries in higher in older adults.
2. Infrequent dental check up.
3. Lower educational and socioeconomic levels.
4. Gender, since males are more affected than females.
5. Physical disability (e.g. Parkinson's disease) where patients have limited manual dexterity that makes the removal of plaque during toothbrushing difficult.
6. Medications that decreases the salivary flow.
7. Diabetes, autoimmune disorders (e.g., Sjögren's syndrome), or radiation therapy.
8. Antipsychotics, sedatives, barbiturates, and antihistamines.
9. Limited exposure to fluoridated water.

11 Epidemiology of Periodontal Disease

CM Marya

DISEASE PROCESS AND CHANGING CONCEPT

During the last 20 years the understanding of periodontal disease has dramatically changed. The tradition concept was of 'continuous progression model of chronic inflammation'. According to this model gingivitis once developed would progress into peridontium, leading to loss of attachment, bone destruction and eventually loss of teeth. It was believed to be the main cause of tooth loss after the age of 40.

The current concept of risk for periodontal disease presents a very different model. Evidence now indicates that the disease has an episodic nature, in which short bursts of tissue destruction takes place. [Burst Theory]. These short periods of disease activity are followed by some repair and mostly longer period of remission. There is still scientific debate as to which model of progression is the best one. But there is a wide spread consensus that loss of attachment is neither evenly distributed within the mouth nor the population. For the majority of population progression of periodontal disease is very slow. An average rate attachment loss of 0.05 – 0.10 mm per year has been demonstrated by Albander (1990). At such a slow rate of progression, people will not loose their supporting alveolar bone during their life time.

Gingivitis

Is inflammatory process of the gingiva in which the junctional epithelium, although altered by the disease, remains attached to the tooth at its original level.

Periodontal Diseases

Periodontitis describes a group of inflammatory diseases that affect all the periodontal structures. It results in the destruction of the attachment apparatus and the development of a periodontal pocket.

EPIDEMIOLOGY

Periodontal disease is a pathological condition characterized by a bacterial challenge that can instigate a destructive host response leading to periodontal attachment loss, bone loss and ultimately, possible tooth loss. Periodontal diseases affect the supporting structures of teeth, i.e. the gingiva (gums), periodontal ligament, alveolar bone and cementum.

A thin, adherent microbial film on the tooth surfaces, called dental plaque, is the main pathological cause of gingival and periodontal inflammation. Poor oral hygiene, faulty food habits, poor nutrition, presence of metabolic diseases such as diabetes, use of tobacco, etc. are the major contributory factors for periodontal diseases. However, it is widely accepted that the periodontal diseases affect over 90 percent of the Indian population, but the majority of them may have only mild gingivitis and bleeding from the gums, which is reversible with proper oral hygiene measures. More advanced periodontal disease with pocket formation and bone loss, which could ultimately lead to tooth loss if not treated properly, may affect 40–45 percent of the population. It is also known that the use of tobacco, especially habitual chewing of tobacco, presence of metabolic diseases such as diabetes, nutritional deficiencies, compromised immune status and increasing age are associated with an increase in periodontal diseases.

PREVALENCE OF GINGIVITIS

Children

The understanding of epidemiology of gingivitis is often difficult due to lack of agreement over measurement criteria used, evaluation standards, examiner subjectivity as to what constitutes inflammation and the difficulty in measuring gingival disease accurately.

Gingiva in deciduous dentition appears to be resistant to plaque induced gingivitis. Studies of American and English children under 5 years recorded little or no gingival inflammation. Using rigid criteria Poulsen amd Moller (1972) found 25 percent prevalence in Danish children. Gingivitis though found in early childhood, is more prevalent and severe in adolescence and seems to level off after adolescence. The transitional period from 6-puberty is marked by tooth irregularity and hormonal changes.

The prevalence of gingivitis among school going children in US ranged from 40–60 percent in various national surveys. Chronic gingivitis has been found in 80 percent of children under 12 years of age and approaches 100 percent by the age of 14 years. (WHO 1978). Lingual surfaces of molars and proximal surfaces are most frequently affected. Gingivitis is usually related with plaque deposits, but Sutcliffe (1972) found that the increased severity of inflammation is not related to an increase in plaque deposition. In puberty the tissues react more vigorously to any given amount of plaque and after puberty the severity of inflammation diminishes.

Children dental health surveys were undertaken in the UK in 1973, 1983 and 1993. The results of these surveys showed that the number of children with plaque and debris increased steadily between the ages 5–8 years, reaching a plateau and before decreasing slightly to the age of 15 years. It showed deterioration in the gingival health (plaque/debris) of younger children over the years, although the prevalence of gingival inflammation in 15 years old remained virtually unchanged. Gingivitis increases in prevalence and severity with increasing age to reach a peak prevalence of 90–100 percent at puberty. A slight decline in prevalence and severity during adolescence is followed by a gradual rise throughout adult life. Temporary decline in prevalence and severity after puberty may reflect an increased social awareness and resulting improved oral hygiene. Table 11.1 shows the prevalence of gingivitis in children of various countries.

Adults

Gingivitis in adults is common and is at the levels observed in older adolescents. The first national survey of adults (1960–62) in US showed 85 percent men and 79 percent females were affected by gingivitis. In the national survey of employed adults in US (1985–86) 47 percent males and 39 percent of females exhibited at least one site that showed bleeding on probing. Gingivitis is closely related with plaque deposits. Surveys conducted in developing countries show that gingivitis is associated with extensive plaque and calculus deposit in adults.

Cuttress et al (1983) in a study of 15–19 years old in New Zealand showed that 79 percent had gingival inflammation. Brown et al (1989) found that prevalence of gingivitis declined from 54 percent (19–44 years age) to 44 percent (45-64 years) and to 36 percent in people of 65 years of age. In most cases gingivitis was restricted to a few teeth.

Table 11.1: Prevalence of gingivitis in children

Country	*Year*	*Age (in years)*	*Prevalence*
Australia	1983	5–6	85%
Sweden	1980	3	69%
Sweden	1981	3	35%
UK	1981	5	48%
USA	1979	5	9%

Studies have shown that in Asian population, transition from chronic gingivitis to chronic periodontitis takes place at an early age than in Europeans, although the difference could be due to differences in oral hygiene habits related to education and socio-economic levels.

It is believed that gingivitis has declined in recent years in the United States probably because of greater attention towards oral hygiene.

PREVALENCE OF PERIODONTITIS

Periodontitis is an inflammatory condition of the gingival tissue in which attachment of the periodontal ligament and some bony support is lost. Only a small proportion of people exhibit severe periodontitis. *Severe* means leading to tooth loss or threatened. Mild gingivitis is common and so is mild to moderate periodontitis. Most adults exhibit some loss of bony support and loss of attachment while still maintaining a functional dentition.

Children

Very rarely a generalized severe periodontitis affects the primary dentition. Periodontitis may affect the primary dentition, usually associated with a major underlying systemic disorder and fault in host response as in Down's syndrome, juvenile diabetes etc. but juvenile periodontitis i.e. early destructive periodontitis has been reported in healthy Albama children by Cogen et al in 1992.

More than 100 WHO surveys throughout the world using CPITN in adolescents (15–19 years) showed that most common condition was calculus with or without gingival bleeding (score-2) which was more prevalent in non-industrialized countries than in industrialized countries.

Adults

Data collected from many parts of world [1980] show that the prevalence of severe periodontitis is in the range of 7–15 percent in almost all populations, regardless of their state of economic development, oral hygiene or availability of dental care.

Kelly et al in 2000 reported that 54 percent of adults had some periodontal pockets of 4 mm or more and 5 percent severe pockets [more than 6 mm].

The WHO publication 'periodontal Profile' first published in 1990 is regularly updated. Profiles are published for three so called *Key Age* groups: Adolescents [15–19 years], Adults [35–44 years], and an Older age cohort [65–74 years].

Updated CPI population data is available in the WHO Global Oral Health Data Bank. The CPI data are expressed in mean percentages of persons with certain CPI scores and the mean number of sextants with CPI scores and presented for the three age groups of adults in relation to the WHO region.

The most severe score or sign of periodontal disease (CPI score 4) varies worldwide from 10 to 15 percent in adult

populations; however, the most prevalent score in all regions is CPI score 2 (gingival bleeding and calculus), which primarily reflects poor oral hygiene.

The prevalence of the disease in the US and worldwide has been estimated to affect 15–20 percent of the adult population, but has not been definitively determined because studies lack a consistent definition of the disease and a consistent methodology. A large US 1990 study by Brown *et al* of 15,132 subjects aged 18–64 years provides an insight into the epidemiology of periodontal diseases. It reported that 4–6 mm pockets were found in 13.4 percent of subjects, and pockets of 7 mm or greater were found far less frequently, in 0.6 percent of subjects. Additionally the study reported that attachment loss greater or equal to 3 mm was found in 44 percent of subjects, increasing with age and affecting an average of 3.4 sites/subject. Attachment loss greater or equal to 5 mm was found in 13 percent of subjects, increasing with age and affecting an average of 0.7 sites/subject, showing that mild to moderate periodontal disease is relatively widespread.

It is evident that the levels of calculus are on an average much higher in most developing countries than in the industrialized countries. From survey in adults (40 years), calculus and pockets 4 or 5 mm deep are the most frequently observed conditions. But there is very less difference for the more severe stages of periodontal disease in this age category between developed and developing countries.

The distribution of periodontal disease within countries also differs according to race or ethnic group regarding prevalence and severity. Beck et al. showed that groups of blacks have a risk of periodontal destruction three times higher than that of whites of the same age cohort. Borrell et al. found that African-Americans were twice as likely to have periodontal disease as were white Americans. The effect of ethnicity on periodontal health status is also documented in adults of developing countries.

It is widely accepted that periodontal diseases affect over 90 percent of the Indian population, but the majority of them may have only mild gingivitis and bleeding from the gums, which is reversible with proper oral hygiene measures. More advanced periodontal disease with pocket formation and bone loss, which could ultimately lead to tooth loss if not treated properly, may affect 40–45 percent of the population (Table 11.2).

Table 11.2: Periodontal surveys conducted in India

1. Marshal-Day and Shourie KL (1947) reported 99.4 percent gingivitis in 9–17 years age group.
2. Mehta and Sanjana (1956) found in 1640 children that 96.9 percent had gingivitis [11–16 age group].
3. According to Nagraj Rao et al (1980) 28 percent had marginal gingivitis and 72 percent chronic generalized gingivitis in 5–10 years of age.
4. Doifode *et al.*(2000) Maharashtra(Nagpur) in 5061 (all age groups) reported a total 34.8 percent Periodontal diseases with:

<15 years	18.4%
15–30 years	36.4%
30–60 years	50.2%
60+ years	54.4%

5. Gathwala (1993) Haryana (Rohtak) reported 36.3 percent gingivitis in 501 children (5–13 years).
6. Shah 2003 Delhi South Delhi CPI index 1052 (above 60 years) 100 percent with:

Mild	: 9.1%
Moderate	: 19%
Severe	: 71.9%

CAUSES OF PERIODONTAL DISEASE (BOX 11.1)

Direct Causes

These include poor oral hygiene leading to accumulation of dental plaque and calculus, and traumatic occlusion.

Indirect Factors

- ***Food impaction*** is the forceful wedging of food against the gingiva between teeth. Where teeth have drifted apart food wedging can take place specially in the presence of an opposing 'plunger cusp'.
- **Tobacco smoking** and chewing reduce tissue resistance and increase the susceptibility to periodontal diseases.
- **Faulty restorations** are probably the most common factors favoring plaque retention. Overhanging filling margins are extremely frequent and result from improper use of matrix bands and failure to polish margins. Badly contoured restorations, particularly over contoured and bulbous crowns and fillings, may impede effective toothbrushings.
- ***Badly designed partial dentures*** can cause tissue irritation in a number of ways. Ill-fitting or inadequately polished dentures tend to act as foci for plaque accumulation. Tissue borne dentures frequently sink into the mucosa and compress the gingival margins causing inflammation and tissue destruction.
- ***Orthodontic appliances*** are worn continuously throughout the day and night and if the patient does not clean the appliance thoroughly, plaque accumulation is inevitable.
- ***Lack of lip-seal*** causes hyperplastic gingivitis in anterior segments, usually the upper incisor regions: Lack of lip seal is frequently associated with mouth breathing, but may be present even when the patient breathes through nose. With incompetent lips the gingivae in the front of the mouth are not bathed in saliva. This seems to have two effects. (i) the normal cleansing action of saliva is diminished so plaque accumulation is encouraged; (ii) dehydration of the tissues may impair their resistance.
- ***Malnutrition*** (deficiency of vitamins A and C, niacin and protein) is associated with a higher prevalence of periodontal diseases.

- ***Endocrine disturbances*** including physiological causes such as puberty, pregnancy, menopause, and pathological causes such as hyperthyroidism, hyperparathyroidism and diabetes may aggravate existing periodontal disease.
- ***Decreased immunity*** as in persons with HIV and those on immunosuppressive drugs.
- ***Blood disorders*** such as acute monocytic leukemia and pernicious anemia can lead to periodontal diseases.
- ***Malalignment*** of the teeth predisposes to plaque retention and interferes with proper plaque removal.
- ***Improper brushing technique***, besides resulting in inadequate plaque removal, can also cause gingival recession.
- ***Drugs***—certain drugs such as phenytoin sodium and nifedipine can cause gingival hyperplasia.

Other Causes

These include low socioeconomic and literacy level, difficult access to an oral health care facility, poor oral health awareness, and lack of oral health insurance. Stress is known to predispose to acute necrotizing ulcerative gingivitis.

BOX 11.1: CAUSES OF PERIODONTAL DISEASES

Direct
- Poor oral hygiene resulting in accumulation of dental plaque and calculus
- Traumatic occlusion

Indirect
- Food impaction
- Chewing and smoking of tobacco
- Faulty restorations
- Badly designed partial dentures
- Orthodontic appliances
- Lack of lip seal/mouth-breathing
- Malnutrition- deficiency of vitamins A and C
- Endocrine disturbances
  - Physiological (puberty, pregnancy and the menopause)
  - Pathological (hyperthyroidism, hyperparathyroidism and diabetes mellitus)
- Decreased immunity
- HIV infection, persons on immunosuppressive drugs
- Blood disorders: Anaemia, leukaemia
- Malalignment of teeth
- Improper brushing technique
- Idiopathic
- Gingival fibromatosis
- Drug induced- phenytoin sodium, nifedipine, etc.

Other Causes
- Socioeconomic status
- Literacy level
- Access to oral health care facility
- Oral health knowledge and awareness
- Health insurance
- Stress

RISK FACTORS IN PERIODONTAL DISEASE

Periodontitis is a complex disease entity with a layered and multifactorial etiology. The causative agents implicated in the disease are often not enough to cause the common clinical picture of inflammation, bleeding and ultimately attachment loss (AL). This observation has led to search for risk factors that differentiate those affected from those spared.

Risk is the "possibility of injury" or the likelihood of developing a condition or health change over a period of time. The term *risk factor* implies that for any disease, there are influences associated with an increased/ decreased likelihood of exposure. The risk factors associated with periodontal disease are Socio-demographic factors, hereditary or acquired conditions, behavioral factors, microbial factors, psychological, host defence and local risk factors (Box 11.2).

STRUCTURE OF THE PERIODONTAL TISSUES

Healthy gingivae are firm with a scalloped outline, pink and knife edged, has a stippled appearance and do not bleed on probing. There is a shallow gingival crevice or sulcus and the junctional epithelium is attached to the enamel (Fig. 11.1).

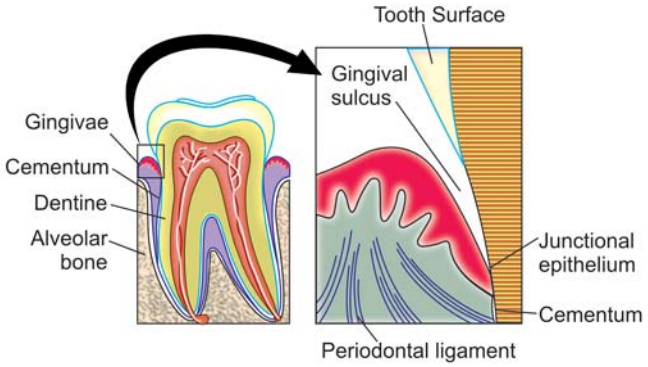


Fig. 11.1: Structure of gingivae with sulcus

The *periodontium* (*perio* = around, *odontos* = tooth) consist of the tissues which surround and support the teeth. Their function is to attach the tooth to the surrounding alveolar bone and to support the tooth during function. For descriptive purposes the periodontium can be divided into the *gingivae* and *periodontal ligament.*

GINGIVAE

Gingivae (singular = gingiva) are those parts of the masticatory mucosa that cover the alveolar process and surround the cervical portion of the teeth.

The gingivae are composed of connective tissue and epithelium, which can be divided into three histologically distinct areas (Fig. 11.2):

BOX 11.2: RISK FACTORS FOR PERIODONTAL DISEASE

Sociodemographic factors
- Age (older age groups)
- Gender (male)
- Socioeconomic Status (SES)/Education
- Ethnicity / Race (African–American, Asians)

Hereditary or acquired conditions
- Diabetes mellitus
- Cardiovascular disease (CVS)
- Obesity
- HIV/ Immunosuppression
- Osteoporosis /Osteopenia

Behavioral factors
- Tobacco use and cigarette smoking
- Patient compliance (oral hygiene practice and regular dental visits)

Microbial risk factor
- Specific bacteria in sub-gingival plaque
  a. *Tannerella forsythensis*
  b. *Porphyromoras gingivalis*
  c. *Aggregatibacter actinomycetemcomitans*
- Pathogenic potential of biofilm
- Total microbial burden

Psychological and cognitive factors
- Stress
- Bruxism

Host defence factors
- Genetic risk factors
  Immune response such as Interleukin-1, Fcγ, vitamin-D receptor

Local risk factors
- Faulty dental restorations
- Untreated dental disease
- Crowding (favors plaque accumulation)
- Furcation

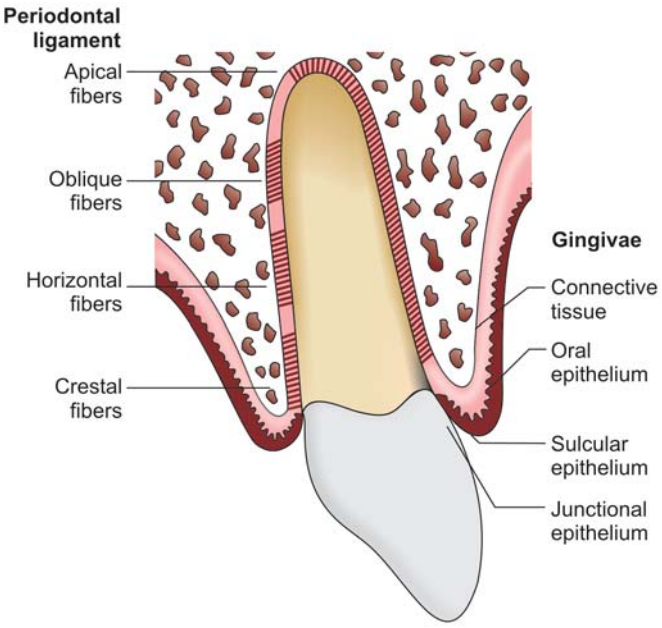


Fig 11.2: Structure of the periodontium

Oral epithelium: Continuous with epithelial lining of the attached gingivae. It is composed of keratinized stratified squamous epithelium.

Sulcular epithelium: Non-keratinized.

Junctional epithelium: Attached to the tooth by hemidesmosomes. It is non-keratinized, and has larger cells with increased intercellular spaces.

PERIODONTAL LIGAMENT

Periodontal ligament is composed of collagen fibers, which form a branching plexus and are inserted into the cementum of the tooth root at one end and the alveolar bone at the other in the form of Sharpey's fibers. They are named according to the orientation of the fiber.

THE NATURAL HISTORY OF PERIODONTAL DISEASE

Gingivitis

Plaque accumulation is greatest in the sheltered interdental region hence gingival inflammation tends to start in the interdental papilla and spreads from there around the neck of the tooth. The stages of development of gingivitis are divided into the *initial lesion*, the *early lesion* and the *established lesion.*

Initial Lesion

It is an inflammatory response to bacterial plaque. It occurs with in 2–4 days. The first changes occur around the small gingival blood vessels apical to the junctional epithelium. There is migration and infiltration of white blood cells into the junctional epithelium and gingival sulcus. There is increased exudation of tissue fluid from gingival crevice. There may be no clinical signs of tissue change at this stage.

Early Gingivitis

If plaque deposition persists, the bacterial plaque becomes older and thicker. The initial inflammatory changes continue with an increased flow of gingival fluid and migration polymorphonuclear leucocytes (PMNs). There is small increase in the number of inflammatory cells 75 percent of which are lymphocytes, a few plasma cells and macrophages. There is breakdown of collagen fiber so that the seal of the marginal cuff of gingiva is weakened. Early signs of gingivitis become apparent with slight gingival enlargement.

Early gingivitis is reversible when plaque is controlled.

Established Gingivitis

Progression from the early lesion leads to the establishment of clinically obvious gingivitis within 7–14 days. Clinical signs of inflammation appear and the interdental papillae may become

swollen and bleed on probing. The number of lymphocytes increases and predominant inflammatory cells are plasma cells. Plasma cells are related to areas of chronic inflammation. Clinical signs of inflammation appear and the interdental papillae may become swollen and bleed on probing. Marginal gingiva becomes spongy. With the increased destruction of collagen and inflammatory swelling the gingival margin can be separated easily from the surface giving rise to '*gingival*' or '*false pocket*'.

There is degeneration of cells of junctional epithelium and some proliferation of junctional and sulcular epithelium continues. As fibrous tissue is destroyed within the site of active inflammation, there is some proliferation of fibrous tissue and formation of new blood vessels at more distant sites. Thus destruction and repair continue side by side.

PERIODONTITIS

Continuous plaque irritation and inflammation damages the integrity of the junctional epithelium. There is degeneration and separation of epithelial cells and there is breakdown of their attachment to tooth surface. Connective tissue fibers are destroyed. The junctional epithelium proliferates into the connective tissue and down the root surface as the dento-gingival fibers and the alveolar crest fibers are destroyed. The epithelium migrates along the root surface. Apical migration of the junctional epithelium continues and as this epithelium separates from the root surface, a *periodontal* or *true pocket* is formed.

The connective tissue is edematous; vessels are dilated and thrombosed; vessel walls break down with hemorrhage into the surrounding tissues. There is a massive inflammatory infiltrate of plasma cells, lymphocytes and macrophages.

The progression of lesion is not continuous, periods of advance and remission take place and fibrosis is a constant feature. With the destruction of periodontal ligament and alveolar crest, resorption, the pocket deepens. Continuance of the disease may lead to varying degree suppuration and abscess formation. Finally the teeth may become loose, migrate and is lost.

Table 11.3 shows the features of periodontal examination.

CLASSIFICATION OF PERIODONTAL DISEASE

Classification according to World Workshop [1989]

I. Adult Periodontitis.
II. Early Onset Periodontitis
  A. Prepubertal Periodontitis
    i. Generalized
    ii. Localized
  B. Juvenile Periodontitis
    i. Generalized
    ii. Localized
  C. Rapidly Progressive Periodontitis
III. Periodontitis Associated with Systemic disease
IV. Necrotizing Ulcerative Periodontitis
V. Refractory Periodontitis

Table 11.3: Features to be noted during a periodontal examination

Visual
• Deposits - supragingival plaque, calculus
• Gingivae - erythema, hyperplasia, recession
• Occlusal abnormalities
Probing
• Pocket depths
• Bleeding on probing
• Subgingival calculus
• Furcation defects
• Palpation
• Mobility

On October 30 – November 2, 1999, **the International Workshop for a Classification of Periodontal Diseases and Conditions** organized by the American Academy of Periodontology was held and a new classification was agreed upon (Tables. 11.4 and 11.5).

DETERMINANTS OF PERIODONTITIS

A *risk factor* is an environmental exposure, aspect of behavior, or an inherent characteristic which is associated with a disease. The association may or may not be causal, though the use of the term increasingly implies known or suspected causality. The term *determinant* is often used synonymously with *risk factor* in the literature, but for clarity is best reserved for risk factors that cannot be modified (e.g., age, previous disease experience). The term *risk indicator* describes plausible correlates of disease identified in cross-sectional studies, while *risk factor* is best applied to those correlates confirmed in longitudinal studies. The term *risk factor* implies a modifiable condition (e.g., smoking, plaque deposits). Risk indicators identified in cross-sectional studies are not always confirmed as risk factors in longitudinal studies. The term *risk marker* is used more in the predictive sense, a factor associated with increased probability of future disease but where causality is usually not implied.

EPIDEMIOLOGY

It is well established that the periodontal disease is initiated by bacterial plaque, but other etiologic factors exist- those which predispose to plaque accumulation and those which modify the inflammatory response.

Epidemiology can be studied under:

1. HOST FACTORS

A. Age

There is a consensus that gingivitis increases in children with age. Massler showed that at the time of puberty, there was a

Table 11.4: Classification of gingival diseases

I. Gingival Diseases

A. Dental plaque-induced gingival diseases

1. Gingivitis associated with dental plaque only
   a. without other local contributing factors
   b. with local contributing factors (See VIII A)
2. Gingival diseases modified by systemic factors
   a. Associated with the endocrine system
      1. puberty-associated gingivitis
      2. menstrual cycle-associated gingivitis
      3. pregnancy-associated
         a. gingivitis
         b. pyogenic granuloma
      4. diabetes mellitus-associated gingivitis
   b. associated with blood dyscrasias
      1. leukemia-associated gingivitis
      2. other
3. Gingival diseases modified by medications
   a. drug-influenced gingival diseases
      1. drug-influenced gingival enlargements
      2. drug-influenced gingivitis
         a. oral contraceptive-associated gingivitis
         b. other
4. Gingival diseases modified by malnutrition
   a. ascorbic acid-deficiency gingivitis
   b. other

B. Non-plaque-induced gingival lesions

1. Gingival diseases of specific bacterial origin
   a. *Neisseria gonorrhea*-associated lesions
   b. *Treponema pallidum*-associated lesions
   c. streptococcal species-associated lesions
   d. other
2. Gingival diseases of viral origin
   a. herpesvirus infections
      1. primary herpetic gingivostomatitis
      2. recurrent oral herpes
      3. varicella-zoster infections
   b. other
3. Gingival diseases of fungal origin
   a. *Candida*-species infections
      1. generalized gingival candidosis
   b. linear gingival erythema
   c. histoplasmosis
   d. other
4. Gingival lesions of genetic origin
   a. hereditary gingival fibromatosis
   b. other
5. Gingival manifestations of systemic conditions
   a. mucocutaneous disorders
      1. lichen planus
      2. pemphigoid
      3. pemphigus vulgaris
      4. erythema multiforme
      5. lupus erythematosus
      6. drug-induced
      7. other
   b. allergic reactions
      1. dental restorative materials
         a. mercury
         b. nickel
         c. acrylic
         d. other
      2. reactions attributable to
         a. toothpastes/dentifrices
         b. mouthrinses/mouthwashes
         c. chewing gum additives
         d. foods and additives
      3. other
6. Traumatic lesions (factitious, iatrogenic, accidental)
   a. chemical injury
   b. physical injury
   c. thermal injury
7. Foreign body reactions
8. Not otherwise specified (NOS)

noticeable increase in prevalence which then falls off. Studies show that 95 percent of people age 30 years had gingivitis [Hugoson and Jordan 1982]. Clere hugh and Lennon (1986) demonstrated a large increase in loss of attachment of over 1 mm between 14–16 years of age.

In most cases the disease progresses slowly and is unlikely to become clinically significant until the fourth decade [adult periodontitis]. It is the most common type of periodontitis and is responsible for advanced destructive disease in middle aged and elderly.

"Rapidly Progressive Periodontitis" is a term used to describe severe generalized periodontitis affecting young adults between 20–35 years of age.

A study on school children aged 6 and 12 years in Calcutta conducted A. Dutta (1965) suggests that periodontal disease increase with age. He found that mean prevalence at 6 years was 73 percent and at 12 years was 89.8 percent.

A study in USA also suggests both prevalence and severity of disease is low in early adult hood and increases with age. [Brown et al 1990].

B. Sex

Periodontal disease is more common in males. Day states Indian females show a significantly lower bone loss from periodontitis but a higher bone loss from periodontosis. Numerous studies reported higher periodontal destruction among males compared to the female population (Brown, Oliver and Löe, 1990; Slade and Spencer, 1995). The reasons for these sex differences are not clear, but it is thought to be related to poorer oral hygiene level, which is usually observed among males (Slade and Spencer, 1995; Albandar and Kingman, 1999). However, the relationship observed between sex and the disease is not apparent and is not considered as strong and consistent. Thus,

Table 11.5: Classification of periodontal diseases

II. Chronic Periodontitis†
- A. Localized
- B. Generalized

III. Aggressive Periodontitis†
- A. Localized
- B. Generalized

IV. Periodontitis as a Manifestation of Systemic Diseases
- A. Associated with hematological disorders
  1. Acquired neutropenia
  2. Leukemias
  3. Other
- B. Associated with genetic disorders
  1. Familial and cyclic neutropenia
  2. Down syndrome
  3. Leukocyte adhesion deficiency syndromes
  4. Papillon-Lefèvre syndrome
  5. Chediak-Higashi syndrome
  6. Histiocytosis syndromes
  7. Glycogen storage disease
  8. Infantile genetic agranulocytosis
  9. Cohen syndrome
  10. Ehlers-Danlos syndrome (Types IV and VIII)
  11. Hypophosphatasia
  12. Other
- C. Not otherwise specified (NOS)

V. Necrotizing Periodontal Diseases
- A. Necrotizing ulcerative gingivitis (NUG)
- B. Necrotizing ulcerative periodontitis (NUP)

VI. Abscesses of the Periodontium
- A. Gingival abscess
- B. Periodontal abscess
- C. Pericoronal abscess

VII. Periodontitis Associated With Endodontic Lesions
- A. Combined periodontic-endodontic lesions

VIII. Developmental or Acquired Deformities and Conditions
- A. Localized tooth-related factors that modify or predispose to plaque-induced gingival diseases/periodontitis
  1. Tooth anatomic factors
  2. Dental restorations/appliances
  3. Root fractures
  4. Cervical root resorption and cemental tears
- B. Mucogingival deformities and conditions around teeth
  1. Gingival/soft tissue recession
     a. facial or lingual surfaces
     b. interproximal (papillary)
  2. Lack of keratinized gingiva
  3. Decreased vestibular depth
  4. Aberrant frenum/muscle position
  5. Gingival excess
     a. pseudopocket
     b. inconsistent gingival margin
     c. excessive gingival display
     d. gingival enlargement (See I.A.3. and I.B.4.)
  6. Abnormal color
- C. Mucogingival deformities and conditions on edentulous ridges
  1. Vertical and/or horizontal ridge deficiency
  2. Lack of gingiva/keratinized tissue
  3. Gingival/soft tissue enlargement
  4. Aberrant frenum/muscle position
  5. Decreased vestibular depth
  6. Abnormal color
- D. Occlusal trauma
  1. Primary occlusal trauma
  2. Secondary occlusal trauma

† Can be further classified on the basis of extent and severity. As a general guide, extent can be characterized as Localized = ≤ 30% of sites involved and Generalized = >30% of sites involved. Severity can be characterized on the basis of the amount of clinical attachment loss (CAL) as follows: Slight = 1 or 2 mm CAL, Moderate = 3 or 4 mm CAL, and Severe = ≥ 5 mm CAL.

sex may be a demographic factor, which may interfere with the effects of other factors and it must be controlled for investigating the disease.

C. Race

According to National Health Survey blacks had more periodontal disease than whites. Several studies involving different racial populations have found some difference in the expression of periodontal disease (Beck et al., 1990). Once again, race is not a modifiable factor, and some discrepancies in disease expression may be explained by the difference in other risk factors between populations.

D. Endocrine Changes

Increase in gingivitis is reported in children as they approach puberty. In females, gingivitis is seen at the time of menstruation and pregnancy. Pathological endocrine changes associated with periodontitis include hyperthyroidism and hyper parathyroidism.

E. Intraoral Distribution

Tooth surface most affected by gingivitis or periodontitis are the proximal surfaces (Loe et al 1965). The teeth most severely affected by gingivitis are the molars and lower anteriors. Attachment loss on average is greater in the maxilla than in mandible, and least in canines, mandibular 1st premolars and maxillary central incisor.

F. Tooth Malalignment

Gingivitis is more common and more severe around malaligned teeth because they are harder to clean.

G. Restoration

Bacteria accumulate more readily on filled surface, than on tooth surface. A smooth and highly polished filling is easier to clean than a rough surface and hence there is lesser degree of plaque accumulation.

H. Traumatic Occlusion

Sharp cusp act as plungers and are derogatory to periodontal health, leading to periodontitis.

I. Oral Hygiene

Poor oral hygiene is a major cause of gingivitis and periodontal disease (Greene J.C, 1963; Greene and Vermillion, 1964). It has been accepted for years that the relationship between oral hygiene status and periodontal disease is consistent (Nagraj Rao, 1980). Loe and Silness have proved in their study that this relation is of cause and effect.

J. Tobacco

Smoking and smokeless tobacco are associated with poor periodontal health. They lower the tissue resistance and increase susceptibility to gingivitis and periodontal disease. Burt et al (1982) reported highest levels of periodontal disease in smokers and lowest levels of periodontal disease in non-smokers.

K. Occupational Habits

Habits like thread biting by tailors and holding of nails between teeth by carpenters cause trauma to the periodontium leading to periodontitis. Miscellaneous habits like pipe smoking, abuse of cigarette holder, pencil biting, nut biting, finger nail biting produces traumatic injury to periodontium.

L. Systemic Factors

Uncontrolled diabetes and heavy metal poisoning predispose to gingivitis and periodontitis. These conditions do not seem to initiate periodontal disease but they accentuate it where it has started for other reasons.

Acute monocytic leukemia may produce gingival enlargement and ulceration.

AIDS and HIV increase susceptibility for destructive periodontal disease.

M. Socio-economic Status

High income group have lower periodontal disease rate than the lower income group probably because they have the means and can afford dental treatment. The possible relationship between periodontal disease and socio-economic status was found in several studies (Beck et al., 1990; Locker and Leake, 1993; Dolan et al., 1997).

Gingival condition is clearly related to lower SES, but the relationship between SES and periodontitis is less direct. It can be certain that gingival health is better among individuals with higher education and with more secure income. SES is a modifiable factor and it can be examined in multivariate models for the disease.

N. Psychosomatic Factors

These factors influence the incidence of periodontal disease through multifactorial effects which include: abnormal oral hygiene habits, clenching and bruxism (produce forces that are destructive to periodontium), nutritional factors, destructive mechanical oral habits and other predisposing factors.

Jacobson (1973) reported that the mouth breathers have more severe gingivitis than non-smokers.

Stress is thought to manifest in the periodontium through behavioral changes, such as increased smoking and poorer oral hygiene.

2. AGENT FACTORS

Agent factors Consists mainly of plaque and calculus.

A. Dental Plaque

Plaque is the soft, non-mineralized, bacterial deposit which forms on teeth that are not adequately cleaned. Once the teeth are cleaned, the earliest deposit to form is the '*acquired pellicle*'. It is a structure less film of salivary glycoproteins selectively adsorbed to the surface of hydroxyapatite crystals, and is visible within minutes of oral prophylaxis and polishing with pumice. Pellicle formation is accompanied by bacterial colonization as microorganism in saliva adsorb to the pellicle. Later a thin layer composed mainly of gram +ve cocci called as *plaque* is formed.

This is followed by increase in gram +ve rods and gram –ve cocci and rods for seven days. After approximately seven days filaments, fusobacteria and spirilla are found in greater number. As the plaque matures further, spirochetes and vibrios appear and filamentous bacteria specially actinomyces may become predominant.

Gingivitis is believed to be the result from quantitative changes in plaque rather than the over growth of specific microorganism. Periodontitis is caused by subgingival down growth of those bacteria best able to evade host defenses and survive in a low oxygen environment. Thus dental plaque are of two types; *supra gingival* and *sub gingival* (Table 11.6).

Table 11.6: Differences between supra and subgingival plaque

	Supragingival plaque	*Subgingival plaque*
1. Matrix	50% Matrix	Little or no matrix
2. Flora	Mostly gram +ve	Mostly gram –ve
3. Motile bacteria	Few	Common
4. Anaerobic/Aerobic	Aerobic	Anaerobic
5. Metabolism	Predominantly carbohydrates	Predominantly proteins

In subgingival plaque, gram +ve bacteria are found in lower proportions and gram –ve bacteria in higher proportions than in supra gingival plaque. The subgingival flora comprises a layer of tooth attached plaque as well as a loosely adherent component in direct association with the pocket epithelium. The tooth attached plaque consists predominantly of gram +ve rods and cocci, while unattached plaque consists mainly of gram –ve organisms.

Tissue damage is caused mainly by penetration of the tissues by various soluble substances produced by plaque bacteria. These toxins have toxic effects on host cells and cause enzymic degradation of tissues. Chemotactic and antigenic effect occurs. There is activation or suppression of inflammatory and immune mechanism, and stimulation of bone resorption.

B. Calculus

Mineralization within plaque results in calculus formation. It consists of Inorganic and Organic component.

Organic components [10–30%] include proteins; carbohydrates; lipids and various non vital microorganisms, predominantly filamentous ones.

Inorganic components [70–90%] are mostly crystalline and amorphous calcium phosphate.

It can be *supra gingival* or *sub gingival*.

Supra gingival calculus formation takes place from interactions between, tooth surface and plaque. Sub gingival involves inflammatory exudates within pockets. It forms more slowly and forms an intimate relationship with the rough root surface. Calculus is always covered by soft plaque and retains toxic bacterial products. The surface texture of calculus promotes plaque accumulation and retention of irritant bacterial deposits. Calculus itself is not capable of initiating periodontal disease. Supra and subgingival calculus vary in their color, composition and content as shown in Table 11.7.

Table 11.7: Differences between supragingival and subgingival calculus

	Supragingival calculus	*Subgingival calculus*
1. Location	Above the margin of gingiva	Below the margin of gingiva
2. Color	White to yellow	Brown to greenish black
3. Composition	More brushite and octacalcium phosphate	Less brushite and octacalcium phosphate
4. Salivary proteins	Present	Absent
5. Sodium content	Lesser	Increases with depth of pocket

Supra and Subgingival Calculus

Supragingival calculus is located coronal to the gingival margin and is visible in the oral cavity. It is usually white to yellow in color. It is hard with clay like consistency and easily detachable from tooth surface.

Composition

Inorganic Content

Supragingival calculus consist of 75.9 percent $Ca_3 (PO_4)_2$, 3.1 percent $CaCO_3$, and traces of $Mg_3(PO_4)_2$.

At least 2/3rd of the inorganic content is crystalline in nature. The four main crystalline forms are:

1. Hydroxy apatite 58%.
2. Mg whitlockite 21%.
3. Octacalcium phosphate 12%.
4. Brushite 9%.

Organic Content

Mixture of protein polysaccharide complexes, desquamated epithelial cells, Leukocyte and microorganism.

Subgingival calculus is located apical to the gingival margin and is not visible in the oral cavity. It is usually dark brown or greenish black in color. It is typically hard and dense and firmly attached to the tooth surface.

Composition

Subgingival calculus has same composition as supragingival calculus with few differences.

Inorganic Content

It is more homogenous with an equally high density of minerals. The predominant mineral is magnesium whitlockite, containing small proportions of magnesia (3%).

It has the same amount of hydroxyapatite but less brushite and octacalcium phosphate.

The ratio of calcium to phosphate is concomitantly high in subgingival calculus with an increase in the sodium content with the depth of the periodontal pocket.

Organic Content

It is similar to that of supragingival calculus although the salivary proteins are not found in it.

C. Stains

Stains are produced by the action of chromogenic bacteria on food substances such as tobacco, tea coffee etc. or by metallic particles. These pigments become absorbed by plaque or pellicle.

3. ENVIRONMENTAL FACTORS

A. Food and Nutrition

Despite observations like sailors suffering from scurvy [deficiency of vitamin 'C'] had bleeding gums; no nutritional

or dietary factors have been shown to be directly related to the prevalence of periodontal disease in the earlier epidemiological studies. Improved understanding of the disease at the cellular level and more stringent nutritional methodologies have brought new interest and provided new insights into the association between nutrition status and periodontal disease. The influence of nutrition on periodontal disease therefore appears to be exerted mainly at 3 different levels.

1. On the metabolism of the gingival crevice-plaque flora.
2. On the repair process in the connective tissue at local site.
3. On the immunologic response to the microbial antigens.

Protein

Protein calorie malnutrition has been associated with osteoporosis of alveolar bone, thinning of periodontal ligament, degeneration of periodontal collagen fibers, retardation in deposition of cementum and delayed gingival wound healing. (Stahl S.S 1966).

Enwonwu (1994) observed the effect of protein –energy malnutrition (PEM) on periodontal disease risk. He observed that aggressive periodontal disease was more prevalent and severe in undernourished population (Table 11.8).

Table 11.8: Proposed mechanism by which PEM enhances periodontal disease (Gregory 2000)

• Decreased resistance of mucosa to colonization and invasion by pathogens.
• Impaired salivary flow and antibacterial properties.
• Increased prevalence and potency of pathogenic oral microorganism (possibly due to altered bacterial profile)
• Cytokines involved in the healing process compromised
• Reduced acute phase protein response

Vitamin C

There is a direct relationship between gingival tissue concentration of ascorbic acid and sulcular epithelial function, collagen synthesis and permeability of sulcular epithelial. In vitamin C deficiency, there is an increase in gingival sulcular epithelial permeability and decrease collagen synthesis and poor sulcular epithelial barrier function due to gingivitis by bacterial toxins and antigens to the underlying connective tissue and lamina propria.

Calcium

Calcium and phosphorus have effect on gingival inflammation, calcium formation, pocket depth and tooth mobility. Binkley (1978) Reported that person who had high dietary calcium showed lesser bone resorption. The studies of Wical et al (1974) and Sorensen (1977) showed an inverse relationship between calcium intake and ridge resorption.

Zinc

Deficiency of Zinc leads to:

1. Inhibition of cell mediated immune functions (Sand Stead 1979).
2. Inhibits collagen formation (Prosed et al 1971)
3. Increased sulcular and junctional epithelial permeability (Joseph et al 1982)
4. Increased alveolar bone resorption (Ekund et al 1980)

Iron

There is an inverse relationship between iron and sulcular and junctional epithelial permeability. Iron deficiency reduces the competence phagocytes and depresses myeloperoxidase in macro phages, which is required for killing of bacteria. Also deficiency of iron inhibits hydroxylation of praline in collagen synthesis (Mallek 1978).

B. Geographic Distribution

Certain geographic areas throughout the world are associated with more periodontal disease than others. Russell describes population according to whether disease is relatively high, intermediate or relatively low.

High includes countries like Chile, Lebanon, Jordan, Thailand, Burma, India, and Ceylon.

EPIDEMIOLOGICAL FACTORS IN PERIODONTAL DISEASE

I. Host Factors
- Age
- Sex
- Race
- Endocrine Changes
- Intraoral Distribution
- Tooth Malalignment
- Restoration
- Traumatic Occlusion
- Oral Hygiene
- Tobacco
- Occupational Habits
- Systemic Factors
- Socio- Economic Status
- Psychosomatic Factors

II. Agent Factors
- Dental Plaque
- Calculus
- Stains

III. Environmental Factors
- Food and Nutrition
- Geographic Distribution
- Urbanization

BACTERIA MOST COMMONLY ASSOCIATED WITH PERIODONTAL DISEASE

- *Porphyromonas gingivalis*
- *Prevotella intermedia*
- *Actinobacillus actinomycetemcomitans*
- Fusobacteria
- *Treponema* spp.

It is found to be intermediate in USA black population, Equador, Columbia and Ethopia.

In relatively low group come US white population and primitive Eskimos of Alaska.

It is observed that underdeveloped and dentist deprived areas show greater periodontal disease than developed countries.

C. Urbanization

Periodontal disease is seen less in urban than in rural population particularly at younger ages. This difference could be attributed more to educational background than to rural life.

Data from various surveys on the prevalence of gingivitis and periodontitis is dependent on whom the disease is defined and the age group from which they were taken.

Gingivitis is found in early childhood, is more prevalent and severe in adolescence, and then tends to level off in older age group. Mild to moderate periodontitis affects a majority of adults. Some 5-20 percent of the population suffers from severe, generalized periodontitis. For those who are most susceptible, periodontitis becomes evident in teenage and early adult years rather than the later years.

Chapter 12

Epidemiology, Etiology and Prevention of Oral Cancer

CM Marya, Rakesh Dhankar

Cancer is one of the major threats to public health in the developed world and increasingly in the developing world. In developed countries cancer is the second most common cause of death. Oropharyngeal cancer is more common in developing countries than developed countries. The prevalence of oral cancer is particularly high among men, the eighth most common cancer worldwide. Incidence rates for oral cancer vary in men from 1 to 10 cases per 1,00,000 population in many countries.

Oral cancer term includes cancers of lip, tongue, buccal mucosa, floor of mouth and pharynx.

The epidemiology of oral cancer is usually described in terms of the yearly incidence of new cases and mortality per 100,000 of a given population. Oral cancer is one of the ten leading cancers in the world. Cancer of the oral cavity comprises approximately 30 percent of head and neck region tumors and 3 percent of all cancers in the United States. In south-central Asia, cancer of the oral cavity ranks among the three most common types of cancer. In India, the age standardized incidence rate of oral cancer is 12.6 per 100 000 population. It is noteworthy that sharp increases in the incidence rates of oral/pharyngeal cancers have been reported for several countries and regions such as Denmark, France, Germany, Scotland, Central and Eastern Europe and to a lesser extent Australia, Japan, New Zealand and the USA. The cancer epidemic in developed countries, and increasingly in developing countries, is due to the combined effect of the ageing of populations, and the high or increasing levels of prevalence of cancer risk factors. It has been estimated that 43 percent of cancer deaths worldwide are due to tobacco, unhealthy diet, physical inactivity and infections. Tobacco use and excessive alcohol consumption have been estimated to account for about 90 percent of cancers in the oral cavity; the oral cancer risk increases when tobacco is used in combination with alcohol or areca nut.

In India, it is one of the common cancers. Oral cancer is predominant in older males. However, in recent years this trend seems to be changing with increasing incidence of oral cancer in females, presumed to result from increasing cigarette smoking in women.

INCIDENCE

The disease is almost twice as common in men and the majority of malignancies [90–95%] are squamous cell carcinomas. The incidence increases with age. There is great variation, however, in sex incidence between various sites in the oral cavity.

IN INDIA AND SRI LANKA

The incidence varies considerably with very high rates found particularly in India and Sri Lanka, where oral malignancy is the commonest type of cancer accounting for 40 percent of all cancers.

WESTERN COUNTRIES

In UK oral cancer accounts for 1–2 percent of all cancers. In US cancers of oral cavity constitutes some 3.1% of all new cases reported and 1.8 percent of all cancers deaths.

Incidence varies from 2.2 in Japan to 22.5 in Brazil/ 100,000 in males.

In the international classification of diseases [9th Revision] WHO, oral cancer is classified under the rubucis 140 [lip], 141 [tongue], 143 [gingival], 144 [floor of mouth], and 145 [other parts of the mouth].

TRENDS

Between 1911 and early 1970 there was steep decline in mortality for male oral cancers. There are indications that the incidence and mortality rates have begun to increase again particularly in young men and women. The reason for this is not clear.

Sex

Males in a given population almost invariably have higher age specific incidence rates than females for all types of oral cancer.

Age

Incidence increases with age and 85 percent of cases are found in those aged 50 and above [cancer research compaign 2000].

Site

In India carcinoma of the tongue in particular is the most common form of cancer in Bombay while buccal mocosa in Madras. In UK tongue is the most frequently involved oral site in England and Wales population while floor of the mouth ranks second with about half the number of cases.

The most common subsite for squamous cell carcinoma of the oral cavity (excluding the lip) is the tongue.

The floor of the mouth is the second most common subsite where oral cavity carcinomas may arise. Carcinoma of the alveolar ridge accounts for approximately 10 percent of oral cavity carcinomas (Table 12.1). Squamous cell carcinoma of the retromolar trigone and hard palate is rare. Similarly, carcinoma of the buccal mucosa is rare in the United States, but is the most common carcinoma of the oral cavity in Southeast Asia because of the widespread use of betel nut (Table 12.2).

Table 12.1: Incidence rates of oral cancer per 100,000 population by site, gender, in India

Site	*Gender*		*Incidence rate*
Lip			
	Male	-	0.6
	Female	-	0.6
Tongue			
	Male	-	14.6
	Female	-	2.2
Mouth			
	Male	-	6.1
	Female	-	3.7

Table 12.2: Causes of oral cancer

Etiology of oral cancer

The causes of oral cancer can be divided into established risk factors and predisposing factors.

Established risk factors

- Smoking tobacco
- Chewing tobacco/oral snuff
- Chewing betel quid [pan] with tobacco
- Heavy consumption of alcohol
- Presence of potentially malignant lesions
- Prior history of oral cavity or other aerodigestive tract cancer
- Age, in conjunction with other risks listed.

Predisposing factors

- Dietary deficiency [Vitamins A, C, E Iron]
- Genetic disposition
- Sunlight [lip cancer]
- Dental trauma
- Viral infection
- Air pollution and environmental exposure to the burning of fossil fuels
- Chronic sepsis in the mouth
- Chemical agents.



Fig. 12.1: Cigarette

SMOKED TOBACCO

It is addictive. Both *smoked* and *smokeless tobacco* contains the alkaloid nicotine which is the main addictive agent. Smoked as well as unburnt tobacco contains thousands of chemical compounds. Many of these compounds are not only irritants and toxin, but they are also carcinogens. The most potent carcinogen in tobacco is the tobacco specific nitrosamines, polycyclic aromatic hydrocarbons and many others.

TYPES

1. *Cigarette* (Fig. 12.1): It is far more popular in urban than rural areas. Indian made cigarettes differ from the foreign made cigarettes, e.g. approximately only 51 percent of Indian cigarette are filtered-tipped compared to 93 percent of the American brands. Also the filter length in Indian cigarettes average 12 mm compared to 20 mm in American brands. The Indian filters trap less nicotine compared to their American counter parts. Tar yield of cigarette classifies cigarette as *low* or *medium*. Low: when tar yield is below 22 mg, High: tar yield is above 22 mg. Compared with nonsmokers, the risk of oral cancer for smokers using low to medium tar cigarette is 8.5 times and for high tar cigarette is 16.4.
2. *Bidi* (Fig. 12.2): Bidi are made by rolling a dried rectangular piece of the Temburni leaf [*Diospyros melanoxylon*] into a conical shape and securing the roll with a thread. Some 60 percent of the weight of a bidi is made up of the temburni leaf wrapper. Bidis produce a smaller volume of smoke than cigarette, because they contain a small amount of coarsely ground tobacco [0.15–0.25 gm] compared to 1 gm of finely



Fig. 12.2: Bidi



Fig. 12.3: Cigar

cut tobacco in cigarette. Yet bidis deliver as much as 45–50 mg tar, compared to 18–28 mg in Indian cigarette. Bidi smoke also contain much higher concentration of several toxic agents such as hydrogen cyanide, carbon monoxide, ammonia, volatile phenols and carcinogenic hydrocarbons than that of US cigarettes.

3. *Cigar/Cheroot/Chutta*: Popular in certain regions of India. About 9 percent of tobacco in India is used to make about 300 million pieces of these products annually.

   Cigar: are made of air cured, fermented tobacco. They are expensive, predominantly smoked in urban high society (Fig. 12.3).

   Cheroots: are small cigars made of heavy bodied tobacco. They have no wrapper and contain a single binder.

   Chutta: are coarsely prepared cheroots made by rolling a tobacco leaf into a cylindrical shape and one end is tied with a thread. Widely used in Tamil Nadu. Andhra Pradesh and Orissa.

   Reverse chutta smoking: It is habit of smoking with the lighted end inside the mouth. Used in this fashion in coastal areas of Andhra Pradesh specially Visakhapatnam and in parts of Orissa. Practiced more by women than men. The temperature of palatal mucosa reaches upto 58° C in this form of smoking.

4. *Dhumti*: Dhumti smoking is prevalent in Goa. It is a kind of a conical cigar made by rolling leaf tobacco in the leaf of a jack fruit tree, occasionally in a dried leaf of a banana plant or in a green leaf of a hansali plant. It is smoked mostly in goa.

   Dhumti are occasionally smoked in reverse, generally by women. Reverse dhumti smoking is much less common in Goa [0.5%] than reverse smoking [46%] in Srikakulum, Andhra Pradesh.

5. *Hookli*: It is a clay pipe commonly used in Bhavnagar district, Gujrat. It has a stem 7–10 cm long with a mouth piece and a bowl. The stem can be wooden with a detachable clay bowl, perhaps to reduce the heat. Solely men practice this habit.

6. *Chilum* (Fig. 12.4): It is a straight 10–14 cm long conical pipe made of clay. It is held vertically and a pebble or a stopper is introduced into chillum to prevent tobacco from entering the mouth. It is filled with coarsely cut tobacco and a burning charcoal is put on tobacco. Its mouth piece is wrapped with a wet cloth to protect the mouth from the heat and prevalent tobacco shreds entering the mouth.

7. *Hookah* (Fig. 12.5): It is an Indian water pipe. It consists of a receptacle for water, which has an opening on the top to which a wooden stem is fixed. At the top of the stem a small



Fig. 12.4: Chilum



Fig. 12.5: Hookah

bowl is attached for tobacco. A long tube is fixed to an outlet on the side of the receptacle, through which the tobacco is smoked. Cut, shredded tobacco moistened with molasses is kept in bowl and burned with charcoal. The smoke is drawn through the water, which cools and filters it.

CONSTITUENTS OF TOBACCO SMOKE

Tobacco smoke is a complex mixture of several thousand chemical compounds—some in tiny quantities—that are the product of burning the ingredients of the tobacco product. These include particulates (tar) of sticky solids, gases such as carbon monoxide, and volatiles. Most importantly, the smoke contains nicotine—the addictive drug. This mixture is constantly changing as the smoke 'ages'—chemicals in the smoke and background atmosphere react with each other and changes under the effect of ultraviolet light. Tobacco smoke is estimated to contain over four thousand compounds, many of which are pharmacologically active, toxic, mutagenic and carcinogenic. The following major components of tobacco smoke have been identified as most likely to cause disease:

Nicotine

Nicotine is among the most toxic of all poisons and acts with great speed. The average lethal dose for an adult human is estimated to be between 30–60 milligrams (mg). Nicotine is the pharmacological agent in the tobacco smoke that causes addiction among smokers. The addictive effect of nicotine is linked to its capacity to trigger the release of dopamine—a chemical in the brain that is associated with the feelings of pleasure. Recent research has suggested that in the long-term, nicotine depresses the ability of the brain to experience please one. Thus, smokers need greater amounts of the drug to achieve the same levels of satisfaction. Smoking is therefore a form of self-medication: further smoking alleviates the withdrawal symptoms which set in soon after the effects of nicotine wear off. Its immediate physiological effects include increased heart rate and blood pressure, constriction of cutaneous blood vessels, and muscular, hormonal and metabolic effects. With prolonged exposure to nicotine, it may contribute (in combination with carbon monoxide) to increased platelet stickiness and aggregation and damage to the lining of the blood vessels, suggesting a potential role in causing coronary disease. Although nicotine does not appear to possess direct carcinogenic activity itself, it enables the formation of tobacco-specific nitrosamines, which are potent carcinogens.

Tar

"Tar" describes the particulate matter inhaled when the smoker draws on a lighted cigarette. Each particle is composed of a large variety of organic and inorganic chemicals consisting primarily of nitrogen, oxygen, hydrogen, carbon dioxide, carbon monoxide, and a wide range of volatile and semivolatile organic chemicals. In its condensate form, tar is a sticky brown substance which can stain smokers' fingers and teeth yellow brown. It also stains the lung tissue. Among the carcinogens or tumor initiators present in cigarettes smoke are the two major classes of tumor initiators: polycyclic aromatic hydrocarbons and tobacco-specific nitrosamines. Benzopyrene as a carcinogen is a prominent polycyclic aromatic hydrocarbon found in tar.

Carbon Monoxide (CO)

Tobacco smoke contains carbon monoxide. Carbon monoxide is a colorless, odorless, poisonous gas. Carbon monoxide interferes with uptake of oxygen in the lungs and with its release from the blood to the tissues that need it. When carbon monoxide is inhaled it combines with the hemoglobin in the blood to form carboxylhemoglobin. As carbon monoxide has a chemical affinity for hemoglobin over 200 times greater than that of oxygen, it binds preferentially with hemoglobin, thereby reducing the amount of oxygenated blood circulated to body organs and tissues. Thus, the oxygen transportation in the body is impaired.

Nitrogen Oxides

Cigarette smoke contains oxides of nitrogen in relatively high levels. This gas is known to cause lung damage in experimental animals similar to that noted in smokers, and may be responsible for initiating lung damage leading to emphysema.

Hydrogen Cyanide and Other Ciliatoxic Agents

Hydrogen cyanide has a direct, deleterious effect on the cilia, part of the natural lung clearance mechanism in humans.

Interference with this cleaning system can result in an accumulation of toxic agents in the lungs, thereby increasing the likelihood of developing disease. Other toxic agents in cigarette smoke which directly affect the cilia include acrolein, ammonia, nitrogen dioxide and formaldehyde.

Metals

Thirty metals have been detected in tobacco smoke, including nickel, arsenic, cadmium, chromium and lead. Arsenic and arsenic compounds and chromium and some chromium compounds are causally associated with cancer in humans, while nickel and cadmium and their compounds are probably carcinogenic to humans. Arsenic levels in tobacco have been elevated in the past due to the use of arsenical pesticides. Cadmium levels may be related to the presence of cadmium in phosphate fertilizers.

Radioactive Compounds

The radioactive compounds found in highest concentration in cigarette smoke are polonium-210 and potassium-40. Other radioactive compounds present include radium-226, radium-228 and thorium-228. Radioactive compounds are well established as carcinogens.

SMOKELESS TOBACCO

Gutka (with tobacco)

Betel quid with tobacco, also known as *gutka* is a dry, relatively nonperishable commercial preparation that consists of betel leaf (*Piper betel*), tobacco, areca nut (*Areca catechu*), catechu (extract of the *Acacia catechu* tree), and slaked lime (calcium hydroxide). Spices—such as cardamom, saffron, cloves, anise seeds, turmeric, and mustard—or sweeteners are also added as flavorants. Gutka is available in sachets and tins. It is consumed by placing a pinch of the mixture in the mouth between the gum and cheek and gently sucking and chewing. The excess saliva produced by chewing may be swallowed or spit out.

Gutka is primarily consumed in the Indian subcontinent (India, Pakistan and Bangladesh). Betel quid without tobacco is widely used in Southeast Asian countries (Taiwan, Myanmar, Thailand, China, Papua New Guinea, and Guam). In the Indian subcontinent, nonperishable, commercially manufactured preparation of betel quid without tobacco is known as *pan masala,* and a freshly prepared betel quid (with or without tobacco) is known as *pan*.

Betel leaf is derived from betel vine while nuts from the betel palm are called as areca nuts. While there is clear evidence of carcinogenicity from tobacco, the risk of oral cancer is also increased in person who chew betel with or without tobacco.

Pan (with tobacco)

Also called as Betel Quid. It consists of 4 main ingredients; betel leaf, areca nut, slaked lime and catechu.

Areca nut contains certain powerful nitrosamines proven to be carcinogenic in animals; these nitrosamines may act as an adjunct to tobacco specific nitrosamines. Areca nut chewing is strongly implicated as an etiologic factor for submucous fibrosis. Areca nut use predispose to oral submucous fibrosis.

Pan Masala

It is a commercial prepration containing areca nut , slaked lime, catechu and condiments. Many contain tobacco. It comes in sachets and tins. Many ingredients are same as of pan. Advantage is that it is not perishable.

Mainpuri Tobacco

It is a mixture of tobacco, slaked lime, finely cut areca nut, camphor and cloves. Epidemiologic studies conducted in areas where it is consumed demonstrated a high prevalence of oral cancer.

Mawa

It is preparation containing thin shavings of areca nut, with addition of some tobacco and slaked lime. Some 5–6 gms areca nut shavings are placed on the cellophane to which about 0.3 gms of tobacco is added. A few drops of watery slaked lime are sprinkled over it and the contents are tied with a thread to into a ball. At the time of use, the packet is rubbed vigorously on the palm to homogenize the contents. The mixture is chewed until it becomes soft, after which it is transferred to mandibular groove.

Tobacco-lime [Khaini] Preparation

It is a mixture of sun-dried tobacco and slaked lime. The two ingredients are usually carried separately in different container. The two ingredients are mixed vigorously with thumb on the palm to make the mixture alkaline and then placed in mouth.

Maharashtra and Gujrat – placed in premolar region of mandibular groove.

Bihar and UP – held in lower labial groove, or in dorsum of tongue.

It is not chewed but retained and sucked from time to time till it becomes bland.

Snuff

It is finely powdered air cured and fire cured tobacco leaves. It may be used orally or nasally.

Some common forms of smokeless tobacco with their constituents used throughout the world are shown in Table 12.3.

Table 12.3: Some common forms of smokeless tobacco

Habit	*Ingredients*	*Population*
Pan/paan/betel quid	Areca nut, betel leaf/inflorescence, slaked lime, catechu, condiments, with or without tobacco	Indian subcontinent, Southeast Asia, Papua New Guinea, Part of South America
Khaini	Tobacco and lime	Bihar (India)
Mishri	Burned tobacco	Maharashtra (India)
Zarda	Boiled tobacco	India and Arab countries
Gadakhu	Tobacco and molasses	Central India
Mawa	Tobacco, lime and areca	Bhavnagar (India)
Nass	Tobacco, ash, cotton or sesame oil	Central Asia, Iran, Afghanistan, Pakistan
Naswar/niswar	Tobacco, lime, indigo, cardamom, oil, menthol, etc	Central Asia, Iran, Afghanistan, Pakistan
Shammah	Tobacco, ash and lime	Saudi Arabia
Toombak	Tobacco and sodium bicarbonate	Sudan

ALCOHOL

By 1988 International Agency for Research on Cancer accepted both tobacco smoking and alcohol consumption as independent risk factors for oral cancer. Combined effect of alcohol and tobacco is greater than the sum of the two effects independently.

MOUTHWASH USE

Mouthwashes with high alcohol content [25% or higher] may increase risk of oral cancer. It appears that the risk from alcohol in mouthwashes is similar, at least qualitatively to that of alcohol used for drinking. Risks generally increased in proportion to frequency and duration of mouthwash use, and were only apparent when the alcohol content of the mouthwash exceeded 25 percent. Although in terms of an attributable risk the contribution of mouthwash use to oral cancer remains small.

VITAMINS AND ESSENTIAL MINERALS

Vitamin A: Risk of oral cancer has been inversely associated with consumption of vitamin A, and also consumption of fruits and vegetables in many studies.
Vitamin C: There is a tenous association of vitamin 'C' with a protective effect against oral, pharyngeal and esophageal cancer.
Vitamin E: Vitamin E like β-carotene is anti-oxidant. Higher serum vitamin levels appear to be associated with decreased risk of oral cancer. Vitamin E use may have some protective effect against leukoplakia and carcinomas.

OCCUPATION

There is increased risk for oral cancer and pharyngeal cancer for workers exposed to formaldehyde. Carpet installers are at a high risk and textile workers at a low risk for oral cancer.

Outdoor workers like farmers, fishermen, foresters, and postal delivery workers are at risk of lip cancer from ultraviolet light in two venues: first, in countries at high latitudes with clean air through which UV penetrates easily, albeit for only part of the year, such as Finland, second, in countries closer to the equator with regular long hours of sunshine, such as rural Greece, where lip can account for 60 percent of oral cancers. Part of the urban/rural difference in incidence of head and neck cancer also relates to atmospheric pollution. Mean sulfur dioxide and smoke concentrations in the atmosphere are positively correlated with SCC of the larynx and, to a lesser extent, the pharynx. The importance of fossil fuel combustion at work, Asbestos, pesticide exposures, and mists from strong inorganic acids were shown to be associated with carcinoma. The risk of laryngeal cancer from acid mists in the steel industry is confirmed.

SUNLIGHT

There is higher incidence of lip cancer in outdoor and rural population than in office workers or urban population. This may be due to exposure to sunlight and UV radiation.

CHEMICAL AGENTS

Exposure to chemical agents like aromatic amines, Alfa toxins, polycyclic aromatic hydrocarbons, etc. is predisposing factor for oral cancer.

POTENTIALLY MALIGNANT LESIONS

Main potentially malignant lesion is:
- Leukoplakia
- Erythroplakia
- Erosive lichen planus
- Submucosal fibrosis.

Such lesion as leukoplakia and erythroplakia can precede the development of malignancies. However the rate of malignant transformation is very low 2–6 percent.

VIRAL INFECTION

Infection with viruses: There are several viruses that seem to increase the risk for oral cancer:

- **Human papillomaviruses (HPV)** are a diverse group of DNA-based viruses that infect the skin and mucous membranes within the human body. Studies suggested that infection with HPV 16 and 18 (sexually transmitted viruses) increase the risk for oral cavity cancer and oropharynx cancer.
- **Epstein-Barr virus** is a virus from the herpes family that causes an asymptomatic infection called infectious mononucleosis (a medical condition common among young adults and adolescents, characterized by fever, sore throat, muscle soreness, and fatigue, and sometimes, with a development of white patches on the tonsils or in the back of the throat). The connection between the Epstein-Barr virus and oral cancer is still investigated.
- **Herpes simplex viruses** cause a viral infection. The connection between this virus and oral cancer is still being investigated.

TRAUMA

Many human cases are described of an oral cancer at the site of chronic trauma arising from a broken tooth, a denture clasp, or an ill-fitting denture flange or excrescence. Studies indicate that denture wearing per se is not a risk factor, but that chronic ulceration from an unsatisfactory appliance may promote a neoplasm in the presence of other risk factors.

The Mechanisms of Tobacco Carcinogenesis

More than 300 carcinogens have been identified in tobacco smoke or in its water-soluble components that will leach into saliva. The major and most studied of these are the aromatic hydrocarbon benz-pyrene and the tobacco specific nitrosamines (TSNs), nitroso-nor–nicotine (NNN), nitrosopyrrollidine (NPYR), nitrosodimethylamine (NDMA), and 4-(methylnitrosamino)-1-(3-pyridyl)- 1-butanone (NNK).

It is known that the polycyclic aromatic hydrocarbons were the carcinogens present in tars, thus the interest in "low-tar" smoking materials. Benz-pyrene is a powerful carcinogen, with twenty to forty nanograms per cigarette.

Mainstream cigarette smoke can contain NNN and NNK. These are generated primarily during pyrolysis, but also endogenously from some smokeless tobacco. They act locally, on keratinocyte stem cells, and are absorbed and act in many other tissues in the body. They produce DNA adducts, principally methyl Guanine, which interfere with DNA replication. There is damage to all replicating cells, including those of the immune response.

PATHOGENESIS

The most common type of oral cancer is epidermoid carcinoma (squamous cell carcinoma). Epidermoid carcinoma originates in abnormal mucosa as either leukoplakia, erythroplakia or speckled leukoplakia. This disease most commonly begins in a leukoplakic lesion which can be smooth or rough, flat or elevated, ulcerated or intact. Leukoplakia is manifested histologically by a thickening of the mucosa.

When the thickened surface layer contains cells with retained nuclei it is termed hyperparakeratosis; if the thickened surface layer cells do not contain nuclei it is termed hyperorthokeratosis.

A thickened spinous layer is called acanthosis; a thickened basal layer, basilar hyperplasia. Actually, many leukoplakic lesions result from combinations of the various thickenings, for instance, hyperparakeratosis with acanthosis. These hyperplasic lesions of oral mucosa hyperparakeratosis, hyperorthokeratosis, acanthosis or combinations generally have a benign course for at least some phases of their biology.

The stage following hyperplasia in the pathogenesis of oral cancer is dysplasia (Fig. 12.6). This is evidenced histologically by cytological atypical cells and an alteration in the sequence of maturation and organization of the epithelium. It is not proven if the removal of the cause of dysplasia in the oral cavity will result in resolution of the disease; therefore, dysplastic areas are considered irreversible precancerous lesions. Carcinoma in situ, cancer confined to the surface epithelium, shows all of the histological criteria of cancer. However, this process has not spread beyond the boundaries of the surface epithelium. Therefore, invasion and metastasis are not present in carcinoma in situ. In other sites of the body (uterine cervix, for example), and perhaps the oral cavity, carcinoma in situ can persist for some time, even years, before progressing into invasive carcinoma. Epidermoid carcinoma can be of varying levels of differentiation which exhibit all the clinical and histologic features of cancer. The sequence in the development of carcinoma seems to be similar regardless of origin (leukoplakia, erythroplakia or speckled leukoplakia). This disease shows invasion and later metastasis. Metastases, which generally occur via the lymphatics of the neck (Fig. 12.7), produce fixed, indurated, matted swellings of the neck. These neck metastases can obtain considerable size, produce fistulation and cause marked discomfort. When the disease spreads beyond the neck, target organs are usually the lungs. Metastasis to the oral cavity from other sites of the body, generally from cancers of the breast, lung or prostate frequently present as a non-symptomatic radiolucency of the posterior aspect of the mandible often associated with the teeth. This radiolucency is irregular, with a "moth eaten" pattern. Although the patient is usually aware of his disease, cases of unsuspected cancers have been diagnosed as a result of periapical granulomas or atypical periodontitis submitted for histopathologic examination. The differential diagnosis of white lesions relies on an adequate history and

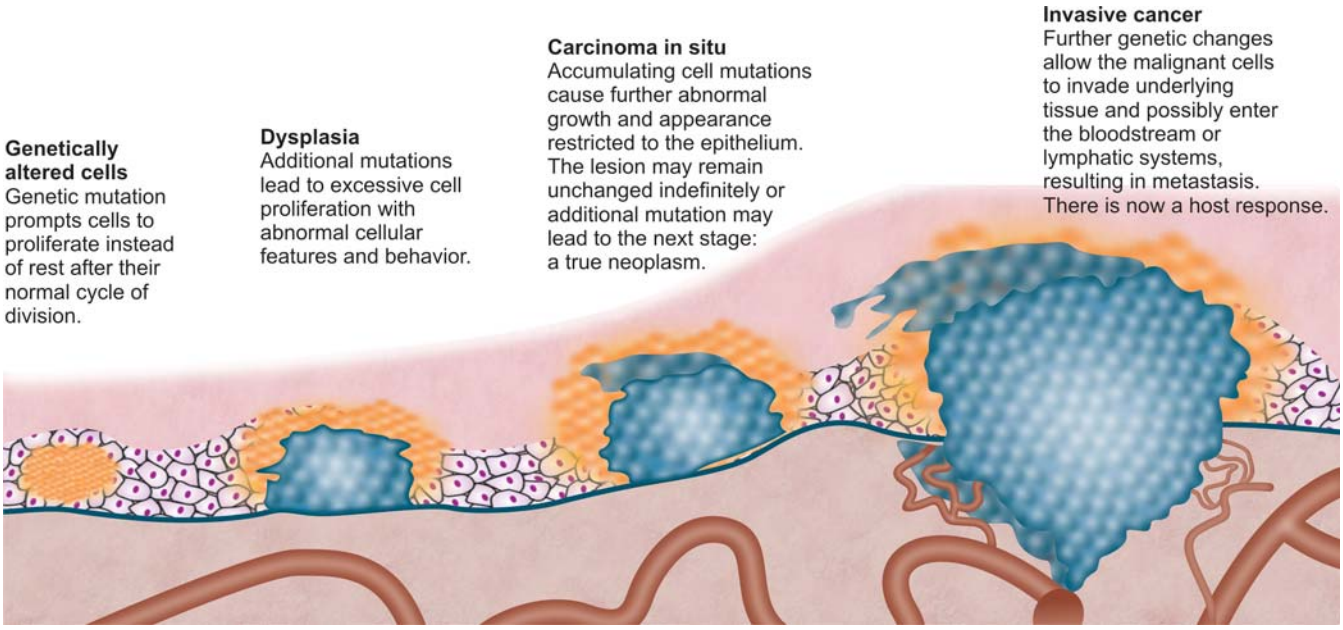


Fig. 12.6: The process of oral cancer

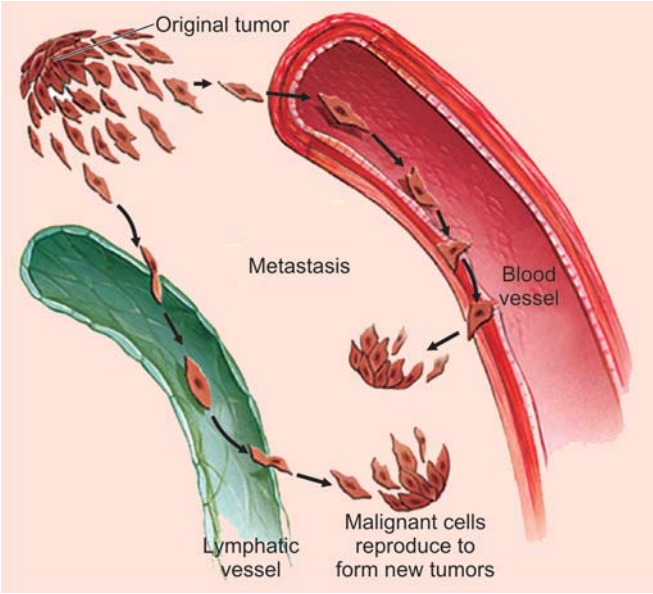


Fig. 12.7: Metastasis

thorough physical examination, as well as histopathological investigation.

PATHOLOGICAL TYPES

The predominant histopathologic type of cancer in the oral cavity is the squamous-cell carcinoma.

a. Squamous cell carcinoma and its variants including:
   - Basaloid squamous cell carcinoma
   - Verrucous carcinoma
   - Sarcomatoid carcinoma.

b. Adenocarcinoma.
c. Ameloblastoma.
d. Melanoma.
e. Lymphoma.
f. Kaposi's sarcoma.

1. Carcinoma of the Lip

This type of cancer chiefly occurs in elderly males. The lower lips are more commonly involved than the upper lip. The right and left sides are affected with equal frequency.

Etiology

- Tobacco mainly through pipe smoking
- Sunlight
- Poor oral hygiene
- Leukoplakia.

Clinical Features

The tumor usually begins on the vermilion border of the lip to one side of the midline. It commences as a small area of thickening, indurations and ulceration or irregularity of the surface. As the lesion becomes larger it creates a small crater like defect or produce an exophytic, proliferative growth of tumor tissue. It is generally slow to metastasize, and a massive lesion may develop before any evidence of regional lymph node involvement.

Treatment

- Small cancers (less than 2 cm) can be cured with surgery or irradiation in most of the cases
- Larger lesions can be treated with either surgery or irradiation. However, with surgery reconstruction with flap is often necessary
- Lesions larger than 4 cm, poorly differentiated lesions and tumors involving the comissures are best treated with radiation therapy.

2. Carcinoma of the Buccal Mucosa

Carcinoma of the buccal mucosa shows an exceptional variation in its incidence.

Etiology

- Chewing tobacco and betel nut
- Leukoplakia
- Chronic irritation as from cheek-biting or sharp tooth or dental prosthesis.

Clinical Features

The lesion develops most frequently along the line opposite the plane of occlusion or inferior to it. These types of carcinoma often appear as a painful ulcerative lesion with induration and infiltration into deeper tissues. Some cases, however, are superficial and appear to be growing outward from the surface rather than invading the tissues. The metastasis from buccal mucosa varies but is relatively high.

Treatment

- Small, superficial T1 lesions without involvement of commissure can be effectively treated by surgery
- For intermediate T2 lesions and for those involving the commissure, irradiation is preferred as it produces high cure rate with good results
- T3 and T4 lesions with deep muscular invasion are treated with radical surgery, reconstruction and postoperative irradiation.

3. Carcinoma of the Tongue

Tongue is the most frequent location for intraoral cancers after buccal mucosa.

Etiology

- Syphilis is known to have a correlation with carcinoma of the tongue
- Leukoplakia is often associated with carcinoma of the tongue
- Other factors include poor oral hygiene, chronic irritation and use of alcohol and tobacco.

Clinical Features

The lesion presents as a painless mass or ulcer, although in most patients the lesion ultimately becomes painful, especially when secondarily infected. The tumor may begin as a superficially indurating ulcer with slightly raised borders and may proceed either to develop a fungating, exophytic, mass or to infiltrate the deep layers of the tongue, producing fixation and indurations. The typical lesion develops on the lateral border or ventral surface of the tongue.

Treatment

- Small, well defined lesions involving the tip and anterolateral border of the tongue can be effectively cured by transoral surgical resection, although, surgery and irradiation is effective in controlling small cancers
- Small, posteriorly situated ill-defined lesions inaccessible for surgical excision can be treated by radiation therapy
- For moderately advanced, medium-sized T2 tumors involving the adjacent floor of the mouth, surgical treatment must include partial glossectomy, partial mandibulectomy, and radical neck dissection
- Advanced T3 and T4 lesions are best treated by combined irradiation and surgery.

4. Carcinoma of the Floor of the Mouth

Etiology

- Smoking especially pipe or cigar
- Other factors including alcohol, poor oral hygiene or dental irritation.

Clinical Features

The lesion is an indurated ulcer of varying size situated on one side of the midline. It may or may not be painful. It is more commonly seen in the anterior portion of mouth and can extend into the lingual mucosa of the mandible and into the mandible proper as well as into the tongue. The carcinoma may invade the deeper tissues and may even extend into submandibular and sublingual glands. Metastasis most commonly occurs in the submaxillary group of lymph nodes. Contralateral metastasis is often seen.

Treatment

- Small tumors can be cured by surgery or irradiation
- For extensive, infiltrative T3 and T4 lesion with marked involvement of the adjacent muscle of the tongue and mandible, radical surgery is the procedure of choice followed by plastic closure and postoperative irradiation.

5. Carcinoma of the Palate

Carcinoma of the palate is not a common carcinoma of the oral cavity.

Etiology

- Smoking especially pipe smoking.

Clinical Features

The lesion manifests as a poorly defined, ulcerated, painful lesion of the midline. It frequently crosses the midline, however, may extend laterally to include the lingual gingival or posteriorly to involve the tonsillar pillar or even the uvula. The tumor may invade into the bone or occasionally into the nasal cavity.

Treatment

- Both surgery and irradiation have been used in the treatment.

6. Carcinoma of the Gingiva

Carcinoma of gingival constitutes an important group of neoplasms.

Etiology

- Chronic irritation is seen to have a role in the development of carcinoma of gingiva.

Clinical Features

Mandibular gingiva is more commonly involved than the maxillary gingiva. It manifests initially as an area of ulceration which may be a purely erosive lesion or may exhibit an exophytic, granular or verrucous type of growth. It may or may not be painful. The tumor arises more commonly in edentulous areas. The fixed gingiva is more frequently involved primarily than the free gingiva. The tumor may invade into the surrounding bone. In the maxilla, gingival carcinoma often invades into the maxillary sinus, or it may extend onto the palate or into the tonsillar pillar. In the mandible, extension into the floor of the mouth or laterally into the cheek as well as deep into the bone is rather common. Metastasis is common with gingival carcinoma.

Treatment

- Small T1 exophytic lesions without bony involvement can be managed by external-beam therapy alone
- For advanced lesions associated with destruction of the mandible, with or without metastasis, radical surgery is preferred.

DIAGNOSTIC EVALUATION

In addition to a complete medical history and physical examination, diagnostic procedures for oral cancer may include the following:

- **Biopsy**—a procedure in which tissue samples are removed (with a needle or during surgery) from the body for examination under a microscope; to determine if cancer or other abnormal cells are present.
- **Computed tomography scan** (Also called a CT or CAT scan.)—a diagnostic imaging procedure that uses a combination of X-rays and computer technology to produce cross-sectional images (often called slices), both horizontally and vertically, of the body. A CT scan shows detailed images of any part of the body, including the bones, muscles, fat, and organs. CT scans are more detailed than general X-rays.
- **Ultrasound**—a diagnostic technique which uses high-frequency sound waves to create an image of the internal organs.
- **Magnetic resonance imaging** (MRI)—a diagnostic procedure that uses a combination of large magnets, radiofrequencies, and a computer to produce detailed images of organs and structures within the body.

Once a diagnosis is made, the cancer will be staged (to determine the extent of the disease) before a treatment plan is established.

Patients with oral cavity cancer should undergo a comprehensive history and physical examination. *Detailed examination* is particularly important for oral cavity tumors in that much can be learnt about cancers that afford opportunity for direct visual inspection and digital palpation. A *biopsy* of lesions in question should be obtained as well as a thorough dental assessment. *Computed tomography* (CT) scans, *panoramic radiographs, magnetic resonance imaging* (MRI), and other imaging studies may also be important for accurate staging of the tumor and in treatment planning. A detailed examination of the head and neck should be performed, with particular focus on oral cavity and oropharynx. This usually begins with a full inspection of the oral cavity, including thorough inspection of the teeth. Palpation of the oral cavity can help assess bony involvement, tongue fixation, and depth of involvement. Deviation or fixation of the tongue suggests involvement of extrinsic muscles of the tongue. Bimanual palpation can help assess the depth of tumor invasion into musculature of the tongue and floor of the mouth. A thorough palpation of the neck is important to assess regional nodal disease.

STAGING

TNM System

A clinical staging system called the TNM system allows the clinician to design treatment strategies, compare results, and

assess the likelihood of treatment success or determine the prognosis. Each letter in TNM has a specific meaning:

- T = the size of the primary tumor
- N = the status of the cervical lymph nodes
- M = the presence or absence cancer in sites other than the primary tumor (Metastasis).

Staging is defined through physical examination, diagnostic tests, and biopsies.

1. Codes Describing the Tumor (T)

Tis	Carcinoma in situ
T1	Tumor ≤ 2 cm in greatest dimension
T2	Tumor >2 cm in greatest dimension, but ≤4 cm
T3	Tumor >4 cm in greatest dimension
T4 (lip)	Tumor invades through cortical bone, inferior alveolar nerve, floor of mouth, or skin of face (i.e. chin or nose).
T4a [oral cavity (Table 12.4)]	Tumor invades adjacent structures (e.g. through cortical bone, into deep [extrinsic] muscles of the tongue, maxillary sinus, skin of face)
T4b	Tumor invades masticator space, pterygoid plates, or skull base and/or encases carotid artery

2. Codes Describing Nodal Involvement (N)

Nx	Regional lymph nodes cannot be assessed (Fig. 12.8)
N0	No regional lymph nodes
N1	Metastasis in a single ipsilateral lymph node ≤3 cm in greatest dimension
N2	Metastases in a single ipsilateral lymph node >3 cm, but <6 cm in greatest dimension; or in multiple lymph nodes none >6 cm in greatest dimension; or in bilateral or contralateral lymph nodes
N2a	Metastasis in a single ipsilateral lymph node >3 cm, but ≤6 cm in greatest dimension
N2b	Metastases in multiple lymph nodes none ≤6 cm in greatest dimension
N2c	Metastasis in bilateral or contralateral lymph nodes, none 6 cm in greatest dimension
N3	Metastasis in a lymph node >6 cm in greatest dimension.

3. Codes Describing Metastasis (M)

M0 No distant metastasis
M1 Distant metastasis

4. Stage Grouping—Classification

Stage 0	T1	N0	M0
Stage I	T1	N0	M0
Stage II	T2	N0	M0
Stage III	T3	N0	M0
	T1-3	N1	M0
Stage IVA	T4a	N0	M0
	T4a	N1	M0
	T1-4a	N2	M0
Stage IVB	Any T	N3	M0
	T4a	Any N	M0
Stage IVC	Any T	Any N	M1

Table 12.4: Symptoms of oral cancer

- White or red patches in the mouth
- A mouth sore that won't heal
- Unexplained bleeding in the mouth
- Loose teeth
- Problems or pain with swallowing
- A lump in the neck
- An earache

THE EXAM REVIEW

The examination is conducted with the patient seated. Any intraoral prostheses are removed before starting. The extraoral and perioral tissues are examined first, followed by the intraoral tissues.

I. EXTRAORAL EXAMINATION

Face (Fig. 12.9)

The extraoral assessment includes inspection of the face, head, and neck. The face, ears, and neck are observed, noting any asymmetry or changes on the skin such as crusts, fissuring, growths, and/or color change. The regional lymph node areas

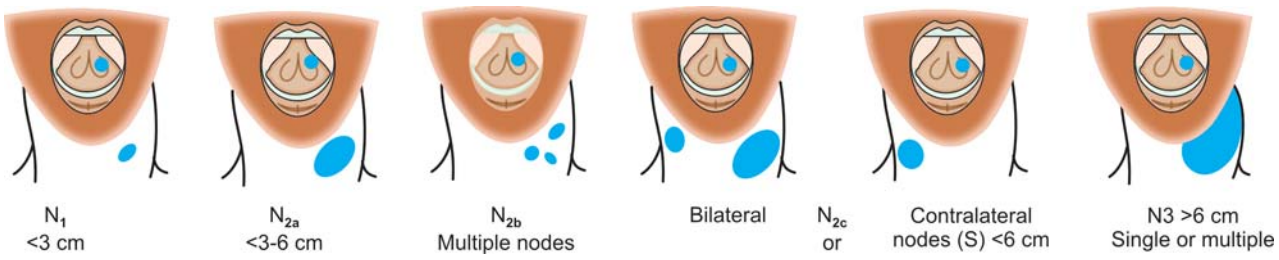


Fig. 12.8: Codes describing nodal involvment (N)



Fig. 12.9: Face



Fig. 12.10: Lips

are bilaterally palpated to detect any enlarged nodes. If enlargement is detected, the examiner should determine the mobility and consistency of the nodes. A recommended order of examination includes the preauricular, submandibular, anterior cervical, posterior auricular and posterior cervical regions.

II. PERIORAL AND INTRAORAL SOFT TISSUE EXAMINATION

The perioral and intraoral examination procedure follows a seven-steps systematic assessment of the lips; labial mucosa and sulcus; commissures, buccal mucosa, and sulcus; gingiva and alveolar ridge; tongue; floor of the mouth; and hard and soft palate.

Lips (Fig. 12.10)

Begin examination by observing the lips with the patient's mouth both closed and open. Note the color, texture and any surface abnormalities of the upper and lower vermilion borders.

Labial Mucosa (Figs 12.11 and 12.12)

It is done with the patient's mouth partially open. Visually examine the labial mucosa and sulcus of the maxillary vestibule and frenum and the mandibular vestibule. Observe the color, texture, and any swelling or other abnormalities of the vestibular mucosa and gingiva.

Buccal Mucosa (Figs 12.13 and 12.14)

Retract the buccal mucosa. Examine first the right then the left buccal mucosa extending from the labial commissure and back to the anterior tonsillar pillar. Note any change in pigmentation, color, texture, mobility, and other abnormalities of the mucosa, making sure that the commissures are examined carefully and are not covered by the retractors during the retraction of the cheek.



Fig. 12.11: Maxillary labial mucosa



Fig. 12.12: Mandibular vestibule and mucosa



Fig. 12.13: Right buccal mucosa examination



Fig. 12.14: Left buccal mucosa examination

Gingiva (Fig. 12.15)

First, examine the buccal and labial aspects of the gingiva and alveolar ridges (processes) by starting with the right maxillary posterior gingiva and alveolar ridge and then move around the arch to the left posterior area. Drop to the left mandibular posterior gingiva and alveolar ridge and move around the arch to the right posterior area.

Second, examine the palatal and lingual aspects as had been done on the facial side, from right to left on the palatal (maxilla) and left to right on the lingual (mandible).



Fig. 12.15: Examination of gingiva



Fig. 12.16: Tongue examination

Tongue (Fig. 12.16)

It is with the patient's tongue at rest, and mouth partially open, inspect the dorsum of the tongue for any swelling, ulceration, coating, or variation in size, color, or texture. Also note any change in the pattern of the papillae covering the surface of the tongue and examine the tip of the tongue. The patient should then protrude the tongue, and the examiner should note any abnormality of mobility or positioning.

Figure 12.17 with the aid of mouth mirrors, inspect the right and left lateral margins of the tongue. Grasping the tip of the tongue with a piece of gauze will assist full protrusion and will aid examination of the more posterior aspects of the tongue's lateral borders (Fig. 12.18).

Figure 12.19 then examines the ventral surface. Palpate the tongue to detect growth.



Fig. 12.17: Examination of lateral borders of tongue



Fig. 12.18: Tongue examination



Fig. 12.19: Tongue (Ventral surface) examination

Floor (Fig. 12.20)

It is done with the tongue still elevated. Inspect the floor of the mouth for changes in color, texture, swellings, or other surface abnormalities.

Palate (Fig. 12.21)

It is with the mouth wide open and the patient's head tilted back, gently depress the base of the tongue with a mouth mirror. First inspect the hard and then the soft palate.

Examine all soft palate and oropharyngeal tissues (Fig. 12.22).



Fig. 12.20: Inspection of the floor of the mouth



Fig. 12.21: Inspection of hard and soft palate



Fig. 12.22: Examination of oropharyngeal tissues



Fig. 12.23: Palpation

Bimanually palpate the floor of the mouth for any abnormalities (Fig. 12.23). All mucosal or facial tissues that seem to be abnormal should be palpated.

THE IMPORTANCE OF EARLY DETECTION

- Early detection saves lives
- With early detection and timely treatment, deaths from oral cancer could be dramatically reduced
- The five-year survival rate for those with localized disease at diagnosis is 81 percent compared with only 30 percent for those whose cancer has spread to other parts of the body
- Early detection of oral cancer is often quite possible. Tissue changes in the mouth that might signal the beginnings of cancer often can be seen and felt easily.

PREVENTION OF ORAL CANCER

Advise the patients to:

1. Eliminate tobacco use and smoking.
2. Avoid/reduce excessive alcohol consumption.
3. Ensure a healthy diet free from vitamin and nutritional deficiencies.
4. Eliminate specific habit such as betel nut chewing.
5. Avoid excessive exposure to sun.

Reduction in prevalence and extent of oral cancer may also be achieved by early detection of pre malignant and malignant lesions, by carrying out a thorough examination of mouth and regional lymph nodes.

The most common sites of cancer includes lower lip, lateral margins of tongue and the floor of the mouth. The 'coffin corner' at the posterior tongue/floor of the mouth is a common site for tumor which is often easily overlooked (Tables 12.5 and 12.6).

Table 12.5: Features of mucosal lesions

Mucosal lesions with following features need to be looked with suspicion
• Chronicity
• Granular appearance or raised exophytic margins
• Induration [firm infiltration beneath the mucosa]
• Presence of abnormal blood vessels
• Regional lymph node enlargement specially if hard.

Table 12.6: Clinical appearance of oral cancer

• Ulcer
• Red or white area
• A lump
• Fissuring
Suspicion lesions must be palpated for induration and fixation to deeper tissues.

LEVELS OF PREVENTION FOR ORAL CANCER (TABLE 12.7)

Primary Prevention

1. Avoid tobacco and alcohol use.
2. Avoid betel nut chewing.
3. Avoid smoking.
4. Avoid exposure to sun.
5. Ensure a healthy diet free from vitamin and nutritional deficiency.
6. Dentists may be able to influence politicians and communities to adopt relevant policies, but more importantly they can directly influence smokers to stop using tobacco, reduce alcohol consumption and improve their diet.

Table 12.7: Oral cancer: levels of prevention and intervention

Levels of prevention modes of intervention	***Primary***		***Secondary***	***Tertiary***	
	Health promotion	*Specific protection*	*Early diagnosis and prompt treatment*	*Disability limitation*	*Rehabilitation*
Services provided by the individual	Periodic visits to dental office; demand for preventive services	Avoidance of known irritants	Self-examination and referral; Use of dental services	Use of dental services	Use of dental services
Services provided by the community	Dental health education programs; Promotion of research Efforts; lobby efforts		Periodic screening and referral Provision of dental services	Provision of dental services	Provision of dental services
Services provided by the dental professional	Patient education	Removal of known irritants in oral cavity	Complete examination; biopsy; oral cytology; complete excision	Chemotherapy; radiation therapy; surgery	Maxillofacial and removable prosthesis plastic surgery; speech therapy; counseling

Secondary Prevention

Patients whose cancer is detected at an early stage generally have much longer survival times than those with late-stage disease.

- Screening of high risk groups
- *Biopsy:* any suspicious oral mucosal lesion including any non healing ulcer [more than two weeks] must be biopsied. Biopsy should be sufficiently large to include enough suspect and apparently normal tissues for correct diagnosis.

  An excisional biopsy should be avoided unless the lesion is very small as it will destroy for the surgeon or radiotherapist the clinical evidence of the site and character of lesion.
- *In vitro staining:* is advised where it is difficult to decide which is more appropriate area of biopsy, especially if there if there are widespread lesions. Staining with toludine blue followed by a rinse with 1 percent acetic acid and then saline may stain the most suspicious area and indicate those which need to be biopsied.

Tertiary Prevention

- Surgery, radiotherapy, and chemotherapy.
- In order to stop the recurrence and spread of oral cancers, dentists and other health specialists should work together to provide multi-disciplinary support for patients.
- Treated patients may still have dental needs which dentists should monitor to maintain life quality. There may be special needs as well.
- Prevention of caries by topical fluoride application, dietary advice.
- Management of a dry mouth, and prosthetic rehabilitation following surgery and radiation therapy.

Rehabilitation after Oral Cancer

Rehabilitation may vary from person-to-person depending on the type of oral cancer treatment, and the location and extent of the cancer. Rehabilitation may include:

- *Dietary counseling:* Many patients recovering from oral cancer surgery have difficulty eating, so it is often recommended that they eat small meals consisting of soft, moist foods.
- *Surgery:* Some patients may benefit from reconstructive or plastic surgery to restore the bones or tissues of the mouth, returning a more normal appearance.
- *Prosthesis:* If reconstructive or plastic surgery is not an option, patients may get benefit from dental or facial-part prosthesis to restore a more normal appearance. Special training may be needed to learn to use a prosthetic device.
- *Speech therapy:* If a patient experiences difficulty in speaking following oral cancer treatment, speech therapy may help the patient relearn the process.

KEY MESSAGES FOR ORAL CANCER PREVENTION

- Don't smoke
- Keep within recommended guidelines for alcohol consumption
- Cut out use of betel-quid and avoid tobacco use in the quid
- Don't sleep with the betel-quid in the mouth overnight
- Rinse your mouth thoroughly after using a quid.
- Discourage children and young adults from chewing betel quid/ areca/gutka/tobacco
- Eat plenty of fresh fruits and green-yellow vegetables

PUBLIC HEALTH APPROACHES TO PREVENTION OF ORAL CANCER

Build Healthy Public Policy

- Tighten restriction on tobacco and alcohol advertizing and promotion
- Subsidize the cost of healthier choices, e.g. fruits and vegetables.
- Improve labeling on betel quid products.

Create Supportive Environment

- Smoke free public spaces, e.g. cinemas
- Increase availability of fresh fruits and vegetables [in school canteen and tuck-shop].

Strengthen Community Action

- Promote establishment of local community-based smoking cessation support groups.
- Establish help lines which appeal to population groups with high rate of smoking.
- Support establishment of local food co-operatives selling cheap high quality fruit and vegetables.

Develop Personal Skills

- Expand personal and social education in schools-life skills; empowerment, refusal and negotiation skills, etc.
- Incorporate tobacco and alcohol control within health promoting schools.

Reorient Health Services

- Expand health professionals education and training in smoking cessation and alcohol control
- Increase numbers and range of health promotion professional, with expertize in smoking and alcohol support.
- Establish evidence-based smoking and alcohol preventive services with primary care setting.

TOBACCO/SMOKING CESSATION

The first step in treating tobacco use and dependence is to identify tobacco users.

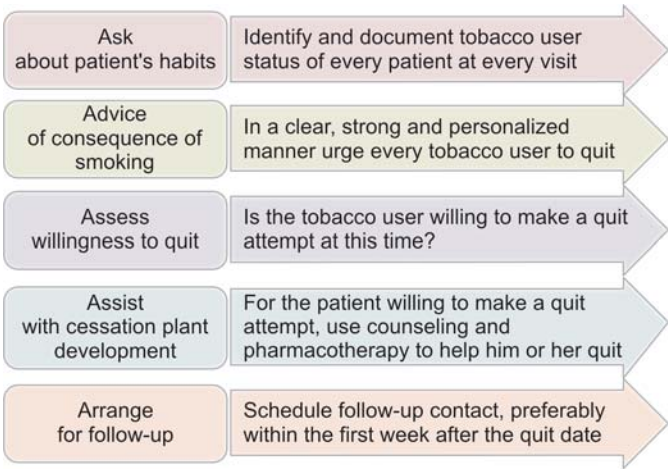
Screening for current or past tobacco use will result in four possible responses:

1. The patient uses tobacco and is now willing to make a quit attempt.
2. The patient uses tobacco but is not now willing to make a quit attempt.
3. The patient once used tobacco but has since quit.
4. The patient never regularly used tobacco.

FOR THE PATIENT WILLING TO QUIT

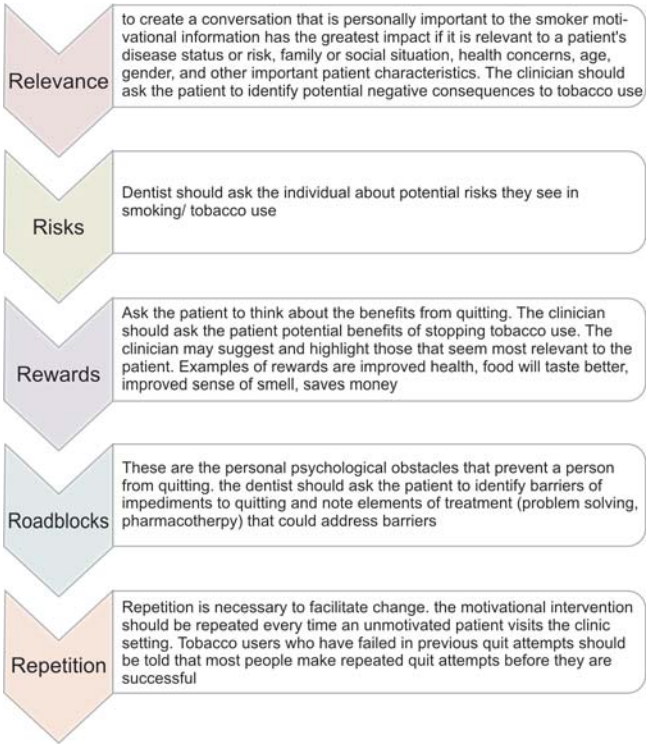
Given that so many tobacco users visit a dentist each year, it is important that these dentist be prepared to intervene with tobacco users who are willing to quit.

The five major steps (the "5 As") to intervention are [**The 5A approach**]:



FOR PATIENTS NOT WILLING TO QUIT

Patients unwilling to make a quit attempt during a visit may lack information about the harmful effects of tobacco, may lack



the required financial resources, may have fears or concerns about quitting, or may be demoralized because of previous relapse. Such patients may respond to a motivational intervention that provides the clinician an opportunity to educate, reassure, and motivate such as the motivational intervention built around the "5 Rs": *relevance*, *risks*, *rewards*, *roadblocks,* and *repetition*. Clinical components of the "5 Rs" are shown in brief strategy below. Motivational interventions are most likely to be successful when the clinician is *empathic*, *promotes patient autonomy* (e.g., choice among options), *avoids arguments*, and *supports the patient's self-efficacy* (e.g., by identifying previous successes in behavior change efforts).

What are the 5 Rs?

Once you have identified a tobacco user has been identified who does not want to quit, the PHS (Public Health Service, **U.S. Department of Health and Human Services**) Clinical Guidelines suggests using a strategy of the 5 Rs:

13 Epidemiology and Etiology of Malocclusion

Gurkeerat Singh

AN EPIDEMIOLOGICAL VIEW OF MALOCCLUSION

Since malocclusion affects a large segment of the population, it is considered to be a public health problem (Draker 1960). Before one can assess, the prevalence of a disease specific criteria must be established in order to quantify this prevalence.

A number of malocclusion indices have been introduced in the attempt to define the characteristic of this problem in the community. Some of these indices are used in broad epidemiological surveys reflecting important factors in the determination of orthodontic need and priority for treatment.

Fisk (1960) Described Malocclusion As:

The condition in which dental structure are not in acceptable equilibrium with each other or with the facial structures and/or the cranium, thus interfering with or posing a potential threat to the normal tissue development and maintenance, effective function or a psychological behavior problem.

According to a Federation Dentaire Internationale (FDI) commission, different types of malocclusion index should be available, depending on the purpose of the epidemiological survey in question. These could be categorized as **descriptive surveys**, which establish the geographical pathology of a disease in terms of the severity of the malocclusion, **administrative surveys**, which are designed to establish the priorities for treatment and **constructive surveys**, which are described as etiological and ecological studies of malocclusion.

Along the lines of these requirements, in 1966 Summers proposed a set of essentials for an acceptable malocclusion index:

It must be able to indicate and quantify the severity of the malocclusion with the necessary degree of accuracy. The numerical score obtained must be compatible with statistical assessment methods.

It must possess a validity which reflects its reproducibility and reliability.

The malocclusion index should reflect the basic orthodontic defects (including skeletal, dental, and neuromuscular anomalies, as well as combinations thereof), and not be subject to the symptoms of normal developmental changes.

The malocclusion index should be designed so as to be readily derivable from the data.

Orthodontic treatment is undertaken to improve dental esthetics, function and health. According to White and Gardiner, *malocclusion is a condition where there is a departure from the normal relation of teeth in the same arch and teeth in the opposing arch.* It is a deviation from normal and not a deviation from ideal.

Unless the deformity is gross, there have to be parameters based upon which the malocclusion should be classified. Thorough knowledge of classifications is essential for a student of community dentistry as they would be frequently referred to during communications between consultants and sometimes, certain identities within a subgroup will require similar treatment protocols.

CLASSIFICATION OF MALOCCLUSION

Classification of malocclusion is the description of dentofacial deviations according to a common characteristic, or norm.

Depending upon which part of the oral and maxillofacial unit is at fault, malocclusions can be broadly divided into three types:

- Individual tooth malpositions.
- Malrelationship of the dental arches or dentoalveolar segments.
- Skeletal malrelationships.

These three can exist individually in a patient or in combination involving each other, depending upon where the fault lies in the individual dental arch or the dentoalveolar segments or the underlying skeletal structure.

ANGLE'S CLASSIFICATION OF MALOCCLUSION

In 1899, Edward Angle classified malocclusion based on the mesialdistal relation of the teeth, dental arches and jaws. He considered the maxillary first permanent molar as a fixed anatomical point in the jaws and the key to occlusion. He based

his classification on the relationship of this tooth to other teeth in the mandibular jaw. More than 100 years have passed since Angle proposed his system of classification yet, it remains the most frequently used classification system. It is simple, easy to use and conveys precisely what it was conceived for, i.e. the relationship of the mandibular teeth with respect to the maxillary first permanent molar.

Angle classified malocclusion into three broad categories. It is presented in a form that is most accepted in the present times (Fig. 13.1).

The three categories are designated as "Classes" and are represented by Roman numerals-I, II and III.

Angle Classification

(A) Class I malocclusion. (B) Class II malocclusion. (C) Class III malocclusion.

The picture shows the position of the mesial cusp of the maxillary molar relative to the mandibular molar in each type of occlusion.

CLASS I-MALOCCLUSION (Fig. 13.2)

The mandibular dental arch is in normal mesiodistal relation to the maxillary arch, with the mesiobuccal cusp of the maxillary first molar occluding in the buccal groove of the mandibular first permanent molar and the mesiolingual cusp of the maxillary first permanent molar occludes with the occlusal fossa of the mandibular first permanent molar when the jaws are at rest and the teeth approximated in centric occlusion.

Class II-Malocclusion

Mandibular dental arch and body are in distal relation to the maxillary arch. The mesiobuccal cusp of the maxillary first permanent molar occludes in the space between the mesiobuccal cusp of the mandibular first permanent molar and the distal aspect of the mandibular second premolar. Also, the mesiolingual cusp of the maxillary first permanent molar occludes mesial to the mesiolingual cusp of the mandibular first permanent molar.

Angle divided the Class-II malocclusions into two divisions based on the labiolingual angulation of the maxillary incisors as:

Class II-Division 1 (Fig. 13.3)

Along with the molar relation which is typical of class II malocclusions, the maxillary incisor teeth is in labioversion.

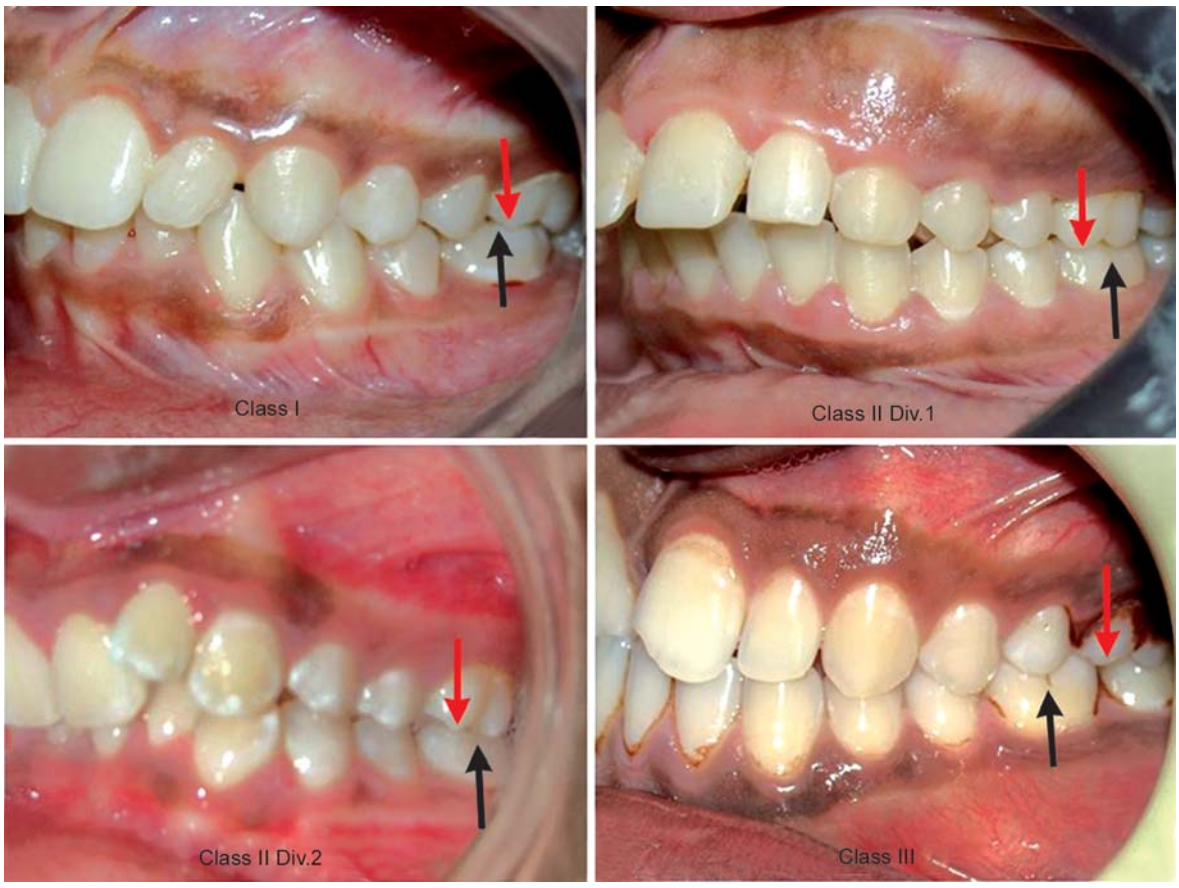


Fig. 13.1: Angle's classification



Fig. 13.2: Angle's class I malocclusion



Fig. 13.3: Angle's class II division 1



Fig. 13.4: Angle's class II division 2

Class II-Division 2 (Fig. 13.4)

Along with the typical Class II molar relationship, the maxillary incisors are near normal anteroposteriorly or slightly in linguoversion whereas the maxillary lateral incisors are tipped labially and/or mesially.

Class II-Subdivision (Fig. 13.5)

When the Class II molar relationship occurs on one side of the dental arch only, the malocclusion is referred to as a subdivision of its division.

Class III-Malocclusion (Fig. 13.6)

The mandibular dental arch and body is in mesial relationship to the maxillary arch with the mesiobuccal cusp of the maxillary first molar occluding in the interdental space between the distal aspect of the distal cusps of the mandibular first molar and the mesial aspect of the mesial cusps of the mandibular second molar.

Pseudo Class III-Malocclusion (Fig. 13.10)

This is not a true Class III malocclusion but the presentation is similar. Here the mandible shifts anteriorly in the glenoid fossa due to a premature contact of the teeth or some other reason when the jaws are brought together in centric occlusion.

Class III-Subdivision

It is said to exist when the malocclusion exists unilaterally.

Angle's classification was the first comprehensive classification of malocclusion. It is still the most widely accepted classification and is used routinely for day to day communication between clinicians. With its simplicity, it also had its inherent drawbacks (Table 13.1).



Fig. 13.5: Angle's class II subdivision (Class I molars on the left side)



Fig. 13.6: Angle's class III malocclusion



Fig. 13.7: Angle's class III malocclusion

DEWEY'S MODIFICATION OF ANGLE'S CLASSIFICATION OF MALOCCLUSION

Dewey in 1915 modified Angle's Class I and Class III by segregating malpositions of anterior and posterior segments as:

Modifications of Angles Class I

- *Type 1:* Angles Class I with crowded maxillary anterior teeth
- *Type 2:* Angles Class I with maxillary incisors in labio-version (proclined)
- *Type 3:* Angle's Class I with maxillary incisor teeth in linguoversion to mandibular incisor teeth (anteriors in cross bite)
- *Type 4:* Molars and/or premolars are in bucco or linguoversion, but incisors and canines are in normal alignment (posteriors in cross-bite)
- *Type 5:* Molars are in mesioversion due to early loss of teeth mesial to them (early loss of deciduous molars or second premolar).

Dewey's Modification of Angle's Class III

- *Type 1:* Individual arches when viewed individually are in normal alignment, but when in occlusion the anteriors are in edge to edge bite
- *Type 2:* The mandibular incisors are crowded and lingual to the maxillary incisors
- *Type 3:* Maxillary arch is underdeveloped, in cross bite with maxillary incisors crowded and the mandibular arch is well aligned.

BENNETTE'S CLASSIFICATION OF MALOCCLUSION

Bennette classified malocclusions based on their etiology as:

- *Class I:* Abnormal location of one or more teeth is due to local factors
- *Class II:* Abnormal formation of a part or a whole of either arch due to developmental defects of bone
- *Class III:* Abnormal relationship between the upper and lower arches and/or between both archs and the facial contour, due to developmental defects of bone.

Table 13.1: Drawback of Angle's classification

1. Angle presumed the first permanent molars as fixed points within the jaws, which definitely is not so.
2. Angle depended exclusively on the first molars. Hence, the classification is not possible if the first molars are missing or if applied in the deciduous dentition.
3. Malocclusions are considered only in the anteroposterior plane. Malocclusion in the transverse and vertical planes is not considered.
4. Individual tooth malocclusions have not been considered.
5. There is no differentiation between skeletal and dental malocclusions.
6. Etiology of the malocclusions has not been elaborated upon.

SKELETAL CLASSIFICATION

Salzmann is 1950 was the first to classify on occlusion based on the underlying skeletal structures.

Skeletal Class I

These malocclusions were purely dental with the bones of the face and jaws being in harmony with one another and with the rest of the head. The profile is orthognathic (Fig. 13.8A). The skeletal Class I was divided further according the dental malocclusion present as:

- *Division 1:* Local malrelations of incisors, canine and premolars
- *Division 2:* Maxillary incisor protrusion
- *Division 3:* Maxillary incisors in linguoversion
- *Division 4:* Bimaxillary protrusion.

Skeletal Class II

These included malocclusion with a subnormal distal mandibular development in relation to the maxilla.

The skeletal Class II was further divided into two divisions based on the features commonly seen with a mandible placed in retruded position.

- *Division 1:* The maxillary dental arch is narrower with crowding in the canine region, cross bite may be present and the vertical face height is decreased. The maxillary anterior teeth are protruded and the profile is retrognathic (Fig.13.8B).
- *Division 2:* The maxillary incisors are lingually inclined, the lateral incisors may be normal or in labioversion (Fig.13.8C).

Skeletal Class III

Here there is an over growth of the mandible with an obtuse mandibular plane angle. The profile is prognathic at the mandible (Fig. 13.8D).

ACKERMAN-PROFITT SYSTEM OF CLASSIFICATION

Ackerman and Profitt proposed a very comprehensive system of classification which divided malocclusions in all the three planes of space and tended to give an indication towards the severity of the malocclusion present. The system proposed by Ackerman-Profitt is based on the set theory, where a set is defined on the basis of morphological deviations from the ideal. The classification was illustrated using the Venn symbolic logic diagram (Fig.13.9A). The classification considered five characteristics, and their interrelationships were assessed. The five characteristics are as follows:

1. *Alignment:* Intra arch alignment and symmetry are assessed as when seen in the occlusal view. A dental arch is classified as ideal/crowded/spaced.
2. *Profile:* The profile can be convex/straight/concave. This also includes the assessment of facial divergence, i.e. anterior or posterior divergence.
3. *Transverse relationships:* These include the transverse skeletal and dental relationships. Buccal and palatal cross bites are noted. These are further subclassified as unilateral or bilateral. Distinction is made between skeletal and dental cross bites.
4. *Class:* Here the sagittal relationship of the teeth is assessed using the Angle classification as Class I/Class II/Class III. A distinction is made between skeletal and dental malocclusions.
5. *Overbite:* Malocclusions are assessed in the vertical plane. They are described as anterior open bite/posterior open bite/anterior deep bite/posterior collapsed bite. Here again a distinction is made as to whether the malocclusion is skeletal or dental.

Characteristic 1 is represented as a square which contains a larger circle representing the profile or characteristic 2. This contains three smaller circles overlapping each other partially, representing the transverse, sagittal and vertical deviations respectively. The confluence of these sets form nine groups, each a combination of certain characteristics. The ninth group represents the most complex malocclusion with all possible features (Fig 13.9B).

INCISOR CLASSIFICATION

The incisor classification is considered simpler and more relevant than Angle's classification. It was adopted by the British Standards Institute in 1983, and is based upon the relationship of the lower incisor edges and the cingulum plateau of the maxillary central incisors.

Class I

The mandibular incisor edges occlude with or lie immediately below the cingulum plateau of the maxillary central incisors (Fig.13.10A).

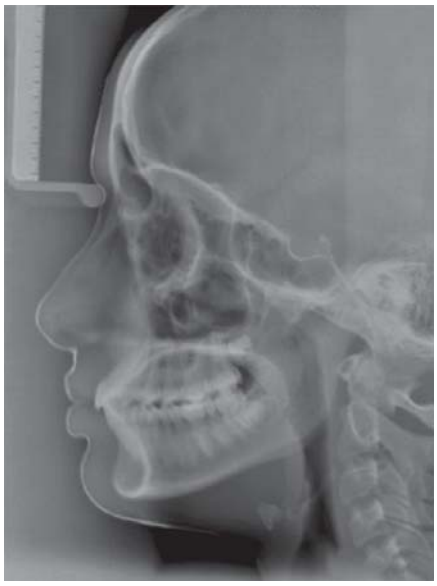


Fig. 13.8A: Skeletal pattern I



Fig. 13.8C: Skeletal Class II division 2

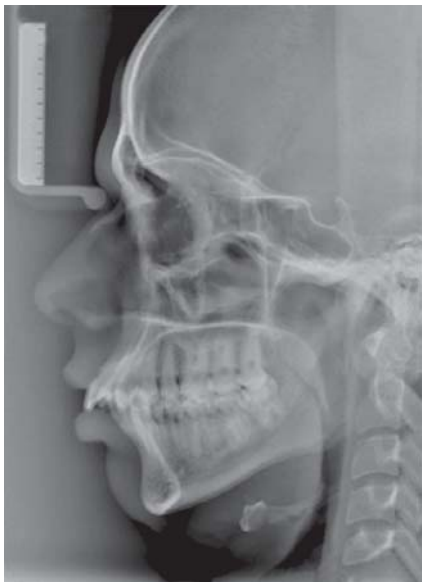


Fig. 13.8B: Skeletal Class II division 1



Fig. 13.8D: Skeletal Class III

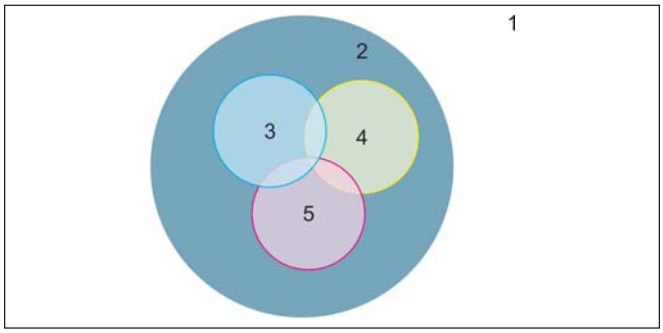


Fig. 13.9A: Venn diagram representing the 5 characters

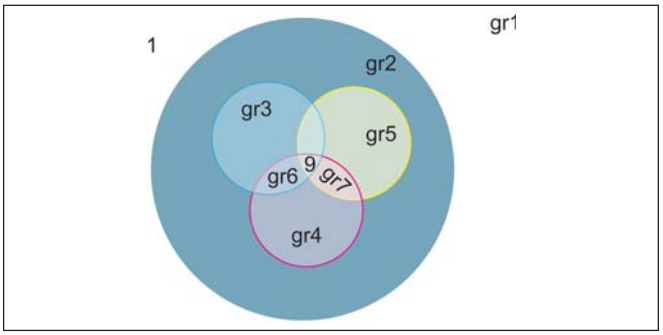


Fig. 13.9B: The 9 groups formed using the Venn diagram model

Class II

The mandibular incisor edges lie posterior to the cingulum plateau of the maxillary central incisors

- *Division 1:* The maxillary central incisors are proclined or of average inclination and there is an increased overjet (Fig. 13.10B)
- *Division 2:* The maxillary central incisors are retroclined; the overjet is normally minimum, but may be increased (Fig. 13.10C).

Class III

The mandibular incisor edges lie anterior to the cingulum plateau of the upper central incisors, the overjet is reduced or reversed (Fig. 13.10D).

All the relevant classifications have been discussed. The Ackerman and Profitt classification conveys the maximum information regarding the characteristics of a malocclusion, yet it is not frequently used. The incisor classification is the simplest to use, yet not the most frequently used. Angle's classifications with all its shortcomings, is still by far the most commonly used classification of malocclusion.

PREVALENCE OF MALOCCLUSION

The aim of epidemiologic studies of malocclusion is to describe and analyze the prevalence and distribution of malocclusion in various populations, the ultimate goal being to identify etiologic factors. A further aim is to contribute to the solution of the public health problems concerning assessment of need for orthodontic treatment and organization of orthodontic services. At an early point, it was realized that due to the complexity of malocclusion, epidemiologic studies had to be based on some kind of classification. Angle's classification is the only one among several typologic classifications which has gained wide ground in the epidemiology of malocclusion. Occasionally, it has been emphasized that Angle's classification is not sufficiently differentiated for epidemiologic purposes, and it has also been pointed out that the individual morphologic

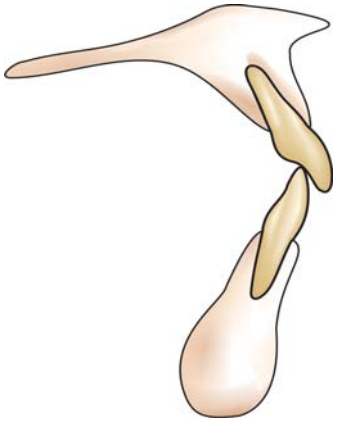


Fig.13.10A

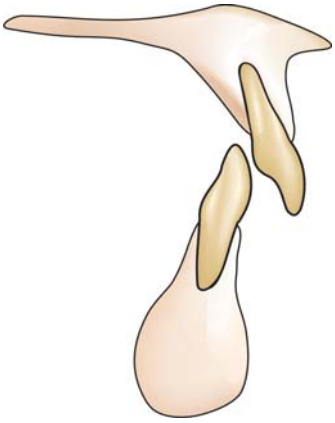


Fig.13.10C

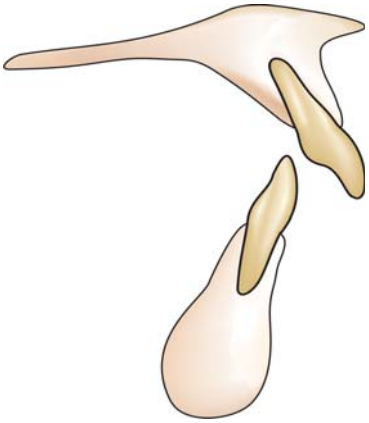


Fig.13.10B

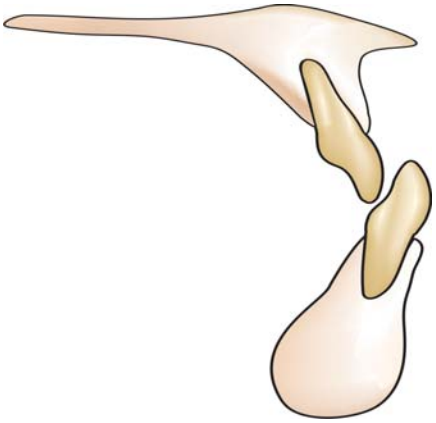


Fig.13.10D

Figs 13.10A to D: Incisor classification

traits of Angle's classes are not all adequately defined. The current major public health problem in this field is to bridge the gap between recognition of the occurrence of the defined single traits or combinations of traits, and determination of the need for treatment of these conditions.

Different surveys have reported data on the prevalence of different types of malocclusion. Most of the studies have been carried out in Europe and North America and a few in Asia. Most of these studies differ in their examination criteria, sampling techniques, age, sex, and availability of radiographs/study casts and examiner accuracy leading to difficulty in direct comparisons. A brief summary of these surveys is presented in Tables 13.2 and 13.3.

None of these studies are complete by themselves and only provide us a list of the prevalence of mal-occlusion prevalent in the studied population at the time the study was conducted.

Table 13.2: Prevalence of malocclusion studies in India

S. No.	*Authors and yeat of study*	*Size and City (State)*	*Age Group*		*Malocculusion %*
1.	Shourie (1952)	1057 (Punjab)	13-16 years	Class I	21.7
				Class II	27.2
				Class III	0.5
2.	Sheikh HS (1960)	500 Orthod patients (Mumbai)	6-13 years	Class I	68.0
				Class II	31.2
				Class III	0.8
3.	Miglani DC, Sharma OD (1963)	1158 (Punjab)	15-25 years	Malocclusion	19.6
4.	Shaikh HS (1966)	400 Orthod patients (Mumbai)	7-21 years	Class I	72.98
				Class II	25.75
				Class III	1.27
5.	Sidhu SS (1966-67)	500 dental patients (Delhi)	6-30 years	Malocclusion	90.00
				Class I	74.66
				Class II	18.65
				Class III	3.10
6.	Jacob TT (Mathew CT (1969)	1001 (Trivandrum)	12-15 years	Malocclusion	49.2
				Class I	45.0
				Class II	4.9
				Class III	0.3
7.	Prasad A Rajendra Savadi Shrivaratna (1971)	1033 (Bangalore)	5-15 years	Malocclusion	51.5
				Girls: 60%	95.0
				Boys: 40%	4.0
				Class I	0.9
				Class II	22.0
				Class III crowding	
8.	Nagaraja Rao G Venkateswarain M, Bhat KS, Subramanyam MV (1980)	511 (Udipi)	5-15 years	Class I	23.0
				Class II	4.5
				Class III	1.3
9.	John VT, Sidhu SS Kharbanda OP (1993)	1085 Adivasi children (Mandav MT)	6-14 years	Malocclusion	14.4
				Class II	3.8
				Overjet	0.4
				Overbits	0.3
				Crowd Max	6.4
				Crowd Mand	7.8
10.	Gardiner JH and Valiathan A (1990)	500 (South Kanra)	10-12 years	Class II	14
11.	Kharbanda OP, Sidhu SS Sundaram KR Shukhla DK (1991)	2817 (Delhi)	5-9 years	Malocclusion	20.3
				Class I	11.7
				Class II	6.0
				Class III	2.6
				Crowd Max crowd	4.2
				Mand. crowd	11.7
				Overjet	3.1
				Overbits	3.5

Contd…

Contd…

S. No.	Authors and yeat of study	Size and City (State)	Age Group		Malocculusion %
12.	Kharbanda OP, Sidhu SS Sundaram KR, Shukla DK (1995)	2737 (Delhi)	10-13 years	Malocclusion	45.7
				Class I	27.7
				Class II	14.6
				Class III	3.4
				Crowd Max	9.5
				Mand. crowd	18.0
				Overjet	11.5
				Overbits	12.3
13.	Alka A Singh, B Singh Kharbanda OP, Shukla DK Goswami K, Gupta S (1995)	1019 (Rural Haryana)	12-16 years	Malocclusion	55.3
				Class I	43.6
				Class II	9.8
				Class III	0.6
				Bimaxillary protrusion	0.5
				Crowd max	5.4
				Mand. crowd	16.1
				Overjet	3.5
				Overbits	12.9

Man = Maxilla, Mand =Mandibular, Ant = Anterior

Table 13.3: Prevalence of malocclusion

Country/city	Year	Prevalence	Type of malocclusion (%)
Mumbai (India)	1942	50%	
Denmark	1968	31%	
United States	1977	46%	
			Whites-Class I-52%
			Blacks-Class I-62%
			Whites-Class II-34%
			Blacks-Class II-18%
			Blacks-Class III-14%
Johannesburg (South Africa)	1981	08%	Class II
Saudi Arabia	1990	16.4%	
Kenya	1993	11%	
India	1998	29.2%	
Lebanon	1999	59.5%	
Jordan	2005	92%	
Kuwait	2005	86.3%	
Tanzania	2006	97.6%	
Lithuania	2009	84.6%	

The prevalence of a problem in the study population causes us to wonder why these problems occur i.e. etiology.

Risk Factors of Malocclusion

Physical

- Congenital absence of teeth
- Premature loss of a tooth
- Mouthbreathing
- Variations in development (e.g. tooth eruption delays and malpositioned teeth)
- Muscular imbalances
- Familial tendency for malocclusion
- Conditions associated with malocclusion (e.g. cleft lip/palate).

Behavioral: Nonnutritive sucking habits, especially after permanent teeth erupt

Disease or Treatment Related

- Birth Injury
- Facial injury
- Acquired problem from systemic condition or its therapy
- Loss of space due to caries
- Musculoskeletal conditions (e.g. cerebral palsy)

- Skeletal growth disorders (e.g. renal disease)
- Failure to wear maintenance devices once malocclusion is corrected.

ETIOLOGY OF MALOCCLUSION

Graber's Classification (Table 13.4)

Graber's classification is one of the easiest to understand and remember as it associates the malocclusion with the etiologic factor. Graber divided the etiologic factors as:

- General or
- Local factors.

General Factors

1. *Heredity:* Child inherits genes from both the parents, with dissimilar genetic material therefore, inheriting of conflicting traits results in anomalies of dentofacial complex. Racial, ethnic and regional intermixture is also a reason for malocclusion.
2. *Congenital:* Congenital defects or developmental defects are malformations seen at the time of birth. Such defects may be caused by a variety of factors including genetic, radiological, chemical, endocrine, infections and mechanical factors. Various congenital defects producing malocclusion include:
   - Cleft lip and palate
   - Cerebral palsy
   - Torticollis
   - Cleidocranial dysostosis
   - Congenital syphilis.
3. *Environment:*
   - Prenatal (trauma, material diet, German measles, material maternal metabolism, etc)
   - Postnatal (birth injury, cerebral palsy, TMJ injury).
4. *Predisposing metabolic climate and disease:*
   - Endocrine imbalance
   - Metabolic disturbances
   - Infectious diseases.
5. *Dietary problems (nutritional deficiency)*
6. *Abnormal pressure habits and functional aberrations:*
   - Abnormal sucking
   - Thumb and finger sucking
   - Tongue thrust and tongue sucking
   - Lip and nail biting
   - Abnormal swallowing habits (improper deglutition).
7. *Posture:* Although not substantiated, posture related malocclusions may be associated with abnormal pressure and muscle imbalance thereby increasing the risk of malocclusion. Children who support their head by resting the chin on their hand or those who hang their head so that the chin rests against the chest have been observed to have mandibular deficiency.
8. *Trauma and accidents:* Children are prone to injuries of the dentofacial region during the early years of life when they learn to crawl, walk and play. Such injuries may go unnoticed and be responsible for non-vitality of teeth; such teeth may not resorb and may deflect erupting permanent teeth into abnormal positions.

Local Factors

1. *Anomalies of Number:*

Supernumerary teeth: Can vary remarkably in size, shape and location. They may closely resemble the teeth of the group to which they belong, i.e. incisors, premolars or molars etc. or they may bear little resemblance to the adjacent teeth. Supernumerary teeth, which bear a close resemblance to a particular group of teeth and erupt close to the original sight of these teeth, are called supplemental teeth. "Mesiodens" is the most commonly seen supernumerary teeth and is usually situated between the maxillary central incisors and can vary considerably in shape.

Missing teeth (congenital absence or loss due to accidents, caries, etc.): The term used to describe one or more congenitally missing teeth is true partial anodontia or hypodontia or oligodontia. The most commonly congenially missing teeth are the third molars, followed by the maxillary lateral incisors.

2. *Anomalies of tooth size:*
   - Microdontia and
   - Macrodontia
   - True generalized macrodontia, where all the teeth are larger than normal aid is seen in cases of pituitary gigantism
   - Relative generalized microdontia may be seen, but is an illusion of the true condition.
3. *Anomalies of tooth shape:*
   These include:
   - True fusion
   - Germination
   - Concrescence, Talon cusp
   - Dens in dente
   - Dilaceration
   - Supernumerary roots.
4. *Abnormal labial frenum:* Mucosal barriers. Fibers which persist between the central incisors are capable of preventing the two contralateral central incisors from coming into close approximation.
   - Blanche test:

   Step 1: The lip is pulled superiorly and anteriorly.

   Step 2: Any blanching in the interdental region is indicative of the fibers of the frenum crossing the alveolar ridge.

   Step 3: The blanch test can be collaborated with an IOPA of the region which shows a slight radiolucent wedging/notching in the interdental alveolar ridge region.
5. *Premature loss:* The premature loss of a deciduous tooth can lead to malocclusion only if the Succedaneous tooth is not sufficiently close to the point of eruption. This can lead to a decrease in the overall arch length as the posterior teeth

Table 13.4: Graber's classification of malocclusion

General Factors

1. Heredity.
2. Congenital.
3. Environment:
   a. Pre-natal (trauma, material diet, German measles, material maternal metabolism, etc.).
   b. Postnatal (birth injury, cerebral palsy, TMJ injury)
4. Pre-disposing metabolic climate and disease:
   a. Endocrine imbalance.
   b. Metabolic disturbances.
   c. Infectious diseases.
5. Dietary problems (nutritional deficiency)
6. Abnormal pressure habits and functional aberrations:
   a. Abnormal sucking.
   b. Thumb and finger sucking.
   c. Tongue thrust and tongue sucking.
   d. Lip and nail biting.
   e. Abnormal swallowing habits (improper deglutition).
   f. Speech defects.
   g. Respiratory abnormalities (mouth breathing etc.).
   h. Tonsils and adenoids.
   i. Psychogenic tics and bruxism.
7. Posture.
8. Trauma and accidents.

Local Factors

1. Anomalies of number: Supernumerary teeth, Missing teeth (congenital absence or loss due to accidents, caries, etc.).
2. Anomalies of tooth size.
3. Anomalies of tooth shape.
4. Abnormal labial frenum: mucosal barriers.
5. Premature loss.
6. Prolonged retention.
7. Delayed eruption of permanent teeth.
8. Abnormal eruptive path.
9. Ankylosis.
10. Dental caries.
11. Improper dental restorations.

have a tendency to migrate mesially. This might cause the permanent successor to erupt malpositioned or get impacted or cause a shift in the midline (in case of anterior teeth).

6. *Prolonged retention of deciduous teeth*: It may cause: (i) Buccal/labial or palatal/lingual deflection in its path of eruption or permanent incisor due to the retained deciduous incisor in its path of eruption. (ii) Impaction of the permanent tooth.
7. *Delayed eruption of permanent teeth:* Nature has provided for a particular sequence for the eruption of individual teeth in each arch. If one of the teeth does not occupy its designated place in this sequence there is a likelihood of migration of other teeth into the available space. As a result, the tooth whose eruption has been delayed might get displaced or impacted.
8. *Abnormal eruptive path:* Generally each tooth travels on a distinct path, since its inception to the location at which it erupts. It can deviate from this eruption path because of many reasons:
   - Tooth bud facing and/or placed or displaced from its ideal location.
   - Presence of a supernumerary tooth may divert a tooth from its eruptive path.
   - Presence of odontomes or a cyst or tremor may divert it, if not altogether prevent its eruption.
   - Unresorbed or retained deciduous teeth might force a tooth to erupt along a path of least resistance rather than in place of the deciduous tooth.
   - Retained root fragments (especially of deciduous molars) may deflect an erupting permanent tooth.
   - A true arch length deficiencies or excess of tooth material may cause one or more teeth to deviate from their eruptive path.
   - Palatal clefts.
9. *Ankylosis:* Ankylosis is a condition which involves the union of the root or part of a root directly to the bone, i.e. without the intervening periodontal membrane. Ankylosis or partial ankylosis is encountered relatively frequently during the mixed dentition stage. Occurs as a result of trauma to the tooth which perforates the periodontal membrane. Ankylosis is also associated with certain

infections, endocrinal disorders and congenital disorder such as cleidocranial dysostosis.

10. *Dental caries:* Proximal caries are especially to blame for the reduction in arch length. Caries can also lead to the premature loss of deciduous or permanent teeth. This might be brought about by migration of adjacent teeth and/or tilting of adjacent teeth into the space available and/or supra-eruption of the teeth in the opposing arch.
11. *Improper dental restorations:* Premature contacts on over contoured occlusal restoration can cause a functional shift of the mandible during jaw closure. Under contoured occlusal restorations can lead to the supraeruption of the opposing dentition.

UNTREATED MALOCCLUSIONS

Untreated malocclusions can cause the following:

- Further derangement in the arrangement of teeth
- Lips, tongue, or cheeks that contact biting surfaces due to poor tooth alignment might cause frequent abrasions or cuts
- Inefficient or uncomfortable biting, chewing, and digestion
- Speech impairments
- Crowded teeth are hard to clean, leading to cavities and gum disease
- Abnormal wear of tooth surfaces might lead to sensitivity or chipping
- Loosening, chipping or fracturing of a malaligned tooth that is overstrained
- Premature loss of teeth
- Injury to a protruding upper incisor
- Thinning of bone and receding gums associated with roots of very crowded or protruded teeth
- Accelerated gum disease and bone loss specially in crowded dentitions
- Temporomandibular joint (TMJ) dysfunction
- Adverse effects on facial development and appearance
- Psychological complexes
- Need for surgery.

14 Dental Health Education

CM Marya

All the national oral health strategies published in recent years have stressed the important role dental professional's play in promoting oral health through health education. It is therefore important that dental health professionals understand the principles of health education and the most effective ways of delivering it within clinical settings. It is very important that the health education messages given to the public are consistent and scientifically correct. Education involves the transfer of knowledge and skills from the educator to the student or learner.

DEFINITION

Health education is defined as any educational activity which aims to achieve a health related goal.

Various definitions have been given for health education:

Brown [1994] defines health education as *'The process of assisting individuals, acting separately or collectively, to make informed decisions about matters affecting their personal health and that of others'*.

The most accepted definition by National Conference on preventive medicine (1977) is '*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.*'

According to above definition the three main objectives of health education are (Box 14.1):

1. *Informing people*: The primary objective is to inform people or provide them with the scientific knowledge about the prevention of disease and promotion of health. This creates an awareness of health needs and helps people to do away with the misconceptions and ignorance they may have about health and disease.
2. *Motivating people*: People must be motivated to change their habits and ways of living as many current health problems are directly related with them for example drug addiction, cigarette smoking, pollution of water, sedentary lifestyles, etc.
3. *Guiding into action*: The people should be encouraged to use judiciously and wisely the health services available to them. They may need help to adopt and maintain healthy lifestyles and practices which may be new to them.

WHO defines it as *"Any combination of learning opportunities and teaching activities designed to facilitate voluntary adaptations of behavior that are conducive to health"*.

BOX 14.1: PRIMARY OBJECTIVE OF HEALTH EDUCATION

According to WHO, the primary objectives of the health education are:

To persuade people

1. To adopt and sustain healthy life practices.
2. To use judiciously and wisely health services available to them.
3. To take their own decisions both individually and collectively to improve their health status and environment.

There are three main domains of learning:

1. *Cognitive:* Understanding factual knowledge (for example, knowledge that tobacco chewing is linked to development of oral cancer).
2. *Affective:* Feelings, emotions and beliefs associated with health (belief that milk teeth are not important).
3. *Behavioral:* Skills development (for example, skills required for effective brushing and flossing of teeth).

CONTENTS OF HEALTH EDUCATION

Human Biology

Most of the teaching regarding human biology is included in school curriculum, like teaching of body parts, their structures and functions. Physical fitness and advantages of exercise, hygiene and good diet, rest and sleep are also taught. The bad effects of alcohol and smoking are also included.

Nutrition

The aim of educating the people about nutrition is to inform them about the importance of optimum and balanced diet, motivate them to make the best use of available resources and preference for the nutritious food and necessarily the most

expensive foods. Education is also given about the preparation, serving and storage of food. The eighth WHO expert committee on nutrition has stated that '*education in nutrition is a major strategic method for the prevention of malnutrition*'. In the global campaign of health for all, promotion of proper nutrition is one of the eight elements of primary health care.

Hygiene

Health education includes the importance of hygiene and its maintenance. It has two aspects:

a. *Personal hygiene:* Education is given to promote hygiene on an individual basis like bathing, clothing, washing hands, care of teeth, nails, coughing, sneezing etc. It should begin at a very early age.
b. *Environmental hygiene:* It further has two aspects; *domestic hygiene* which includes general hygiene at home, use of soap, light and ventilation, hygienic disposal of waste etc. *Community hygiene* includes hygiene of the surrounding, e.g. proper collection and disposal of garbage, proper drainage and avoidance of stagnation of water to check water-borne diseases.

Family Health Care

The aim of health education is to strengthen and improve the quality of life of the whole family. Focus is not on an individual but the family as a whole. Focus of attention is now a days on mother and child health care, family planning, immunization, nutrition, population dynamics and other related activities.

Control of Communicable and Non-Communicable Diseases

Education regarding nature of disease is given. Diseases like leprosy, tuberculosis, malnutrition, alcoholism, drug addiction, dental diseases, etc. are a few of the ones which need health education activities. People are educated to prevent the occurrence of such diseases and are also encouraged to participate actively in programs directed towards disease control, health protection and promotion.

Mental Health

The changing society brought with it certain new types of chronic diseases. The present day life style and culture has shown an increase in diseases related to mental health like depression, neurosis, etc. The aim of education in mental health is to keep people healthy mentally and to prevent mental breakdown.

Prevention of Accidents

Modernization is a major factor for increase in accidents, which may take place on road, work place or even at home. Health education should be directed towards safety measures in their respective workplace like factories, mines, roads and safe environment should be provided.

Use of Health Services

Individuals should be educated about the health services that are available. They should be motivated to avail those services and actively participate in national health program for prevention of disease and health promotion.

PRINCIPLES OF HEALTH EDUCATION

The content and methodology of health education are derived from the field of medicine and public health and from the physical, biological, social and behavioral sciences. Behavior is learned by individuals and merely transmitted by one person to another. Learning and teaching is a two way process of transaction between the teacher and student. For teaching to be truly effective, the educator must assess each learner and prescribe activities that are compatible with that of learner's lifestyle.

There are TEN principles of health education based on the principles of learning:

1. Interest
2. Participation
3. Comprehension
4. Known to unknown
5. Reinforcement
6. Learning by doing
7. Motivation
8. Good human relations
9. Soil, seed and sower
10. Social leaders

Interest

Health education should be related to the interest of the people. People usually listen to and pay heed to information that they are really interested in knowing. Health programs should be based on 'felt needs' of the people, i.e. needs the people feel about themselves. If the program is based on their need, they accept it whole heartedly and make the program a success. It is only then, that the purpose of health education program is fulfilled or achieved.

Participation

People should be motivated to be a part of the health education program. If they participate actively, they will accept the program and will also encourage the others to do so. Group discussion, workshops, panel discussion are methods of active learning.

Comprehension

It means capacity of understanding. An educator needs to know the level of understanding and education of the people towards

whom the program is to be directed. The educator must try to educate in local language as much as possible or use language which people understand. Scientific or strange words which are difficult to understand must be avoided.

Known to Unknown

A health educator must try to find out the existing level of knowledge of the people and based upon that he should plan his education program. He should start from what they know and gradually proceed further and provide them with new information. This is a slow process.

Reinforcement

Remembering and learning new things in a single health campaign is not possible. For this, constant repetition is required. It is like booster dose. Constant reinforcement leaves a permanent impression on mind and helps them to understand and accept new health principles.

Learning by Doing

Hearing and seeing does not make an individual a good user. Its only when they do the new thing, they can really appreciate new practice. So, the people should be motivated to do the new practice to understand it. This principle of learning by doing is based on a famous Chinese proverb "IF I HEAR, I FORGET; IF I SEE, I REMEMBER; IF I DO, I KNOW".

Motivation

All individuals have a desire to learn. Initiation of this desire is referred to as motivation. It is of two types:
Primary: These are inborn desires which initiate people to take action, e.g. hunger, survival, sex, etc.
Secondary: These are based on desires caused by external forces or incentives, e.g. praise, love, reward or punishment.

Health education motivation is an important factor for achieving results.

Good Human Relations

This principle states that to be a good health educator one must be friendly and possess good personal qualities. Health educator must listen patiently and should be sympathetic and kind. All this would make a health educator a good friend in whom people can confide and clear their doubts.

Soil, Seed and Sower

In terms of health education, *soil* refers to people to whom education is to be given. It is important to know the social factors, their belief, prior knowledge and health needs of the people. *Seed* refers to the health facts to be given to the people. They should be truthful and have a scientific base. *Sower* refers to the transmitting media. It should be simple, attractive and acceptable to the people.

All three soil, seed and sower should be interrelated to have an impact on people.

Social Leaders

Community leaders are important medium for health education. As people respect them and listen to them they can play an important role in health education, e.g. sarpanches, village headman, school teachers, etc.

Theories and models are among health educator's most useful tools as they tackle the challenges of (a) needs assessment, (b) program planning, (c) program implementation, (d) program evaluation, (e) coordi-nation of services, (f) acting as a resource of health information, and (g) communicating needs, concerns, and resources outlined in the Framework.

According to Babbie (2003), *Theory* is defined as "A systematic explanation for the observations that relate to a particular aspect of life". *Models* on the other hand are best defined as "… a subclass of theory" (McKenzie and Seltzer, 2001). While theories are organized around ideas, concepts, and constructs, models are representations of theory. Models provide the vehicle for applying the theories. A theory, capable of full explanation of something as complex as human behavior, would be far too cumbersome to be useful.

MODELS OF HEALTH EDUCATION

Medical Model

This model was described by Vuori (1980). This model is based on 'facts' and 'expert' knowledge given in a didactic fashion (one way lecture). This model uses medical profession as a *teacher* to control transmission of selected knowledge. The recipients of the knowledge are passive and are expected to conform to the norm of absorbing a fixed message. The commonly used methods such as lectures, film shows, and posters are utilized to raise awareness, inform the appropriate action to be taken and to reinforce approved behavior. It is the most commonly used form of health education.

This model has advantages in using expertise efficiently to transmit knowledge, in having non-ambiguous aims and being easy to monitor and evaluate.

This model is criticized by people giving reasons that it induces dependency on the medical profession and thereby reducing self-reliance and disempowering the individual. Another criticism is that mere passing of relevant knowledge is insufficient to change attitudes towards health and illness.

Educational Model

This model aims to provide access to learning and to guide learning in a way which promotes understanding and develops power of reasoning. The basis of this model lies in voluntarism. The philosophy is that education should facilitate decision making, leaving people free to select a voluntary response and to choose for themselves from the available options. There is no teacher because people teach themselves, guided by an

arbitrator or facilitator. It replaces the medical model which suggests that providing information is sufficient to bring about a desired behavior change.

The method used is discussions, role plays and debates. The advantage lies in the wide variety of methods available. Knowledge and skills are easily transferred amongst peers and will be valued by them and wider society.

The model is criticized because of its idealism. It is unrealistic to expect that learner will be able to access or absorb all knowledge about health behavior. Another disadvantage is that, it gives access to all knowledge to an individual or group who develop attitudes as a result of that knowledge. It fails to take into account the influences of socialization process which include parental guidance, peer pressure on the ability to make decisions.

Self-empowerment Model

Also known as by a number of other names which have almost same philosophy. These are: *The Pastoral Model, The Selfesteem Model* and *The individual model.*

The basis of this model lies in the concept that action depends on the picture individuals have of themselves, and how they feel about themselves. How they see themselves within the context of their peers, family and environment. Only if people feel that they are important to themselves and therefore to others, they will feel the need to care for their own health. Unless people feel that they are, able to influence their own health, they will not bother to attempt to do so. This model revolves around promoting an awareness of the self. The concept is of self-empowerment. It fosters personality growth.

There is no teacher, only a facilitator who provides opportunity for group settings and ensures an environment of trust and openness. Personal involvement and participation is maximized making the learning process more enjoyable and more permanent. This model is based on actual experiences.

The element missing from this model is that of environmental influences and controls over which an individual can have no power.

Radical Model

This model works to enable people to cooperate and work in group to solve the problems by critical social analysis. There is no teacher or educator but only an energizer who conducts community programs in which the residents analyze social situations, work together to force change which will improve chances of making healthy choices. The fundamental features of this model are recognition of power control and researching ways to change the balance. It is based on relevant issues and mobilizes all sections of a society.

Health Belief Model and Health Action Model

Health belief models such as those based on field theory of Rosenstock (1966 and 1974), Becker and Maiman and Janz and Becker (1984) hypothesize that decisions to undertake health actions rely on individual's perception of their susceptibility and the psychological costs of taking certain action. In order to take recommended health actions, a person must satisfy certain factors. These include:

- *Knowledge*: They must know about the action
- *Perceived susceptibility:* They must think that they are likely to or can suffer from this condition.
- *Potential severity of condition:* They must think that the consequence of suffering from the condition is significant to them.
- *Prevention works:* They must think that there is an alternative that works, and that the action being encouraged will prevent the condition from occurring.
- *Acceptability and priority:* They must accept that the new behavior is more important than other behaviors which currently are being used.

Health Education and Propaganda/Publicity

To 'educate' means to impart knowledge by formal instruction to teach. 'Propaganda' means the organized dissemination of information.

The difference between health education and propaganda are discussed (Box 14.2).

COMMUNICATION

The art and science of communication forms the foundation of oral health education and disease prevention. Although, we know that telling people is not enough to cause a change in behavior, often the way in which they are told is the most important factor in our failure to communicate effectively.

Argyle (1983) suggests that communication is a form of social interaction, intended to reach certain goals. Goals are satisfied by the certain behavior or responses on the part of others and in order to get these responses a variety of verbal and non-verbal methods are used called as *communication*.

Definition

Daniels and Spiker (1994) define communication as *Shared meaning created among two or more people through verbal and non-verbal transaction.*

KEY ELEMENTS IN COMMUNICATION

There are four elements in the process of communication:

- Communicator
- Audience
- Message
- Channels of communications

1. *Communicator:* He is the person who has to deliver the health message. A good communicator:
   - Has clearly defined objectives
   - Knows the needs and interest of the audience
   - Tries to find out the abilities of the audience
   - Must have a valid and useful message
   - Selects the best channel for communication.

BOX 14.2: DIFFERENCE BETWEEN HEALTH EDUCATION AND PROPAGANDA

Health Education	*Propaganda*
1. Knowledge and skills are actively acquired by the people.	1. Knowledge is installed in the minds of people.
2. Initiates people to think for themselves.	2. Discourages thinking because of readymade slogans.
3. Makes people to use judgement before action.	3. Results in reflexive behavior where people tend to take impulsive actions. It is also called as reflective behavior.
4. Primitive desires are disciplined in this process.	4. It arouses and stimulates primitive desires.
5. Appeals to reasoning.	5. The process appeals to emotions.
6. Person tries to acquire knowledge through self-reliant activity.	6. Person receives knowledge passively and it is spoon-fed.
7. In this process, person develops individuality, personality and self esteem.	7. The person develops set pattern of attitude and behavior depending upon the mould used.
8. The end result is aimed at developing favorable attitude, habits and skills.	8. End results bring no change in attitude or behavior.

2. *Audience:* They are the receivers of the health message. They are the target groups who need advice or the health message. They can either be the whole population or selective group like industrial workers, school children, expectant mothers etc.
3. *Message:* It is information which the communicator passes to the audience. For a message to be accepted by the audience it should be:
   - Simple and understandable by the people
   - Should fulfill the objective
   - Should be of interest & needs of the audience.
4. *Communication channels:* These are the medium of communication. Selection of media is very important. It should be:
   - Attractive
   - Interesting and entertaining
   - Efficient in conveying the health message clearly.

Partners in Oral Health Education:

- General practitioners
- School nurses
- Pharmacists
- Health visitors
- Teachers
- Primary health care workers
- School governors
- Preschool care takers
- Local authority staff
- Politicians–local and central government
- Voluntary workers
- Business /commercial people
- Colleges and lecturers.

BARRIERS OR ROAD BLOCK OF COMMUNICATION

The roadblocks in the process of communication can be subdivided into four categories. They may interact with each other or may individually act as barrier in communication process.

Environmental

These include noise, poor visibility, overcrowding, congestion. They can make a person to loose interest in the health message.

Physiological

Physiological barriers like difficulty in hearing, seeing, inability to express have an impact on communication.

Psychological

These are neurosis, emotional disturbances or other psychological problems which makes a person non receptive to health message. Special methods and patience is required to overcome this type of barrier.

Cultural

Cultural barrier includes customs beliefs, attitudes, and religion. This also includes basic level of knowledge and understanding.

For effective transmission of health message, the barrier or road blocks should be identified and removed as per the situation. Inability to do so would leave little impact on the audience and people would not accept and act upon the health message given to them.

AIDS IN HEALTH EDUCATION

A health educator makes use of various aids in the process of health education. These can be categorized into audio, visual and a combination of Audio and Visual aids

1. *Audio aids*: They are based on the principles of sound and electricity.

These include:

- Tape recorders
- Microphones

- Megaphones
- Gramophone
- Amplifiers
- Radio.

2. *Visual aids:*
   A. Which requires projection.
      These include:
      - Slides
      - Films
      - Epidiascopes
      - Bioscope
      - Overhead projectors
      - Transparencies.

   B. Which don't require projection.
      These include:
      - Models
      - Blackboard
      - Posters
      - Charts
      - Graphs
      - Specimens.

3. *Combined audio-visual aids:*
   - Televisions
   - Cinemas
   - Video cassette player and recorder
   - Slide-tape combinations
   - Multimedia computers.

METHODS IN HEALTH EDUCATION

These can be broadly divided into three groups.

1. Health Education for Individual and Family

A. *One to one supervision*
It is a direct approach method, given by personal interviews. It has a lasting effect because it provides a two way communication. It can be given in the consultation room of doctors, in the health centers or in homes. The individual has an advantage of clarifying doubts and the educator can persuade the individual to change his behavior. Disadvantage is in number of people reached, i.e. they are very small.

B. *Interactive computer software*.

2. Health Education for the Group

It is an effective method of educating masses or groups like school children, industrial workers etc. Different methods for group education are:

A. *Lectures:* It is an oral presentation. It is a one way communication. It should be based on the needs of the group and must relate directly to the interest of people. Subject should deal with not more than 5 to 6 points and should be of short duration. Lectures can be made more effective and interesting by using audio-visual aids like models, charts, flannel graph [a piece of rough flannel fixed on a wooden board for displaying pictures , graphs etc.], flash cards which are a series of cards each with an illustration related to the topic.

B. *Symposium:* It is conducted under a chairman. It is a series of speeches, given by experts. Each person presents an aspect of subject briefly. In the end the audience may ask questions.

C. *Group discussions:* It is a two way communication, participants learn by freely expressing and exchanging their views, experiences and knowledge. There is a group leader who initiates the discussion and ensures everybody participates actively in a healthy manner. Here the members are expected to:
   - Listen to the other person idea
   - Express ideas clearly and concisely
   - Suggest relevant matter
   - Accept criticism gracefully
   - Help to reach a conclusion.

   Group discussion has shown to be a very effective method to bring about a change in behavior. When a group decides collectively to accept an idea, individual members are encouraged to accept the same. Group should consist of 6 to 20 members. They should have common problem and similar concern.

D. *Panel discussion:* It consists of a chairman who opens the meeting and 4 to 8 speakers who are expert on the topic to be discussed. The speakers discuss the problem in front of a large group or audience. Once the main aspect are explored and discussed by speaker the audience is encouraged to take part. The members discuss amongst themselves and the responsibility of making it a success lies with the chairman who keeps the discussion going.

E. *Workshop:* It consists of small groups with each group having a chairman and a recorder, who records the proceeding. Each group with the help of consultant and resource personnel carry out a series of meetings. Experts discuss on specific issues, with emphasis on individual work, within the group. Here each participant gets opportunity to improve his work under expert guidance. It usually lasts a few days and the participants leave with an action plan on the problem.

F. *Demonstration:* It is a practical presentation of performing a task, e.g. showing brushing and flossing technique. It is more effective than speech and written text alone as practical demonstration leaves a lasting impression on the mind of target group.

G. *Role playing:* It is also called as socio-drama, as the situation or the message to be conveyed is performed by a group in the form of drama. The audience actively pays attention and can be included into the role playing. It is a good education device in school education.

H. *Institute:* It is a place where number of meeting takes place, scheduled over several days or weeks, to convey specific instructions or information on a particular subject matter or work. The purpose is to impart information, create awareness and interest, with the help of lectures, panel or group discussion and symposium
I. *Conference/Seminars*
J. *Simulation exercises:* The objective is to make the learner go through situation that is close to real life in the form of an exercise or game, e.g. different first aid techniques.

3. Health Education for General Public/Mass Approach

For educating the masses or general public the most effective method is making use of 'mass media'. Although a large number of people are reached, it is a 'one way' communication. Hence, it is less effective in changing human behavior. It includes:

- Television
- Radio
- Health magazines
- Health exhibitions
- Press
- News papers
- Posters
- Films
- Health museums.

BOX 14.3: SETTINGS FOR ORAL HEALTH EDUCATION

- Primary care
- Schools and colleges
- Hospitals and clinics
- Preschool education and care
- Local authority services
- Workplace
- Commercial organizations
- Community based initiatives
- Older people's residential homes.

Clarifying the core oral health education messages, the health education authority published a consensus document which was produced by a group of leading figures in oral health sciences based on the published evidence on effective preventive strategies.

Key messages are:

- *Diet:* Reduce the consumption, specially the frequency of intake, of food and drinks containing sugar.
- *Toothbrushing:* Clean the teeth thoroughly twice every day with a fluoride tooth paste.
- *Dental visit:* Visit a dentist at least once a year [preferably twice] for an oral examination.
- *Fluoridation:* Request the local water supplying authority to supply water with the optimum fluoride level for that area (0.7-1.2 ppm).

STEPS IN HEALTH EDUCATION PLANNING

1. Identify needs and priorities.
2. Set aims and objectives.
3. Decide the best way of achieving the aims.
4. Identify resources.
5. Plan evaluation methods.
6. Set an action plan.
7. Evaluation.

Identify Needs and Priorities

The public health problem should be identified to establish the objectives. The people requiring oral health education must be identified. Specific group should be selected, to ensure health education activity is tailored to their particular needs. In planning effective health education, both professionally defined needs and the target group's concern (felt and expressed needs) have to be taken into consideration.

Set Aims and Objectives

Based on the assessed needs of the group an aim can be set, specifying the desired change that is planned. One aim in this oral health example could be to improve and maintain the periodontal health through more effective plaque control methods. Objectives state what outcome results from the education action. They specify in detail the steps required to achieve the set aim. There are three types of educational objectives *cognitive* (levels of knowledge), *affective* (attitudes and beliefs) and skills (acquisition of new behaviors and skills).

As a guide to set useful objectives the acronym SMART can be helpful.

Specific focus and precision are essential in setting objectives.

Measurable: Objectives must be easily assessed to gauge progress.

Appropriate: The needs of the individual or population group should be the central focus in the objectives of any intervention.

Realistic: Achievable yet challenging objectives help to motivate those involved in delivering the desired outcomes.

Time related: It is essential that a timescale is specified to assess changes achieved.

Decide the Best Way of Achieving the Aims

Once desired aims and objectives have been formulated the best way of achieving them should be decided. By this stage, the content and method of education should be apparent.

Identify Resources

The resources needed and available to implement the program should be identified. In health education, resources may include

people's expertise and existing skill, and material such as leaflets or oral hygiene aids.

Plan Evaluation Methods

A full evaluation of any health education program is a very important element. Evaluation is designed to assess whether the set aims and goals have been achieved. For this, appropriate evaluation measures should be selected.

Set an Action Plan

The planned action for the program should be initiated.

Evaluation

Evaluation information can be collected both during and at the end of the program to assess the impact of the program.

STEPS OF LEARNING

People are *unaware* of certain habit or behavior which is detrimental to their health. *Awareness* is given to them by giving them information. The information becomes relevant if it is conceived by them with *self-interest*, otherwise the facts are irrelevant. Only after the information has been accepted by an individual, a positive *attitude* can be adopted by the individual. A positive attitude towards the message may enable an individual to *believe* that a change in behavior is required and is beneficial for him. But an action may not necessarily follow. A *commitment* is necessary to bring about a permanent *behavior change* (Fig. 14.1).

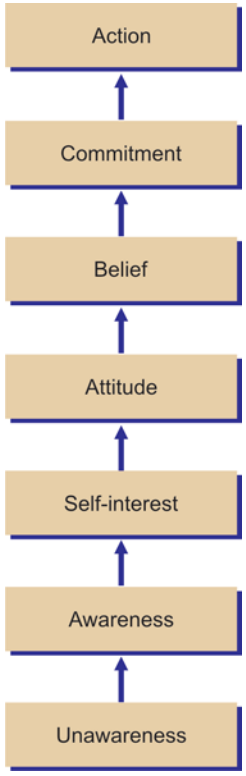


Fig.14.1: Steps of learning

VARIOUS HEALTH EDUCATION METHODS AND MEDIA

Methods are defined as the ways in which the education is carried out where as the medium connotes the particular means of communication employed in the method.

The various health education methods have their strengths and limitations which are discussed below:

Lecture

Strengths

- Presents factual material in direct, logical manner
- Contains experience which inspires
- Stimulates thinking to open discussion
- Useful for large groups.

Limitations

- Experts are not always good teachers
- Audience is passive
- Learning is difficult to gauge
- Communication in one way.

Preparation

- Needs clear introduction and summary
- Needs time and content limit to be effective
- Should include examples, anecdotes.

Lecture with Discussion

Strengths

- Involves audience at least after the lecture
- Audience can question, clarify and challenge.

Limitations

- Time may limit discussion period
- Quality is limited to quality of questions and discussion

Preparation

- Requires that questions to be prepared prior to discussion.

Panel of Experts

Strengths

- Allows experts to present different opinions
- Can provoke better discussion than a one person discussion
- Frequent change of speaker keeps attention from lagging.

Limitations

- Experts may not be good speakers
- Personalities may overshadow content
- Subject may not be in logical order.

Preparation

- Facilitator coordinates focus of panel, introduces and summarizes
- Briefs panel.

Videotapes

Strengths

- Entertaining way of teaching content and raising issues
- Keep group's attention
- Looks professional
- Stimulates discussion.

Limitations

- Can raise too many issues to have a focussed discussion
- Discussion may not have full participation
- Only as effective as following discussion.

Preparation

- Need to set up equipment
- Effective only if facilitator prepares questions to discuss after the show.

Classroom Discussion

Strengths

- Pools ideas and experiences from group
- Effective after a presentation, film or experience that needs to be analyzed
- Allows everyone to participate in an active process.

Limitations

- Not practical with more that 20 people
- Few people can dominate
- Others may not participate
- Is time consuming
- Can get off the track.

Preparation

- Requires careful planning by facilitator to guide discussion
- Requires question outline.

Small Group Discussion

Strengths

- Allows participation of everyone
- People often more comfortable in small groups
- Can reach group consensus.

Limitations

- Needs careful thought as to purpose of group
- Groups may get side tracked.

Preparation

- Needs to prepare specific tasks or questions for group to answer.

Role Playing

Strengths

- Introduces problem situation dramatically
- Provides opportunity for people to assume roles of others and thus appreciate another point of view
- Allows for exploration of solutions
- Provides opportunity to practice skills.

Limitations

- People may be too self-conscious
- Not appropriate for large groups
- People may feel threatened.

Preparation

- Trainer has to define problem situation and roles clearly
- Trainer must give very clear instructions.

Worksheets/Surveys

Strengths

- Allows people to think for themselves without being influenced by others
- Individual thoughts can then be shared in large group.

Limitation

- Can be used only for short period of time.

Preparation

- Facilitator has to prepare handouts.

15 Oral Health Survey Procedures

CM Marya

World Health Organization (WHO) has a long tradition of epidemiological survey methodology and surveillance in oral health. The so-called WHO Global Oral Health Data Bank was established in 1967. The bank emerged from the gathering of information from surveys on the growing burden of dental caries among children, particularly notable in industrialized countries. Most of the surveys carried out in these countries were initially motivated by the need for planning of oral health services or organization of public health intervention programs. Over the past decades, WHO has encouraged Member States to report information on disease level for making international comparisons, by use of a standardized methodology. For comparison between countries, certain indicator age groups are suggested: 5 to 6 years, 12 years, 15 years, 35 to 44 years and 65 years or more (or 65 to 74 years), and a simplified pathfinder sampling methodology (convenience sampling) has been developed for urgent data collection in countries or settings where probability sampling is not possible. To ensure data of high validity and reliability, WHO has designed basic instruments and record forms for use in the collection of clinical data. Standard criteria for recording clinical conditions are recommended, focusing on dentition status, prosthetic status and needs, dental caries and dental treatment needs, developmental anomalies of teeth, periodontal disease and treatment needs, oral mucosal lesions and oral precancer/cancer. Special attempts have been made to obtain high quality data through specification of clearly defined examination procedures, training, and calibration trials for assessment of intra- or inter-examiner variability.

Standard methodology for the collection of epidemiological data on oral health has been designed by WHO and used by countries worldwide for the surveillance of oral disease and health. Global, regional and national oral health databanks have highlighted the changing patterns of oral disease which primarily reflect changing risk profiles and the implementation of oral health programs oriented towards disease prevention and health promotion. The WHO Oral Health/Country Area Profile Program (CAPP) provides data on oral health from countries, as well as program experiences and ideas targeted to oral health professionals, policy-makers, health planners, researchers and the general public.

European Health Survey System goals can be summarized as follows:

- Identification of health problems
- Description of the health status and health needs of the population
- Estimation of the prevalence and distribution of health indicators
- Analysis of social (in)equality in health and access to health services
- Study of health care consumption and its determinants, as well as preventive care
- Study of possible trends in health status, lifestyle and health care services consumption among the population.

SCIENTIFIC METHOD IN CONDUCTING A DENTAL SURVEY

1. Establishing the objectives.
2. Designing the investigation.
3. Selecting the sample.
4. Conducting the examination.
5. Analysis of data.
6. Drawing the conclusion.
7. Publishing the result/report.

1. Establishing the Objectives

The objectives of the investigation must be absolutely clear to the investigator. The design of the study is based on the objectives of the study. The objectives could either be to test a hypothesis or describing what is to be measured.

2. Designing the Investigation

Designing can be done under the following:

Type of Study

The epidemiological study could be:

Descriptive Study

Which could be – A *Prevalence Study,* (cross-sectional study) or an *Incidence Study* (longitudinal study). *Prevalence study* is one in which occurrence of a disease or condition in a population is expressed at a given point in time. These are commonly used for making comparison between two or more population. *Incidence study* tells about the amount of new disease in a population measured over a period of time.

Analytical Study

It helps to assess the association between the cause and effect. It could either be:

- *Case control study* (retrospective study): In which both exposure and outcome have occurred before the start of the study. It uses a control or comparison group to support or refute an inference.
- *Cohort study* (prospective study): Cohort defined it as a group of people who share a common characteristic or experience within a defined time period. The study proceeds forward from cause to effect. The cohorts are identified before the appearance of the disease. The comparison group could be from general population from which cohort is drawn or unexposed similar, cohort similar. The study group is observed over a period of time to determine the frequency of disease among them and influence of various factors of interest on the occurrence of disease.

3. Selection of the Sample

In an investigation, it is usually impossible to include or examine every individual in the population or universe under investigation because of unavailability of resources such as time, money, manpower, etc. Hence, a small number of individual called as *sample* must be chosen from the population. Sample should be representative of the population.

Various sampling techniques are:

A. *Random sampling technique:* In a truly random sample each individual has an equal chance of being included in the sample.
   a. *Simple random sample*: If population is small, a number is allocated to each unit and the numbers are selected by the use of random number table or a computer package.
   b. *Systematic random sample*: If the population is large, the first unit is selected by random numbers and then every nth one is selected. For example, if total population is 3000 (N) and a sample of 300 (n) is required then using the formula:

      N/n = 3000/300 = 10

      Therefore a 1 in 10 sample is required. The first number between 1 and 10 is selected using a random number and then every 10th number is used.

B. *Stratified random sampling:* Stratification is a method of increasing the precision of a random sample. If condition under investigation is suppose to be related to various factors such as age, sex, occupation then the population is first divided into subgroups or strata, prior to sampling and then each stratum is sampled randomly to produce a known sample.

C. *Cluster sampling:* This is useful when
   - Full extent of population is unknown
   - No satisfactory sample frame exists
   - Need to decrease field and administrative cost.

D. *Multistage sampling:* When the population is large and scattered, the area is divided into '1st stage sampling unit' from which 2nd stage units are selected.

4. Conducting the Examination

Different Types of Examination

According to American dental association, examination can be classified into:

Type 1: This includes a complete examination, using mouth mirror and explorer, good illumination, full mouth radiographs and additional diagnostic methods, if indicated such as study models, pulp testing, transillumination and laboratory investigations.

Type 2: This is a limited examination, using mirror and explorer, good illumination and bite-wing radio-graphs. Periapical radiographs if indicated.

Type 3: It includes examination using a mirror and explorer only, using a good illumination.

Type 4: This is screening procedure only, using a tongue depressor and available illumination.

For an epidemiological study of dental conditions the following aspects are of great importance:

- Examination method
- Diagnostic aid
- Diagnostic criteria
- Data recording
- Training and calibration
- Consent.

Examination Method

WHO has produced a manual 'Oral Health Surveys- basic method' to standardize the various survey methods which

help in comparison of the findings at the national and international levels. It gives a simple procedural and diagnostic system for epidemiological studies.

Diagnostic Aid

Basic requirement for the mouth examination includes a chair, a source of illumination and some means to clean debris of teeth.

Diagnostic Criteria

The diagnostic criteria and classification for the diagnosis of the disease or condition should be well defined. The criteria should be as simple as possible in order to facilitate reproducibility and standardization. The diagnostic method should be both *valid* and *reliable*.

Validity of a test is its ability to measure what it is intended to measure. It means all ill subjects should be detected and no healthy subject should be diagnosed as ill. The validity of a diagnostic method can be determined by calculating the sensitivity and specificity of the method. A test is *sensitive* if all cases in which the condition exists are positively diagnosed. The test is *specific* if a positive diagnosis is made only when the condition is present.

Reliability of a test is its ability to give the same results if repeated.

Data Recording

A recorder live or tape recorder is necessary for receiving the information called by the examiner. Recording method should be decided in advance including the recording sheet.

Training and Calibration

Each examiner should diagnose the condition in the same way on every occasion, as should the other examiner using the same criteria.

Intra-examiner variability can be measured by carrying out a reproducibility test. This helps the examiner to check their ability to produce the same diagnosis of the same condition on various occasions. This should be done both before the start of a study and during the study by re-examining a sample say-10 percent of the individual concerned.

Inter-examiner variability is to be taken care of, if more than one examiner is involved in a study. This is done by making them undergoing training and calibration exercises. They must be carefully standardized in their diagnosis. This exercise should be repeated if the study is of a longer duration.

Consent

Consent should be obtained from all those concerned with the investigation, e.g. local authorities, schools, parents, etc.

5. Analyzing Data

Methods of analysis of data [what test] must be decided at the beginning of the study.

6. Drawing the Conclusion

Care must be taken that the conclusion is specifically related to the investigation that has been carried out, and no conclusion is directed to the population as a whole unless the investigation was designed accordingly.

7. Publishing the Result/Report

It should be clear and simple so that the results can be understood easily. The usual method of presentation of results includes:

a. *Introduction*:
   - Reasons of conducting the survey
   - Review of literature
   - Objectives of investigation
   - Hypothesis to be tested

b. *Materials and methods:*
   - Selection and description of sample
   - Methods used for diagnosis
   - Diagnostic criteria
   - Technique of investigation.

c. *Results*:
   - Appropriate tabulation and illustration.

d. *Discussion and conclusion*.

ORAL HEALTH SURVEYS (WHO-1997)

Basic oral health surveys provide a sound basis for estimation of the present oral health status of a population and its future needs for oral health care. They produce reliable baseline data for development of national or regional oral health program and for planning of appropriate numbers and types of personnel for oral care.

Design of a Basic Oral Health Survey

Basic oral health surveys are used to collect information about the oral health status and treatment needs of a population, and subsequently, to monitor changes in levels and patterns of disease. In this way, it is possible to assess the appropriateness and effectiveness of the services being provided and to plan or modify oral health services and training programs as needed. Basic oral health surveys are not designed to collect information about etiological factors affecting disease distribution of severity, or about the clinical effectiveness of different preventive or care procedures. However, the information obtained using basic surveys can be used to monitor aspects of the effectiveness of oral care services.

Uses of Basic Oral Health Surveys

They can be used to determine:

1. The extent to which existing oral health services are coping with the current need for oral care.
2. The nature and extent of required preventive, curative and restorative oral health services.
3. The resources needed to establish, maintain, expand or reduce an oral health care program, including the estimate of the number and type of personnel required.

Special Characteristics of Oral Diseases

The particular features of the epidemiology of oral diseases have permitted the development of an approach to sample design and survey planning for the most common oral diseases that is different from traditional sample designs. The special considerations concerning the two major oral diseases – dental caries and periodontal diseases – are as follows:

1. The diseases are strongly age-related, as there is often an increase in severity and prevalence with increased age.
2. The diseases exist in all populations, varying only in severity and prevalence.
3. One of the diseases, dental caries, is irreversible (at the cavitations level used in the methods described here) and thus information on current status provides data not only on the amount of disease present, but also on previous disease experience.
4. There is extensive documentation on variation of profiles of dental caries for population groups with different socioeconomic levels and environmental conditions.
5. Many observations are made in slandered measurements for each subject, i.e. for each tooth in case of caries and for the six sextants of the mouth in the assessment of the periodontal diseases.

PATHFINDER SURVEYS

The special factors associated with the most common oral diseases and the extensive experience gained in oral epidemiology over the past 25 years have enabled a practical, economic survey sampling methodology to be defined, called the "pathfinder" method.

The method used is a *stratified cluster sampling technique*, which aims to include the most important population subgroups likely to have differing disease levels. It also proposes appropriate numbers of subject in specific index age groups in any one location. In this way, reliable and clinical relevant information for planning is obtained at minimum expense.

The method is suitable for obtaining the following information:

- The overall prevalence of the common oral diseases and conditions affecting the population.
- Variations in disease level, severity and need for treatment in subgroups of the population. This enables groups in special need of services to be identified.
- Age profiles of oral diseases in the population to enable care needs for different age group to be determined, to provide information about severity and progression of disease, and to give an indication as to whether the levels are increasing and decreasing.

Pathfinder surveys can be classified as either *pilot* or *national,* depending on the number of sampling sites and the age groups or index ages included.

A *pilot survey* is one that includes only the most important subgroups in the population and only one or two index ages, usually 12 years and one other age group. Such a survey provides the minimum amount of data needed to commence planning. Additional data should then be collected in order to provide a reliable baseline for the implantation and monitoring of services.

A national pathfinder survey incorporates sufficient examination sites to cover all important subgroups of the population that may have differing disease levels or treatment needs, and atleast three of the age groups or index ages.

This type of survey design is suitable for the collection of data, for the planning and monitoring of services in all countries, whatever is the level of disease, availability of resources, or complexity of services. The following method is recommended as a general guideline for general basic oral health surveys for the planning, monitoring and evaluation of oral care services.

Subgroups: Sampling sites are usually chosen so as to provide information on population groups likely to have different levels of oral disease. The sampling is usually based on administrative divisions of a country – the capital city, main urban centers, and small towns and rural areas. In countries, where there are different geophysical areas, it is usual to include atleast one sampling site in each area type.

If there are several distinct ethnic groups in the population with known, or suspected, differences in level of oral disease, it may be necessary to include separate samples of each of these groups in the main subdivisions for the survey. Once the different groups are decided upon, application of random sampling of subjects within the groups is desirable.

The assistance of local health administrators can be very useful when the final decision is made as to which population subgroups are significant for the study and should be represented in the final sample. Between 10 and 15 sampling points are usually sufficient for countries with small to moderate populations. If, however, there are large urban centers in the country, it might be necessary to locate several additional sampling points in atleast two cities.

Index Age and Age Groups

The following ages and age groups are recommended: 5 years for primary teeth and 12, 15, 35 to 44 and 65 to 74 years for permanent teeth.

- *5 years:* Where it is practical and feasible, children should be examined between their 5th and 6th birthdays.

This age is of interest in relation to levels of caries in the primary dentition which may exhibit changes over a shorter time span then the permanent dentition at other index ages. In some countries, 5 years is also the age at which children begin primary school.

- *12 years:* This age is especially important, as it is generally the age at which children leave primary school, and thus in most countries, is the last age at which a reliable sample may be obtained easily through the school system. Also, it is likely at this age that all permanent teeth, except third molars, will have erupted. For this reason, 12 years has been chosen as the global monitoring age for caries for international comparisons and monitoring of disease trends. However, in some countries, many school-age children do not attend school. In these circumstances, an attempt should be made to survey two or three groups of non-attenders, from different areas, in order to compare their oral health status with that of children going to school.
- *15 years:* Data for persons of this age can be compared with the data for 12-year-old to provide an estimate of increase in prevalence and severity of caries. At this age, the permanent teeth have been exposed to the oral environment for 3 to 9 years. This is particularly useful in populations for which there are no, or very little, previous data. This age is also important for the assessment of periodontal disease indicators in adolescents. In countries, where it is difficult to obtain reliable samples of this age group, it is usual to examine 15-year-old in two or three areas only, i.e. in the capital city or other large town and in one rural area.
- *35 to 44 years* (mean = 40 years): This age group is the standard monitoring group for health conditions of adults. The full effect of dental caries, the level of severe periodontal involvement, and the general effects of care provided can be monitored using data for this age group. Sampling adult subjects is often difficult. Sample can, however, be drawn from organized groups, such as office or factory workers. Use may also be made of readily accessible groups, e.g. at a market, to obtain a reasonably representative sample in situations where truly representative sampling is not feasible. Care must be taken to avoid obvious bias, such as sampling outpatients at a dental clinic.
- *65 to 74 years* (mean = 70 years): This age group has become more important with the changes in age distribution and increase in lifespan that are now occurring in all countries. Data for this group are needed both for planning appropriate care for the elderly and for monitoring the overall effects of oral care services in a population. Examination of representative members of this age group is often not as difficult as for the previous age group, as elderly people are more likely to be found in or near their homes, or in the day centers of institutions, and can therefore be examined during the day.

Number of Subjects

The number of subjects in each index age group to be examined ranges from a minimum of 25 to 50 for each cluster or sampling site, depending on the expected prevalence and severity of oral disease.

Such a sample design permits the identification of significant differences between urban and rural groups and, in certain situations, between different socioeconomic groups.

However, a total of 25 subjects (with equal numbers of females and male) are sufficient only in populations where caries and periodontal disease levels are estimated to be low or very low. In population with levels moderate or high – the standard size for each sample should be 40 to 50 subjects.

If the level of dental caries in the population is unknown, it will be necessary to estimate the level of disease before starting the survey. A rapid and effective way of estimating the prevalence of caries in a population is by classifying a group of subjects as caries-free or not.

If more than 20 percent of the children in the class are caries-free, the caries prevalence is low.

If 5-20 percent are caries-free, the prevalence is moderate.

If fewer than 5 percent are caries-free, the prevalence is high.

This estimate of prevalence may then be used as a guide when deciding on standard sample size and when completing the checklist for survey planning and sampling design.

Level of Precision

The following example (Table 15.1) is a practical guide to total sample size and is based on dental caries data for 12-year-old. The level of precision in estimating caries prevalence (i.e. number of decayed, missing, or filled teeth (DMFT)), from a sample of 100 subjects, is shown below for low, moderate and high caries prevalence.

Table 15.1: Level of precision to estimate caries prevalence in 12-year-old

Caries prevalence	*Proportion of caries-free 12-year-old (%)*	*Level of precision for estimate of DMFT for sample size, n = 100*
Low	More than 20	± 0.4
Moderate	5-20	± 0.5
High	Less than 5	± 1.0

As an example, consider a population with a moderate level of caries. A sample of 100 subjects of 12 years of age is examined, and the mean DMFT per person is found to be 4.1. This means that the value of the DMFT for the whole population of 12-year-old is somewhere between 3.6 and 4.6 (4.1±0.5). This level of precision is certainly sufficient to allow the data from such a survey to be used in planning oral care services.

Table 15.2: Sample groups for each index age or age group can be divided as follows

Urban	4 sites in the capital city or metropolitan area	(4 x 25 = 100)
Urban	2 sites in each of 2 large towns	(2 x 2 x 25 = 100)
Rural	1 site in each of 4 villages in different regions	(4 x 25 = 100)
Total	12 sites x 25 subjects	= 300

Applying this cluster distribution to the entire population (all index ages and age groups) the total sample is 4 x 300 = 1200 (Table 15.2). Using such a sample, comparison can then be made between urban and rural groups and, in certain situations, between different socioeconomic groups in the capital city or large towns. Areas where the disease prevalence is either much higher or much lower than the national average, may also be identified from the results of such a survey. As a general guideline for basic oral health surveys for planning, monitoring and evaluating oral care services, this pathfinder approach to sample design and selection is recommended.

ORGANIZING THE SURVEY

Preparing a Survey Protocol

It is important to prepare a written protocol for the survey, which should contain the following information:

- Main objective and purpose of the survey
- A description of the type of information to be collected and of the methods to be used
- A description of the sampling methods to be used
- Personnel and physical arrangements
- Statistical methods to be used in analyzing the data.

Obtaining Approval from the Authorities

Permission to examine population groups must be obtained from a local, regional or national authority. For example, if school children are to be examined, then the school authorities should be approached, the purpose of the survey explained and their approval obtained. In some instances, written permission from parents must be given before children can be examined.

Budgeting

A budget for the survey should be prepared, which should include all resources required, including personnel, to carry out the survey. Basic oral health surveys can often be conducted as part of the duties of dental public health workers.

Scheduling

One of the most important aspects of survey planning is the preparation of a schedule for data collection. If this is not done, examining personnel may waste time waiting for subjects to arrive, or be otherwise unnecessarily delayed.

As a guideline, a basic examination of a child usually takes about 5 to 10 minutes, while a complete examination of an adult may take between 15 and 20 minutes. Daily and weekly schedules can then be prepared with some flexibility for unexpected delays. These should be made available to survey personnel, as well as to school and health authorities.

Reliable observations and consistent judgments are important in surveys. Since fatigue contributes significantly to inaccuracy and inconsistency, it is unwise to make the schedule too demanding.

Emergency Care and Referral

A list of referral facilities should be prepared before the survey to refer a person detected during an examination, with condition that required immediate attention or is life-threatening to an appropriate care facility.

Courtesy Reporting

It is appropriate, and often essential, to report the survey findings to local authorities. The report may be a simple summary of the number of subjects examined and the observations of the examiner. This can usually be delivered personally, on the spot. A full technical report will require more time to prepare, but should be sent as soon as it is complete.

RELIABILITY AND VALIDITY OF DATA

Training and Calibrating Examiners

Although examiners may differ in their assessments of the oral health status of individuals, they should be in close agreement in assessing the status of population groups. When an epidemiological survey is undertaken by a team, it is essential that the participating examiners be trained to make consistent, clinical judgements. There are two main reasons for variability of clinical scoring:

- The difficulty in scoring the different levels of oral diseases, particularly dental caries and periodontal diseases
- Physical and psychological factors, such as fatigue, fluctuations in interest in the study, and variations in visual acuity and tactile sense. All these affect the judgement of examiners from time-to-time and to different degrees.

The objectives of standardization and calibration are:

- To ensure uniform interpretation, understanding and application by all examiners of the codes and criteria for the various diseases and conditions to be observed and recorded
- To ensure that each examiner can examine consistently.

Where possible, an experienced epidemiologist who has been trained in accordance with the recommended methodology for basic oral health surveys should be employed as a trainer and calibrator. Training in the criteria usually

takes 2 days with a further 2 to 3 days for calibration, though extra time may be needed depending on how many examiners are to be trained and the number of indices to be used in a survey. It is desirable to have an interval of atleast a few days between training and calibration to allow the examiners time to assimilate knowledge of the indices and practice the procedures.

When only one examiner is involved and an experienced trainer is not available, the examiner should first practice the examination on a group of 10 subjects with a wide range of levels of disease conditions. Then the examiner should determine how consistently he or she apply the diagnostic criteria by examining a group of about 20 subjects twice, ideally or successive days, or with a time interval of at least 30 minutes between examinations. These subjects should be pre-selected so that they possess, collectively, the full range of conditions expected to be assessed in the main survey by comparing the result of the two examinations, the examiner will be able to obtain an estimate of the extent and nature of the diagnostic variability. If the variability is large, the examiner should review the interpretation of the criteria and conduct additional examinations until acceptable consistency is achieved. In general, agreement for most assessments should be in the range of 85 to 95 percent.

When the survey is to be conducted by a group of examiners, it is necessary to assess the consistency of each examiner (intra-examiner reproducibility) and also the variations between examiners (inter-examiner reproducibility). When an experienced trainer is not available, each examiner should first practice the examination on a group of 10 subjects. Then each examiner should independently examine the same group of 20 or more subjects and compare his or her findings. When findings contain major discrepancies, subjects should be recalled in order that differences in diagnoses can be reviewed by the examiners and resolved by group discussion. It is essential that a group of examiners should be able to examine with reasonable consistency, using a common standard. If certain examiner consistently product significantly different results from the majority, and attempts to correct their performance fail, they should be excluded from the survey team. It should be made clear to all potential examiners, before these examinations begin, that ability to standardize examination results is not a measure of clinical skill.

Unless all members of the survey team can examine in a consistent manner, regional or group variations in disease prevalence or severity may be missed or wrongly interpreted. Since there will always be some variation between examiners, it is advisable that, in the actual survey, they should all examine similar percentages of each major subgroup of the sample population.

Duplicate Examinations

Examiners may change the way they apply diagnostic criteria during the course of a series of examinations. To allow detection and correction of this tendency, it is advisable for each examiner to perform duplicate examinations on 5 to 10 percent of the sample (not less than 25) in the main survey. The most convenient age groups on which to perform duplicate examinations are likely to be 12 or 15-year-old because of ease of access. As far as possible, the examiner should not be able to identify the subjects who are re-examined, or know that a subject has been examined previously, since this information may affect the thoroughness or quality of the duplicate examination. The recorder, or perhaps a local schoolteacher, should be requested to arrange for the re-examination of 5 to 10 percent of the subjects during the course of the survey. It is recommended that duplicate examinations are conducted at the beginning (i.e. immediately after calibration), about half-way through the survey, and at the end of the survey.

When the survey is to be conducted by a group of examiner, an experienced epidemiologist may be appointed to act as a validator for the survey team. The validator should examine at least 25 subjects who have already been examined by each member of the survey team.

For information on how to calculate the reproducibility of survey results, see Annex 2.

IMPLEMENTING THE SURVEY

General

Contacts with Persons in Authority

The organization of a survey must commence well before the date on which it is intended to start examinations. It is necessary to contact persons in authority in the institutions or organizations where people will be examined. For example, in schools the Principal should be contacted for information as to when the school is in session, when the children will be available for examination, and whether there is a suitable area or room that could be used for the examination. In addition, the principal might be able to provide basic information about the socioeconomic level and nutritional status of the children, water sources, seasonal accessibility of the school, and any health promotion or health education activities carried out in the school.

Keeping a Logbook

The organizer of the survey should maintain a logbook in which the location of each day's examinations, the number of persons examined, an information about each survey location are recorded. Occasionally, observations made and impressions formed at this time can have an important bearing on later assessment of survey results. If these are not clearly described at the time of observation, they will either be forgotten or confused.

Preliminary Exercise

For investigators planning their first oral health survey, it is helpful to examine two classes of 12-year-old children in local

primary schools as a preliminary exercise. This will give the survey personnel an opportunity of working together and of identifying and discussing any organization or technical problems that may arise. The calibration of the examiners (see page 13) and training of the recording clerks can be performed at the same time.

Sources of Fluorides

A sample of drinking-water should be collected at each examination site and sent for analysis of fluoride content. Clean polyethylene bottles of 25 to 30 ml capacity should be used for this purpose. They should be rinsed in distilled water prior to rinsing twice with the water to be sampled. The bottles should then be filled, closed firmly and clearly labeled with a permanent ink pen, giving the date of collection, location and source of the water. In many countries, it is possible to obtain fluoride analysis services through public health and/or water supply departments.

In addition, information should be gathered on:

- Sources of fluorides available to the survey population, other than water (e.g. salt, tables and milk)
- Levels of usage of topical fluorides, especially dentifrices and/or other products likely to have an impact on dental caries.

Personnel and Organization

Recording Clerk

Each examiner should be assisted by an alert and cooperative recording clerk who is able to follow instructions. The examiner should give the clerk clear instructions about recording data on the assessment form. Before the survey begins, the clerk should practice the procedure.

When direct-entry computer systems are used, recording clerk should be given specific instructions and training concerning their use.

Organizing Clerk

It is also desirable to have an organizing clerk at each examination site to maintain a constant flow of subjects in the examination(s) and to enter general descriptive information on the record forms. The organizing clerk should also check the finished records for accuracy and completeness, so that missing information may be obtained before the survey team moves to another location. This person should also be responsible for ensuring that the examiners have an adequate supply of sterile instruments.

Daily Review of Assessment Forms

It is very important that each examiner reviews each day's assessment forms on the same day, for completeness and accuracy of recordings.

Instruments and Supplies

The quantity and weight of instruments and supplies used in the survey should be kept to a minimum. The following instruments and supplies are required for each examiner:

- Plane mouth mirrors, periodontal probes which confirm to WHO specification several pairs of tweezers
- Containers (one for used instruments and one for sterilizing instruments) and concentrated sterilizing solution
- A wash basin (for either water and soap of disinfectant solution)
- Cloth of paper hand towels
- Gauze.

Sufficient numbers of instruments should be available to avoid the need to interrupt examinations while used ones are sterilized. Generally, a minimum of 30 mouth mirrors and 30 periodontal probes per examiner should be provided, as this will permit instruments to be sterilized while the other are being used.

Used instruments should be placed in disinfectant solution, then washed before sterilization.

Infection Control

Current national recommendations and standards should be followed for both infection control and waste disposal.

Examiners are responsible for maintaining adequate infection control in survey procedures. During their training, it should be emphasized that with proper use of dental mirrors and the periodontal probe, all areas of oral cavity can be fully examined without the need for digital manipulation of the oral tissues, hence reducing the risk of cross-infection.

The use of disposable masks and gloves and the wearing of protective glasses are recommended.

Examination Area

The area [indoor or outdoor] for conducting examinations should be planned and arranged for maximum efficiency and ease of operation.

Examination Position

The examination position for the subjects depends on the furniture available. The most comfortable position is on a table or bench, and the examiner to sit behind the subject's head. Subjects can also be examined seated in a chair with a high backrest, the examiner standing behind or in front of the chair. If furniture is not available, children can be examined lying on a cloth on the ground and the examiner seated cross legged behind the child's head.

Lighting

The lighting should be as consistent as possible throughout the survey. If electricity is available at all locations, a

lightweight portable examination light (in the blue-white color spectrum) should be used. Inflammatory and structural changes of the oral tissues are more difficult to detect under normal artificial light (yellow-red in color) than under natural or corrected artificial light. If electricity or battery-operated lights are not available at some survey sites, natural light should be used at all locations.

If an artificial source is used, the subject should face away from any natural light sources, to avoid variation in illumination. However, if natural light alone is being used, the subject should be positioned so as to receive maximum illumination, while avoiding discomfort from direct sunlight. The chair or table should face the opening through which the light enters, and be placed as close to it as possible.

Seating of Recording Clerk

The recording clerk should sit close enough to the examiner so that instructions and codes called by examiner are easily heard and the examiner can see if the findings are being recorded correctly.

Supply of Survey Forms

An adequate supply of assessment forms, carbon paper, sharpened pencils, erasers and copies of the recording instructions, coding list and measurement criteria should be readily available.

Avoidance of Crowding

If possible, the examination should be arranged in such a way that subjects enter at one point and leave at another. Subjects should not be allowed to crowd around the examiner or recorder and should enter the examination area one at a time.

ASSESSMENT FORM

Standard Codes

Standard codes must be used for all sections of the form. If this requirement is not observed, WHO will not be able to process the data and summarize the results, as the standard computer program will not be suitable. If some of the oral health assessments are not carried out, or are not applicable to the age group being examined, the unused sections of the form should be cancelled with a diagonal line, or by using code 9 in the appropriate box (=not recorded).

Oral Health Assessment Form

The standard form for oral health assessment is designed for collection of all the information needed for planning oral care services and thorough monitoring and replanning of existing care services.

The form includes the following sections:

1. Survey identification information.
2. General information.
3. Extraoral examination.
4. Temporomandibular joint assessment.
5. Oral mucosa.
6. Enamel opacities/hypoplasia.
7. Dental fluorosis.
8. CPI (periodontal status, formerly called Community Periodontal Index of Treatment Needs or CPITN).
9. Loss of attachment.
10. Dentition status and treatment need.
11. Prosthetic status.
12. Prosthetic need.
13. Dentofacial anomalies.
14. Need for immediate care and referral
15. Notes.

This form is suitable for surveying children as well as adults.

Country code (Boxes 1 – 4) on the form are reserved for the WHO code for the country in which the survey is carried out and should not be filled in by the investigator.

Date of Examination (Boxes 5 –10)

Only the year and month (recorded in Boxes 5-8) will be entered into the computer data file. Recording the day helps an investigator to refer back to any one day's examinations that may need to be reviewed or checked.

Identification Number (Boxes 11 – 14)

Each subject examined should be given an identification number. This number should always have the same number of digits as the total number of subjects to be examined. Thus, if it is intended to examine 1400 subjects, the first subject should be numbered 0001.

It is important to ensure that each identification number should be used only once. When more than one examiner participates in a survey, cross-checking should be done . If a total of 1400 subjects are to be surveyed by two examiners, examiner 1 should use numbers 0001 – 0700, and examiner 2 should use numbers 0701-1400.

Examiner (Box 15)

If more than one examiner is participating in the survey, each examiner should be assigned a specific code, which should be entered in Box 15. Similarly, if a validating examiner is participating in the survey, he or she should also be assigned a specific code.

Original/Duplicate Examinations (Box 16)

If a subject is being re-examined to assess reproducibility, then the first (original) examination is scored "1" and any

subsequent duplication examinations are coded 2,3,4, etc. in Box 16, but data from the first examination only are included in the survey analysis.

Date of Birth (Boxes 17-20)

The year and month of birth should be entered for cross-checking purposes whenever possible.

Age (Boxes 21 and 22)

Age should be recorded as age at last birthday (i.e. a child in 14th year of life is 13). If the age is less than 10 years, "0" should be entered in the box 21 (i.e. 6 years = 06). If the age of the subject is not known, it may be necessary to make an estimate on the basis of, for instance, stage of tooth eruption or, for adults, major events in the community. When the age has been estimated, the manner of estimation should be reported.

Sex (Box 23)

The appropriate code (1 = male, 2 = female) should be entered in Box 23.

Ethnic Group (Box 24)

In different countries, ethnic and other groups are identified in different ways, e.g. by area or country of origin, race, color, language, religion or tribal membership and local health and education authorities should be consulted for this. Ethnic group information must be recorded at the time of examination and coded in Box 24.

Occupation (Box 25)

A coding system should be devised according to local usage for recording occupation groups and the appropriate code entered in Box 25.

The code 0-8 may be used to identify different occupations.

Geographical Location (Boxes 26 and 27)

Record the site where the examination is conducted. This allows up to 99 geographical location (villages, schools etc.) to be identified (00-98).

Location Type (Box 28)

Record information about each site surveyed. The purpose of including these data is to obtain general information about the availability of services at each survey site. Three codes are used:

1. Urban site.
2. Peri-urban area: This has been included in order to indicate areas surrounding major towns, which may have characteristics similar to those of rural areas, i.e. very few health facilities of any kind and usually no excess to oral health care facilities.
3. Rural area or small village.

Other Data (Boxes 29 and 30)

These boxes are for recording other information about the subjects examined or the survey location. Information such as use of tobacco or a chew stick or the level of fluoride in the water can be recorded.

Note: The codes 0-8 may be used in these boxes.

Contraindication to Examination (Box 31)

Local practices must be taken into consideration when establishing the presence of conditions contraindicating the conduct of any part of the examination which might place subjects at risk or cause them discomfort. Examiners should use their judgment in this matter.

The following codes are used:

0 - No contraindication
1 - Contraindication

Clinical Assessment

In order to ensure that all conditions are detected and diagnosed, it is recommended that the clinical examination follows the order of the assessment form.

Extraoral Examination (Box 32)

The extraoral examination should be performed in the following sequence:

a. General overview of exposed skin areas (head, neck, limbs).
b. Perioral skin areas (nose, cheeks, chin).
c. Lymph nodes (head, neck).
d. Cutaneous parts of upper and lower lips.
e. Vermilion border and commissures.
f. Temporomandibular joint (TMJ) and parotid gland region.

The following codes and criteria are used:

0. Normal extraoral appearance.
1. Ulceration, sores, erosions, fissures - head, neck, limbs.
2. Ulceration, sores, erosions, fissures - nose, cheeks, chin.
3. Ulceration, sores, erosions, fissures - commissures.
4. Ulceration, sores, erosions, fissures - vermilon border.
5. Cancrum oris.
6. Abnormalities of upper and lower lips (e.g. clefts).
7. Enlarged lymph nodes - head, neck.
8. Other swellings of the face and jaws.
9. Not recorded.

Temporomandibular Joint Assessment (Boxes 33-36)

Symptoms (Box 33). The following codes and criteria area used:

0. No symptoms.
1. Occurrence of clicking, pain, or difficulties in opening or closing the jaw once or more per week.
9. Not recorded.

Signs (Boxes 34-36). The following codes and criteria are used:

0. No signs.
1. Occurrence of clicking, tenderness (on palpation) or reduce mobility (opening<30mm).
9. Not recorded.

Clicking (Box 34) of one or both temporomandibular joints. Clicking is evaluated directly by an audible sharp sound or by palpation of the temporomandibular joints.

Tenderness (on palpation) (Box 35) of the anterior temporalis and/or masseter muscles on one or both sides. The tenderness should be evaluated by unilateral palpation with the firm pressure of two fingers, exerted twice on the most voluminous part of the muscle. Tenderness is recorded only if the palpation spontaneously provokes an avoidance reflex.

Reduced jaw mobility – opening of means<30 mm (Box 36), taken as the distance between the incisal tips of the central maxillary and mandibular incisors. As a general guide, in an adult jaw, mobility is considered to be reduced if the subject is unable to open his or her jaw to the width of two fingers.

Oral Mucosa (Boxes 37-42)

An examination of the oral mucosa and soft tissues in and around the mouth should be made on every subject. The examination should be thorough and systematic and be performed in the following sequence:

a. Labial mucosa and labial sulci (upper and lower).
b. Labial part of the commissures and buccal mucosa (right and left).
c. Tongue (dorsal and ventral surfaces, margins).
d. Floor of the mouth.
e. Hard and soft palate.
f. Alveolar ridges/gingiva (upper and lower).

Either two mouth mirrors or one mirror and the handle of the periodontal probe can be used to retract the tissues. Boxes 37-39 should be used to record the absence, presence, or suspected presence, of the conditions coded 1 to 7 for which examiners can make a tentative diagnosis and to which they should be alert during clinical examinations. Code 8 should be used to record a condition not mentioned in the precoded list, e.g., hairy leukoplakia or Kaposi sarcoma. Whenever possible, the tentative diagnosis should be specified in the space provided.

The codes and criteria are:

0. No abnormal condition.
1. Malignant tumor (oral cancer).
2. Leukoplakia.
3. Lichen planus.
4. Ulceration (aphthous, herpetic, traumatic).
5. Acute necrotizing gingivitis.
6. Candidiasis.
7. Abscess.
8. Other condition (specify if possible).
9. Not recorded.

The main location of the oral mucosal lesion(s) should be recorded in Boxes 40-42 as follows:

0. Vermilion border
1. Commissures
2. Lips
3. Sulci.
4. Buccal mucosa
5. Floor of the mouth.
6. Tongue
7. Hard and/ or soft palate.
8. Alveolar ridges/gingival
9. Not recorded.

Enamel Opacities/Hypoplasia (Boxes 43-52)

The modified developmental defects of enamel (DDE) index are used. Enamel abnormalities are classified into one of three types on the basis of their appearance. They vary in their extent, position on the tooth surface, and distribution within the dentition.

The codes are criteria are as follows:

0. Normal
1. *Demarcated opacity*: In enamel of normal thickness and with an intact surface, there is an alteration in the translucency of the enamel, variable in degree. It is demarcated from the adjacent normal enamel with a distinct and clear boundary and can be white, cream, yellow or brown in color.
2. *Diffuse opacity:* Also an abnormality involving an alteration in the translucency of the enamel, variable in the degree, and white in color. There is no clear boundary between the adjacent normal enamel and the opacity can be linear or patchy or have a confluent distribution.
3. *Hypoplasia:* A defect involving the surface of the enamel and associated with a localized reduction in the thickness of the enamel. It can occur in the form of:(a) pits – single or multiple, shallow or deep, scattered, or in rows arranged horizontally across the tooth surface, (b) grooves – single or multiple, narrow or wide (max.2 mm), or (c) partial or complete absence of enamel over considerable area of dentine. The affected enamel may be translucent or opaque.
4. Other defects.
5. Demarcated and diffuse opacities.
6. Demarcated opacity and hypoplasia.
7. Diffuse opacity and hypoplasia.
8. All three conditions.
9. Not recorded.

Clinical examination: Ten index teeth should be examined on the buccal surfaces only and coded in Boxes 43 to 52. If any index teeth are missing, relevant box(es) should be left blank.

	14	13	12	11	21	22	23	24	
46									36

Buccal surfaces, i.e. from the incisal edges or cuspal points to the gingiva and from the mesial to the distal embrasure, should be inspected visually for defects and, if there is any doubt, areas such as hypoplastic pits should be checked with the periodontal probe to confirm the diagnosis. Any gross plaque or food deposits should be removed and the teeth should be examined in a wet condition.

Specific areas of concern in differentiating between enamel opacities and other charges in dental enamel are: (a) white spot decay, and (b) white cuspal and marginal ridges on premolar and molar teeth and, occasionally, on lateral incisors.

If there is any doubt about the presence of abnormality, the tooth surface should be scored "normal" (Code 0). Similarly, a tooth surface with a single abnormality less than 1 mm in diameter should be scored "0". Any abnormality that cannot be readily classified into one of the three basic types should be scored "other defects" (Code 4). A tooth should be regarded as present once any part of it has penetrated the mucosa and any abnormality present on the erupted portion should be recorded. If more than two-thirds of a tooth surface is heavily restored, badly decayed or fractured, it should not be examined (Code 9).

Dental Fluorosis (Box 53)

Fluorotic lesion are usally bilaterally symmetrical and tend to show a horizontal striated pattern across the tooth. The premolars and second molars are most frequently affected, followed by the upper incisors. The mandibular incisors are least affected.

The examiners should note the distribution pattern of any defects and decide if they are typical of fluorosis. The defects in the "questionable" to "mild" categories (the most likely to occur) may consist of fine white lines or patches, usually near the incisal edges or cusp tips. They are paperwhite or frosted in appearance like a snowcapped mountain and tend to fade into the surroundings enamel.

It is recommended that Dean's index criteria (3) should be used. The recording is made on the basis of two teeth that are most affected. If the two teeth are not equally affected, the score for the less affected of the two should be recorded. When teeth are scored, the examiner should start at the higher end of the index, i.e. "severe", and eliminate each score until he or she arrives at the condition present. If there is any doubt, the lower score should be given.

The codes and criteria are as follows:

0. *Normal:* The enamel surface is smooth, glossy and usually a pale creamy-white color.
1. *Questionable:* The enamel shows slight aberrations from the translucency of normal enamel, which may range from a few white flecks to occasional spots.
2. *Very mild:* Small, opaque, paper-white areas scattered irregularly over the tooth but involving less than 25 percent of the labial tooth surface.
3. *Mild:* The white opacity of the enamel of the teeth is more extensive than for code 2, but covers less than 50 percent of the tooth surface.
4. *Moderate:* The enamel surfaces of the teeth show marked wear and brown stain is frequently a disfiguring feature.
5. *Severe:* The enamel surfaces are badly affected and hypoplasia is so marked that the general form of the tooth may be affected. There are pitted or worm areas and brown stains are widespread. The teeth often have a corroded appearance.
8. Excluded (e.g. a crowned tooth).
9. Not recorded.

Community Periodontal Index (CPI) (Boxes 54-59)

Indicators: Three indicators of periodontal status are used for this assessment: gingival bleeding, calculus and periodontal pockets.

A specially designed lightweight CPI probe with a 0 to 5 mm ball tip is used, with a black band between 3.5 and 5.5 mm and rings at 8.5 and 11.5 mm from the ball tip.

Sextants: The mouth is divided into Sextants defined by tooth numbers: 18 to 14, 13 to 23, 24 to 28, 38 to 34, 33 to 43 and 44 to 48. A sextant should be examined only if there are two or more teeth present which are not indicated for extraction. (Note: This replaces the former instruction to include single remaining teeth in the adjacent sextant.)

Index teeth: For adults aged 20 years and over, the teeth to be examined are:

17	16	11	26	27
47	46	31	36	37

The two molars in each posterior sextant are paired for recording and, if one is missing, there is no replacement. If no index teeth or tooth is present in a sextant qualifying for examination, all the remaining tooth in that sextant are examined and the highest score is recorded as the score for the sextant. In this case, distal surface of third molars should not be scored.

For subjects under the age of 20 years, only six index teeth – 16, 11, 26, 36, 31 and 46 are examined. This

modification is made in order to avoid scoring the deepened sulci associated with eruption as periodontal pockets. For the same reason, when children under the age of 15 are examined, pockets should not be recorded, i.e. only bleeding and calculus should be considered.

Sensing gingival pockets and calculus: An index tooth should be probed, using the probe as a "sensing" instrument to determine pocket depth and to detect subgingival calculus and bleeding response. The sensing force used should be not more than 20 grams. A practical test for establishing this force is to place the probe point under the thumb nail and press until blanching occurs. For sensing subgingival calculus, the lightest possible force that will allow movement of the probe ball tip along the tooth surface should be used.

When the probe is inserted, the ball tip should follow the anatomical configuration of the surface of the tooth root. If the patient feels pain during probing, this is indicative of the use of too much force.

The probe tip should be inserted, gently into the gingival sulcus or pocket and the total extent of the sulcus or pocket explored. For example, the probe is placed in pocket at the distobuccal surface of the second molar, as close as possible to the contact point with the third molar, keeping the probe parallel to the long axis of the tooth. The probe is then moved gently with short upward and downward movement, along the buccal sulcus or the pocket to the mesial surface of the second molar, and from the distobuccal surface of the first molar towards the contact area with the premolar. A similar procedure is carried out for the lingual surfaces, starting distolingually to the second molar.

Examination and Recording

The index teeth or all remaining teeth in a sextant where there is no index tooth should be probed and the highest score is recorded in the appropriate box. The codes are:

0. Healthy.
1. Bleeding observed, directly or by using a mouth mirror, after probing.
2. Calculus detected during probing, but all of the black band on the probe visible.
3. Pocket 4 to 5 mm (gingival margin within the black band on the probe).
4. Pocket 6 mm or more (black band on the probe not visible).

X. Excluded sextant (less than two teeth present).

9. Not recorded.

Loss of Attachment (Boxes 60–65)

Information on loss of attachment may be collected from index teeth in order to obtain an estimate of the lifetime accumulated destruction of the periodontal attachment. This permits comparisons between population groups but is not intended to describe the full extent of loss of attachment in an individual.

The most reliable way of examining for loss of attachment in each sextant is to record this immediately after recording the CPI score for that particular sextant. The highest score for CPI and loss of attachment may not necessarily be found on the same tooth in a sextant.

Loss of attachment should not be recorded for children under the age of 15.

Probing pocket depths gives some indication of the extent of loss of attachment. This measurement is unreliable when there is gingival recession, i.e. when the cementoenamel junction (CEJ) is visible. When the CEJ is not visible and the highest CPI score for a sextant is less than 4 (probing depth less than 6 mm), any loss of attachment for that sextant is estimated to be less than 4 mm (loss of attachment score=0).The extent of loss of attachment is recorded using the following codes.

0. Loss of attachment 0 to 3 mm (CEJ not visible and CPI score 0–3).

If the CEJ is not visible and the CPI score is 4, or if the CEJ is visible :

1. Loss of attachment 4 to 5 mm (CEJ within the black band).
2. Loss of attachment 6 to 8 mm (CEJ between the upper limit of the black band and the 8.5 mm ring).
3. Loss of attachment 9 to 11 mm (CEJ between the 8.5 mm and 11.5 mm rings).
4. Loss of attachment 12 mm or more (CEJ beyond the 11.5 mm ring).

X. Excluded sextant (less than two teeth present).

9. Not recorded (CEJ neither visible nor detectable).

Dentition Status and Treatment Need (Boxes 66–161)

The examination for dental caries should be conducted with a plane mouth mirror. Radiography for detection of approximal caries is not recommended because of the impracticability of using the equipment in all situations.
A tooth should be considered present in the mouth when any part of it is visible. If a permanent and primary tooth occupy the same tooth space, the status of only the permanent tooth should be recorded.

Dentition status. For recording dentition status, Boxes 66–97 are used for upper teeth and Boxes 114–145 for lower teeth. The same boxes are used for recording both primary teeth and their permanent successors. An entry must be made in every box pertaining to coronal and root status. In the case of surveys of children, where the root status is not assessed, a code "9" (not recorded) should be entered in the box pertaining to root status.
Care should be taken to diagnose tooth-colored fillings, which may be extremely difficult to detect.

Codes for the dentition status of primary and permanent teeth (crowns and roots) are given in the table below (Table 15.3):

Table 15.3: Code and Status of primary and permanent teeth

Code			Condition/status
Primary teeth	*Permanent teeth*		
Crown	Crown	Root	
A	0	0	Sound
B	1	1	Decayed
C	2	2	Filled, with decay
D	3	3	Filled, no decay
E	4	-	Missing, as a result of caries
-	5	-	Missing, any other reason
F	6	-	Fissure sealant
G	7	7	Bridge abutment, special crown or Veneer/implant
-	8	8	Unerupted tooth (crown)/ unexposed root
T	T	-	Trauma (fracture)
-	9	9	Not recorded

The criteria for diagnosis and coding (primary tooth codes within parentheses) are:

0 (A) *Sound crown:* A crown is recorded, sound if it shows no evidence of treated or untreated clinical caries. The stages of caries that precede cavitation, as well as other conditions similar to the early stages of caries, are excluded because they cannot be reliably diagnosed. Thus, a crown with the following defects, in the absence of other positive criteria, should be coded as sound:

- White or chalky spots
- Discolored or rough spots that are not soft to touch with a metal CPI probe
- Stained pits or fissures in the enamel that do not have visual signs of undermined enamel, or softening of the floor or walls detectable with a CPI probe
- Dark, shiny, hard, pitted areas of enamel in a tooth showing signs of moderate to severe fluorosis
- Lesions that, on the basis of their distribution or history, or visual/tactile examination, appear to be due to abrasion.

Sound root: A root is recorded as sound when it is exposed and shows no evidence of treated or untreated clinical caries. (Unexposed roots are coded 8).

1 (B) *Decayed crown:* Caries is recorded as present when a lesion in a pit or fissure, or on smooth tooth surface, has an unmistakable cavity, undermined enamel or a detectably softened floor or wall. A tooth with a temporary filling, or one which is not only sealed (code 6 (F)) but also decayed, should also be included in this category. In cases, where the crown has been destroyed by caries and only the root is left, the caries is judged to have originated on the crown and therefore scored as crown caries only. The CPI probe should be used to confirm visual evidence of caries on the occlusal, buccal and lingual surfaces. Where any doubt exists, caries should not be recorded as present.

Decayed root: Caries is recorded as present when a lesion feels soft or leathery to probe with the CPI probe. If the root caries is discrete from the crown and will require a separate treatment, it should be recorded as root caries. For single carious lesions affecting both the crown and the root, the likely site of origin of the lesion should be recorded as decayed. When it is not possible to judge the site of origin, both the crown and the root should be recorded as decayed.

2 (C) *Filled crown with decay*: A crown is considered filled, with decay, when it has one or more permanent restorations and one or more areas that are decayed. No distinction is made between primary and secondary caries, i.e. the same code applies whether or not the carious lesions are in physical association with the restoration(s).

Filled root with decay: A root is considered filled, with decay, when it has one or more permanent restorations and one or more areas that are decayed. No distinction is made between primary and secondary caries.

In the case of fillings involving both the crown and the root, judgment of the site of origin is more difficult. For any restoration involving both the crown and the root with secondary caries, the most likely site of the primary carious lesion is recorded as filled, with decay. When it is not possible to judge the site of origin of the primary carious lesion, both the crown and the root should be recorded as filled, with decay.

3 (D) *Filled crown no decay*: A crown is considered filled, without decay, when one or more permanent restorations are present and there is no caries anywhere on the crown. A tooth that has been crowned because of previous decay is recorded in this category. (A tooth that has been crowned for reasons other than decay, e.g. a bridge abutment, is coded 7 (G)).

Filled root with no decay: A root is considered filled, without decay, when it has one or more permanent restorations and there is no caries anywhere on the root.

In the case of fillings involving both the crown and the root, judgment of the site of origin is more difficult. For any restoration involving both the crown and the root, the most likely site of the primary carious lesion is recorded as filled. When it is not possible to judge the site of origin, both the crown and the root should be recorded as filled.

4(E) *Missing tooth:* It occurs as a result of caries. This code is used for permanent or primary teeth that have been extracted because of caries and is recorded under coronal status. For missing primary teeth, this score should be used only if the subject is at an age when normal exfoliation would not be a sufficient explanation for absence.

Note: The root status of a tooth that has been scored as missing because of caries should be coded "7" or "9".

In some age groups, it may be difficult to distinguish between unerupted teeth (Code 8) and missing teeth (Codes 4 or 5). Basic knowledge of tooth eruption patterns, the appearance of the alveolar ridge in the area of the tooth space in question, and the caries status of other teeth in the mouth may provide helpful clues in making a differential diagnosis between unerupted and extracted teeth. Code 4 should not be used for teeth judged to be missing for any reason other than caries. For convenience, in fully edentulous arches, a single "4" should be placed in boxes 66 and 81 and/or 114 and 129 as appropriate, and the respective pairs of numbers linked with straight lines.

5 (-) *Permanent tooth missing, for any other reason:* This code is used for permanent teeth judged to be absent congenitally or extracted for orthodon-tics reasons or because of periodontal disease, trauma, etc.

As for code 4, two entries of code 5 can be linked by a line in cases of fully edentulous arches.

Note: The root status of a tooth scored 5 should be coded "7" or "9".

6 (F) *Fissure sealant:* This code is used for teeth in which a fissure sealant has been placed on the occlusal surface, or for teeth in which the occlusal fissure has been enlarged with a rounded or "Flame-shaped" bur, and a composite material placed. If a tooth with a sealant has decay, it should be coded as 1 or B.

7 (G) *Bridge abutment, special crown or veneer:* This code is used under coronal status to indicate that a tooth forms part of a fixed bridge, i.e. is a bridge abutment. This code can also be used for crowns placed for reasons other than caries and for veneers or laminates covering the labial surface of a tooth on which there is no evidence of caries or a restoration.

Note: Missing teeth replaced by bridge pontics are coded 4 or 5 under coronal status, while root status is scored 9.

Implant: This code is used under root status to indicate that an implant has been placed as an abutment.

8 (-) *Unerupted crown:* This classification is restricted to permanent teeth and used only for a tooth space with an unerupted permanent tooth but without a primary tooth. Teeth scored as unerupted are excluded from all calculations concerning dental caries. This category does not include congenitally missing teeth, or teeth lost as a result of trauma, etc. For differential diagnosis between missing and unerupted teeth, see code 5.

Unexposed root: This code indicates that the root surface is not exposed, i.e. there is no gingival recession beyond the CEJ.

T (T) *Trauma (fracture):* A crown is scored as fractured when some of its surface is missing as a result of trauma and there is no evidence of caries.

9 (-) *Not recorded:* This code is used for any erupted permanent tooth that can not be examined for any reason (e.g. because of orthodontics bands, severe hypoplasia, etc.)

This code is used under root status to indicate either that tooth has been extracted or that calculus is present to such an extent that a root examination is not possible.

Treatment Needs of Individual Teeth

Treatment requirement should be assessed for the whole tooth, including both coronal and root caries. Immediately after the status of a tooth is recorded, the type of treatment required, if any, should be recorded (Boxes 98 – 113 and 146 – 161). If no treatment is required, code "0" should be placed in the appropriate treatment box.

The codes and criteria for treatment needs are:

0 – None (no treatment). This code is recorded if a crown and a root are both sound, or if it is decided that a tooth should not receive any treatment.

P – Preventive, caries arresting care.

F – Fissure Sealant.

1 – One surface filling.

2 – Two or more surface filling.

One of the codes P, F, 1 or 2 should be used to indicate the treatment required to:

- Treat initial, primary or secondary caries
- Treat discoloration of a tooth, or a developmental defect
- Treat lesions due to trauma, abrasion, erosion or attrition
- Replace unsatisfactory fillings or sealant.

A sealant is considered unsatisfactory, if partial loss has extended to exposure of a fissure, pit, or junction or surface of the dentine which, in the examiner's opinion, requires resealing.

A filling is considered unsatisfactory if one or more of the following condition exist:

- A deficient margin to an existing restoration that has leaked or is likely to permit leakage into the dentine. The decision as to whether a margin is deficient should be based on the examiner's clinical judgement, on evidence gained from the insertion of a CPI probe at the margin, or on the presence of the severe staining of the tooth structure.
- An overhanging margin of an existing restoration that causes obvious local irritation to the gingivae and cannot be removed by recontouring of the restoration.
- A fracture of an existing restoration that either causes it to be loose or permits leakage into the dentine.
- Discoloration

3 – Crown for any reason.
4 – Veneer or laminate (may be recommended for aesthetic purposes).
5 – Pulp care and restoration. This code is used to indicate that a tooth probably needs pulp care prior to restoration with a filling or crown because of deep and extensive caries, or because of tooth mutilation or trauma.
Note: A probe should never be inserted into the depth of a cavity to confirm the presence of a suspected pulp exposure.
6 – Extraction. A tooth is recorded as "indication on for extraction", depending on the treatment possibilities available, when:
- caries has so destroyed the tooth that it cannot be restored
Periodontal diseases has progressed so far that the tooth is loose, painful or functionless and, in the clinical judgement of the examiner, cannot be restored to a functional state
- a tooth needs to be extracted to make way for a prosthesis, or
- extraction is required for orthodontics or cosmetic reasons, or because of impaction.

7/8-Need for other care. The examiner should specify the types of care for which codes 7 and 8 are used. The use of these two codes should be kept to minimum.
9 - Not recorded.

Prosthetic Status (Boxes 162 and 163)

The presence of prostheses should be recorded for each jaw (Box 162, upper jaw; Box 163, lower jaw). The following codes are provided for this:
0 – No prosthesis.
1 – Bridge.
2 – More than one bridge.
3 – Partial denture.
4 – Both bridge(s) and partial denture(s).
5 – Full removable denture
9 – Not recorded.

Prosthetic Need (Boxes 164 and 165)

A recording should be made for each jaw on the perceived need for prostheses (Box 164, upper jaw; Box 165 lower jaw), according to the following codes.
0. No prosthesis needed.
1. Need for oneunit prosthesis (one tooth replacement).
2. Need for multiunit prosthesis (more than one tooth replacement).
3. Need for a combination of one and/or multiunit prosthesis.
4. Need for full prosthesis (replacement of all teeth).
9. Not recorded.

Dentofacial Anomalies (Boxes 166 – 176)

Dental Aesthetic Index (DAI) criteria (4) are used. It is recommended that this index should be used for age groups in which there are no longer primary teeth, usually from 12 years.
Missing incisor, canine and premolar teeth (Boxes 166 and 167): The number of missing permanent incisor, canine and premolar teeth in the upper and lower arches should be counted
Crowding in the incisal segments (Box 168): Both the upper and the lower incisal segments should be examined for crowding. Crowding in the incisal segments is the condition in which the available space between the right and left canine teeth is insufficient to accommodate all four incisors in normal alignment.
0. No crowding.
1. One segment crowded.
2. Two segments crowded.

If there is any doubt, the lower score should be assigned
Spacing in the incisal segments (box 169): Both the upper and lower incisal segments should be examined for spacing. When measured in the incisal segments, spacing is the condition in which the amount of space available between the right and left canine teeth exceeds that required to accommodate all four incisors in normal alignment. Spacing in the incisal segments is recorded as follows:
0. No spacing.
1. One segment spaced.
2. Two segments spaced.

If there is any doubt, the lower score should be assigned.
Diastema (Box 170): A midline diastema is defined as the space, in millimeters, between the two permanent maxillary incisors at the normal position of the contact points.
Largest anterior maxillary irregularity (Box 171): Irregularities may be either rotations out of, or displacements from, normal alignment. The four incisors in the upper (maxillary) arch should be examined to locate the greatest irregularity
Largest anterior mandibular irregularity (Box 172): The measurement is the same as on the upper arch except that it is made on the lower (mandibular) arch.
Anterior maxillary overjet (Box 173): Measurement of the horizontal relation of the incisors is made with the teeth in centric occlusion. The distance from the labial-incisal edge of the most prominent upper incisor to the labial surface of the corresponding lower incisor is measured with the CPI probe parallel to the occlusal plane
Anterior mandibular overjet (Box 174): Mandibular overjet is recorded when any lower incisor protrudes anteriorly or labially to the opposing upper incisor, i.e. is in crossbite.
Vertical anterior open bite (Box 175): If there is a lack of vertical overlap between any of the opposing pairs of incisor

(openbite), the amount of openbite is estimated using the CPI probe.

Anteroposterior molar relation (Box 176): This assessment is most often based on the relation of the permanent upper and lower first molars. If the assessment cannot be based on the first molars because one or both are absent, not fully erupted, or mishappen because of extensive decay or fillings, the relations of the permanent canines and premolars are assessed.

The following codes are used:

0. Normal.
1. Half cusp: The lower first molar is half a cusp mesial or distal to its normal relation.
2. Full cusp: The lower first molar is one cusp or more mesial or distal to its normal relation.

Need for Immediate Care and Referral (Boxes 177– 180)

It is the responsibility of examiner or team leader to ensure that referral to an appropriate care facility is made, if needed.

There is a need for immediate care if pain, infection or serious illness will result unless treatment is provided within a certain period of time. This period may vary from a few days to a month, depending on the availability of oral health services.

OBTAINING ASSISTANCE FROM WHO

WHO offers assistance whenever possible, either directly or through one of its collaborating centers.

Pre-survey Assistance

WHO assists with survey planning, in particular with advice on the sampling plan and use of the standard assessment form if requested. The aims of such assistance are to foster the use of uniform survey methods and to help investigators develop objectives and survey plans to meet their specific needs. When seeking pre-survey assistance from WHO investigators are requested to provide the following information:

- Name and address of the principal investigator
- Area(s) and region(s) to be surveyed
- Estimates of the total population, the number or percentage of the school age population and the number or percentage of those who attend school
- Estimates of the levels of caries, periodontal disease and other oral conditions for the ages under consideration (previous survey data should be provided if available)
- Important subgroups or divisions within the population, including the urban: rural population ratio, ethnic groups, socioeconomic levels.

Assistance in training and calibration may, under certain circumstances, be available from WHO.

Post-survey Assistance

WHO may also assist with the summary and analysis of data derived from the use of procedures recommended in the manual, provided that the standard format and coding have been used.

POST SURVEY ACTION AND PREPARATION OF SURVEY REPORTS

Sending Forms for Analysis

It is strongly recommended that completed assessment forms should be photocopied and stored separately as a safeguard against loss.

At the end of each day of the survey, the principal investigator should ensure that all the forms are assembled in numerical order (by registration number) to facilitate checking. It is not necessary to sort the forms by location or age group, as this will be done by the computer.

Preparation of Survey Reports

The report of the survey should usually contain the following information:

a. *Statement of the purposes of the survey:* This statement should include a concise and clear description of the aims of the survey and the expected ways in which the result will be used.
b. *Materials and methods:* Under this heading, it is customary to include the following:
   - *Area and population surveyed:* A general description of the geographical region and of people examined is required
   - *The nature of the information collected and the methods used:* A description is required of the type of the information collected and of the methods used to collect the data used, e.g. questionnaire, interview or clinical examination. It is also essential to indicate the year of data collection
   - *Sampling Method:* An explanation should be given of the method of sampling that was used, the size of the total samples and sub-samples, and the extent to which the sample is considered representative of the study population. The number and description of persons who were selected for the samples but not examined, and any sampling problems encountered should be reported
   - *Personnel and physical arrangements:* It is desirable to give a brief account of the physical arrangement at the examination sites, the equipment used, and the organization, training and experience of the personnel employed in collecting, processing and tabulating the data. Arrangement made for standardization and

calibration of examiners and for checking the consistency of examiners during the course of survey should be described

- *Statistical analysis and computational procedure:* The statistical methods used in compiling the final summary table from the raw data should be described briefly or references given. For example, reference can be made to methods described in this manual, where appropriate
- *Cost analysis:* Information on survey expenses is of considerable interest. Reporting of cost of planning, calibration examinations, field work, supervision, statistical analysis, salaries and overheads facilitates the critical evaluation of survey methods and provide useful economic data
- *Reliability and reproducibility of the results:* It is important to include data or interexaminer and intraexaminer variability as revealed by pre-survey calibration examination and duplicate examination conducted during the course of the survey. The information gives the planner for the area and the reader of the report an indication of the degree of examiner error that may apply to any of the result.

c. *Results:* Results may be presented in several ways. Conciseness is important. The text should contain a short description of the more important results and summary tables.

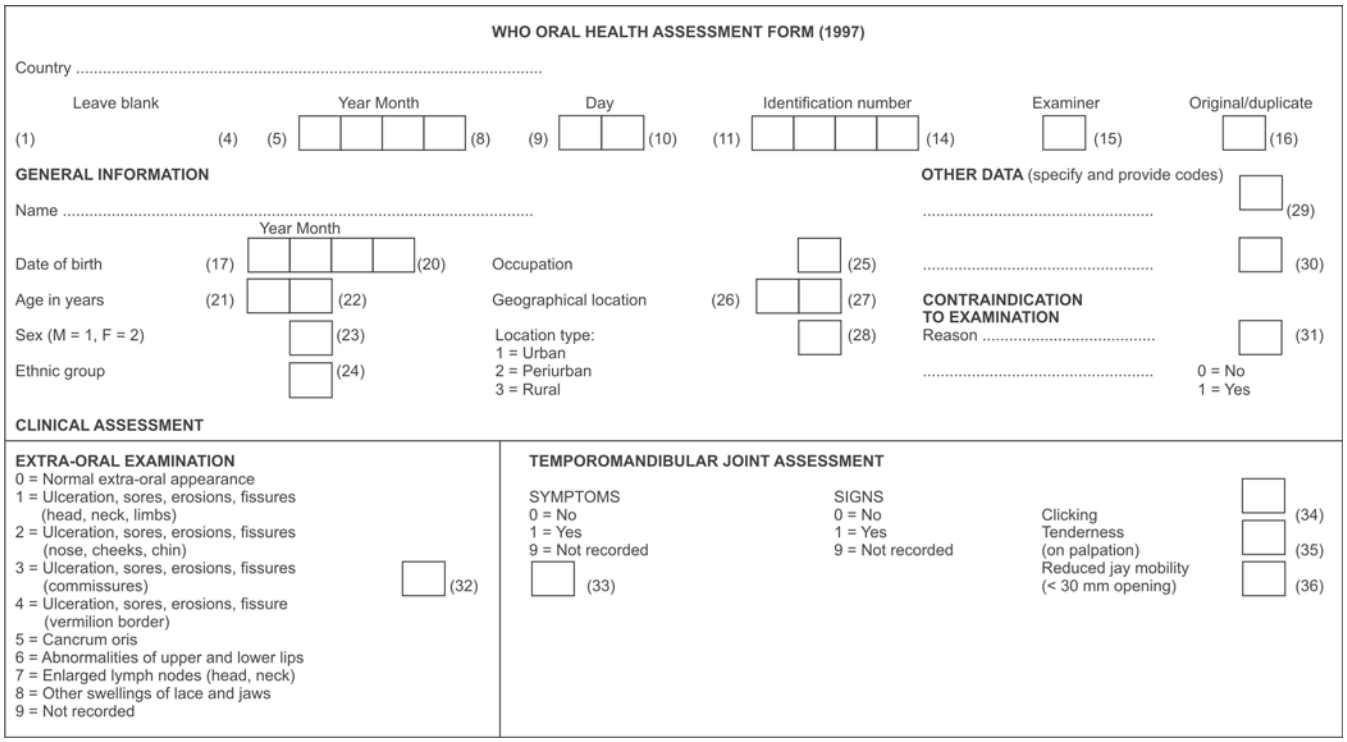
A few diagrams like graphs, histograms, bar-charts or pie-charts may be used to illustrate points that are neither easily explained in the text, nor easily visualized from tables. A cardinal rule for both figures and tables is that they should be clearly labeled, so that they are readily comprehensible without reference to the text.

The basic summary tables provided by the WHO standard program address two main areas – oral health status and treatment needs of the population.

d. *Discussion and conclusion:* The result of the survey should be discussed under two headings:

- The oral health status of the population should be compared with data from previous surveys of the same population. If such data are unavailable, comparison may be made with results of surveys in similar or neighboring populations
- Treatment needs of the population examined should be reported together with a brief discussion of the different treatment approached possible, and of the implications of each approach for the future oral health status of the population.

e. *Summary or abstract:* A brief summary of the report is required, of a suitable length for use as an abstract. The objectives of the study and the number of people examined should be stated and a few of the more important results given for caries and periodontal diseases in two or three age groups for the whole sample, e.g. the proportion of subjects affected by caries and the proportion with bleeding and/or calculus and pocketing may be included. Any unusual or unexpected results obtained should be noted.



WHO ORAL HEALTH ASSESSMENT FORM (1997)

Country .....

Leave blank (1) (4) | Year Month (5) ☐☐☐☐ (8) | Day (9) ☐☐ (10) | Identification number (11) ☐☐☐☐ (14) | Examiner ☐ (15) | Original/duplicate ☐ (16)

GENERAL INFORMATION

Name .....

Date of birth (Year Month) (17) ☐☐☐☐ (20)

Age in years (21) ☐☐ (22)

Sex (M = 1, F = 2) ☐ (23)

Ethnic group ☐ (24)

Occupation ☐ (25)

Geographical location (26) ☐☐ (27)

Location type: 1 = Urban 2 = Periurban 3 = Rural ☐ (28)

OTHER DATA (specify and provide codes)

..... ☐ (29)

..... ☐ (30)

CONTRAINDICATION TO EXAMINATION

Reason ..... ☐ (31)

..... 0 = No 1 = Yes

CLINICAL ASSESSMENT

EXTRA-ORAL EXAMINATION

0 = Normal extra-oral appearance
1 = Ulceration, sores, erosions, fissures (head, neck, limbs)
2 = Ulceration, sores, erosions, fissures (nose, cheeks, chin)
3 = Ulceration, sores, erosions, fissures (commissures)
4 = Ulceration, sores, erosions, fissure (vermilion border)
5 = Cancrum oris
6 = Abnormalities of upper and lower lips
7 = Enlarged lymph nodes (head, neck)
8 = Other swellings of lace and jaws
9 = Not recorded

☐ (32)

TEMPOROMANDIBULAR JOINT ASSESSMENT

SYMPTOMS
0 = No
1 = Yes
9 = Not recorded
☐ (33)

SIGNS
0 = No
1 = Yes
9 = Not recorded

Clicking ☐ (34)
Tenderness (on palpation) ☐ (35)
Reduced jay mobility (< 30 mm opening) ☐ (36)

ORAL MUCOSA

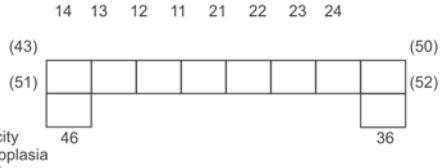
CONDITION
0 = No abnormal condition
1 = Malignant tumour (oral cancer)
2 = leukoplakia
3 = Lichen planus
4 = Ulceration (aphthous, herpetic, traumatic)
5 = Acute necrotizing gingivitis
6 = Candidiasis
7 = Abscess
8 = Other condition (specify if possible) .....
9 = Not recorded

(37) ☐ ☐ (40)
(38) ☐ ☐ (41)
(39) ☐ ☐ (42)

LOCATION
0 = Vermilion border
1 = Commissures
2 = Lips
3 = Sulci
4 = Buccal mucosa
5 = Floor of mouth
6 = Tongue
7 = Hard and/or soft palate
8 = Alveolar ridges/gingiva
9 = Not recorded

ENAMEL OPACITIES/HYPOPLASIA

Permanent teeth
0 = Normal
1 = Demarcated opacity
2 = Diffuse opacity
3 = Hypoplasia
4 = Other defects
5 = Demarcated and diffuse opacity
6 = Demarcated opacity and hypoplasia
7 = Diffuse opacity and hypoplasia
8 = All three conditions
9 = Not recorded



DENTAL FLUOROSIS

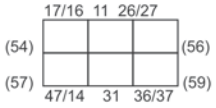
0 = Normal
1 = Questionable
2 = Very mid
3 = Mild
4 = Moderate
5 = Severe
8 = Excluded
9 = Not recorded

☐ (53)

COMMUNITY PERIODONTAL INDEX (CPI)

0 = Healthy
1 = Bleeding
2 = Calculus
3 = Pocket 4 – 5 mm (black band on probe partially visible)
4 = Pocket 6 mm or more (black band on probe not visible
X = Excluded sextant
9 = Not recorded

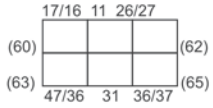
* Not recorded under 15 years of age



LOSS OF ATTACHMENT

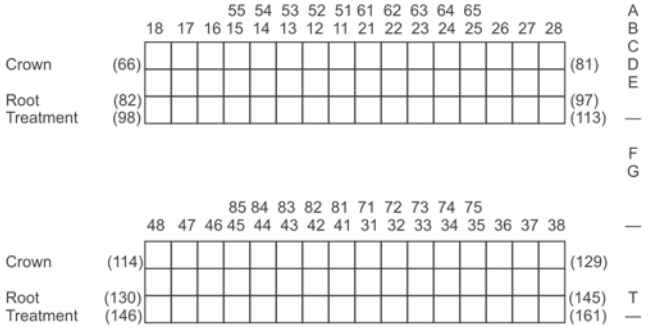
0 = 0 – 3 mm
1 = 4 – 5 mm (cementoenamel junction (CEJ) within black band)
2 = 6 – 8 mm (CEJ between upper limit of black band and 8.5 mm rings)
3 = 9 – 11 mm (CEJ between 8.5 mm and 11.5 mm rings)
4 = 12 mm or more (CEJ beyond 11.5 mm ring)
X = Excluded sextant
9 = Not recorded

* Not recorded under 15 years of age



DENTITION STATUS AND TREATMENT NEED

Identification number ☐☐☐☐



	Primary teeth *Crown*	Permanent teeth *Crown*	Permanent teeth *Root*	STATUS	TREATMENT
	A	0	0	Sound	0 = None
	B	1	1	Decayed	P = Preventive, caries-arresting care
	C	2	2	Filled, with decay	F = Fissure sealant
	D	3	3	Filled, no decay	1 = One surface filling
	E	4	—	Missing, as a result of caries	2 = Two or more surface fillings
	—	5	—	Missing, any other reason	3 = Crown for any reason
	F	6	—	Fissure sealant	4 = Veneer of laminate
	G	7	7	Bridge abutment, special crown crown or veneer/implant	5 = Pulp care and restoration
	—	8	8	Unerupted tooth, (crown)/unexposed root	6 = Extraction
					7 = Need for other care (specify).....
					8 = Need for other care (specify).....
	T	T	—	Trauma (fracture)	
	—	9	9	Not recorded	9 = Not recorded

PROSTHETIC STATUS

Upper Lower
(162) ☐☐ (165)

0 = No prosthesis
1 = Bridge
2 = More than one bridge
3 = Partial denture
4 = Both bridge(s) and partial denture(s)
5 = Full removable denture
9 = Note recorded

PROSTHETIC NEED

Upper Lower
(164) ☐☐ (165)

0 = No prosthesis needed
1 = Need for one-unit prosthesis
2 = Need for multi-unit prosthesis
3 = Need for a combination of one-and/or multi-unit prosthesis
4 = Need for full prosthesis (replacement of all teeth)
9 = Not recorded

DENTOFACIAL ANOMALIES

DENTITION

(166)(167)Missing incisor, canine and premolar teeth—maxiliary and mandibular—enter number of teeth

SPACE

☐ (165) Crowding in the incisal segments:
0 = No crowding
1 = One segment crowded
2 = Two segments crowded

☐ (169) Spacing in the incisal segments:
0 = No spacing
1 = One segment spaced
2 = Two segments spaced

☐ (170) Diastema in mm

☐ (171) Largest anterior maxiliary irregularity in mm

☐ (172) Largest anterior mandibular irregularity in mm

OCCLUSION

☐ (173) Anterior maxillary overjet in mm

☐ (174) Anterior mandibular overjet in mm

☐ (175) Vertical anterior openbite in mm

☐ (176) Anterio-posterior molar relation:
0 = Normal
1 = Half cusp
2 = Full cusp

NEED FOR IMMEDIATE CARE AND REFERRAL

Life-threatening condition ☐ (177)
Pain or infection ☐ (178)
Other condition (specify) ..... ☐ (179)

0 = Absent
1 = Present
9 = Not recorded

Referral
0 = No
1 = Yes
9 = Not recorded

☐ (180)

NOTES

16 Dental Indices

CM Marya

Dental indices provide a quantitative method for measuring, scoring, and analyzing dental conditions in individuals and groups. An index describes the status of individuals or groups with respect to the condition being measured. It is an objective mathematical description of a disease or condition based on carefully determined criteria under specified circumstances.

Oral health surveys depend on dental indices, as do researchers and clinicians, to help in understanding trends and patient's needs. In epidemiological oral health surveys, an index is used to show the prevalence and incidence of a particular condition, to provide baseline data, to assess the needs of a population, and to evaluate the effects and results of a community program. Researchers use indices to determine baseline data and to measure the effectiveness of specific agents, interventions, and mechanical devices. In private practice, index scores are used to educate, motivate, and evaluate the patient. By comparing scores from the initial exam during a follow-up exam, the patient can measure the effects of personal daily care.

The first dental index, developed by Schour and Massler, was known as a Papilla, Marginal gingiva and Attached gingiva (PMA) Index. Each of those areas was examined and scored from 0 to 5, depending on the severity of inflammation. The PMA Index, largely of historic interest now, was primarily used in surveys of acute gingivitis. The status of a patient's periodontal health or disease is commonly measured by an index in private practices. One of the most widely used is the Periodontal Screening and Recording (PSR) TM Index, adapted in 1992 from a system in use in Europe called the Community Periodontal Index of Treatment Needs. The PSRTM is an early detection system for periodontal disease. It is not intended to replace full periodontal charting, but to serve as a simple and convenient screening tool.

Today, dental indices are used to assess both individual and group oral health and disease status. They can be simple, measuring only the presence or absence of a condition, or they can be cumulative, measuring all evidence of a condition, past and present. Irreversible indices measure conditions that will not change, such as dental caries. A reversible index measures conditions that can be changed, such as the amount of bacterial plaque present.

DEFINITION

An index is defined as a numerical value describing the relative status of a population on a graduated scale with definite upper and lower limits, which is designed to permit and facilitate comparison with other populations classified by the same criteria and methods (AL Russell).

Professional Implications

Dental professionals from the private practice clinician to the researcher use indices to benefit their patients. A dentist or hygienist might use a PI to impress upon a patient the need for better oral hygiene. A World Health Organization researcher might use the same index to assess the home care practices of a population. Indices will continue to be important and necessary tools for dental professionals.

PROPERTIES OF AN IDEAL INDEX

1. *Reliability:* It should be able to measure consistently at different times and under a variety of conditions. The term is synonymous with reproducibility, repeatability that is, if a researcher examined the same patient with the same condition multiple times, each times the score or results would be the same.
2. *Validity:* It should measure what it is intended to measure. It should accurately reflect the extent or degree to which the condition or disease is present.
3. *Clarity, simplicity and objectivity:* The examiner should be able to remember the criteria. Index should be easy to apply. The criteria should be clear and simple.
4. *Quantifiability:* The index should be amenable to statistical analysis, so that status of a group can be expressed by a statistical measure. For example, mean, median.
5. *Acceptability:* The use of an index should not be painful and demeaning to the subject.

6. *Sensitivity:* The index should be able to detect reasonably small shifts, in either direction in the condition.

TYPES OF INDICES

Simple index: It is the one which measures the presence or absence of a condition. For example, an index which measures the presence of plaque without evaluating its effects on the gingiva.

Cumulative index: It is the one which measures all the evidence of a condition (past and present). An example is DMFT index for dental caries.

Irreversible index: An index which measures the conditions that will not change. For example, a dental caries index.

Reversible index: One that measures conditions that can be changed or reversed.

Full mouth indices: These indices measure the patient's entire periodontium or dentition e.g. Russell's periodontal index.

*Simplified indices:*These indices measure only representative samples of dental apparatus e.g. Green and Vermillion's simplified oral hygiene index (OHI-S).

Indices are also classified in general categories according to the entity which they measure

1. Disease index: e.g. 'D' (Decay) portion of the DMF index is the best example for disease index.
2. Symptom index: e.g. measuring gingival or sulcular bleeding are essentially examples for symptom indices.
3. Treatment index: e.g. the 'F' (Filled) portion of DMF index is best example for treatment index.

PURPOSE AND USES OF AN INDEX

Indices can be used for individual assessment, for clinical trials or epidemiological surveys as shown in Table 16.1.

IDEAL REQUISITES OF AN INDEX

- Should be simple to use and calculate
- Uses a minimal amount of time to complete
- Does not cause discomfort to the patient
- Is acceptable to the patient
- Requires minimum equipment and expense
- Has clear-cut criteria that are easily understood
- Is reproducible in assessing the condition by the same or different examiner
- *Should be realistic:* It should relate numerically to the clinical stages of the specific disease.

In addition to measuring a patient's periodontal status, dental indices can measure the amount of plaque and calculus present or not present in a patient's mouth, the amount of bleeding present in the gingiva, the amount of tooth mobility present at a given time, the amount of fluorosis present, and the number of decayed, missing, or filled teeth present.

RECOMMENDED METHOD OF PERFORMANCE OF AN INDEX

- Explain procedure to patient/client.
- Drape patient/client.
- Give patient/client protective eyewear.
- Wash hands.
- Don PPE. (Personal protective equipment)
- Position patient/client in reclined position in dental chair.
- Adjust dental light for maximum illumination.
- Apply lubricant gel to patient/client's lips and opaque colored restorations.
- Dry teeth with compressed air using recommended sequence.
- Carry out the index.

Table 16.1: Purpose and uses of an index

Type	*Uses*
Individual assessment	Evaluation and monitoring the progress and maintenance of oral health. Measures effects of personalized disease control programs overtime. Monitors progress of disease healing. Patient education and motivation Provides individual assessment to help patient to recognize an oral problem
Clinical trial Determines the effect of an agent or procedure on the prevention, progression, or control of a disease	Comparison of an experimental group with a control group Determines baseline data before the experimental factors are introduced Measures the effectiveness of specific agents used for prevention, control and treatment of oral conditions. Measures the effectiveness of mechanical devices used for personal care, i.e. toothbrushes, interdental cleaning aids.
Community health/ epidemiologic survey Survey for the study of disease characteristics of populations	Not designed for evaluation of an individual patient Measures the prevalence and incidence of a oral condition occurring within a population Provides baseline data to show existing dental health practices Compares the effects of a community program and evaluates the results Finds out the needs of a community

INDICES COMMONLY USED IN DENTISTRY (BOX 16.1)

Periodontal Indices

There are 4 main areas in periodontal disease for which indices are required:

a. Plaque or soft deposits on teeth
b. Calculus
c. Gingivitis
d. Periodontal destruction or loss of attachment
   - Dental caries
   - Fluorosis
   - Malocclusion

BOX 16.1: INDICES USED IN DENTISTRY

1. *Indices used in assessing oral hygiene:*
   a. Oral hygiene index.
   b. Simplified oral hygiene index.
   c. Modified patient hygiene performance index.
   d. Plaque free score index.
   e. Plaque control record.
   f. Oral health status index.
2. *Indices used in assessing plaque and debris:*
   a. Plaque component of the periodontal disease index.
   b. Schick and Ash modification of plaque criteria.
   c. Turseky-Gilmore-Glickman modification of the Quigley Hein plaque index.
   d. Plaque index.
   e. Modified navy plaque index.
   f. Distal mesial plaque index.
3. *Indices used in assessing calculus:*
   a. Calculus surface index.
   b. Calculus surface severity index.
   c. Marginal line calculus index.
   d. Calculus component of the periodontal disease index.
   e. Probe method of calculus assessment.
4. *Indices used in assessing gingival inflammation*
   a. Papillary marginal attachment index.
   b. Gingivitis component of the periodontal disease index.
   c. Gingival index.
   d. Papillary marginal gingivitis index.
   e. Modified gingival index.
   f. Gingival tissue index.
   g. Gingival pain index.
5. *Indices used in assessing gingival bleeding:*
   a. Sulcus bleeding index.
   b. Papillary bleeding index.
   c. Gingival bleeding index.
   d. Interdental bleeding index.
   e. Gingival status index.
   f. Bleeding points index.
   g. Quantitative gingival bleeding index.
   h. Gingival fluid flow index.
6. *Indices used in assessing periodontal diseases:*
   a. Periodontal index.
   b. CPITN.
   c. CPI.
   d. Periodontal disease index.

Contd...

Contd...

   e. Gingival bone count index.
   f. Navy periodontal disease index.
   g. Gingivitis periodontitis missing teeth index.
   h. Periodontitis severity index.
   i. Extent and severity index.
   j. Gingival sulcus measurement component of periodontal disease index.
   k. Periodontal screening and recording index.
7. *Indices used in assessing dental caries:*
   a. DMFT index.
   b. DMFS index.
   c. def index.
   d. Root caries index.
   e. Modified DMFT index.
   f. Caries Severity index.
   g. Czechoslovakia caries index.
   h. DMF surface percentage index.
   i. Functional measure index.
   j. Dental health index.
   k. WHO dentition status.
   l. Restorative Index.
8. *Indices used in assessing dental fluorosis:*
   a. Dean's fluorosis index.
   b. Moller's fluorosis index.
   c. Chronological fluorosis assessment index.
   d. Fluorosis risk index.
   e. Young's classification.
   f. Al-alomsi classification.
   g. Murray and Shaw classification.
   h. The FDI index.
   i. Thylstrup Fejerskov fluorosis index.
   j. Tooth surface index of fluorosis.
9. *Indices used in assessing malocclusion*
   a. Malalignment index.
   b. Handicapping malocclusion assessment index.
   c. Occlusal feature index.
   d. Occlusal index.
   e. Index of orthodontic treatment needs.
   f. Norwegian index of orthodontic treatment needs.
   g. Handicapping labiolingual deviation index.
   h. Massler and Frankel index.
   i. Peer assessment rating index.

Some of the more widely known indices are:

PERIODONTAL INDICES

Plaque Index (PI)

The PI as developed by Silness and Loe (1964) assesses the thickness of plaque at the cervical margin of the tooth (closest to the gum). Four areas, distal, facial or buccal, mesial, and lingual, are examined.

- Each tooth is dried and examined visually using a mirror, an explorer, and adequate light. The explorer is passed over the cervical third to test for the presence of plaque. A disclosing agent may be used to assist evaluation.
- Missing teeth are not substituted.
- Four different scores are possible.

- Each of the four surfaces of the teeth (buccal, lingual, mesial and distal) is given a score from 0 to 3.

PI Score for Tooth

The scores from the four areas of the tooth are added and divided by four in order to give the plaque index for the tooth with the following scores and criteria:

Scoring Criteria: The Plaque Index

Scores	*Criteria*
0	No plaque
1	A film of plaque adhering to the free gingival margin and adjacent area of the tooth. The plaque may be seen in situ only after application of disclosing solution or by using the probe on the tooth surface.
2	Moderate accumulation of soft deposits within the gingival pocket, or the tooth and gingival margin which can be seen with the naked eye.
3	Abundance of soft matter within the gingival pocket and/or on the tooth and gingival margin.

The indices for the following six teeth may be grouped to designate the index for the group of teeth: 16, 12, 24, 36, 32, and 44. (Fig. 16.1).

PI for an Individual

The index for the patient is obtained by summing the indices for all six teeth and dividing by six

Interpretation for PI Scores

Four ratings may be assigned:

0 = Excellent oral hygiene
0.1-0.9 = Good oral hygiene
1.0-1.9 = Fair oral hygiene
2.0-3.0 = Poor oral hygiene

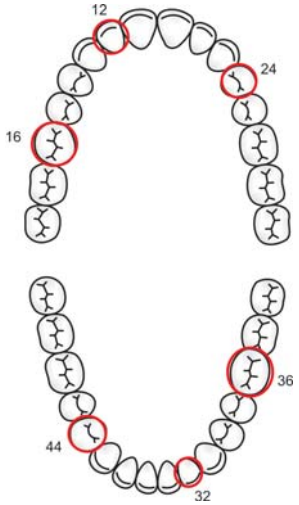


Fig. 16.1: Teeth and surfaces scored (Silness and Loe PI)

PLAQUE CONTROL RECORD

It was given by O'Leary, Drake TJ, and Naylor JE (1972). This system measures plaque present, rather than plaque not present, but no attempt is made to differentiate in the quantity of plaque seen on each surface.

Selection of Teeth and Surfaces

- All teeth are examined.
- Missing teeth are indicated on the record form as a single thick horizontal line.
- Four surfaces are examined: facial, lingual, mesial and distal.
- The number of surfaces examined may be increased from four to six. When using six surfaces, they are facial (or buccal), mesiofacial, mesiolingual, lingual, distolingual, and distofacial.

Procedure

Plaque is disclosed by either applying disclosing agent or the patient is asked to chew disclosing tablet and swish and rub the solution over the tooth surfaces with the tongue before rinsing. Each tooth surface is examined for plaque at the gingival margin and recording is done.

Scoring

For individual: The number of surfaces with plaque is multiplied by 100, and divided by the number of tooth surfaces examined.

Percent with plaque =

$$\frac{\text{The number of surfaces with plaque}}{\text{Number of tooth surfaces examined}} \times 100$$

For example, if an individual has 26 teeth, that equals 104 surfaces.

If eight surfaces are found to have plaque, then 800 are divided by 104, leaving a plaque control index of 7.6 percent.

A score under 10% is considered good.

NAVY PLAQUE INDEX

The Navy Plaque Index (NPI) was developed by Grossman FD and Fedi PF (1970) as part of the Navy Periodontal Screening Examination, along with the Navy Periodontal Disease Index. It reflects the plaque control status of the patient and emphasizes plaque in the cervical portion of the tooth which is in contact with the gingiva margins.

Teeth Examined

16 - Maxillary Right First Molar
21 - Maxillary Left Central Incisor

24 - Maxillary Left First Premolar
36 - Mandibular Left First Molar
41 - Mandibular Right Central Incisor
44 - Mandibular Right First Premolar

Substitutions

If 16, 24, 36 or 44 are missing, then substitute the next most posterior tooth.

If 21 or 41 are missing, then substitute the nearest incisor in the arch. If all incisors are missing from the arch, then substitute a cuspid.

Surfaces Examined on Each Tooth

Facial gingival area (G) mesial proximal area (M) distal proximal area (D)

Lingual gingival area (G) mesial proximal area (M) distal proximal area (D).

SCORING CRITERA—NPI

Plaque status	*Designated*	*Points*
Plaque in contact with gingival tissue on mesial proximal surface	M	3
Plaque in contact with gingival tissue on facial or lingual surface	G	2
Plaque in contact with gingival tissue on distal proximal surface	D	3
Plaque on facial or lingual surface of tooth surface but not in contact with gingival tissue	R	1

For Each Tooth

Facial points = (M points on facial aspect) + (G points on facial aspect) + (D points on facial aspect) + (R points on facial aspect)

Lingual points = (M points on lingual aspect) + (G points on lingual aspect) + (D points on lingual aspect) + (R points on lingual aspect)

Calculating the NPI

Tooth score = (facial points) + (lingual points)
NPI score = MAX (all 6 tooth scores)
NPI total = SUM (all 6 tooth scores)

Interpretation

Minimum score for a surface : 0
Maximum score for a surface : 9
Minimum tooth score : 0
Maximum tooth score : 18
Maximum NPI score : 18
Minimum NPI total : 0

ORAL HYGIENE INDEX (OHI)

The OHI, developed by John C Greene and Jack R Vermillion (1960), has two components, the debris index and the calculus index, and is an indication of oral cleanliness. The scores may be used singly or in combination. For scoring, the clinician divides the dentition into sextants and selects the facial (or buccal) and lingual tooth surface in each sextant that is covered with the greatest amount of debris and calculus. Twelve surfaces, therefore, are evaluated. For this index, a surface includes half the circumference of the tooth.

The Oral Hygiene Index is composed of the combined Debris Index and Calculus index, each of these index is in turn based on 12 numerical determinations representing the amount of debris or calculus found on the buccal and lingual surfaces of each of three segments of each dental arch.

The Maxillary and the Mandibular arches are each composed of three segments (Fig. 16.2).

SEGMENTS

Maxillary

1. *Segment 1:* The segment distal to the right cuspid.
2. *Segment 2:* Upper right canine to upper left canine.
3. *Segment 3:* The segment distal to the left cuspid.

Mandibular

4. *Segment 4:* The segment distal to the left cuspid.

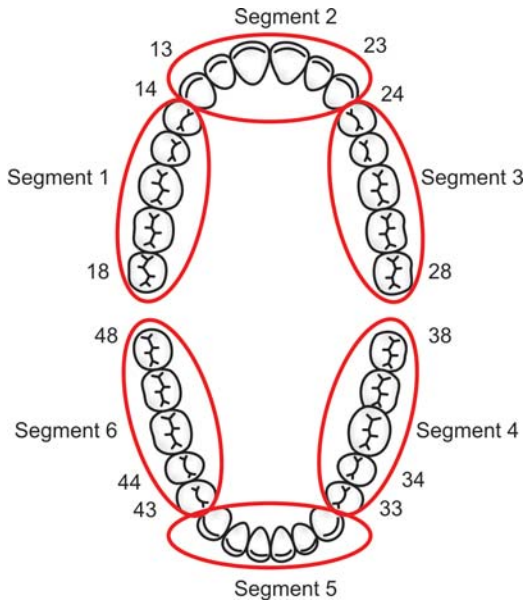


Fig. 16.2: Various segments of the mouth [OHI]

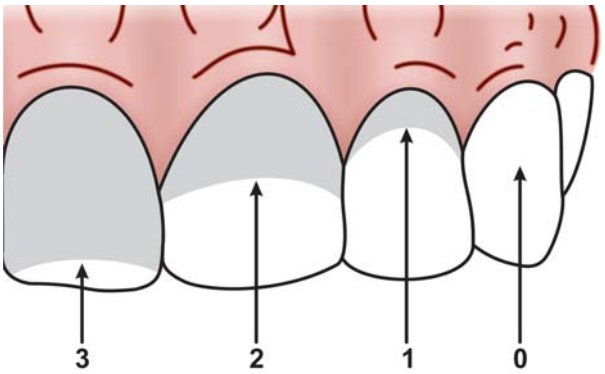


Fig. 16.3: Scoring method for debris

5. *Segment 5:* Lower left canine to lower right canine.
6. *Segment 6:* The segment distal to right cuspid.

Each segment is examined for debris or calculus. From each segment one tooth is used for calculating the individual index, for that particular segment. The tooth used for the calculation must have the greatest area covered by either debris or calculus (Fig. 16.3).

The method for scoring calculus is the same as that applied to debris, but additional provisions are made for recording subgingival deposits.

Debris Score

Scores	*Criteria*
0	No debris or stain present
1	Soft debris covering not more than one third of the tooth surface, or presence of extrinsic stains without other debris regardless of surface area covered
2	Soft debris covering more than one third, but not more than two thirds, of the exposed tooth surface.
3	Soft debris covering more than two thirds of the exposed tooth surface.

$$\text{Debris index (DI)} = \frac{\text{Total debris score}}{\text{No. of segments scored}}$$

Calculus Score

Scores	*Criteria*
0	No calculus present
1	Supragingival calculus covering not more than one third of the exposed tooth surface.
2	Supragingival calculus covering more than one third but not more than two thirds of the exposed tooth surface and/or the presence of individual flecks of subgingival calculus around the cervical portion of the tooth.
3	Supragingival calculus covering more than two third of the exposed tooth surface and/or a continuous heavy band of subgingival calculus around the cervical portion of the tooth.

$$\text{Calculus index (CI)} = \frac{\text{Total calculus score}}{\text{No. of segments scored}}$$

The average individual or group debris and calculus scores are combined to obtain Oral hygiene index, as follows.

Oral hygiene index = Debris index + Calculus index

A perfect score would be 0, and the worst score possible is 12

The Simplified Oral Hygiene Index (OHI-S)

This index was given by John C. Greene and Jack R. Vermillion in 1964. It offers a more rapid method for evaluation of oral cleanliness of population groups, but lacks in degree of sensitivity in comparison to the original OHI index.

It differs from the original index in:

- Number of tooth surfaces scored [6 rather than 12].
- The method of selecting the tooth surfaces to be scored
- The scores which can be obtained.

Selection of Tooth

The six surfaces examined for the OHI-S are selected from four posterior and two anterior teeth.

- In the posterior teeth, the first fully erupted tooth distal to the second bicuspid, usually the first molar but sometimes the second or third molar, is examined on each side of each arch.
- In the anterior portion of the mouth upper right central incisor and lower left central incisor are scored.
- In the absence of either of these anterior teeth, the central incisor on the opposite side of the midline is substituted.
- Only fully erupted permanent teeth are scored. A tooth is considered to be fully erupted when the occlusal or incisal surface has reached the occlusal plane
- Natural teeth with full crown restorations and surfaces reduced in heights by caries or trauma are not scored. Instead an alternate tooth is examined.

Surfaces to be Seen (Fig. 16.4)

- Six surfaces are examined [from four posterior teeth and two anterior teeth].

Upper molars [6 | 6] : The buccal surfaces of selected teeth is inspected.

Lower molars [6 | 6] : The lingual surfaces of the selected teeth are checked.

Upper and Lower Central incisor 1 : labial surface is scored.

Examination Method

To obtain the scores for debris and calculus, each of the six selected tooth surfaces are examined for debris and then calculus. The surface area covered by debris is estimated by running the side of a No. 5 explorer (Shepherd's Crook) along

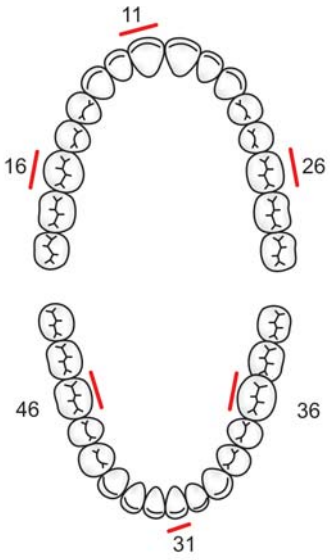


Fig. 16.4: Six teeth and the surfaces scored (OHI-S)

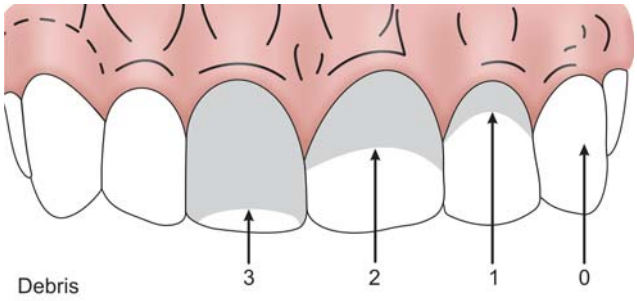


Fig. 16.5A: Scoring method for debris

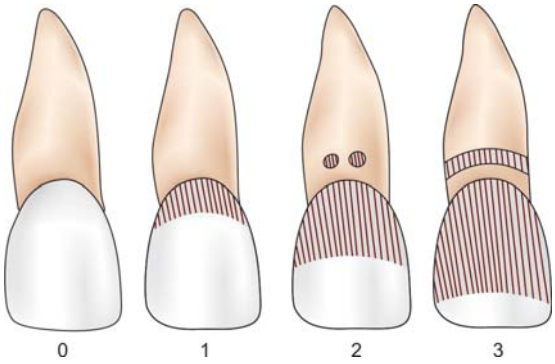


Fig. 16.5B: Scoring method for calculus

the tooth surfaces being examined (Explorer is moved from incisal/occlusal to gingival margin). The occlusal or incisal extent of the debris is noted as it is removed. Same No. 5 explorer is used to estimate the surface area covered by the supragingival and subgingival calculus.

1. Spray water into patient/client's mouth and instruct patient/client to swish.
2. Insert saliva ejector into patient/client's mouth.
3. Select teeth for examination by choosing six specific teeth with one in each sextant.
4. Evaluate teeth.
   a. Start evaluation with maxillary posterior sextant and work way around maxillary arch.
   b. Drop down to mandibular left lingual posterior sextant and work way around to other side of mouth.
5. Evaluate teeth for soft debris by recording six debris scores on appropriate recording form(s).
6. Evaluate teeth for calculus by recording six calculus scores.
7. Calculate debris score by totalling debris scores and dividing by number of teeth scored.
8. Calculate calculus score by totalling calculus scores and dividing by number of teeth scored.
9. Calculate OHI-S score by adding debris score to calculus score that equals OHI-S score.
10. Record OHI-S score in patient/client's chart or on appropriate recording form(s).

Scoring Criteria (Debris) (Fig. 16.5A)

Scores	*Criteria*
0	No debris or stain present.
1	Soft debris covering not more than one third of the tooth surface being examined or presence of extrinsic stains without debris regardless of surface area covered.
2	Soft debris covering more than one third, but not more than two thirds, of the exposed tooth surface.
3	Soft debris covering more than two thirds of the exposed tooth surface.

Scoring Criteria (Calculus) (Fig. 16.5B)

Scores	*Criteria*
0	No calculus present.
1	Supragingival calculus covering not more than one-third of the exposed tooth surface being examined.
2	Supragingival calculus covering more than one-third but not more than two thirds of the exposed tooth surface and /or the presence of individual flecks of subgingival calculus around the cervical portion of the tooth.
3	Supragingival calculus covering more than two third of the exposed tooth surface or a continuous heavy band of subgingival calculus around the cervical portion of the tooth.

In the simplified OHI, the worst score possible is 6.

Interpretation

Individually DI-S and CI-S is scored as follows:

0.0 to 0.6 = Good oral hygiene
0.7 to 1.8 = Fair oral hygiene
1.9 to 3.0 = Poor oral hygiene

An OHI-S is scored as follows:

0.0-1.2	=	Good oral hygiene
1.3 -3.0	=	Fair oral hygiene
3.1 -6.0	=	Poor oral hygiene

PATIENT HYGIENE PERFORMANCE INDEX (PHP INDEX)

It was developed by Podshadley AG, and Haley JV (1968) to assess the extent of plaque and debris over a tooth surface as an indication of oral cleanliness. Debris for PHP was defined as the soft foreign material consisting of bacterial plaque, material alba and food debris that is loosely attached to tooth surfaces.

Most useful for individual patients who have significant plaque accumulation.

Teeth and Surfaces Examined (Fig. 16.6)

Tooth Numbers in FDI System

16 - Upper right first molar
11 - Upper right central incisor
26 - Upper left molar
36 - Lower left first molar
31 - Lower left central incisor
46 - Lower right first molar

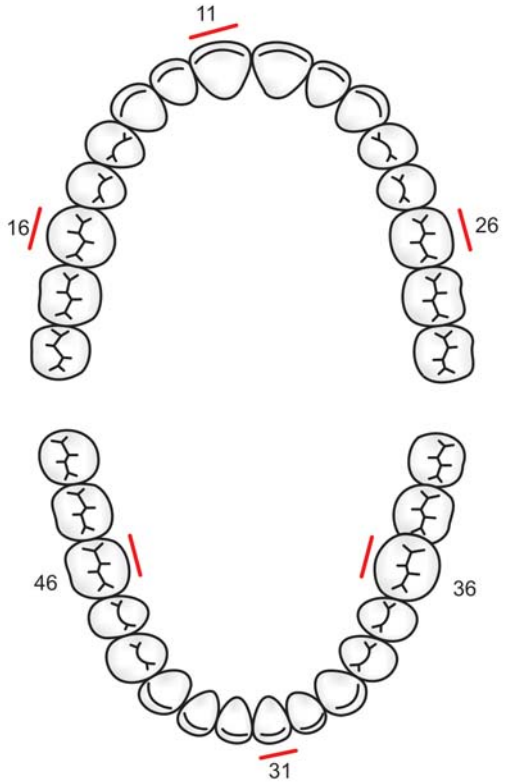


Fig. 16.6: PHP index: 6 tooth surfaces are scored

Surfaces

Facial surfaces: Incisors and maxillary molars.
Lingual surfaces: Mandibular molars

Substitutions for Missing Teeth

- The second molar is used if the 1st molar
  - Is missing
  - Less than three–fourth erupted
  - Has a full crown
  - Is broken down
- The third molar is used when the second molar is missing.
- The adjacent incisor the of the opposite side is used, when the central incisor is missing.

Procedure

- Disclosing solution is applied.
- Patient is asked to swish for 30 seconds and expectorate but not rinse.
- Examination is made using a mouth mirror.
- Each tooth surface to be evaluated is subdivided into five sections as follows (Fig. 16.7).
  Vertically: Three divisions mesial, middle and distal.
  Horizontally: The middle third is subdivided into gingival, middle and occlusal or incisal thirds.
- Each area with plaque is scored a point so each tooth score can range from 1 to 5 points.

Scoring

Debris scores for individual tooth: Add the scores for each of the five subdivisions. The scores range from 0 to 5.
PHP for an individual: Total the scores for the individual teeth and divide by the number of the teeth examined. The PHP value ranges from 0 to 5.

PHP Index for a group: To obtain the average PHP score for a group or a population, total the individual score and divide by the number of people examined.

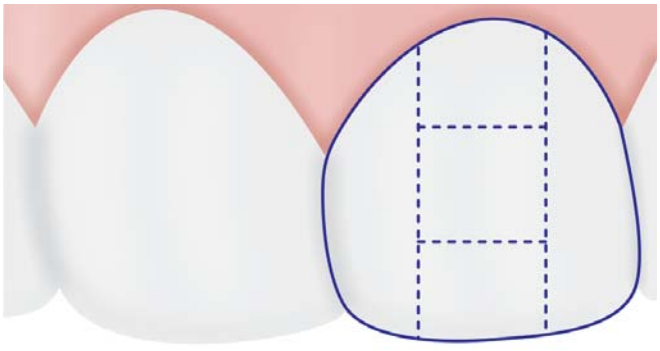


Fig. 16.7: Subdivision of a tooth into 5 sections (PHP index)

Interpretation

Nominal scale for evaluation of scores:
Rating scores
1. Excellent = 0 (No debris)
2. Good = 0.1-1.7
3. Fair = 1.8-3.4
4. Poor = 3.5- 5.0

GINGIVAL INDEX (GI)

Also attributed to Loe and Silness (1963), the GI assesses the severity of gingivitis based on color, consistency, and bleeding on probing. It describes the clinical severity of gingival inflammation as well as its location. Mesial, lingual, distal, and facial (or buccal) surface of each teeth are examined. A probe is used to press on the gingiva to determine its degree of firmness, and to run along the soft tissue wall adjacent to the entrance to the gingival sulcus.

Teeth Examined

1. Maxillary right first molar.
2. Maxillary right lateral incisor.
3. Maxillary left first bicuspid.
4. Mandibular left first molar.
5. Mandibular left lateral incisor.
6. Mandibular right first bicuspid.

Surfaces Examined on each Tooth

Buccal, lingual, mesial and distal.

Bleeding potential is based on the following criteria:

Scoring Criteria: Gingival Index

Average gingival index (Score)	*Interpretation*
0	Normal gingiva/absence of inflammation
1	Mild inflammation: Slight change in color, slight edema. No bleeding on probing;
2	Moderate inflammation: Redness edema and glazing. Bleeding on probing
3	Severe inflammation: Marked redness and edema. Ulceration and a tendency for spontaneous bleeding

Each surface is given a score, and then the scores are totaled which gives the score for area and divided by four gives score for the tooth. Totaling all scores and dividing by the number of teeth examined provides GI score per person.

Interpretation: Gingival Index

Average gingival index (Score)	*Interpretation*
2.1 - 3.0	Poor (severe gingivitis), severe inflammation
1.1 - 2.0	fair (moderate gingivitis), moderate inflammation,
0.1 - 1.0	Good (mild gingivitis), mild inflammation
< 0.1	Excellent (no gingivitis), no inflammation

Limitations

To eliminate the need to perform probing and to better describe milder forms of inflammation, several subsequent modifications were made.

CALCULUS SURFACE INDEX

This index was developed by Ennever J, Sturzenberger CP and Radike AW (1961).

The Calculus Surface Index is a measure of dental calculus formation. It can be used to quantitate the accumulation of dental calculus in short-term testing programs to evaluate the effectiveness of preventive care.

Method

Presence or absence of supragingival and/subgingival or gubgingival calculus on the four mandibular incisor is assessed.

Each of the 4 mandibular incisors is assessed on 4 surfaces (one labial, one lingual and two proximal).

The presence or absence of calculus is examined by visual or tactile examination using a mirror and dental explorer (sickle type).

Each surface with calculus is scored 1 point.

Scoring

For a person
Calculus surface index = Sum total of calculus points on the 16 surfaces surveyed

Interpretation

Minimum score: 0
Maximum score: 16

PERIODONTAL INDEX (PI)

Russell [1956] developed an index for measuring periodontal disease that could be used in population surveys. It can be based solely upon the clinical examination, or it can make use of dental X-rays if they are available. It places greater emphasis on advanced disease. PI determines the periodontal disease status of populations in epidemiologic studies. Each

tooth is scored according to the condition of the surrounding tissues. On examination, each tooth is assigned a score using the following criteria:

Scoring

1. Each tooth is scored separately according to the following criteria.
2. Rule: When in doubt, assign the lower score.

Reasons for its Widespread Use

i. Ease of use
ii. Clarity of criteria
iii. Reasonable comparability of results

Scoring values (0, 1, 2, 6, and 8) relate to the stages of the disease scored in an epidemiological survey to the clinical condition observed. The jump from 2 to 6 in the scale recognizes the change in disease condition from a severe gingivitis to an overt destructive periodontal disease with obvious loss of attachment. PI can be considered a true interval scale.

Scores for each tooth are added, and the total is divided by the number of teeth examined. Scores can be interpreted as follows:

- 0.0-0.2 = Clinically normal supportive tissues.
- 0.3-0.9 = Simple gingivitis.
- 0.7-1.9 = Beginning destructive periodontal disease.
- 1.6-5.0 = Established destructive periodontal disease.
- 3.8-8.0 = Terminal periodontal disease.

Individual score = Average (scores for all of the teeth in the mouth)

Population score = Average (individual scores in population examined).

PERIODONTAL DISEASE INDEX (PDI)

The periodontal disease index was introduced by Sigurd P Ramfjord in 1959. It was a modification of Russell index, particularly designed for assessing the extent of pocket deepening below the cementoenamel junction. It combines the evaluation of gingival status with the probed attachment level (crevice depth measured from the cementoenamel junction).

Selection of Teeth and Surfaces

Teeth examined: (FDI system tooth numbers are in the parenthesis)

1. Maxillary right first molar - (16)
2. Maxillary left central incisor - (21)
3. Maxillary left first bicuspid - (24)
4. Mandibular left first molar - (36)
5. Mandibular right central incisor - (41)
6. Mandibular right first bicuspid - (44)

If any of the teeth are missing or unerupted, then only the teeth present are examined (only fully erupted teeth are used).

Substitution is not made for missing teeth.

Procedure

1. Under consistent light, gingiva is dried with cotton to observe the form.
2. Gentle pressure is applied with a probe to determine consistency.
3. Michigan probe No. 0 was used originally.
4. Four measurements are made from each tooth, on the mesial, distal, facial and lingual surfaces.

SCORING CRITERIA FOR RUSSELS (PI) INDEX

Criteria for field studies	*Additional X-ray criteria*	*Score*
Negative (neither overt inflammation in the investing tissues, nor loss of function due to destruction of supporting tissues)	Radiographic appearance normal	0
Mild gingivitis (overt area of inflammation in the free gingivae, but this area does not circumscribe the tooth)		1
Gingivitis (inflammation completely circumscribes the tooth, but there is no apparent break in the epithelial attachment)		2
(Not used in field study)	Early, notchlike resorption of the alveolar crest	4
Gingivitis with pocket formation (the epithelial attachment is broken, and there is a pocket. There is no interference with normal masticatory function, the tooth is firm in its socket, and has not drifted).	Horizontal bone loss involving the entire alveolar crest, up to half of the length of the tooth root (distance from apex to cementoenamel junction)	6
Advanced destruction with loss of masticatory function (tooth may be loose, tooth may have drifted, tooth may sound dull on percussion with a metallic instrument, the tooth may be depressible in its socket)	Advanced bone loss, involving more than half of the length of the tooth root, or a definite intrabony pocket with definite widening of the periodontal membranes. There may be root resorption, or rarefaction at the apex	8

Scoring Method: Periodontal Disease Index

Gingivitis	No signs of inflammation	0
	Mild to moderate inflammatory gingival changes, not extending around the tooth	1
	Mild to moderately severe gingivitis extending all around the tooth	2
	Severe gingivitis characterized by marked redness, swelling, tendency to bleed and ulceration	3
Gingival crevice depth	Gingival crevice in any of the four measured areas (mesial, distal, buccal, lingual), extend apically to the cementoenamel junction but not more than 3 mm	4
	Gingival crevice in any of the four measured areas extending apically to the cemento-enamel junction from 3 mm to 6 mm inclusive.	5
	Gingival crevice in any of the four measured areas extending more than 6 mm apical to the cementoenamel junction.	6

Scoring PDI

For individuals: Add the scores for individual teeth and divide by the number of teeth examined. The PDI ranges from 0 to 6.

For group: Total the individual PDI scores and divide by the number of individuals examined. The average ranges from 0 to 6.

Plaque and Calculus Component of the Periodontal Disease Index (PDI).

Although not part of PDI, a Plaque Index and Calculus Index are included when making a survey hence described.

Dental Plaque (PDI)

For each of 6 teeth mentioned above 4 surfaces (facial, lingual, mesial and distal) are scored from 0 to 3.

Procedure

i. Apply disclosing agent
ii. Patient is asked to expectorate and rinse with water
iii. Specific surfaces with disclosed plaque are observed.

Scoring Criteria for Plaque

Criteria	*Score*
None	0
Present on some but not on all interproximal, buccal and lingual surfaces	1
Plaque present on all of the interproximal, buccal and lingual surfaces, but covering less than half of these surfaces	2
Plaque extends once all interproximal, buccal and lingual suface and once more than one half of these surfaces	3

Calculus (PDI)

To measure the presence and extent of calculus a subgingival explorer or a periodontal probe is used.

Procedure

For each of the 6 teeth, four surfaces (mesial, distal, facial, lingual/palatal) are scored from 0 to 3.

Scoring Criteria for Calculus

Criteria	*Score*
None	0
Supragingival calculus, extending only slightly below the free gingival margin (not more than 1 mm)	1
Moderate amount of supra- and subgingival calculus or subgingival calculus alone	2
An abundance of supra- and subgingival calculus	3

Scoring

For individual teeth: Add scores for each surface and divide by the number of surfaces (4).
For an individual: Add the scores for an individual tooth and divide by the number of teeth.

GINGIVAL BLEEDING INDEX (GBI)

Unwaxed dental floss is used to measure a GBI, developed by Carter and Barnes (1974). A full complement of teeth has 28 proximal areas to be examined. Floss is passed interproximally, first on one side of the dental papilla, then on the other. The clinician curves the floss around each tooth and passes it below the gingival margin, taking care not to lacerate the gingiva. Any bleeding noted indicates the presence of disease. The numbers of bleeding areas versus proximal areas scored is recorded. It can be used for initial patient evaluation and motivation or over time to assess response to interventions to improve periodontal health.

Procedure

Selection of Teeth

The mouth is divided into 6 segments (upper right, upper anterior, upper left, lower left, lower anterior, lower right). Areas involving the third molars are not scored because of variations in arch position, access and vision.

Method

Unwaxed dental floss is alternately passed interproximally into the gingival sulcus on both sides of the interdental papillae. With the floss extended as far as possible towards the buccal and lingual, the floss is carried to the bottom of the sulcus. The floss is then moved in an incisogingival motion

for one double stroke. Care is taken not to cause laceration of the papillae. A new length of clean floss is used for each interproximal unit.

Bleeding is generally immediately evident in the area or on the floss, but 30 seconds are allowed for reinspection of each segment. If bleeding is copious, the patient should rinse between segments.

An area is non-scoreable when tooth positions, diastemas or other factors compromise the desirable interproximal relationships.

Bleeding Assessment

No attempt is made to quantify the degree of bleeding. Bleeding is assessed only as present or absent.

Scoring Codes for GBI

Not bleeding : None (blank)
Bleeding : B
Not-scoreable : X

Recording Method

Interproximal areas of maxillary teeth	*Code*
17-16	____
16-15	____
15-14	____
14-13	____
13-12	____
12-11	____
11-21	____
21-22	____
22-23	____
23-24	____
24-25	____
25-26	____
26-27	____

Similarly scores are recorded for mandibular teeth.

Result

Total scoreable areas = 26 - (number of non-scoreable areas)

Gingival Bleeding Score (total bleeding areas) = Sum of number of bleeding areas

Interpretation

The fewer the number of bleeding sites, the less the extent of gingivitis. Ideally the score should be 0.

If the patient is to be followed over time, previous bleeding sites are monitored to see if they become non-bleeding. The goal of interventions is to reduce the score as much as possible.

PAPILLARY-MARGINAL-ATTACHED GINGIVAL INDEX

PMA index is probably the oldest reversible index which was developed by Schour I and Massler M (1944).

It was used to assess the extent of gingival changes in large groups for epidemiological studies. It was based on the concept that the extent of inflammation serves as an indicator of the severity of the condition. The presence or absence of inflammation is recorded in three areas of gingiva around the teeth.

Selection of Teeth and Surfaces

Three gingival units are examined for each tooth

P = Papillary portion between the teeth

1. Papilla is numbered by the tooth just distal to it. Papilla is not present when teeth are separated by a diastema or there is an edentulous area.
2. Inflammation usually begins within the papilla at the col area.
   Papillary changes—Mild gingivitis.

M = Marginal collar around the teeth.

1. It is located between papillae, attached by junctional epithelium, and demarcated from attached gingiva by the free gingival groove.
2. Papillary and marginal gingival inflammation- Moderate gingivitis.

A = Attached gingiva overlying the alveolar bone

1. Stippled gingiva between the free gingival groove and the mucogingival junction.
2. Spread of inflammation from papillary and marginal gingivitis into the attached gingiva – Severe gingivitis.

Method

All the teeth can be assessed starting from maxillary second molar of one side to the second molar of the other side and then mandibular second molar of the same side to the second molar of the other side. Third molars are not included. Adequate light and mouth mirror are used. Probe usually a blunt probe is used for pressing on gingiva.

Scoring Criteria

Papillary =P

0 = Normal, no inflammation.
1+ = Mild papillary engorgement, slight increase in size.
2+ = Obvious increase in size of gingival papilla, bleeding on pressure.
3+ = Excessive increase in size with spontaneous bleeding
4+ = Necrotic papilla.
5+ = Atrophy and loss of papilla (through inflammation).

Marginal = M

0 = Normal, no inflammation visible.
1+ = Engorgement, slight increase in size, no bleeding.
2+ = Obvious engorgement, bleeding upon pressure.

3+ = Swollen collar, spontaneous bleeding, beginning infiltration into attached gingiva.
4+ = Necrotic gingivitis.
5+ = Recession of the free marginal gingiva below the cementoenamel junction as a result of inflammatory changes.

Attached = A
0 = Normal; pale rose, stippled
1+ = Slight engorgement with loss of stippling, change in color may or may not be present.
2+ = Obvious engorgement of attached gingiva with marked increase in redness, pocket formation present
3+ = Advanced periodontitis, deep pockets evident.

Scoring
P-M-A for individual
Count the number of P, M and A units scored and record separately as: P-M-A =?-?-?

Keeping the total separate, as on adding the sum will not represent the area of the gingiva where the inflammation is present.

P-M-A for a group: The average of the P, M and A is computed by totalling each for all individuals and then dividing each number of individuals examined.

GINGIVAL BONE COUNT INDEX

The Gingival Bone Count Index was developed by Dunning JM and Leach LB (1960). It is a composite score based on the gingival condition and degree of bone loss affecting a person's teeth. This can be used to evaluate periodontal health, especially in epidemiologic studies.

Method

- The gingival score is based on the clinical examination.
- The bone score is based on the clinical examination and evaluation of dental X-rays.
- A mean for each score is then computed for the whole mouth.

Scoring Criteria

A single gingival score and a single bone score is generated for each tooth studied.

Gingival Score

Criteria/Finding	*Score*
Negative	0
Mild gingivitis involving the free gingiva (margin, papilla, or both)	1
Moderate gingivitis involving both free and attached gingiva	2
Severe gingivitis with hypertrophy and easy hemorrhage	3

Bone Score

Criteria/Finding	*Score*
No bone loss	0
Incipient bone loss or notching of alveolar crest.	1
Bone loss about one fourth of root length, or pocket formation on one side, not over one half of root length.	2
Bone loss about one half of root length, or pocket formation on one side, not over three fourth root length, mobility slight	3
Bone loss about three quarters of root length, or pocket formation on one side to apex, mobility moderate	4
Bone loss complete, mobility marked	5

Gingival bone score
= SUM ((gingival score) + (bone score))/
(number of teeth examined) =
= (mean gingival score) + (mean bone score)

Interpretation

- Minimum score: 0
- Maximum score: 8

The higher the score, the more serious the periodontal disease.

COMMUNITY PERIODONTAL INDEX OF TREATMENT NEEDS (CPITN)

The FDI-WHO Joint Working Group on periodontal diseases supports the use of the CPITN as an epidemiological screening procedure for periodontal treatment needs in populations. The Community Periodontal Index of Treatment Needs (CPITN) is an epidemiologic tool developed by the World Health Organization (WHO) for the evaluation of periodontal disease in population surveys. It can be used to recommend the kind of treatment needed to prevent periodontal disease. Following extensive discussion and testing the CPITN was finalized and described in 1982 (Ainamo Jukka, Barmes David, Beagrie George, Cutress Terry, Martin Jean and Sardo-Infirri Jennifer).

The CPITN is primarily a screening procedure which requires clinical assessment for the presence or absence of periodontal pockets, calculus and gingival bleeding. Use of a special CPITN periodontal probe (or its equivalent) is recommended.

For epidemiologic purposes in adult populations, 10 specified index teeth are examined. For persons under 20 years of age only, six index teeth are specified. In dental practice, all teeth are examined and the highest score for each sextants noted. Only six scores are recorded. Measures of gingival recession, tooth mobility, intensity of inflammation,

precise identification of pocket depths or differentiation between supra- and subgingival calculus are not included in the CPITN. Individuals are assigned to one of four treatment need categories determined from their CPITN scores.

Teeth examined: Two methods of selection

Sextants: Total six sextants

14 teeth on the maxilla and 14 teeth on the mandible, divided into three segments on each arch with following tooth numbers (FDI).

Maxilla:

Sextant 1 : 17 to 14
Sextant 2 : 13 to 23
Sextant 3 : 24 to 27

Mandible:

Sextant 4 : 37 to 34
Sextant 5 : 33 to 43
Sextant 6 : 44 to 47

Third molars are not used unless they function in place of the second molars.

Index Teeth

In epidemiological surveys, for adults aged 20 years or more, only 10 index teeth are examined (5 teeth on the maxilla and 5 teeth on the mandible). These have been identified as the best estimators of the worst periodontal condition of the mouth.

MAX	17	16	11	26	27
MAND	47	46	31	36	37

The molars are examined in pairs and only one score, the highest is recorded. Only one score is recorded for each sextant.

For young people, up to 19 years only, six index teeth

MAX	16	11	26
MAND	46	31	36

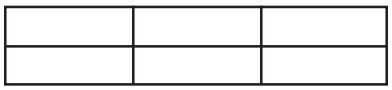
The second molars are excluded as index teeth at these ages because of the high frequency of false (noninflammatory associated with tooth eruption) pocket.

For screening and monitoring purposes in dental practice all teeth in a sextant are examined for adults over age 19 years. Only one score, the highest is recorded for each sextant

When examining children less than 15 years, pockets are not recorded although probing for bleeding and calculus are carried out as routine.

Recording Data

The following box chart is recommended as the epidemiologic and dental office chart for recording CPITN data. The recommended periodontal probe for use with CPITN was described in the WHO 621 report (WHO 1978). The approved basic probe is suitable for general use in epidemiology and routine screening of patients in general practice. The CPITN is particularly designed for gentle manipulation of the often very sensitive soft tissues around the teeth; as such it is different in concept from the probes for dental caries and most other oral care instruments in current use.



The Probe

The probe has color coding between 3.5 and 5.5 mm markings at intervals from the tip. The working tip has a ball 0.5 mm in diameter. The functions of ball tip are:

i. To aid in detection of calculus and other tooth surface roughness.
ii. To facilitate assessment of the base of the pocket and reduce the risk of over measurement.

A variant of this basic probe has two additional lines at 8.5 mm and 11.5 mm from the working tip. The additional lines may be of use when performing a detailed assessment and recording of deep pockets for the purpose of preparing treatment plan for complex periodontal therapy. The two instruments can be identified as:

CPITN-E for the epidemiologic probe with 3.5 and 5.5 mm markings (Fig. 16.8).

CPITN-C for the clinical probe with the additional 8.5 and 11.5 mm markings (Fig. 16.9).

Sensing Gingival Pockets

An index tooth should be probed, using the probe as a "sensing" instrument to determine pocket depth and to detect subgingival calculus and bleeding response. The sensing force used should be not more than 20 grams. A practical test for establishing this force is to place the probe point under the thumb nail and press until blanching occurs. For sensing subgingival calculus, the lightest possible force that will allow movement of the probe ballpoint along the tooth surface should be used.

The ball-end should be in contact with the root surface. When inserting the probe, the ballpoint should follow the anatomical configuration of the surface of the tooth root. If the patient feels pain during probing, this is an indicative of the use of too much force.

The probe tip should be inserted gently into the gingival pocket and the depth of insertion read against the color coding. The total extent of the pocket should be explored and at least six points on each tooth should be examined: mesiobuccal, midbuccal, distobuccal, and the corresponding lingual sites.

CODES AND CRITERIA (FIG. 16.10)

The codes are listed in the descending order of treatment complexity as follows:

Code X: When only one tooth or no tooth is present in the sextant (third molars are excluded unless they function in place of second molars).

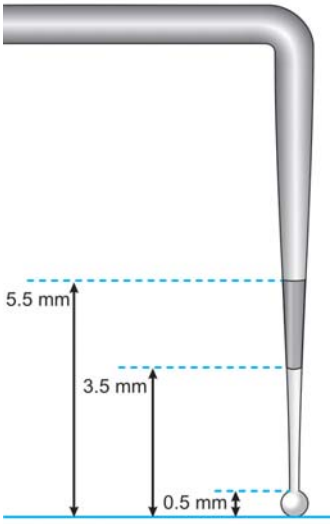


Fig. 16.8: Community periodontal index of treatment needs (CPITN) 'E' probe

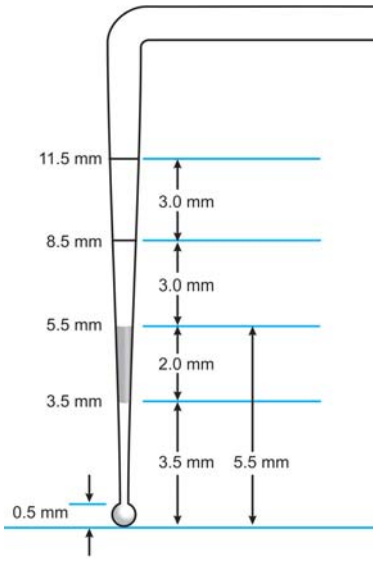
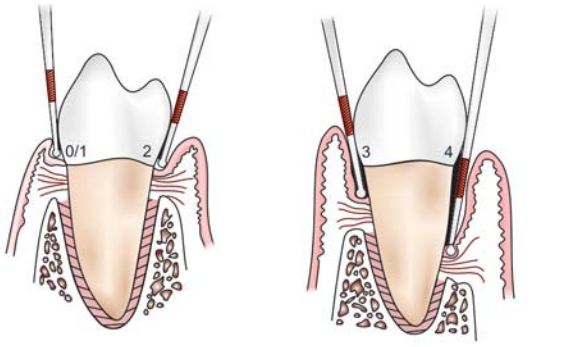


Fig. 16.9: Community periodontal index of treatment needs (CPITN) 'C' probe

Code 4: Pathological pocket of the 6 mm or more, that is, the black area of the CPITN probe is not visible.
Note: If the designated tooth or teeth are found to have a 6 mm or deeper pocket in the sextant being examined, a code of 4 is given to the sextant. Recording of Code 4 makes further examination of that sextant unnecessary. There is no need to record the presence or absence of pathological pockets of 4 or 5 mm, calculus or bleeding.

Code 3: Pathological pocket of 4 or 5 mm that is when the gingival margin is on the black area of the probe.



Code-0 = No Periodontal disease (Healthy Periodontium)
Code-1 = Bleeding observed during or after probing
Code-2 = Calculus or other plaque retentive factors either seen or felt during probing
Code-3 = Pathological pocket 4 to 5 mm in depth. Gingival margin situated on black band of the probe
Code-4 = Pathological pocket 6 mm or more in depth. Black band of the probe not visible

Fig. 16.10: Community periodontal index of treatment needs (CPITNs)

Note: If the deepest pocket is found at the designated tooth or teeth in a sextant is 4 or 5 mm, a code 3 is recorded. There is no need to examine for calculus or gingival bleeding.

Code 2: Calculus or other plaque retentive factors such as ill fitting crowns or poorly adapted edges of restoration are either seen or felt during probing.
Note: The black band remains fully visible.

Code 1: Bleeding observed during or after probing (either immediate or delayed).

Code 0: Healthy tissue: The black band on the probe remains fully visible. There is no bleeding after probing. No calculus, restoration overhangs or other plaque retention factors are present.

Treatment Needs

TN 0: A recording of code 0 (health) or X (missing) for all six sextant indicates that there is no need for treatment.

TN 1: A code of 1 or higher indicates that there is need for improving the personal oral hygiene of that individual.

TN 2: a. Code of 2 or higher indicates a need of professional cleaning of the teeth and removal of plaque retentive factors. Patient require oral hygiene instructions

b. Shallow to moderate pocketing (4 or 5 mm, code 3). Oral hygiene and scaling will reduce inflammation and bring 4 or 5 mm pockets to values of or below 3 mm. Thus, sextants of these pockets are placed in the same treatment category as scaling and root planning, i.e. Treatment Needs 2 (TN2)

TN 3: A sextant scoring code 4 (6 mm or deeper pockets) may or may not be treated successfully by means of deep scaling and efficient personal oral hygiene measures. Code 4 is therefore assigned as complex treatment which can involve deep scaling, root planning and more complex procedures.

Explanation of the Clinical Criteria and Treatment Needs

Bleeding on gentle probing, plaque retentive factors (calculus or overhangs of restoration), 4 or 5 or 6 mm or deeper pockets are basic indicators if treatment needs. These criteria were chosen for the following reason.

1. TN 1: Bleeding is sign of a early disease which can be over come by self care following suitable oral health care educations and instructions. Control of gingival bleeding is a prerequisite for all periodontal therapy. This treatment is recognized as treatment need 1 (TN1). The control or elimination of gingival bleeding should be the prime goal even if further treatment is not available.
2. TN 2: Although not pathological in themselves, Calculus and other plaque retentive factors favor plaque retention and inflammation. Unlike plaque that can be eliminated by self care, the removal of calculus demands the professional care defined as treatment need 2 (TN2).
3. TN 3: In patient with deep pocket even after scaling, root planning and control of bleeding by oral hygiene methods there will generally be residual pockets. The treatment of these conditions may require complex therapy for which skilled and trained dental professionals are needed. This treatment is recognized as TN 3.

Substitution for Excluded and Missing Index Teeth

The ten CPITN index teeth are first molar and second molars in the posterior sextant and a central incisor in each of the two anterior sextant. When one or more index teeth are missing at the time of examination, substitute teeth are selected using the following rules:

1. Two or more functioning teeth must be present in a sextant for it to qualify for scoring.
2. If in posterior sextant, one of the two index teeth is not present or has to be excluded, then the recording is based on the examination of remaining index tooth.
3. If both index teeth in posterior sextant are absent or excluded from examination, all the remaining teeth in that sextant are examined and highest score recorded.
4. In the anterior maxillary sextant, if tooth 11 is excluded, substitute 21. If 21 is also excluded, then identify the worst score for the remaining teeth. Similarly substitute tooth 41 if 31 is missing.
5. In subjects under 20 years of age, if the first molar is not present or has to be excluded the nearest adjacent premolar is examined.
6. If all teeth in a sextant are missing or only one functional tooth remains, the sextant is coded as missing
7. A single tooth in a sextant is considered as a tooth in the adjacent sextant and subject to the rules for that sextant. If single tooth is an index tooth, then the worst index tooth score is recorded.

Examination Procedure

The aim is to determine the highest score applicable to each sextant with least number of measurements.
First decide whether the sextant can be validly scored. More than one functional tooth should be present.

If 'no', then give a score X and move to the next sextant. If 'yes', examine index teeth (epidemiological) or all teeth (in clinical screening procedure) in the order of presence of 6 mm or deeper pockets; 4 to 5 mm pockets, calculus or other plaque retentive factors and bleeding only.

Determine appropriate highest score for each sextant. As soon as the highest score criteria has been determined there is no need to examine for the presence of lower score criteria.

Number of Probings Per Sextant

The tip of the CPITN probe is gently inserted between tooth and gingiva to the full depth of the sulcus or pocket and the probing depth read by the observation of the position of the black band. Recommended sites for probing are mesial, midline and distal on both facial and lingual surfaces. The probing may be done by withdrawing the probe between each probing or alternatively with probe tip remaining in the sulcus the probe may be 'walked' around the tooth. Sites in addition to the recommended one should be probed, if there is suspicion that a higher scoring condition is present.

Explanation of the Clinical Criteria

Bleeding on gentle probing, plaque retentive factors (calculus or over hangs of restoration), 4 or 5 or 6 mm or deeper pockets are basic indicators if treatment needs. These criteria were chosen for the following reason.

1. TN 1: Bleeding is sign of a early disease which can be over come by self care following suitable oral health care educations and instructions. Control of gingival bleeding is a pre requisite for all periodontal therapy. This treatment is recognized as treatment need 1 (TN1). The control or elimination of gingival bleeding should be the prime goal even if further treatment is not available.
2. TN 2: Although not pathological in themselves, Calculus and other plaque retentive factors favor plaque retention and inflammation. Unlike plaque that can be eliminated by self care the removal of calculus demands the professional care defined as treatment need 2 (TN 2).
3. TN 3: In patient with deep pocket even after scaling, root planning and control of bleeding by oral hygiene methods there will generally be residual pockets. The treatment of

these conditions may require complex therapy for which skilled and trained dental professionals are needed. This treatment is recognized as TN 3.

COMMUNITY PERIODONTAL INDEX (CPI)

Indicators

Three indicators of periodontal status are used for this assessment:

1. Gingival bleeding
2. Calculus
3. Periodontal pockets

A specially designed lightweight CPI probe with a 0.5 mm ball tip is used, with a black band between 3.5 and 5.5 mm and rings at 8.5 and 11.5 mm from the ball tip.

Sextants

The mouth is divided into sextants defined by tooth numbers: 18-14, 13-23, 24-28, 38-34, 33-43, and 44-48. A sextant should be examined only if there are two or more teeth present and not indicated for extraction. (Note: This replaces the former instruction to include single remaining teeth in the adjacent sextant.)

Selection of teeth: For adults aged 20 years and over, the teeth to be examined are:

17	16	11	26	27
47	46	31	36	37

The two molars in each posterior sextant are paired for recording, and if one is missing, there is no replacement. If no index teeth or tooth is present in a sextant qualifying for examination, all the remaining teeth in that sextant are examined and the highest score is recorded as the score for the sextant. In this case, distal surfaces of third molars should not be scored.

For subjects under the age of 20 years, only six teeth - 16, 11, 26, 36, 31 and 46 - are examined. This modification is made in order to avoid scoring the deepened sulci associated with eruption as periodontal pockets. For the same reason, when examining children under the age of 15 are examined, pockets should not be recorded, i.e. only bleeding and calculus should be considered.

Sensing Gingival Pockets and Calculus

An index tooth should be probed, using the probe as a "sensing" instrument to determine pocket depth and to detect subgingival calculus and bleeding response. The sensing force used should be not more than 20 grams. A practical test for establishing this force is to place the probe point under the thumb nail and press until blanching occurs. For sensing subgingival calculus, the lightest possible force that will allow movement of the probe ball tip along the tooth surface should be used.

When the probe is inserted, the ball tip should follow the anatomical configuration of the surface of the tooth root. If the patient feels pain during probing, this is an indicative of the use of too much force.

The probe tip should be inserted gently into the gingival sulcus or pocket and the total extent of the sulcus or pocket explored. For example, the probe is placed in the pocket at the distobuccal surface of the second molar, as close as possible to the contact point with the third molar, keeping the probe parallel to the long axis of the tooth. The probe is then moved gently, with short upward and downward movements, along the buccal sulcus or pocket to the mesial surface of the second molar, and from the distobuccal surface of the first molar towards the contact area with the premolar. A similar procedure is carried out for the lingual surfaces, starting distolingually to the second molar.

Examination and Recording

The index teeth, all remaining teeth in a sextant where there is no index tooth, should be probed and the highest score is recorded in the appropriate box. The codes are:

0 Healthy
1 Bleeding observed, directly or by using mouth mirror, after probing
2 Calculus detected during probing, but all the black band on the probe visible
3 Pocket 4 to 5 mm (gingival margin within the black band on the probe)
4 Pocket 6 mm or more (black band on the probe not visible)
X Excluded sextant (less than two teeth present)
9 Not recorded

Loss of Attachment (Fig. 16.11)

Information on loss of attachment gives an estimate of the lifetime accumulated destruction of the periodontal attachment. Loss of attachment should not be recorded for children under the age of 15.

Highest score recorded in the appropriate box.

The codes are:

0 Loss of attachment 0 to 3 mm (CEJ not visible and CPI score 0-3).
1 Loss of attachment 4 to 5 mm (CEJ within the black band).
2 Loss of attachment 6 to 8 mm (CEJ between the upper limit of the black band and the 8.5 mm ring).
3 Loss of attachment 9 to 11 mm (CEJ between 8.5 mm and 11.5 mm ring).
4 Loss of attachment 12 mm or more (CEJ beyond the 11.5 mm ring).
X Excluded sextant (less than two teeth present)
9 Not recorded (CEJ neither visible nor detectable).

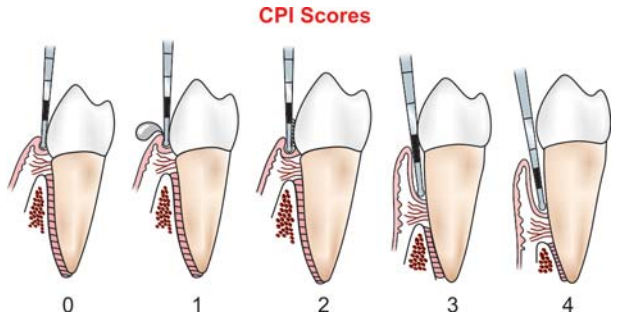


Fig. 16.11A: Community periodontal index codes

Code 0. Healthy periodontal tissues. Entire black band of the probe is visible.
Code 1. Entire black band is visible, but bleeding is present after gentle probing.
Code 2. Entire black band is visible, but calculus is present. (Bleeding may or may not be present.)
Code 3. 4 to 5 mm pocket depth. (Black band on probe partially hidden by gingival margin.)
Code 4. 6 mm or greater pocket depth. (Black band of the probe is completely hidden by the gingival margin.)

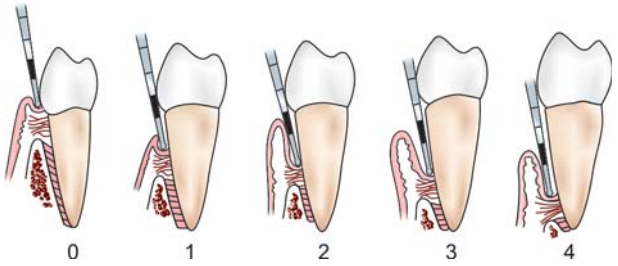


Fig. 16.11B: CPI: Lost of attachment codes

Code 0. 0 to 3 mm loss of attachment. (Cementoenamel junction [CEJ] is covered by the gingival margin and the CPI score is 0 to 3.) If the CEJ is visible, or if CPI score is 4, LOA codes 1 to 4 are used.
Code 1. 3.5 to 5.5 mm loss of attachment. (CEJ is within the black band on the probe.)
Code 2. 6 to 8 mm loss of attachment. (CEJ is between the top of the black band and the 8.5 mm mark on the probe.)
Code 3. 9 to 11 mm loss of attachment. (CEJ is between the 8.5 and the 11.5 mm marks on the probe.)
Code 4. 12 mm or greater loss or attachment. (CEJ is beyond the highest [11.5 mm] mark on the probe.)

TURESKY-GILMORE-GLICKMAN MODIFICATION OF THE QUIGLEY-HEIN PLAQUE INDEX

Quigley G and Hein J (1962) proposed a system for scoring dental plaque. They examined only the facial surfaces (gingival third) of the anterior teeth using basic fuchsin as a disclosing agent, and scoring 0 to 5.

Plaque Scoring System for Quigley and Hein

Scoring criteria	*Score*
No plaque	0
Flecks of stain at the gingival margin	1
Definite line of plaque at the gingival margin	2
Gingival third of surface	3
Two thirds of surface	4
Greater than two thirds of surface	5

This was modified by Turesky S, Gilmore ND and Glickman I to more explicitly describe mild to moderate plaque deposits in 1970.

Scoring by the Turesky Modification

i. All teeth assessed except third molars (maximum number 28)
ii. A staining solution is used to show plaque deposits (Quigley and Turesky used basic fuchsin, Gordon used erythrosine)
iii. Both the facial and lingual surfaces examined (maximum number 56)
iv. A score is assigned to each facial and lingual non-restored surface.

MODIFIED PLAQUE SCORING SYSTEM OF TURESKY ET AL (Fig. 16.12)

Criteria	*Score*
No plaque	0
Separate flecks of plaque at the cervical margin of the tooth	1
A thin continuous band of plaque (up to 1 mm) at the cervical margin of the tooth	2
A band of plaque wider than 1 mm coercing less than one-third of the crown of the tooth	3
Plaque covering at least one-third but less than two thirds of the crown of the tooth	4
Plaque covering two-thirds or more of the crown of the tooth	5

Total score = Sum (scores for all facial and lingual surfaces)
Index = (total score) / (number of surfaces examined)

Interpretation

A score of 0 or 1 is considered low.
A score of 2 or more is considered high.

THE NAVY PERIODONTAL DISEASE INDEX (NPDI)

The Navy Periodontal Disease Index Index (NPDI) was developed as part of the Navy Periodontal Screening

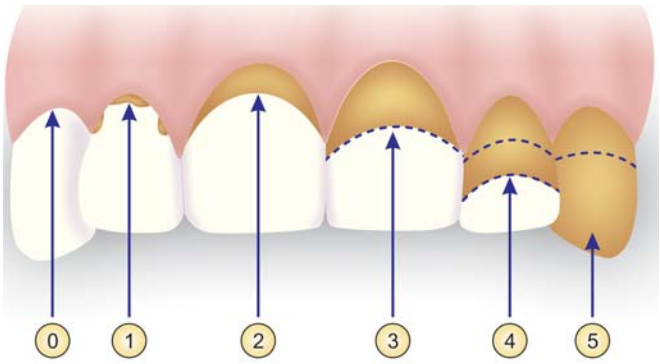


Fig. 16.12: Tooth areas graded by the Turesky et al modified Quigley Hein plaque index

Examination, along with the Navy Plaque Index. It is composed of a gingival and a pocket scores. The NPDI score can be used to determine the level of treatment required by the individual patient.

Teeth examined

16 - Maxillary Right First Molar
21 - Maxillary Left Central Incisor
24 - Maxillary Left First Premolar
36 - Mandibular Left First Molar
41 - Mandibular Right Central Incisor
44 - Mandibular Right First Premolar

Substitutions

If 16, 24, 36 or 44 are missing, and then substitute the next most posterior tooth.

If 21 or 41 are missing, then substitute the nearest incisor in the arch. If all incisors are missing from the arch, then substitute a cuspid.

Gingival Score

Each tooth is examined for evidence of inflammatory change, which constitutes one or more of the following findings:

- Any change from normal gingival color
- Loss of normal density and consistency
- Slight enlargement or blunting of the papilla or gingiva
- Tendency to bleed upon palpation or probing

Scoring Criteria

Gingival Score	*Points*
Gingival tissue is normal in color and tightly adapted to the tooth. Tooth is firm and no exudate is present.	0
Inflammatory changes are present but do not completely encircle the tooth.	1
Inflammatory changes completely encircle the tooth.	2

Pocket Score

With a calibrated periodontal probe, take six measurements of each designated tooth:

1. Mesial facial surface
2. Middle facial surface
3. Distal facial surface
4. Mesial lingual surface
5. Middle lingual surface
6. Distal lingual surface

Scoring Criteria

Pocket measurements	*Points*
Probing reveals sulcular depth not over 3 mm.	0
Probing reveals pocket depth greater than 3 mm but not over 5 mm	5
Probing reveals pocket depth greater than 5 mm	8

Pocket score = Maximum score taken at the 6 probing sites

Calculating the NPDI

Tooth score = Gingival score + pocket score
NPDI score = Maximum of all six tooth scores
NPDI total = Sum of all six tooth scores

Interpretation

- Minimum tooth score : 0
- Maximum tooth score : 10
- Minimum NPDI score : 0
- Maximum NPDI score : 10
- Minimum NPDI total : 0
- Maximum NPDI total : 60

Mobility Index

The mobility index, developed by Grace and Smales, can be useful to track the amount of mobility in teeth over a period of time. Grade 0 indicates no apparent mobility. Grade 1 is assigned to a tooth in which mobility is perceptible, but less than 1 mm buccolingually. Grade 2 mobility is between 1 to 2 mm, and Grade 3 mobility exceeds 2 mm buccolingually or vertically.

Evaluation of Tooth Mobility

Tooth mobility may be present due to hyperfunction or loss of attachment. Figure 16.13 illustrates how to assess for tooth mobility by using the index finger and the handle of a probe.

Class I: 0.5 to 1.0 mm facial lingual tooth movement.
Class II: 1 to 2 mm facial lingual tooth movement.
Class III: Over 2 mm facial lingual tooth movement and apical coronal depressibility (can be depressed in socket).

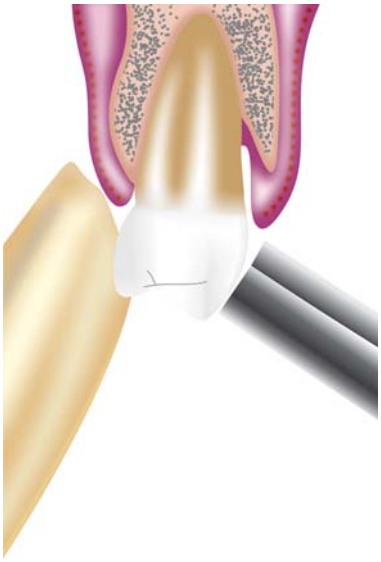


Fig. 16.13: Classification of mobility

INDICES FOR DENTAL CARIES

Diagnosis of dental caries is difficult in initial stages. Early approximal lesions are readily revealed by a radiograph but may not be detected by an explorer. There always exists inter examiner variations.

Decayed, Missing and Filled Teeth (DMFT) Index

This index was developed by Henry Klein, Carrole E Palmer and Knutson JW in 1938. This index was based on the fact that the dental hard tissues are not self healing and established caries leaves a scar. The tooth either remains decayed and if treated may be extracted or filled. It is an irreversible index

DMFT describe the amount (the prevalence) of dental caries in an individual. DMFT numerically expresses the caries prevalence and is obtained by calculating the number of teeth (T) which are:

- Decayed (D)
- Missing (M)
- Filled (F).

It is thus used to get an estimation illustrating how much the dentition until the day of examination has become affected by dental caries

Thus:

- How many teeth have caries lesions (incipient caries not included)?
- How many teeth have been extracted?
- How many teeth have fillings or crowns?

Selection of Teeth

All 28 teeth are examined (based on 28 teeth).

Teeth not included are:

- Third molars
- Unerupted teeth (a tooth is considered as erupted when the occlusal surface or incisal edge is totally exposed)
- Supernumerary and congenitally missing teeth
- Teeth removed for reasons other than dental caries such as for orthodontic reasons and impactions
- Teeth restored for reasons other than dental caries, such as trauma, use as a bridge abutment and cosmetic purposes
- Retained primary tooth when the successor permanent is present. The permanent tooth is considered.

Procedure

Each tooth is examined using a mouth mirror, an explorer and adequate light. The teeth should be observed by visual means as much as possible and only questionable small lesions should be checked by using an explorer.

Rules for Scoring DMFT

- No tooth should be counted more than once.
- Decayed (D), Missing (M) and Filled (F) teeth should be recorded separately
- Tooth lost or filled due to reasons other than caries are not included
- Deciduous teeth are not considered in DMFT index
- A tooth with several filling is counted as one tooth.

Criteria for Recording

i. Decayed (D) recording:
   - When dental caries and a restoration are present on the same tooth, the tooth is recorded as D
   - When a crown is broken due to caries, it is recorded as D.
   - Tooth with temporary restoration are recorded as decayed.

ii. Missing (M) recording:
   - When a tooth has been extracted because of dental caries
   - When a tooth is carious, cannot be restored and is indicated for extraction.

iii. Filled (F) recording:
   - Permanent restorations are recorded as F

Criteria for Identification of Dental Caries

- Lesion is clinically visible and obvious
- Discoloration or loss of translucency typical of undermined or demineralized enamel

- Definite catch and the explorer tip can penetrate into soft yielding material.

DMFT Scores

The sum of the three figures forms the DMFT value. For example: DMFT of 4 + 3 + 9 = 16 means that 4 teeth are decayed, 3 teeth are missing and 9 teeth have fillings. It also means that 12 teeth are intact

Individual DMFT

Total each component separately ie total D, total M, total F.

Total D + M + F = DMF SCORE

Group Average

- Total the D, M and F for each individual
- Divide the total DMF by the number of individuals examined.

Average DMF =

$$\frac{\text{Total DMF}}{\text{Total Number of Individuals Examined}}$$

Treatment Needs

Percentage needing restorations (%) =

$$\frac{\text{Total Number of D Tooth}}{\text{Total Number Examined}} \times 100$$

LIMITATIONS OF DMFT INDEX

- DMF values are not related to the number of teeth at risk. A DMF score does not directly gives an indication of the intensity of attack in any one individual, e.g. a child of 8-year-old may have DMF score of 3 with only nine permanent teeth in mouth (one-third of teeth have been already affected by caries), whereas an adult may have a DMF score of 8 (more than the child score) out of 32 teeth (only one fourth of the teeth have been affected)
- The DMF index is invalid when teeth have been removed or lost due to other reasons, e.g. periodontal reasons
- The index gives equal weight to all the three components, i.e. missing decayed and well-restored teeth
- Does not tell about the treatment needs of a person
- The DMF index can overestimate caries experience in cases having teeth with preventive restorations
- Cannot be used for root caries.

Decayed, Missing, Filled Surface Index (DMFS)

DMFS index assesses the total no of tooth surfaces affected rather than the tooth. It is a more detailed index in which DMF is calculated per tooth surface. DMFS

Rules, method and criteria are same as that of DMFT index except that all tooth surfaces are examined in DMFS index.

Surfaces Examined

Anterior teeth: Four surfaces are examined; Facial, Lingual, Mesial and Distal.

Posterior teeth: Five surfaces are examined; Facial, Lingual, Mesial, Distal and Occulusal.

Maximum value for DMFS comes to 128 for 28 teeth.

Posterior teeth: 16 with 5 surface, each: 16 × 5 = 80

Anterior teeth: 12 with 4 surface, each: 12 × 4 = 48

Total = 128 surfaces.

Calculating the DMFS

Individual

Total number of decayed surfaces	= D
Total number of missing surfaces	= M
Total number of filled surfaces	= F
Total DMFS score for an individual	= D +M+ F (surfaces)

It is a more precise index but takes a longer time to perform.

WHO MODIFICATION OF DMF INDEX

1. Third molars are included.
2. Teeth with temporary restorations are considered as decayed (D).
3. Initial caries is not regarded as decayed.

DENTAL CARIES INDEX FOR DECIDUOUS TEETH (dmft and dmfs)

This index for primary teeth was given by Grubbel in 1944. It is used for the primary dentition, consisting of maximum 20 teeth.

Designations are "deft" or "defs":

Where d = decayed primary teeth
e = extracted tooth/indicated for extraction (due to caries)
f = filled teeth/surfaces

Selection of Teeth or Surfaces

dmft: 20 teeth are evaluated (all the primary teeth are included).

For Surfaces

dmfs: 88 surfaces are evaluated.
Posterior teeth: 8 teeth × 5 surfaces = 40 surfaces
Anterior teeth: 12 teeth × 4 surfaces = 48 surfaces

Teeth not Counted

- Missing teeth, including unerupted and congenitally missing teeth.

- Teeth restored for reasons other than dental caries are not counted as f.
- Supernumerary teeth

Procedure and Criteria

Same as for DMFT

Calculating the def

Total def score = d + e + f
Total defs score = d + e + f surfaces.

MIXED DENTITION

In mixed dentition, DMFT or DMFS and a deft and defs index are done separately and never added together. Separate index is done for each child for permanent teeth and primary teeth starting with permanent teeth first.

WHO INDEX FOR DENTAL CARIES

CODES GIVEN BY WHO

Permanent tooth code	*Condition / status*	*Primary tooth code*
0	Sound	A
1	Decayed	B
2	Filled, with decay	C
3	Filled, no decay	D
4	Missing, as a result of caries	E
5	Missing, any other reason	–
6	Sealent, varnish	F
7	Bridge abutment or special crown	G
8	Unerupted tooth	–
9	Excluded tooth	–
10	Trauma	T

To assess dental caries in a population, a DMFT index is used. During a systematic examination with a mirror and CPI Probe that includes the crown and exposed root of every primary and permanent tooth, each crown and root are assigned a number based on the result of that exam. The numbers are recorded in boxes corresponding to each tooth to provide a DMFT chart. It is recommended, that care should be taken to record all tooth-colored fillings, which may be difficult to detect.

Numbers are assigned as follows:

- **0:** A zero indicates a sound crown or root, showing no evidence of either treated or untreated caries. A crown may have defects and still be recorded as 0. Defects that can be disregarded include white or chalky spots; discolored or rough spots that are not soft; stained enamel pits or fissures; dark, shiny, hard, pitted areas of moderate to severe fluorosis; or abraded areas.
- **1:** One indicates a tooth with caries. A tooth or root with a definite cavity, undermined enamel, or detectably softened or leathery area of enamel or cementum can be designated as 1. A tooth with a temporary filling, and teeth that are sealed but decayed, are also termed 1. Score 1 is not assigned to any tooth in which caries is only suspected. In cases where the crown of a tooth is entirely decayed, leaving only the root, score 1 is assigned to both crown and root. Where only the root is decayed, only the root is termed as 1. In cases, where both the crown and root are involved with decay, whichever site is judged the site of origin is recorded as 1. These criteria apply to all numbers.
- **2:** Filled teeth, with additional decay, are termed 2. No distinction is made between primary caries which is not associated with a previous filling, and secondary caries, adjacent to an existing restoration.
- **3:** It indicates a filled tooth with no decay. If a tooth has been crowned because of previous decay, that tooth is judged 3. When a tooth has been crowned for another reason such as aesthetics or for use as a bridge abutment, 7 is used.
- **4:** It indicates a tooth that is missing as a result of caries. Only crowns are given 4 status. Roots of teeth that have been scored as 4 are recorded as 7 or 9. When primary teeth are missing, the score should be used only if the tooth is missing prematurely. Primary teeth missing because of normal exfoliation needs no recording.
- **5:** A permanent tooth missing for any other reason than decay is given as 5. Examples are teeth extracted for orthodontia or because of periodontal disease, teeth that are congenitally missing, or teeth missing because of trauma. The 5 is assigned to the crown, the root is given a 7 or 9. Knowledge of tooth eruption patterns is helpful to determine whether teeth are missing or not yet erupted. Clues to help in the determination include appearance of the alveolar ridge in the area in question, and caries status of other teeth in the mouth.
- **6:** A 6 is assigned to teeth on which sealants have been placed. Teeth on which the occlusal fissure has been enlarged and a composite material placed should also be termed 6.
- **7:** A 7 is used to indicate that the tooth is part of a fixed bridge. When a tooth has been crowned for a reason other than decay, this code is also used. Teeth that have veneers or laminates covering the facial surface are also termed 7 when there is no evidence of caries or restoration. A 7 is also used to indicate a root replaced by an implant. Teeth that have been replaced by bridge pontics are scored 4 or 5; their roots are scored 9.
- **8:** This code is used for a space with an unerupted permanent tooth, where no primary tooth is present. The category does not include missing teeth. Code 8 teeth are excluded from calculations of caries. When applied to a root, an 8 indicates the root surface is not visible in the mouth.

- **9:** Erupted teeth that cannot be examined because of orthodontic bands, e.g. are coded a 9. When applied to a root, a 9 indicates the tooth has been extracted. The crown of that tooth would be scored a 4 or 5.
- **T:** Indicating trauma, a T is used when a crown is fractured, with some of its surface missing but with no evidence of decay.

The "D" of DMFT refers to all teeth with codes 1 and 2. The "M" applies to teeth scored 4 in subjects under age 30, and teeth scored 4 or 5 in subjects over age 30. The "F" refers to teeth with code 3. Those teeth coded 6, 7, 8, 9, or T are not included in DMFT calculations.

To arrive at a DMFT score for an individual patient's mouth, three values must be determined: the number of teeth with carious lesions, the number of extracted teeth, and the number of teeth with fillings or crowns. A patient who has two areas of decay, six missing teeth and 11 filled or crowned teeth, e.g. has a DMFT score of 19. Teeth that include both decay and fillings or crowns, are only given one point, a D. Thirteen teeth (based on a full dentition of 32) remain intact.

It is also possible to determine more detailed DMFS (decayed, missing, or filled surface) scores. As anterior teeth have four surfaces and posterior teeth have five, a full dentition of 32 teeth includes 148 surfaces. A patient with seven decayed surfaces, 20 surfaces from which teeth are missing, and 42 surfaces either filled or included in a crown, the DMFS score is 69. 79 surfaces are intact.

For primary dentition, scoring is referred to as "deft" or "defs" (decayed, extracted, or filled).

SIGNIFICANT CARIES INDEX

In 2000, the World Health Organization developed the significant caries index (SiC) to be used when studying DMFT scores on a global basis. A single population may include a number of individuals with low DMFT scores, as well as those with high scores. A mean DMFT value would not accurately reflect the status of the population. The SiC Index isolates and highlights those individuals with the highest caries values in a particular population.

To calculate a SiC Index, individuals are sorted according to DMFT values. The third of the population with highest caries scores is isolated, and a mean DMFT for this subgroup is calculated. The resulting value is the SiC Index.

DMFT score show that there is a skewed distribution of caries prevalence. Clearly, the mean DMFT value does not accurately reflect this skewed distribution leading to incorrect conclusion that the caries situation for the whole population is controlled while in reality several individuals still have caries.

A new index called the 'Significant Caries Index' (SiC) was proposed by Bratthall D in the year 2000, in order to bring attention to those individuals with the highest caries scores in each population. The SiC Index is the Mean DMFT of the one third of the study group with the highest caries score. The index is used as a complement to the mean DMFT value.

Steps to Calculate Significant Caries Index

- Sort the individuals according to their DMFT
- Select the one third of the population with the highest caries values
- Calculate the Mean DMFT for this subgroup, suppose the DMFT of 15 students was calculated as
  e.g. 0, 1, 5, 0, 0, 2, 1, 7, 0, 9, 0, 4, 1, 0, 5

  Arranged in increasing order the DMFT Scores are 0, 0, 0, 0, 0, 0, 1, 1, 1, 2, 4, 5, 5, 7, 9

  The highest 1/3rd scores are - 0, 0, 0, 0, 0, 0, 1, 1, 1, 2, 4, 5, 5, 7, 9

  Thus, the SiC Index is - 4 + 5 + 5 + 7 + 9 / 5 = 30/ 5 = 6.0

  DMFT - 0 + 0+ 0 + 0 + 0 + 0 + 1 + 1 + 1 + 2 + 4 + 5 + 5 + 7 + 9 / 15 = 35 / 15 = 2.33.

Viewpoints

Researchers all over the world develop dental indices to suit their particular needs, resulting in some duplication. There are at least six indices that measure the presence or absence of plaque. Indices have become flexible, able to be adapted, modernized, or simplified to fit different needs. They will continue to develop as those needs change again.

Professional Implications

Dental professionals from the private practice clinician to the researcher use indices to benefit their patients. A dentist or hygienist might use a PI to impress upon a patient the need for better oral hygiene. A World Health Organization researcher might use the same index to assess the home care practices of a population. Indices will continue to be important and necessary tools for dental professionals.

FLUOROSIS INDEX

Dean's Fluorosis Index

HT Dean's fluorosis index was developed in 1942 and is currently the most universally accepted classification system. An individual's fluorosis score is based on the most severe form of fluorosis found on two or more teeth. Dean's is used to score the amount of dental fluorosis (discoloration) present on teeth. Fluorosis generally appears as a horizontal striated pattern across a tooth. Molars and bicuspids are most frequently affected, followed by upper incisors. The mandibular incisors are usually least affected. Fluorosis tends to be bilaterally symmetrical. Defects may appear as fine white or frosted lines or patches near the incisal edges or cusp tips. A score is given, based on the two teeth most affected. If the teeth are not equal in appearance, the less affected tooth is the one scored.

Scores and Criteria for Dean's Fluorosis Index

Score	Criteria
Normal (0)	The enamel represents the usually translucent semivitriform type of structure. The surface is smooth, glossy, and usually a pale creamy white color.
Questionable (0.5)	The enamel discloses slight aberrations from the translucency of normal enamel, ranging from a few white flecks to occasional white spots. This classification is utilized when a definite diagnosis of the mildest form of fluorosis is not warranted and a classification of "normal" is not justified.
Very mild (1)	Small, opaque, paper white area scattered irregularly over the tooth but not involving as much as approximately 25% of the tooth surface. Frequently included in this classification are teeth showing no more than 1 to 2 mm of white opacity at the tip of the summit of the cusps of the bicuspids or second molars.
Mild (2)	The white opaque areas in the enamel of the teeth are more extensive but do not involve as much as 50% of the tooth.
Moderate (3)	All enamel surfaces of the teeth are affected, and surfaces subject to attrition show marked wear. Brown stain is frequently a disfiguring feature.
Severe (4)	All enamel surfaces are affected and hypoplasia is so marked that the general form of the tooth may be altered. The major diagnostic sign of this classification is the discrete or confluent pitting. Brown stains are widespread and teeth often present a corroded appearance.

Source: Dean 1942. American Association for the Advancement of Science.

THYLSTRUP-FEJERSKOV INDEX OF FLUOROSIS (TF)

This index has a stronger biological basis than Dean's index because the index scores were developed by relating them to histologic features of affected enamel. As the procedure includes drying of tooth it is the most sensitive of the existing indices. Also it requires assessment of only one surface per tooth because fluorosis affects all tooth surfaces equally. It can be used on selected teeth or entire dentition.

Clinical Criteria and Scoring for the TF (Thylstrup-Fejerskov) Index

Score	Criteria
0	Normal translucency of enamel remains after prolonged air drying.
1	Narrow white lines corresponding to the perikymata.

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Score	Criteria
2	*Smooth surfaces:* More pronounced lines of opacity that follow the perikymata. Occasionally confluence of adjacent lines. *Occlusal surfaces:* Scattered areas of opacity <2 mm in diameter and pronounced opacity of cuspal ridges.
3	*Smooth surfaces:* Merging and irregular cloudy areas of opacity. Accentuated drawing of perikymata often visible between opacities. *Occlusal surfaces:* Confluent areas of marked opacity. Worn areas appear almost normal but usually circumscribed by a rim of opaque enamel.
4	*Smooth surfaces:* The entire surface exhibits marked opacity or appears chalky white. Parts of surface exposed to attrition appear less affected. *Occlusal surfaces:* Entire surface exhibits marked opacity. Attrition is often pronounced shortly after eruption.
5	*Smooth surfaces and occlusal surfaces:* Entire surface displays marked opacity wtih focal loss of outermost enamel (pits) < 2 mm in diameter.
6	*Smooth surfaces:* Pits are regularly arranged in horizontal bands < 2 mm in vertical extension. *Occlusal surfaces:* Confluent areas < 3 mm in diameter exhibit loss of enamel. Marked attrition.
7	*Smooth surfaces:* Loss of outermost enamel in irregular areas involving < 1/2 of entire surface. *Occlusal surfaces:* Changes in the morphology caused by merging pits and marked attrition.
8	*Smooth and occlusal surfaces:* Loss of outermost enamel involving > 1/2 of surface.
9	*Smooth and occlusal surfaces:* Loss of main part of enamel with change in anatomic appearance of surface. Cervical rim of almost unafffected enamel is often noted.

TOOTH SURFACE INDEX OF FLUOROSIS (TSIF)

This index was developed in 1984 by Horowitz HS, Driscoll WS, Meyers RJ and used by researcher in the National Institute of Dental Research. It is probably more sensitive than Dean's index specially for the mildest forms of fluorosis. Each tooth surface is seen and scored on a 0-7 scale, whereas Dean's index applies only to two worst teeth in the mouth.

Selection of Teeth

All the teeth are assessed.

Surface

Anterior teeth: Separate score is given for every intact labial or lingual surface of anterior teeth.

Posterior teeth: Every buccal, occlusal and lingual surface are given a separate score.

Scoring Criteria

Clinical Criteria and Scoring System for the Tooth Surface Index of Fluorosis

Score	*Criteria*
0	Enamel shows no evidence of fluorosis.
1	Enamel shows definite evidence of fluorosis, namely areas with parchment-white color that total less than 1/3rd of the visible enamel surface. This category includes fluorosis confined only to incisal edges of anterior teeth and cusp tips of posterior teeth ("snow capping").
2	*Parchment*-white fluorosis totals at least 1/3rd of the visible surface but less than 2/3rd.
3	*Parchment*- white fluorosis totals at least 2/3rd of the visible surface.
4	Enamel shows staining in conjunction with any of the preceding levels of fluorosis. Staining is defined as an area of definite discoloration that may range from light to very dark brown.
5	Discrete pitting of enamel exists, unaccompanied by evidence of staining of intact enamel. A pit is defined as a definite physical defect in the enamel surface with a rough floor that is surrounded by a wall of intact enamel. The pitted area is usually stained or differs in color from the surrounding enamel.
6	Both discrete pitting and staining of the intact enamel exists.
7	Confluent pitting of the enamel surface exists. Large areas of enamel may be missing and the anatomy of the tooth may be altered. Dark-brown stain is usually present.

Dental Fluorosis Index by Moller (1965)

Weighting	*Diagnosis*	*Clinical criteria*
0	Normal	The enamel shows the usual translucency. The surface is smooth, shiny and usually of a pale, creamy white to grey white colour. In this group are also opacities, which are not considered to be of fluorotic character.
0	Optimal	The enamel is on clinical inspection completely homogeneously mineralised without hypomineralisation of any sort. The enamel is smooth and mirror-like, and has a shiny. "Varnished" look. The colour is creamy white to yellowish white.
0.25	Questionable	In areas with relatively low fluoride content in drinking water, there are cases which even the most experienced researchers cannot classify as either normal or very mild. These cases show mainly labially in the upper front teeth as very narrow, opaque, paper-white, horizontal lines in the tooth's incisal third especially. In back teeth are now and then seen small, opaque spots (about

Contd...

Contd...

Weighting	*Diagnosis*	*Clinical criteria*
		0.5 mm in diameter) directly on the cusp tips, while the rest of the tooth is completely normally mineralised. The features of these opaque lines and spots are so fine that they are often confused with perichymata. This fine feature shows more clearly with drying the tooth, a procedure which should always be done while diagnosing.
0.25-1	Very Mild	Clearer opaque, paper-white, transversely oriented striations or spots, found spread especially on the upper incisors' labial surfaces and most concentrated in the incisal third. In the back teeth are seen opaque regions (< 1 mm in diameter) directly on the cusp tips. Opaque, paper-white, narrow, transversely running lines reach down over the cusp, while the rest of the tooth is normal. The opaque regions cover almost a fourth of the surface of the tooth. When viewed from a distance, the tooth seems to have a slightly mother-of-pearl sheen. The lower grades of very mild dental fluorosis are rated 0.5 and the worst 1.0.
1.5-2	Mild	The mainly transversely running opaque lines and spots are more clear and stretch further down over the tooth's surface towards the outer circumference. One can detect that the opaque lines begin to merge together into diffuse regions, so that the tooth seen at a distance (40-50 cm) seems whiter - more opaque - than a normally mineralised tooth. Seen close to these opaque areas take up, however, at most half of the tooth's surface. Changes in the front teeth's lingual surfaces are considerably less obvious than on the labial. As far as the back teeth are concerned, the changes in labial and lingual surfaces are of more or less the same degree. On the cusps of canines, premolars and molars there are cases where the cusp tips are worn, so that the wear facets peripherally are bordered by a narrow, opaque ring (an expression of the fluorotic surface layer) surrounded by the clearer underlying enamel. In pronounced cases the development of pigment can be seen, especially in the upper incisors. Lower grades of mild dental fluorosis are scored 1.5 and the worst 2.0.

Contd...

Contd...

Weighting	*Diagnosis*	*Clinical criteria*
2.5-3	Moderate	The opaque regions take up practically all the tooth's surface. Tooth shape is normal, but a weak "pit" development can be found, especially on premolar buccal and palatal surfaces, as well as upper incisor labial surfaces. Pigment where present can vary in color from yellow to brown. The lower grades of moderate dental fluorosis are rated 2.5 and the worst 3.0.
3.5-4	Severe	The shape of the tooth can be changed. The development of pits is pronounced. Merging of pits is often seen. Sometimes the outer layer of enamel is parlty or completely missing, and the tooth has a corroded look. Pigmentation varies in color from brown, to dark brown, to black. Lower degrees of severe dental fluorosis score 3.5 and the worst 4.0.

INDICES FOR MALOCCLUSION

The Dental Aesthetic Index (DAI)

The Dental Aesthetic Index (DAI) is an orthodontic index which incorporates socially defined aesthetic standards. In addition, it provides a severity measure for psychologic and functional impairment. It consists of 10 components multiplied by weights based on regression coefficients, plus a constant.

Component	*Finding*	*Weight*
Constant		**13**
Missing teeth	Number of missing incisor, canine and premolar teeth	6
Crowding in incisal segments	Number of segments crowded	1
Spacing in incisal segments	Number of segments spaced	1
Diastema	In millimeters	3
Anterior irregularity in maxilla	Largest irregularity in mm	1
Anterior irregularity in mandible	Largest irregularity in mm	1
Anterior maxillary overjet	In millimeters	2
Anterior mandibular overjet	In millimeters	4
Vertical anterior openbite	In millimeters	4
Anteroposterior molar relation	Largest deviation from normal 0.5 cusp=1 >=1 cusp=2	3

Where:

Diastema = the space between 2 adjacent teeth on the same dental arch

DAI score = SUM((finding) * (weight))

Interpretation

Minimum score: 13

Further the score falls from the norm of most acceptable dental appearance, the more the occlusal condition may be judged socially or physically handicapping if left untreated.

THE INDEX OF ORTHODONTIC TREATMENT NEED (IOTN)

Overview

The Index of Orthodontic Treatment Need (IOTN) was developed as a means to objectively measure a person's need for orthodontic treatment.

Components

1. Dental health: 5 grades from none to very great
2. Aesthetics: attractiveness of the patient's labial aspect ranked from 1 (close to normal) to 10.

Dental Health Component Grade 1: None

- Extremely minor malocclusions including displacements < 1 mm.

Dental Health Component Grade 2: Little

- Increased overjet 3.6 to 6.0 mm, with competent lips.
- Reverse overjet 0.1 to 1.0 mm
- Anterior to posterior crossbite with up to 1 mm discrepancy between retruded contact position and intercuspal position.
- Displacement of teeth 1.1 to 2.0 mm
- Anterior or posterior openbite 1.1 to 2.0 mm
- Increased overbite ≥ 3.5 mm, without gingival contact.
- Pre-normal or post-normal occlusions with no other anomalies. Includes up to half a unit discrepancy.

Dental Health Component Grade 3: Moderate

- Increased overjet 3.6 to 6.0 mm, with incompetent lips.
- Reverse overjet 1.1 to 3.5 mm
- Anterior or posterior crossbites with 1.1 to 2.0 mm discrepancy.
- Displacement of teeth 2.1 to 4.0 mm
- Lateral or anterior crossbite 2.1 to 4.0 mm
- Increased and complete overbite without gingival trauma.

Dental Health Component Grade 4: Great

- Increased overjet 6.1 to 9.0 mm
- Reversed overjet > 3.5 mm with no masticatory or speech difficulties
- Anterior or posterior crossbites with > 2 mm discrepancy between retruded contact position and intercuspal position
- Severe displacement of teeth, > 4 mm
- Extreme lateral or anterior openbites, > 4 mm
- Increased and complete overbite with gingival or palatal trauma
- Less extensive hypodontia requiring pre-restorative orthodontic space closure to obivate the need for a prosthesis
- Posterior lingual crossbite with no functional occlusal contact in one or both buccal segments
- Reverse overjet 1.1 to 3.5 mm with recorded masticatory and speech difficulties
- Partially erupted teet, tipped and impacted against adjacent teeth
- Supplemental teeth

Dental Health Component Grade 5: Very Great

- Increased overjet > 9 mm
- Extensive hypodontia with restorative implications (more than 1 tooth missing in any quadrant) requiring pre-restorative orthodontics
- Impeded eruptions of teeth (with the exception of the third molars) due to crowding, displacement, the presence of supernumerary teeth, retained deciduous teeth, and any pathological cause
- Reverse overjet > 3.5 mm with reported masticatory and speech difficulties
- Defects of cleft lip and palate
- Submerged deciduous teeth.

Aesthetic Component

- A patient's score is based on matching his or her dental appearance with one of a series of 10 photographs showing the labial aspect of different Class I or Class II malocclusions ranked according to their attractiveness.

Chapter 17

Dental Auxiliaries

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DENTAL TEAM

The concept of dental team is used to describe the providers of dental care, all of whom perform different roles and function. They undergo different training and work together to provide care to dental patients.

A *dentist* is a person licensed to practice dentistry under the laws of the appropriate state, territory or nation. The laws ensure that to obtain a license a person must obtain the required qualification. The dentist is responsible, ethically and legally for providing to the patient, the highest quality comprehensive dental care, which includes the inseparable components of medical and dental history, examination, diagnosis, treatment planning, treatment services and health maintenance. In carrying out that responsibility and to increase the capacity of the profession to provide patient care in the most cost-effective manner, the dentist may delegate certain patient care functions to allied dental personnel for which the allied dental personnel has been trained.

Dental auxiliary is a term for all persons who assist the dentist in delivering dental care. They can be classified into operating or nonoperating depending upon whether they are allowed to carry out any intraoral procedures in the treatment of the patients.

The primary purpose of dentists delegating functions to allied dental personnel is to increase the capacity of the profession to provide patient care while retaining full responsibility for the quality of care. This responsibility includes identification of the need for specific types of allied dental personnel and establishment of appropriate controls on the patient care services provided by allied dental personnel.

The dental profession has the responsibility to provide guidance to all agencies, organizations and governmental bodies that have the responsibility and authority for, decisions on utilization, education, and supervision of allied dental personnel. In this context, the primary responsibility is to assure that decisions on allied dental personnel utilization will not adversely affect the health and well-being of the public or cause an increased risk to the patient. In meeting these responsibilities, dentists must also identify those functions or procedures that require the knowledge and skill of the dentist and therefore, must be performed only by a licensed dentist. These functions and procedures include, but are not limited to: examination, diagnosis and treatment planning; prescribing work authorizations; surgical or cutting procedures on hard or soft tissue; prescribing drugs and other medications; and administering local, parenteral, inhalational, or general anesthesia.

The transfer of permissible functions from the dentist to the allied dental personnel must not result in a reduced quality of patient care. In all cases, the authority and responsibility of the dentist for the overall oral health of the patient must be maintained to assure cost-effective delivery of services to the patient and avoid fragmentation of the dental team.

Constituent dental societies should advocate the functions which may be appropriately delegated to allied dental personnel based on: (1) the best interests of the patient; (2) the education, training and credentialing of the allied dental personnel; (3) considerations of cost-effectiveness and efficiency in delivery patterns; and (4) valid research demonstrating the feasibility and practicality of utilizing allied dental personnel in such roles in actual practice settings.

COMPREHENSIVE DENTAL CARE

A coordinated approach, by a dentist, to the restoration or maintenance of the oral health and function of the patient, utilizing the full range of clinically proven dental care procedures, which includes examination and diagnostic, preventive and therapeutic services.

DEFINITION

Dental auxiliaries is a person who is given responsibility by a dentist so that, he or she can help the dentist in providing dental care, but who is not himself or herself qualified with a dental degree.

a. "Dental auxiliary" means a person who may perform dental supportive procedures authorized by the provisions of these regulations under the specified supervision of a licensed dentist.
b. "Dental assistant" means an unlicensed person who may perform basic supportive dental procedures specified by these regulations under the supervision of a licensed dentist.
c. "Registered dental assistant" or "RDA" means a licensed person who may perform all procedures authorized by the provisions of these regulations and in addition may perform all functions which may be performed by a dental assistant under the designated supervision of a licensed dentist.
d. "Registered dental hygienist" or "RDH" means a licensed person who may perform all procedures authorized by the provisions of these regulations and in addition may perform all functions which may be performed by a dental assistant and registered dental assistant, under the designated supervision of a licensed dentist.
e. "Registered dental assistant in extended functions" or "RDAEF" means a person licensed as a registered dental assistant who has completed postlicensure clinical and didactic training approved by the board and satisfactorily performed on an examination designated by the board for registered dental assistant in extended function applicants.
f. "Registered dental hygienist in extended functions" or "RDHEF" means a person licensed as a registered dental hygienist who has completed postlicensure clinical and didactic training approved by the board and satisfactorily performed on an examination designated by the board for registered dental hygienist in extended functions applicants.

CLASSIFICATION

Based on the nature of duties they perform auxiliaries can be classified into two categories:

WORLD HEALTH ORGANIZATION (WHO) CLASSIFICATION

Non-operating Auxiliary

a. *Clinical:* This is a person who assists the professional in his clinical work but does not carry out any independent procedures in the oral cavity.
b. *Laboratory:* This is a person who assists the professional by carrying out certain technical laboratory procedures.

Operating Auxiliary

According to WHO, this is a person not being a professional, is permitted to carry out certain treatment procedures in the mouth under the direction and supervision of a professional.

Revised Classification

Non-operating

- Dental surgery assistant
- Dental secretary/receptionist
- Dental laboratory technician
- Dental health educator

Operating

- School dental nurse
- Dental therapist
- Dental hygienist
- Expanded functions of operating dental auxiliaries

TYPES OF SUPERVISION

In all instances, a dentist assumes responsibility for determining, on the basis of diagnosis, the specific treatment patients will receive and which aspects of treatment may be delegated to qualified personnel. The degree of supervision required to assure that treatment is appropriate and does not jeopardize the systemic or oral health of the patient varies with the nature of the procedure and the medical and dental history of the patient.

Supervision and coordination of treatment by a dentist are essential to comprehensive oral health care. Unsupervised practice by allied dental personnel reduces the quality of oral health care, fails to protect the dental health of the public and is opposed by the American Dental Association. The types of supervision are:

Personal Supervision

"Personal Supervision" means the dentist is personally operating on a patient and authorizes the dental auxiliary to aid his/her treatment by concurrently performing a supportive procedure.

Direct Supervision

"Direct supervision" means the dentist is in the dental office, personally diagnoses the condition to be treated, personally authorizes the procedure(s)/duty(ies), remains in the dental office while the procedure(s)/duty(ies)are being performed and examines the patient before his/her dismissal.

Indirect Supervision

"Indirect supervision" means the dentist is in the dental office, personally diagnoses the condition to be treated, personally authorizes the procedure(s)/duty(ies), and remains in the dental office while the procedure(s)/duty(ies) is being performed by the dental auxiliary.

General Supervision

"General Supervision" means the dentist has authorized the procedure(s)/duty(ies) and such is being carried out in accordance with his/her diagnosis and treatment plan.

General supervision is not acceptable to the American Dental Association because it fails to protect the health of the public. Personal, direct, and indirect supervision are appropriate for delegation of duties to allied dental personnel providing direct patient care. However, in some states, licensed dental hygienists are permitted to perform duties, except for intraoral expanded functions, under general supervision, as delegated by the supervising dentist. In order to assure the safety of the patient, the following criteria must be followed whenever functions are performed under general supervision:

1. Any patient to be treated by a dental hygienist must first become a patient of record of a dentist. A patient of record is defined as one who:
   a. Has been examined by the dentist;
   b. Has had a medical and dental history completed and evaluated by the dentist; and
   c. Has had his/her oral condition diagnosed and a treatment plan developed by the dentist.
2. The dentist must provide to the dental hygienist prior written authorization to perform clinical dental hygiene services for that patient of record. Such authorization should remain in effect for a limited time period as specified by state law.
3. The dentist shall examine the patient, following performance of clinical services by the dental hygienist. Such examination shall be performed within a reasonable time as determined by the nature of the services provided, the needs of the patient and the professional judgment of the dentist.

Public Health Supervision

That oversight where a licensed dental hygienist may provide dental hygiene services, as specified by state law or regulations, when such services are provided as part of an organized community program in various public health settings, as designated by state law, and with general oversight of such programs by a licensed dentist designated by the state.

NONOPERATING AUXILIARIES

Dental Surgery Assistant

Also called as *dental assistant.* An individual who may or may not have completed an accredited dental assisting education program and who aids the dentist in providing patient care services and performs other nonclinical duties in the dental office or other patient care facility. The dental surgery assistant helps to ensure smooth running of the clinical area, and to help the dentist and his staff so that, they are able to spend more time providing actual dental care to patients. The scope of the patient care functions that may be legally delegated to the dental assistant varies based on the needs of the dentist, the educational preparation of the dental assistant and state dental practice acts and regulations. Patient care services are provided under the supervision of a dentist. Traditionally, they were given responsibility for the management of instruments, equipments, materials including the cleaning, sterilizing and recycling of these.

Dental assistants perform some or all of the following duties:

- Prepare patients for dental examination and assist the dentist during the examination
- Asking about the patient's medical history and taking blood pressure and pulse
- Helping patients feel comfortable before, during and after dental treatment
- Sterilize and maintain instruments and equipment
- Prepare dental instruments and filling materials
- Educate patients concerning oral hygiene
- Schedule patient appointments and record dental procedures performed
- Invoice patients for dental services
- Order dental and office supplies
- Providing patients with instructions for oral care following surgery or other dental treatment procedures, such as the placement of a restoration (filling)
- Serving as an infection control officer, developing infection control protocol and preparing and sterilizing instruments and equipment.

Dental Secretary/Receptionist

This is person who helps the dentist in his secretarial work and patient reception.

Dental Laboratory Technician/Certified Dental Technician

An individual who has the skill and knowledge in the fabrication of dental appliances, prostheses and devices in accordance with a dentist's laboratory work authorization. They are also called as *dental mechanic*.

Dental Laboratory Technology is both a science and an art. Since each dental patient's needs are different, the duties of a dental laboratory technician are comprehensive and varied. Although dental technicians seldom work directly with patients, except under the direction of a licensed dentist, they are valuable members of the dental care team. They work directly with dentists by following detailed written instructions and using impressions (molds) of the patient's teeth or oral soft tissues to create:

- Full dentures for patients who are missing all of their teeth
- Removable partial dentures or fixed bridges for patients who are missing only one or a few teeth
- Crowns, which are caps for teeth that are designed to restore their original size and shape

- Veneers that enhance the esthetics and function of the patient
- Orthodontic appliances and splints.

Denturists are those dental laboratory technicians who are permitted in some states in the United States and elsewhere, e.g. Denmark to fabricate dentures directly for patients without the prescription of a dentist.

A denturist may perform some or all of the following duties:

- Measure patients' jaws to determine size and shape of dentures required
- Make impressions of patient's teeth, gums and jaws
- Construct dentures or direct other workers to construct dentures
- Fit and modify new dentures
- Repair dentures
- Reline and rebase dentures
- Fabricate mouth protectors, antisnoring prostheses and removable prostheses on implants
- May prepare partial dentures

Dental Health Educator

This is a person who instructs in the prevention of dental disease. They impart important information about oral diseases and help educate the community about how to maintain good oral health how to prevent the occurrence of oral diseases.

OPERATING AUXILIARIES

School Dental Nurse (New Zealand Type)

This is a person who is permitted to diagnose dental diseases and to plan and carry out certain specified preventive and treatment measures in the treatment of dental diseases in school children.

The New Zealand school dental nurse plan was established in 1923 (training began in 1921). The stimuli for this program were the presence of extensive dental diseases in children. The treatment of children was difficult because of insufficient dentist and the large distances between communities. The government trained young women to be known as *school dental nurse*, who would provide bulk of the treatment in the school dental service. After a training period of 2 years each nurse was assigned to a school.

Duties include:

1. Oral examination
2. Prophylaxis
3. Topical fluoride application
4. Administration of local anesthesia
5. Advice on dietary fluoride supplements
6. Cavity preparation and placement of amalgam and silicate fillings in primary and permanent teeth.
7. Pulp capping
8. Extraction of primary teeth only
9. Classroom and parent-teacher dental health education
10. Individual patient instruction in tooth brushing and oral hygiene
11. Referral of more complex cases to dentist.

Advantages

- Care can be provided to children in areas where no care would otherwise is available.
- Dental nurses are presumed to provide cheaper dental care than dentists.

Disadvantages

- It is thought that recipients do not develop self-responsibility for seeking dental health care.
- Another debatable issue is whether increased availability of less expensive care leads to decreased quality of care, as dental nurse cannot provide the same quality of care as dentists can.

Dental Therapist

This is a person who is permitted to carry out certain specified preventive and treatment measures to the prescription of the supervising dentist including cavity preparation and restoration of teeth. They are also called as dental nurse. They may work in public health service as in United Kingdom or may work under a dentist in private practice (Australia). Duties are almost similar to those of the New Zealand school dental nurse except that they are not allowed to diagnose and plan dental care. The supervising dentist is responsible for determining the degree of supervision required in each individual case, according to the capacity and working experience of the therapist concerned.

Dental Hygienist

Dental Hygienist is an individual who has completed an accredited dental hygiene education program and an individual who has been licensed by a state board of dental examiners to provide preventive care services under the supervision of a dentist. Functions that may be legally delegated to the dental hygienist are based on the needs of the dentist, the educational preparation of the dental hygienist and state dental practice acts and regulations, but always include, at a minimum, scaling and polishing the teeth.

Dental hygienists may perform the following tasks:

- Educate and counsel children and adults on dental health, plaque control, oral hygiene and nutrition
- Patient screening procedures; such as assessment of oral health conditions, review of the health history, oral cancer screening, head and neck inspection, dental charting and taking blood pressure and pulse

- Remove deposits and stains from teeth by scaling and root planing
- Give local anesthetic for dental procedures
- Assist in the prevention and control of dental caries (decay) and gum disease
- Select and use appropriate fluoride treatments and polish tooth restorations
- Taking and developing dental radiographs (x-rays)
- Make impressions of patient's mouth for the construction of study casts and mouth guards
- Apply and remove periodontal packs
- Instruct patients on how to look after their teeth and mouth after operations
- Assist in the management of periodontal disease
- Teaching patients appropriate oral hygiene strategies to maintain oral health; (e.g. toothbrushing, flossing and nutritional counseling)
- Performing documentation and office management activities
- Applying preventive materials to the teeth (e.g. sealants and fluorides).

Expanded Functions/ Duties of Operating Dental Auxiliaries [EFDA OR EDDA]

This is person who is permitted to carry out certain specified preventive and treatment measures including reversible procedures under the direct supervision of a dentist. An EFDA is a dental assistant or dental hygienist in some cases, who has received further training in duties related to the direct treatment of the patients, though still working under the direct supervision of a dentist. It excludes diagnosis, treatment planning, cutting of hard or soft tissues and prescription of drugs. They are allowed '*reversible*' procedures. Being reversible it is considered that procedures undertaken by the auxiliary could be repeated by the dentist without excessive harm to the patient, if the work performed by the auxiliary is of unacceptable quality.

Procedures permitted include:

1. Placing rubber dams
2. Restoration of teeth in which cavities have been prepared by a dentist with amalgam and other plastic filling materials
3. Taking radiographs
4. Taking impression
5. Topical application of fluoride
6. Making of study models
7. Making of impression trays
8. Casting and polishing of inlays and dentures
9. Placing and removing matrix bands
10. Removing sutures
11. Monitoring of nitrous oxide
12. Removing and replacing ligature wires on orthodontic appliances
13. Applying desensitizing agents
14. Applying pit and fissure sealents

Registered Restorative Assistant in Extended Functions

May perform any duties that a dental assistant may perform.

Allowed to perform the following procedures under direct supervision:

1. Cord retraction of gingivae for impression procedures
2. Taking impressions for cast restorations
3. Formulating indirect patterns for endodontic post and core castings
4. Fitting trial endodontic filling points
5. Drying canals, previously opened by the supervising dentist with absorbent point
6. Testing pulp vitality
7. Removing excess cement from subgingival tooth surfaces with a hand instrument
8. Fitting and cementing stainless steel crowns
9. Placing, condensing, and carving amalgam restorations
10. Placing class I, III, and V nonmetallic restorations
11. Taking face-bow transfers and bite registrations for fixed prostheses
12. Taking final impressions for tooth-borne, removable prostheses
13. Placing and adjusting permanent crowns for cementation by the dentist
14. Applying etchants for bonding restorative materials.

AUXILIARIES PERSONNEL IN INDIA

Of all the dental auxiliaries discussed, the dental auxiliary currently present in India are dental hygienist, dental laboratory technician and dental surgery assistants. They have to undergo a training of 2 years in institutions which have been recognized by Ministry of Health; Government of India and certificate course recognized by Dental Council of India.

According to the regulations and ordinance issued by DCI for dental mechanics and Hygienist; the eligibility criteria are:

i. A candidate should be atleast 17 years of age on or before 31st December of year of admission
ii. Candidate should have passed senior school certificate examination.

FOUR-HANDED DENTISTRY

Four-handed dentistry is a team concept where highly skilled individuals work together in an ergonomically designed environment to improve productivity of the dental team, improve the quality of care for dental patients while protecting the physical well-being of the operating team.

Four-handed dentistry is not simply transferring instruments from one person to another.

Newer Dental Assistant by California Dental Association 2006 (CDA) USA

Registered Orthodontic Assistant	*Registered Surgery Assistant*	*Registered Restorative Assistant*
Any duties that a dental assistant may perform	Any duties that a dental assistant may perform	Any duties that a dental assistant may perform
Mouth mirror inspections	Mouth mirror inspections	Mouth mirror inspections
Sizing, fitting, adjusting, prepositioning, curing in a position approved by the supervising dentist, and removal of orthodontic bands and brackets	Monitoring of patients during the preoperative, intraoperative and postoperative phases, using noninvasive instrumentation such as pulse oximers, electrocardiograms, and capnography.	Sizing, fitting, adjusting, intraorally fabricating, temporarily cementing, and removing temporary crowns
Coronal polishing	Taking impressions for surgical splints and occlusal guards	Placing bases and liners on sound dentine
Removing excess cement from supragingival surfaces of teeth	Placement and removal of surgical sutures and dressings	Removing excess cement from supragingival surfaces of teeth
Prepare teeth for bonding	Adding medications, drugs and fluids, to intravenous lines using a syringe in the presence of a licensed dentist	Taking face-bow transfers and bite registrations for diagnostic models for case study only
Activating bleaching agents with nonlaser, light-curing devices	Removal of intravenous lines	Taking impressions for space maintaining appliances and occlusal guards
Removal of excess cement from coronal surfaces of teeth under orthodontic treatment by means of an ultrasonic scaler	Coronal polishing	Coronal polishing
Taking face-bow transfers and bite registrations	Other procedures authorized by the board through regulation	Applying pit and fissure sealants
Placing metal separators Placing ligature ties and arch wires		Placing and removing temporary restorations Activating bleaching agents with nonlaser, light-curing devices
Taking orthodontic impressions	Only after providing evidence of having completed a board approved course in the procedure	Other procedures authorized by the board through regulation

This system of four-handed dentistry is based on the following principles:

1. *Positions:* The dentist (or hygienist), assistant and patient are seated and positioned properly.
2. Assistant utilization: The operator uses the skills of competent, full-time chair side assistant.
3. *Treatment organizations:* Every aspect of the patient's treatment is organized and repetitive tasks simplified to take maximum advantage of the chair side time available.
4. *Equipment arrangement:* The equipment used is selected carefully and positioned properly to enable the operating team to use the principles of work simplification and motion economy.

The two most frequent issues facing dentists are (1) the need to minimize stress and fatigue and (2) the need to maintain or even increase productivity without sacrificing the quality of care. The use of this concept of four-handed dentistry enables the dentist to spend their time at chair side actually working on the patients more efficiently.

TEAM - Training in expanded auxillary program provides a framework where dental students are trained to work and supervise the operating and non-operating auxiliaries.

18 Finance in Dentistry

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Dental plans are contracts between the sponsor (an employer or organization) and the third party (an insurance company), according to which you can arrange your dental treatment into the most suitable pattern. Usually, dental insurance plans do not cover the full cost of dental care. Dental care programs have some provisions that limit the amount the insurance company will pay.

An average dental plan covers 100% for preventive measures, 80% for basic dental work, and 50% for major procedures. Basic dental insurance coverage falls into three major categories:

PREVENTIVE AND DIAGNOSTIC DENTAL CARE

Nearly all dental insurance policies cover basic dental services such as check-ups, X-ray pictures, cleanings, and some other procedures preventing tooth and gum disease. Since regular dental care prevents more serious potential problems, such coverage can be rather important.

BASIC DENTAL CARE AND DENTAL PROCEDURES

Basic dental procedures include fillings, fixing chipped teeth, tooth extractions, periodontal treatment, root canals, etc. However, with some dental insurance providers, some procedures cannot be listed as basics, for instance, root canals. It is up to you to select a dental insurance provider who covers most items of basic dental care and dental procedures.

MAJOR DENTAL CARE

Major dental care usually includes dental surgery, denture work, orthodontics, and other serous expensive dental procedures. Some dental insurance plans cover a portion of major dental care costs.

COMMON TERMS

Dental Health Maintenance Organization (DHMO) is a legal entity that accepts the premise to provide the services at a fixed price during a defined period of time. The enrollees in these plans are to apply only to the designated specialist working within the network of providers.

Co-insurance is a fixed percentage of charges the insured has to pay in order to cover dental treatment services.

Co-payment is the dollar amount of the fee the insured has to pay the dentist after the insurance company has paid a certain percentage stipulated in the contract.

Deductible is a fixed dollar amount that a policyholder is to pay each year before the dental plan begins to pay for basic, restorative and orthodontic benefits.

Direct Reimbursement Plan is a dental insurance plan that is usually entirely funded by the employer and allows the insured to see any dentist of his/her choice without any network restrictions.

Fee schedule is a list of fees a dentist is expected to charge for certain dental care procedures, which determines a specific amount your insurance provider reimburses you for your dental care expenditures. The fee schedule is stable and unrelated to a particular dentist's fee.

Indemnity Insurance Plans (also Traditional Dental Care Plans or Fee-for-Service Plans) is a variety of plans that provide preventive, basic, major restorative and orthodontic dental coverage. With an indemnity insurance plan you acquire flexibility to choose the professionals you want to apply to.

Nonparticipating Dentist is a dentist who has not signed any contract with a network of providers to accept participants of a certain dental plan under stipulated conditions. If you choose a network-based plan, you will have to pay comparatively a lump sum applying to a nonparticipating dentist.

Participating Dentist (Provider) is a dentist who signs a contract with the insurance company and agrees to provide dental services and supplies to eligible participants at a fixed price.

Premium is the money amount one is to pay on a regular basis (usually either every month or every year) so that, the insurance company could fund your dental plan.

Provider is a licensed, plan approved dentist.

Usual, Customary, and Reasonable Fee (UCR Fee) is a fee associated with each dental procedure which reflects the fees charged by the majority of dentists for the services in question in a given area. The "UCR" fee can help you determine whether your dentist is charging too much.

Third Party Payer: An organization other than the patient (first party) or health care provider (second party) involved in the financing of personal health services.

Table of Allowances: A list of covered services with an assigned dollar amount that represents the total obligation of the plan with respect to payment for such services, but does not necessarily represent the dentist's full fee for that service.

Prepaid Dental Plan: A method of financing the cost of dental care for a defined population, in advance of receipt of services.

Preferred Provider Organization (PPO): A formal agreement between a purchaser of a dental benefit program and a defined group of dentists for the delivery of dental services to a specific patient population, as an adjunct to a traditional plan, using discount fees for cost savings.

Indemnity Plan: A dental plan where a third-party payer provides payment of an amount for specific services, regardless of the actual charges made by the provider. Payment may be made either to enrollees or, by assignment, directly to dentists. Schedule of allowances, table of allowances, or reasonable and customary plans are examples of indemnity plans.

MECHANISM OF PAYMENT FOR DENTAL CARE

1. Fee for service
2. Post payment plan
3. Private third party prepayment plans
   a. Commercial insurance company
   b. Nonprofit health service corporation
      i. Delta dental plan
      ii. Blue cross/blue shield
   c. Prepaid group practice, including health maintenance organization [HMO]
   d. Capitation plan
4. Salary
5. Public programs

FEE FOR SERVICE

Private fee for service also called as 'two-party arrangement' is the traditional form of reimbursement for dental service. In this system the patient takes an appointment and dentist suggest the appropriate treatment and informs the patient his fee for the service. If the patient accepts the recommended treatment and receives the services of the dentist, then he is responsible to pay the fee.

By 1980, there was a fall in this method of payment, although still the most common method due to substantial growth in various other forms of payment for dental services.

Advantages

1. It is culturally acceptable: Most common method of doing business.
2. It is flexible: The dentist can modify his fees according to market condition and can also practice 'price discrimination' (some patients, e.g. wealthier ones pay more than others for the same service).
3. Administratively simple: the dentist may not always keep a written list of fees for various procedures.

Disadvantage

There are many patients who due to cost of treatment may still not be able to afford the treatment under this method of payment.

POSTPAYMENT PLAN

It was first started by local dental societies in Pennsylvania and Michigan in late 1930s. Under this plan the patient borrows money from a bank/finance company to pay the dentist fee, at the appointment when agreement to receive the care is made. After, the application is approved by the bank, the entire fee is paid to the dentist. The patient then repays the loan (with interest) in the budgeted amount to the lending institution.

This type of payment plans were developed with the hope that budget payment plans would bring the benefits to a large number of the population for routine dental care. But it was utilized more by middle income group rather than low income group and was used primarily for prosthetic treatment. The problems associated with it were the defaulted loans and the low income group people were not easily accepted credit worthy by banks. Payments by credit cards have restricted the postpayment plans.

PRIVATE THIRD PARTY PREPAYMENT PLANS

Third party payment is defined as payment for services by some agency rather than directly by the beneficiary of those

services. In this the dentist and the patient are the first and second parties and the administrator of the finances is called as the third party. Third party is also known as the carrier, insurer, underwriter or the administrative agent.

Definition

Third party is defined as the party to a dental prepayment contract that may collect premiums, assume financial risk, pay claims and provide administrative services.

Prepayment is a mechanism to distribute the financial load of dental care over a group. Virtually, all of those covered can reasonably expect to make regular and somewhat predictable use of the benefits. It is in contrast to insurance which involves a group of people making small payments in order to cover the risk of a few suffering a catastrophic loss. It is expected that very few of them will ever suffer such a loss and therefore, most will never collect any insurance benefit.

The purchaser of this type of plan can be organized private group e.g., a union or it can be an employer, a governmental agency or a union employer welfare fund. When government act as a third party the term commonly used is *public financing* of care. In private third party plans, premiums are collected to meet the costs providing care as well as the administrative cost of the third party.

REIMBURSEMENT OF DENTISTS IN PREPAYMENT PLANS

UCR FEE METHOD

The American Dental Association (ADA) prefer the Usual, Customary and Reasonable [UCR] fee method for reimbursement for dentist in prepayment plans.

Usual fee: The fee usually charged for a given service by an individual dentist to private patients.ie dentist's usual fee

Customary fee: When the fee is in the range of the usual fee charged by the dentists of similar training and experience for the same service within the specific and limited geographic area.

Reasonable fee: A fee is reasonable if it meets the above two criteria or it may differ from dentist's usual and customary fee if justifiable in the opinion of the responsible association, considering the special circumstances or for the particular patient in question.

A TABLE OF ALLOWANCE

It is defined as a list of covered services that assigns to each service a sum that represents the total obligation of the plan with respect to payment for such service, but that does not necessarily represent a dentist's full fee for that service. For example, if third party plan permits a fee of $ 70 for a particular treatment for which the dentist usual fee is $ 100, the dentist after providing the service will collect $70 from the carrier and may charge the patients $30 to cover up his usual fee of $100.

But this method of reimbursement may leave people unsatisfied because patients are unaware that this plan may not cover them in full for dental treatment.

FEE SCHEDULE

It is defined as maximum dollar allowances for dental procedures that apply under a specific contract, or it is the list of the charges established or agreed to by a dentist for specific dental services.

These fee schedules are sometimes established by public programs, such as Medicaid in some states of USA. Dentistry opposes fee schedule because of following reasons:

1. Their potential inflexibility, i.e. fees listed can fall below the customary fees, particularly in times of rapid inflation.
2. The assumption that all dentist's treatment is of the same quality and therefore worth the same fees.
3. The fear that their autonomy is threatened, specially if the fee schedule is not controlled by dentist.

CAPITATION

ADA defines capitation fee as a dental benefit program in which a dentist or dentists contract with the program sponsor to provide all or most of the dental services covered under the program to subscribers in return for a payment on a percapita basis. It is usually a fixed monthly payment paid by a carrier to the dentist based on the number of patients assigned to the dentist for treatment. The dentist receives a fixed sum of money per head per month, regardless of whether the participant receives treatment in that particular month or not.

PRIVATE THIRD PARTY PREPAYMENT PLANS

A. Commercial Insurance Plan

Commercial insurance companies have over the period of time seen dental insurance as a potentially profitable area of business. The basic difference between commercial insurance companies and the dental service corporation, e.g. Delta is that commercial insurance company which operate for profit. Therefore, the commercial insurance carriers charge a higher premium than service corporations in order to allow for the profit margins.

In most of the cases dentist do not file their UCR fees with a commercial insurance company, rather the carrier develops the fee profiles [it works out the 'going rate' for services in that area]. The dentists are paid at that rate. The amounts can vary from one insurer to another. They can offer attractive total health insurance packages to potential groups of purchasers. Their large financial reserves allow them to offer reduced dental premiums to a particular group to compete in market in contrast to service corporations.

Advantage for Dentist

- Many commercial companies pay the dentist directly (rather than the patient). Some dentist specially in early days of dental insurance reported that payment through commercial companies was "hassle-free" and quicker than dental service corporations.
- Commercial companies conduct less fee audits and posttreatment dental examinations, though most use preauthorization, annual expenditure limits and careful monitoring of treatment patterns like service corporations.

B. Nonprofit Health Service Corporations

i. *Delta dental plans / dental service corporations:* It is a legally constituted not-for-profit organization that negotiates and administers contracts for dental care, incorporated on a state-by-state basis. Originally dental service corporations (now called as Delta Dental Plans) were sponsored by the constituent dental societies in each state of USA.

Both dental service corporations and private insurance companies are subject to the insurance laws of the state in which they operate. As the number of dental service corporations grew, the need for a national organization of dental service organizations became apparent. There was formation of National Association of Dental Service Plans in 1966. The name became Delta Dental Plans Association [DDPA] in 1969.

The Delta plans also manage the dental benefits for dependents of active duty military personnel through a program called DDP Delta, which is in place since 1995.

Delta also monitors quality of care provided and tries to keep a program's cost under control. Quality of care is sometimes monitored by posttreatment examinations of a sample of individual patients by a panel of dentist. They ensure that:

– The care claimed and paid for was in fact provided.
– The treatment is of "acceptable" quality.

Instances of noncompliance of the contract are taken very seriously by the insurers like billing for services not actually provided and waiving the required co-payments.

Reimbursement of Dentist in Delta Plans

Delta plans uses UCR fee for service concept as the method for payment. Reimbursement of dentist in this program depends upon, whether the dentist is participating or nonparticipating. A participating dentist is defined as any duly licensed dentist with whom a Delta plan has a contractual agreement to render care to covered subscribers.

Conditions for Participating Dentist Under Delta Plan

1. Filing of their usual and customary fees with Delta
2. Acceptance of payment for their services at the 90th percentile of fees, other than the co-payments as specified.
3. Post-treatment inspection of randomly chosen patients by other dentist.
4. Fee audits by auditors from delta, who may check the office records to ensure that the dentist is charging the Delta plan patients the same fees as being charged by the other patients. They also check that the co-payments are being charged from the patients.
5. The withholding by Delta of a small amount of each payment, usually to build-up insurance reserves.

90th Percentile

The percentile of a set of data divide the total frequency into hundredths, so that that the 90th percentile is the value below which 90 percent of the observations lie.

When payment is made at the 90th percentile, 90 percent of the participating dentists receive their full fee for the service. All participating dentist file their fee for a particular treatment in that given area. The fee usually varies from one dentist to another. So, majority of dentist will get their full fee at 90th percentile but few whose fee is more than 90th percentile will be paid at less than their usual fee.

The rationale behind paying the 90th percentile is to control payment at the top end while majority of the dentist (90%) will receive their full fee.

Blue Cross/Blue Shield

Blue cross and Blue shield dental plans have adopted many of the cost-control features pioneered by Delta plans like pre-filing of UCR fee by the dentist. In some states Blue Cross and Blue Shield dental plans resemble Delta plans in terms of administration and benefits.

C. Prepaid Group Practice

The term group practice can be difficult to define precisely as arrangements of dentist working together are so varied. ADA now prefers to use the term *nonsolo* practice rather than group practice. ADA definition states that a nonsolo dentist "works in a practice with at least one other dentist. Some of these dentists may be employed by the owner dentist in the practice".

There is no inherent relation between group practice and any form of financing. Net income in a group practice can be divided equally or can be decided according to patient load, years of service and specialty status. Some group practice prefers to make their entire dentist salaried.

Payments by patients in majority of the group practice is the usual fee-for-service basis and a few larger group practices offer contracts to consumer groups on a prepaid and capitation basis.

Advantages for a Dentist Practicing in a Group

1. Organized lifestyle: Vacations and continuing education leaves can be planned as colleagues in the practice can temporarily care for the dentist's patients for that period.

2. Less disruption in practice due to illness.
3. Financial fringe benefits such as sick leaves and pension plans can be built.
4. Quality of care is said to be improved because of the built-in peer review.
5. Sharing of the personnel, equipment and other resources make group practice more economical.

Problems Associated with Group Practice

1. Dentists considering group practice essentially need to be temperamentally compatible.
2. Dentists are taught to work independently.

HEALTH MAINTENANCE ORGANIZATION [HMO]

HMO was intended to provide an acceptable alternative to the fee-for-service payment system and to help restrain the cost of care.

Definition

"A legal entity which provides a prescribed range of health services to each individual who has enrolled in the organization in return for a prepaid, fixed and uniform payment".

HMO has five essential elements:

i. A managing organization.
ii. A delivery system.
iii. An enrolled population.
iv. A benefit package.
v. A system of financing and prepayment.
HMO's use a prepaid capitation system of financing medical services.

Dental Personnel in HMO's

There are four basic organizational modes under which dental care can be provided in an HMO.

STAFF MODEL

In this dentist, dental hygienists and dental assistants are salaried employees of the HMO.

GROUP MODEL

HMO contracts directly with a group practice, parternership or corporations for the provision of dental services. A regular capitation premium is paid to the group concerned by the HMO.

INDEPENDENT PRACTICE ASSOCIATION [IPA]

The IPA is an association of independent dentist that develops its own management and fiscal structure for the treatment of patients enrolled in an HMO.

The dentist remains in their own clinic/office and treat their usual fee for service or other patients. The IPA receives its capitation premium from the HMO in turn reimburses the individual dentist on a capitation basis or a modified fee-for-service basis. The ADA considers the IPA to be an open panel, since all dentists in a community are supposedly free to join.

CAPITATED NETWORK OR DIRECT CONTRACT MODEL

It is similar as IPA except that the HMO contracts directly with the individual providers for provision of services.

CAPITATION PLAN

Reimbursement of the dentist by capitation as in a HMO became more common during 1980.

Definition

ADA defines it as a dental benefit program in which a dentist or dentists contract with the program's sponsor or administrator to provide all or most of the dental services covered under the program to subscribers in return for a payment on a per capita basis.

A capitation fee is usually a fixed monthly payment paid by a carrier to a dentist based on the number of patients assigned to the dentist for treatment, regardless of whether the participant in the plan receives care or not.

Closed panel are defined by the ADA as existing when patients eligible to receive benefits can receive them only if services are provided by dentists who have signed an agreement with the benefits plan.

Only a small percentage of providers in an area are available to provide care under the plan. Purest form of closed panel is a practice set up by a union for the treatment of the union's members and staff by salaried dentist who treat only the union group and their dependents.

Open Panel

They are characterized by three features:

1. Any license dentist may choose to participate.
2. The dentist may accept or refuse any beneficiary of the plan.
3. The beneficiary may receive treatment from among all licensed dentists.

SALARY

Dentists are paid salary in some group practices (specially in closed panel), e.g. those employed by public agency or in armed forces. For many dentists salaried practice appeals as a life carrier specially as a new practice cannot assume the certainty of success.

Advantages

1. An immediate reasonably good salary.
2. Fringe benefits such as health disability insurance and liability coverage.
3. Retirement plan.
4. Paid vacation time.
5. Freedom from overhead costs and day to day worries of private practice.
6. A chance to improve clinical experience and speed.

Disadvantage

Salary may not be as high as peak earnings in private practice.

PUBLIC PROGRAMS

In the US by late 1980s only slightly over 2% of all dental expenditures were from public funds, compared to over 40% of total health expenditures. Over half of all public expenditures for health care went towards hospital care, physician's service, nursing home care and construction of health care facilities.

MEDICARE

Title XVIII of the Social Security Amendments of 1965 is the program known as Medicare. It removed all financial barriers for hospitals and physician services for all persons aged 65 and over, regardless of their ability to pay. By the mid-1970 medicare had two parts:

Part A: Hospital insurance.
Part B: Voluntary supplemental medical insurance.

Both parts contain a series of service benefits available, and both parts require some payments by the patients.

Medicare was brought into being because of:

1. Voluntary health insurance system was unable to provide adequately for people over 65 years of age.
2. The health insurance industry primarily operates for profit, and the risk of adverse selection in those over 65 was high.
3. Also because the income of persons of 65 and above is usually quite less than those who are employed, so they have less funds to spend on health care.

The segment of medicare for dental problems is limited to treatments requiring hospitalization such as fractures or cancer treatment which constitutes a negligible proportion of the program.

MEDICAID

It is the title XIX of the Social Security Amendments of 1965. It was intended to bring access to health care by funding to meet the health care needs of all indigent and medically indigent segment of the society. Medically indigent refers to those who are not dependent on public welfare to meet the basic necessities of life, but who do not have sufficient income to purchase health care through the usual private practice channels.

Medicaid is a joint federal state program. In order to qualify for the federal government.

19 Oral Health Promotion

CM Marya

After the Second World War, the governments of most industrialized nations began to invest heavily in health. Government policy at this time was largely concerned with developing health services, such as hospitals and primary health care facilities. But rising cost of medical services forced the governments to turn their attention to finding ways of reducing or stabilizing costs while continuing to secure improvement in health. Moreover, at the same time it was recognized that the major modern health problems like heart diseases, cancer, cardiovascular diseases could not be cured but could be prevented by changes in personal behavior or social and physical environments in which they lived.

CONCEPT OF HEALTH

WHO in 1948 defined health as "a complete state of physical, mental and social well-being and not merely the absence of disease and infirmity".

In relation to oral health the main aim of organized dentistry has been the eradication of disease from the mouth and the replacement of teeth lost due to disease or trauma. From this point the aim should be to obtain and maintain a functional, pain free asthetically and socially acceptable denition for the life span of most people.

Health promotion must take into account not only the prevention of disease of the oral cavity, but also the aspects of the individual's life which can affect the oral health.

Health Promotion

Health promotion is the process of enabling people to increase control over, and to improve, their health. To reach a state of complete physical, mental and social well-being, an individual or group must be able to identify and to realize aspirations, to satisfy needs, and to change or cope with the environment. Health is, therefore, seen as a resource for everyday life, not the objective of living. Health is a positive concept emphasizing social and personal resources, as well as physical capacities. Therefore, health promotion is not just the responsibility of the health sector, but goes beyond healthy lifestyles to well-being.

Prerequisites for Health

The fundamental conditions and resources for health are:

- Peace
- Shelter
- Education
- Food
- Income
- A stable ecosystem
- Sustainable resources
- Social justice and equity

DEFINITION OF HEALTH PROMOTION

WHO (1984) defines health promotion as "the process of enabling the individuals and communities to increase control over the determinants of health and thereby improve their health, representing a mediating strategy between people and their environment, combining personal choice and social responsibility for health to create a healthier future.

PRINCIPLES OF HEALTH PROMOTION

Following are the priorities for health promotion as outlined by WHO:

1. Health promotion involves the population as a whole in the context of their everyday lives.
2. It involves public participation and requires problem defining and decision-making life skills be developed further in individuals and communities.
3. It combines different approaches and needs community development, organizational change and activities to identify and remove health hazards.
4. It is directed towards action on the determinants of health and requires close cooperation between different sectors of society.

5. Oral health promotion is not a medical service but involves advocacy and education by health professionals.

ORAL HEALTH PROMOTION

Oral health promotion can be defined as "public health actions to protect or improve oral health and promote oral well-being through behavioral, educational and enabling socioeconomic, legal, fiscal, environmental and social measures".

Quality criteria of dental care services as defined by WHO and others, include those that are acceptable, accessible; adequate, appropriate; available; effective; efficient; ethical; equitable; and evidence-based.

STRATEGIES OF ORAL HEALTH PROMOTION

Ottawa Charter for Health Promotion

The first international conference on health promotion was held in Ottawa, Canada from 17th to 21st November, 1986. The conference was primarily a response to growing expectations for a new public health movement around the world. Discussions focused on needs within industrialized countries, but took into account similar concerns in all other regions. The aim of the conference was to continue to identify action to achieve the objectives of the World Health Organization (WHO) — health for All by the year 2000 initiative, launched in 1981.

Three Basic Strategies

The Ottawa charter identify three basic strategies for health promotion:

- *Advocate:* Good health is a major resource for social, economic and personal development, and an important dimension of quality of life. Political, economic, social, cultural, environmental, behavioral and biological factors can all favor or harm health. Health promotion aims to make these conditions favorable, through advocacy for health.
- *Enable:* Health promotion focuses on achieving equity in health. Health promotion action aims to reduce differences in current health status and ensure the availability of equal opportunities and resources to enable all people to achieve their full health potential. This includes a secure foundation in a supportive environment, access to information, life skills and opportunities to make healthy choices. People cannot achieve their fullest health potential unless they are able to control those things that determine their health. This must apply equally to women and men.
- *Mediate:* The prerequisites and prospects for health cannot be ensured by the health sector alone. Health promotion demands coordinated action by all concerned, including governments, health and other social and economic sectors, nongovernment and voluntary organizations, local authorities, industry and the media.

The Ottawa charter for health promotion (Fig. 19.1): Can be built into a model for improving oral health promotion. The Ottowa charter called for action in five areas:

1. *Create supportive environment:* It means making healthy choices the easy choices, creating such physical and social environment that maximizes the possibility of leading healthy lives. Providing minimal information necessary to prevent oral diseases, for example banning of smoking in work place and public areas. Encourage shops that are near to schools to stock, promote and sell sugar free foods.
2. *Build healthy public policy:* It means working to ensure that all organizations specially central government and policy makers, must take account of the potential health effects of the policies they develop and implement.

   A food and health policy to reduce production and consumption of nonmilk extrinsic [refined] sugar.
   Policy on water fluoridation.
3. *Strengthen community action:* Oral health promotion involves increasing the ability in recognition and modification of such physical and social environment by the community which are hazardous to health.

   It involves public participation and works through the actions of communities in identifying priorities, planning strategies and their implementation in improving health.
4. *Develop personal skills:* Individuals and communities can be motivated to take actions which improve their health. They should be provided with necessary information and education so as to enable them to adopt practices which promote health and enhance their ability to cope with stress and strains of life. Differentiate between lay beliefs



Fig. 19.1: Strategies for health promotion

and practices that are health promoting and those that are harmful and need to be changed.

5. *Reorient health services:* It involves the shift from traditional system of curing the diseases to prevention of diseases and promotion of health. Make health services more accessible and acceptable to group that are disadvantaged.

The Jakarta Declaration

In 1997 the WHO Jakarta Declaration on heading health promotion into the 21st century added priorities for the future, these are:

a. Promote social responsibility for health
b. Increase investment for health development
c. Expand partnership for health promotion
d. Increase community capacity and empower the individual
e. Secure an infrastructure for health promotion.

APPROACHES IN ORAL HEALTH PROMOTION

There are different approaches to health promotion, which show the diversity of ways of working within health promotion. Various approaches are:

1. *Preventive:* The aim of this approach is to bring a reduction in disease levels.
2. *Behavior change:* This approach aims to encourage individuals to take responsibility for their health and adopt healthier lifestyles.
3. *Educational:* The educational approach aims to provide people with knowledge and information about their health related behavior.
4. *Empowerment:* This aims to assist people in iden-tifying their own concerns and priorities, and help them develop the confidence and skill to deal with such issues.
5. *Social change:* This approach acknowledges the importance of socioeconomic and environmental factors in determining health. It aims at changing the physical, social and economical environments to promote health.

CONCEPTS IN HEALTH PROMOTION

1. *Equity and inequality: Equity* refers to differences in opportunities to be healthy and *inequality* means actual and measurable differences in health status. These differences are unfair and unjust and they should be minimized to the maximum. Ensuring that the entire population has access to appropriate and affordable dental care is step to equity and equality in oral health.
2. *Empowerment:* It is achieved when people are enabled to set their priorities, make decisions and plan and implement their own strategies for achieving better health. It involves the provision of health education, teaching people the skills they need in order to use health information effectively. Also, increasing their confidence, that they have a choice and can exercise control over the options available to them.
3. *Advocacy:* It involves educating the decision makers or policy makers, politicians, community leaders and other influential individuals such as representatives of the media in order to influence the decisions that have a bearing on the health of the population. Here, health professional needs to be both a technical expert providing scientific knowledge for decision-making and political activist for mobilizing support.

   Health promotion shifts the responsibility for health from the formal health care system to individuals, communities and decision makers at all levels of society. For this, the training of the health professionals needs to be changed to match the broader role required by the new public health.

ELEMENTS OF HEALTH PROMOTION

Tannahill (1985) suggested a model of health promotion using three essential elements. These are *health education*, *prevention* and *health protection*. Their interrelationship produces seven domains (Fig. 19.2).

1. *Positive health education:* Area 1 is pure education activities such as promoting the use of fluorides, tooth paste and tooth brushing. Education about oral health and general health will benefit each other.
2. *Preventive services and facilities:*

   Area 2 includes—
   - School screening programs
   - Fissure sealant application

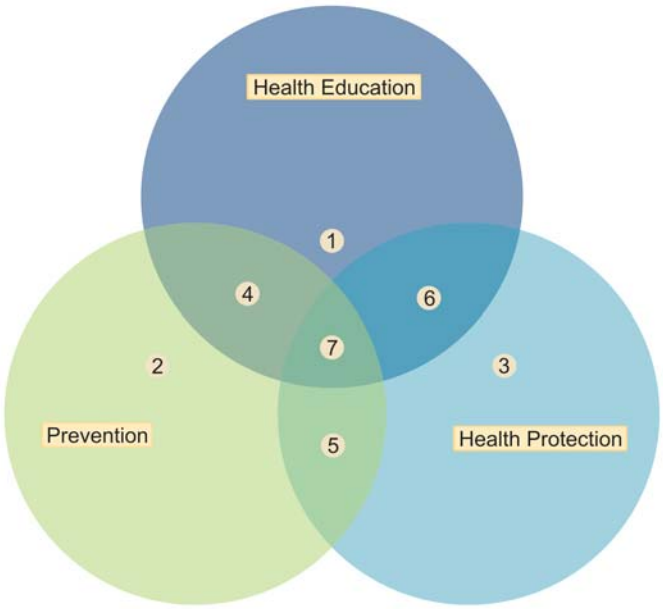


Fig. 19.2: Seven domains in health promotion

- Topical fluoride application
- Professional cleaning of teeth
- Screening programs to detect early cancers of mouth.

3. *Positive health protection:* It is about increasing the chance for people to live in a healthy environment. It is about making the healthy choices the easier choices.
4. *Health education for preventive health protection:* The basis of health education for preventive health protection is aimed at influencing decision or policy makers, because it is very important that these policy makers understand the importance of the preventive health protection.
5. *Preventive health protection:* It involves the use of legal or regulatory approach and policies, or voluntary code of practice to prevent disease or ill health. Fluoridation of water supplies, iodization of salt are good examples.
6. *Health education aimed at positive health protection:* This involves raising awareness of and securing positive health protection measures among the public and policy makers.
7. *Health education for preventive health protection:* The basis of health education for preventive health protection is aimed at influencing decision or policy makers, because it is very important that these policy makers understand the importance of the preventive health protection.

   Sometimes health education alone is ineffective, e.g. wearing of helmet by drivers of two wheelers, use of seat belts while driving, and for this reason laws are mandatory.

METHODS OF ORAL HEALTH PROMOTION

Health promotion represents a mediating strategy between people and their environments, synthesizing personal choice and social responsibility in health to create a healthier future.

Essentials of health promotion include:

- Focus on determinants of health.
- Working in partnership with various agencies and sectors.
- Adopting a strategic approach.

Determinants of Health

Health promotion focuses on the determinants of health, i.e. socioeconomic and environmental factors and the individual health related behavioral elements. It attempts to avoid a victim-blaming approach by recognizing the limited control many individuals often have over their health. Previously the health professionals wrongly assumed that individuals are always capable of modifying elements of their lifestyle, and ignored the complex collection of factors that influence and determine human behavior. This narrow approach has restricted the achievement of desired changes in behavior. Health promotion emphasizes on making *the healthy choices*, the *easy choices,* e.g. consumption of non-milk extrinsic sugars, optimum exposure to fluorides, avoidance of alcohol consumption and smoking.

Working in Partnership

Community participation is an essential component of health promotion, which includes active involvement of the local community in all aspects. Multisectorial working is a key element of health promotion. Various sectors in society have a significant influence on health such as government department, agriculture, education and the voluntary organizations (Table 19.1). These different sectors should work together to ensure that health promotion policies are formulated, implemented, monitored and evaluated on a regularly basis.

Table 19.1: Various partners in oral health

- Health professionals (doctors, health visitors, nurses, etc.).
- Education sector (teacher, school management).
- Government (local and national).
- Industry (food producers, food retailers).
- Voluntary sector.

Strategic Action/Approach

A strategic approach is required for the development of effective health promotion policies. It should be based on an appropriate assessment of local needs and resources. Many health problems share common risk factors for example, eating an unhealthy diet, high in fat and sugar and low in fiber, smoking and alcohol can lead to the development of obesity, coronary heart disease, diabetes as well as oral diseases such as periodontal disease, dental caries, and oral cancer. Health promotion strategies based on a common risk factor approach helps to deal effectively with a combination of health problems together, which proves to be more effective in the long term and is more efficient in the optimal use of resources (Fig. 19.3).

Health promotion involves the population as a whole, rather than focusing only on people at risk for specific diseases. Health promotion can utilize a combined whole population strategy and a high-risk strategy which aims to enable people to take control of and responsibility for their health.

STAGES OF BEHAVIOR CHANGE

The Transtheoretical Model (TTM) describes how individuals make intentional changes or acquire positive health behaviors. The different stages called the '*stages of change*' represent the decision-making process required to change behavior.

The stages are:

1. Precontemplation
2. Contemplation
3. Preparation
4. Action
5. Maintenance
6. Relapse

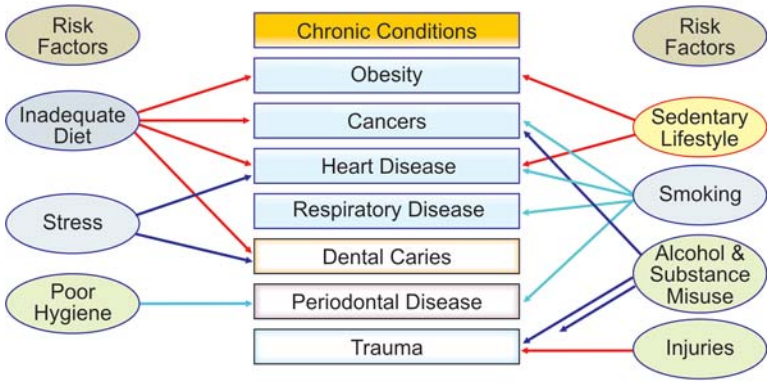


Fig. 19.3: Common risk factor approach

Precontemplation is the stage of entry during which no foreseeable intent to change is evident (Fig. 19.4). Contemplation represents the next stage of the model in which an intent to change is first considered. Continuing further in forward direction of change, an individual makes preparation to take action to change. Once a change in behavior has been adopted for more than 6 months, individuals are then considered in the maintenance stage. Termination of the model occurs with sustained change. Relapse can occur at any time, but TTM allows an individual to re-enter the model at various stages.

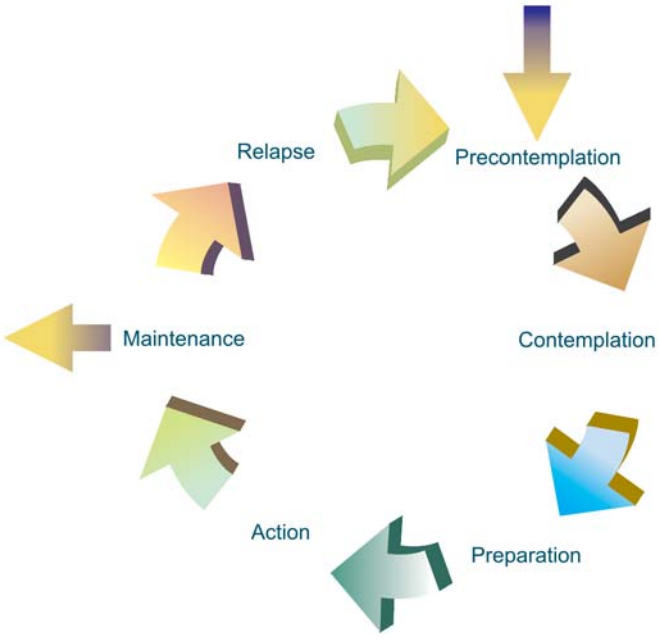


Fig. 19.4: Transtheoretical model

GOALS OF ORAL HEALTH

An overall oral health goal is to *achieve a natural, functional, acceptable dentition, which enables an individual to eat, speak, and socialize without discomfort, pain or embarrassment for a lifetime, and which contributes to general well-being. In practical terms that is, the retention throughout life of a functional, esthetic, natural dentition of not less than 20 teeth and not requiring recourse to prosthesis (WHO, 1982).*

A group of chief dental officers from Northern European countries proposed goals for acceptable levels of oral health (Table 19.2).

In addition the acceptable levels of oral health would include:

- Freedom from pain
- Satisfactory prosthetic replacement of any missing dental unit which obviously detracts from esthetics.
- No unacceptable intrinsic anomalies
- An occlusion, which is functionally and cosmetically acceptable
- No unacceptable deposits

Global goals for oral health were established by Federation Dentaire International (FDI) and World Health Organization (WHO). These were intended for countries to either adopt them as they were suggested or to be modified according to their own circumstances (Table 19.3).

GLOBAL ORAL HEALTH GOALS

Global Goals for the Year 2020

The FDI (represented by Dr Martin Hobdell and Newell Johnson), WHO (Dr Poul Erik Petersen) and the IADR (Dr John Clarkson) have presented the new goals for the year 2020. This document containing proposals for new global

Table 19.2: Suggestions for acceptable levels of dental health (WHO, 1982)

Age	*Mean No. of missing teeth*	*DMF*	*Periodontal status*
12	0	2	0 teeth with pockets > 3 mm
15	0	3	0 teeth with pockets > 3 mm
18	0	4	0 teeth with pockets > 3 mm
35-44	2	12	Fewer than 7 teeth with pockets > 4.5 mm
65-74	10	12	20 functional teeth

Table 19.3: Global goals for oral health for the year 2000 by FDI and WHO

- 50% of 5-6 years old will be caries free.
- The global average will be not more than 3 DMF teeth at age 12.
- 85% the population should retain all their permanent teeth at age 18.
- A 50% reduction in present levels of edentulousness at age 35 to 40 will be achieved.
- A 25% reduction in present levels of edentulousness at age 65 and over will be achieved.
- A database will be established for monitoring changes in oral health.

oral health goals, objectives and targets, useful as a framework for health planners at regional, national and local levels and are not intended to be prescriptive.

Goals

- To minimize the impact of diseases of oral and craniofacial origin on health and psychosocial development, giving emphasis to promoting oral health and reducing oral disease amongst populations with the greatest burden of such conditions and diseases.
- To minimize the impact of oral and craniofacial manifestations of systemic diseases on individuals and society, and to use these manifestations for early diagnosis, prevention and effective management of systemic diseases.

Targets

By the year 2020 the following will have been achieved over baseline. The goals are general and no absolute values (X) are given as they have to be established on the basis of local circumstances such as the adequacy of the information base, local priorities and oral health systems, as well as disease prevalence and severity and socioenvironmental conditions.

Out of the 16 targets proposed*; Pain, functional disorders, infectious diseases, oropharyngeal cancer, oral manifestations of HIV-infection, noma, trauma, craniofacial anomalies, dental caries, developmental anomalies of teeth, periodontal diseases, oral mucosal diseases, salivary gland disorders, tooth loss, health care services, health care information systems*, targets for dental caries, periodontal disease and tooth loss are mentioned below:

Dental Caries

- To increase the proportion of caries free 6- year-old by X%.
- To reduce the DMFT particularly the D-component at age of 12 years by X% with special attention to high-risk groups within populations, utilizing both distributions and means.
- To reduce the number of teeth extracted due to dental caries at ages 18, 35 to 44 and 65 to 74 years by X%.

Periodontal Diseases

- To reduce the number of teeth lost due to periodontal diseases by X% at ages 18, 35 to 44 and 65 to 74 years with special reference to smoking, poor oral hygiene, stress and intercurrent systemic diseases.
- To reduce the prevalence of necrotizing forms of periodontal diseases by X% by reducing exposure to risk factors such as poor nutrition, stress and immunosuppression.
- To reduce the prevalence of active periodontal infection (with or without loss of attachment) in all ages by X%.
- To increase the proportion of people in all ages with healthy periodontium (gums and supporting bone structure) by X%.

Tooth Loss

- To reduce the number of edentulous persons by X% at ages 35 to 44 and 65 to 74 years.
- To increase the number of teeth present by X% at ages 18, 35 to 44 and 65 to 74 years.
- To increase the number of individuals with functional dentitions (21 or more natural teeth) by X% at ages 35 to 44 and 65 to 74 years.

GLOBAL ORAL HEALTH GOALS, OBJECTIVES AND TARGETS FOR THE YEAR 2020

Goals

- To promote oral health and to minimize the impact of diseases of oral and craniofacial origin on general health and psychosocial development, giving emphasis to promoting oral health in populations with the greatest burden of such conditions and diseases;
- To minimize the impact of oral and craniofacial manifestations of general diseases on individuals and society, and to use these manifestations for early diagnosis, prevention and effective management of systemic diseases.

Objectives

- To reduce mortality from oral and craniofacial diseases;
- To reduce morbidity from oral and craniofacial diseases and thereby increase the quality of life;

- To promote sustainable, priority-driven, policies and programs in oral health systems that have been derived from systematic reviews of best practices (i.e. the policies are evidence-based);
- To develop accessible cost-effective oral health systems for the prevention and control of oral and craniofacial diseases using the common risk factor approach;
- To integrate oral health promotion and care with other sectors that influence health;
- To develop oral health programs to improve general health;
- To strengthen systems and methods for oral health surveillance, both processes and outcomes;
- To promote social responsibility and ethical practices of care givers;
- To reduce disparities in oral health between different socio-economic groups within countries and inequalities in oral health across countries.

BARRIERS IN ACCESS TO DENTAL HEALTH SERVICES

- Lack of awareness of seriousness of oral health
- Lack of or insufficient dental insurance
- Lack of transportation
- Uncompensated time from work
- Limited income
- Low community-to-private provider ratio
- Dentist nonparticipation with medicaid/CHIP
- Low medicaid program reimbursement rates for dental services

STAGES IN PLANNING AN ORAL HEALTH PROMOTION STRATEGY

1. *Need assessment:* Proposed strategy should address the need of the population
2. *Set goals:* Goals should be clear, measurable and realistic (achievable)
3. Development of action and evaluation plan
4. Implementation of plan
5. Evaluation of progress

NATIONAL ORAL HEALTH PROGRAM IN INDIA

WHO focused its attention on oral health in 1994 and chose the theme "Oral Health for Healthy Life" for World Health Day. National Oral Health Policy has been formulated by the "Dental Council of India", through the inputs of two national workshops organized way back in 1991 and 1994 at Delhi and Mysore respectively. These workshops considered the recommendations of national workshops on oral health goals for India, Bombay, 1984 and a draft oral health policy prepared by Indian Dental Association in 1986. As a follow-up measure of these efforts, the core committee appointed by Ministry of Health and Family Welfare could succeed to move the resolution in fourth conference of Central Council of Health and Family Welfare in the year 1995.

Ministry of Health and Family Welfare, Government of India accepted in principle National Oral Health Policy in the year 1995 to be included in National Health Policy. In pursuance to National Oral Health Policy 'National Oral Health Care Program' was been launched as "Pilot Project" to cover five states (Delhi, Punjab, Maharashtra, Kerala and North Eastern States) for its implementation.

The proposed Oral Health Care Program envisages three pronged implementation strategies of; oral health education, preventive program and curative service.

Program at various levels of primary, secondary and tertiary health care delivery services. Oral health has been recognized as an integral part of general health.

Objectives

National Oral Health Care Program a project of DGHS and Ministry of Health and Family Welfare was initiated in 1998 and later on the department of dental surgery, All India Institute of Medical Sciences was chosen as the nodal agency to implement it.

The objectives of this program are to improve the oral health of the masses and to prevent/reduce the burden of oral disease in the country. Towards this objective, the nodal agency is working to develop an accessible, low-cost, sustainable, primary preventive program using existing primary health care infrastructure and resources.

The program has 3 basic components:

1. To provide oral health education to masses through a network of dental surgeons, health care workers, anganwadi workers and school teachers
2. To produce information, education and communication material (IEC) to train the health workers and to conveying oral health messages to the people and
3. To formulate guidelines to strengthen oral health set-up at district level, community health centers and primary health centers.

The Ministry of Health and Family Welfare decided to implement Oral Health Program right up to the village level. The program aims at designing an accessible low cost, sustainable oral health care program suitable for national dissemination targeting the focus on rural population. The goals of National Oral Health Care Program are:

The Short-term Goals (for the Pilot Project)

- To develop an accessible, low cost, sustainable Oral Health Primary Preventive Program using existing infrastructure and resources.
- To frame and develop the training module for master trainers (dental surgeons)
- To frame and develop the training module for health workers
- To develop IEC material for oral health awareness generation in the public.

- To suggest the guidelines for strengthening for oral health set-ups at centre and state level.
- To begin with, one district in each of these states was chosen to test run the strategies evolved through two national and four regional workshops organized in the country, to achieve the following goals.

Long-term Goals

1. Oral Health for all by the year 2010.
2. To bring down the incidence of oral and dental diseases to less than 40 percent from the existing prevalence of 90 percent.
3. To bring down the DMFT in school children between 6 to 12 years of age to less than two which is approximately four at present.
4. To reduce high prevalence of periodontal diseases to lower prevalence.
5. At the age of 18 years, 85 percent should retain all their teeth.
6. To achieve 50 percent reduction in edentulousness between the age of 35 to 44 years.
7. To achieve 25 percent reduction in edentulousness at the age of 65 years and above.
8. To achieve 50 percent reduction in the present level of malocclusion caused by oral habits in children and dento-facial deformities.
9. To reduce the number of new cases of oral cancers and precancerous lesions from the existing levels of 19 per lac.

THE MAGNITUDE OF THE PROBLEM

Oral Health Problems in India

Before any preventive program is designed for a particular oral disease or condition, the problem must be clearly recognized and understood. Unfortunately, in our country no national survey has been conducted to understand the magnitude of oral and dental problems, however, isolated studies are available to indicate the prevalence of oral and dental diseases. These studies have clearly indicated that dental caries, periodontal diseases, malocclusion and dentofacial deformities and oral cancer are highly prevalent in our country.

1. *Dental caries*: Dental caries has been consistently increasing both in prevalence and severity for the last five decades. In the year 1941, its prevalence was reported between 40 to 50 percent with an average DMFT of 1.5. In 1980's the point prevalence increased to about 80 percent in children with an average DMFT of 2 to 6 at the age of 16 years in different regions of the country. The point prevalence in 10 to 15 years old children of Delhi was found to be 39.2 percent and DMFT was 2.61 in the year 1992 (Prakash H, et al, 1992), while according to Global Oral Data Bank (WHO's website) in 1996 the point prevalence was 89 percent with DMFT ranging between 1.2 to 3.8. Dental caries is consistently increasing in its prevalence and severity especially in children and today according to a number of investigators 80 to 85 percent of children suffer from this disease and the average number of decayed, missing and filled teeth per child at the age of 16 years is about four in rural areas and five in urban areas with almost no dental restorative help available particularly in the rural and deprived areas.
2. *Gum or periodontal diseases:* Almost 95 to 100 percent of our adult population is suffering from periodontal diseases which are initially painless, chronic, self-destructive leading to gradual tooth loss and mostly people accept it as the disease of old age.
3. *Oral cancer:* Oral cancer presents a major health problem in India as 30 to 35 percent of all cancers diagnosed are oral cancers with buccal mucosa contributing to about 15 percent of that. The prevalence of oral cancers in India ranges between 0.02 to 0.03 percent in different Urban and Rural areas with southern states more prone to it, some part of the Uttar Pradesh also has special predilection.
4. *Malocclusion:* About 30 percent of the children suffer from malaligned teeth and jaws effecting proper functioning of dentofacial apparatus and aesthetics.

STATUS OF ORAL HEALTH CARE SYSTEM IN INDIA

The oral health care has not received due importance in India. During the past 50 years of independence the medical sciences have made tremendous progress in combating most of the communicable and non-communicable diseases, however, the oral health care has been neglected. This is evident from the increased prevalence of dental diseases in recent years and from the meagre funds being allotted for oral health care. It is recently the government of India accepted the oral health policy in 1995 and has been made part of the National Health Policy.

As per dental manpower committee report of Dental Council of India there are approximately 44,000 dentists for population of more than 100 million with dentist population ratio of 1:30,000 in urban areas and 1:1, 50,000 in rural areas. In the past decade, the country has established 140 approved and recognized dental colleges but these colleges have been set-up arbitrarily and haphazardly without considering the magnitude/ need of the population in different states. It has been well established that preventive programs are very cost-effective and advantageous method for fighting oral diseases. But restorative/rehabilitative approach has been practised in India inspite of being very expensive and with limited facilities. About 75 percent of the rural population has been totally neglected, it is therefore, essential for a vast country like India

preventive approach including health education and promotion should be given due importance in implementing the oral health care.

ECONOMIC BURDEN OF ORAL DISEASES

a. Treatment Cost

It is a well-know fact that the treatment of dental disease is very expensive and time consuming. For a rough estimate, if we consider only children below 16 years for restorative treatment of dental caries having average DMFT of two, it would require about 66 years for all dental professionals of the country to restore caries teeth and about 520 crores rupees (statistics below).

- Population of India about 10 billion
- The children in age range of 3 to 16 years— 26 crores
- Total number of cavities (average two DMFT)— 52 crores
- Cost of filling per cavity (approximately 10 rupees each)— 520 crores
- If each dentist is filling 6 cavities per day then total fillings done per day— 6 × 36000 = 216000
- The days required to fill 52 crore cavities - 52,00, 00,000/ 216000 = 24070 days = 66 years

In USA alone $ 43,83,000.00 were spent in 1970 for dental caries with major expenditure going for restoration of caries teeth. This sum was approximately 1 percent of total national income and 10 percent of nation's health bill. Similarly in UK in 1977 approximately 250 million pounds were spent in England and Wales alone on dental treatment within the general dental services section of national health services. Whereas in India approximately 2 percent of budget is spent on health and there is no separate allocation for oral health.

b. Loss of Man-days

Though the dental diseases are not considered to be life threatening but they seriously affect day to day activities. When a person is suffering from dental pain due to any of the mentioned dental diseases, he is amenable to loss of concentration on his work or may not be able to work at all. Though the factor does not seem to be important but it has serious economic implications on the country. In India, we do not have statistical data but it can be estimated by the data of other countries for example in USA in the year 1988 on an average eight working hours per person were lost due to either dental problems or appointment with dentist. So, we can very well understand the social and economic implications due to ignorance of oral health.

The loss of working hours is especially important in Indian context since about 25 to 30 percent of the population is below poverty line and depends on daily earnings. The families where a worker is the only earning member, the situation can be even worse if the earning member suffer from dental ailment stopping him from working for one full day. This could lead to serious situation for food and daily needs for the whole family of 4 or 5 persons.

c. Public Health Expenditure

This is very unfortunate that till date in India no serious effort been taken to improve oral health of the masses. Till today oral health does not have a separate budget allocation in national or state health budget. As compared to other countries, we are still lacking in paying sufficient attention to such an important part of our health.

In India with increasing level of dental diseases, limited resources and manpower it seems practically impossible to provide curative services to each and every individual, which is primary duty of government of India. To find out a viable mean to handle such situation the only alternative seems to be preventive approach. This is relatively simple and cost-effective utilizing oral health education, preventive strategies and mass media utilization.

STRATEGIES FOR IMPLEMENTATION

Oral Health Education

It is recommended that to spread the message of oral health to the masses, all the three media of communication, i.e. audio-visual, print and folk media should be utilized to the maximum. For children and people with low literacy level, these messages should be more pictorial than in writing. Central Health Education Bureau shall be involved to formulate IEC material.

It is recommended that to spread oral health awareness, existing infrastructure should be strengthened. Multipurpose health workers (MPW) should be trained to impart oral health education, provide basic pain relief and be able to refer the cases for further investigation and treatment.

It is proposed that one dental surgeon for a population of 30,000 should be appointed at PHC level and in tribal and remote areas; one health assistant/hygienist to cover a population of 20,000 should be available.

Since school children constitute a major proportion of population and children learn easily and they have long years to go, oral health education of school children will have far reaching benefits. Therefore, it is recommended that one dentist should be appointed for a population of 50,000 school children. Regular oral health promotional activities in the form of health education, regular dental check-up, demonstration of brushing and rinsing technique and preventive and interceptive treatment can be undertaken at school level. In addition, chapters on oral health can be included in school textbooks of 3rd, 5th and 8th grade level, commensurating with the maturity level of the child.

Utilization of the Mass Media

Since there is a widespread network of radio and television and press and cable network in our country, the proper

utilization of these medias will ensure not only spreading the right message but also would lend authentically to what the various types of workers would be propagating in the field. For this purpose, with the help of the Ministry of Mass Communication, some short 2 to 3 minutes films can be made to be projected on television at peak hours and also with clearly defined radio messages and flashes. NGOs, electronic media, TV and press should be involved in spreading the message of oral health awareness. Oral health education materials like charts, posters, pamphlets, models and comics should be developed to be used in the community and schools. Special plays, skits, poems and songs on oral health should be developed as part of the folk media to spread oral health awareness in rural areas.

Oral Health Set-up

- Administrative set-up at the center, state and district levels should be strengthened for planning, implementation, monitoring and evaluation of oral and dental health care services at the center and state levels.
- Definite norms should be laid down for establishment of dental clinics at different levels in terms of:
  - Dental manpower
  - Space
  - Dental equipment
  - Dental instruments
  - Dental materials
- At least one dental clinic for every 30,000 population in the rural areas at the PHC level should be established in a phased manner
- District and subdivisional level dental clinics should be strengthened in respect of dental manpower and dental equipment
- Existing dental clinics at various levels should be equipped with the latest dental equipment and materials as per established norms
- Local practitioners should be involved on contractual basis for imparting oral health education and to perform interceptive treatment like ART, etc.
- As per internship program laid down by the DCI, every dental college/institution should adopt one district/rural centers/slums in their areas so as to provide the preventive oral (dental) health services to the rural and communities of the district by interns under supervision of their teacher and should also impart oral health education and undertake interceptive and basic curative and emergency treatment for two months on rotational basis.
- Intensive dental health care program for the school children should be implemented. Schoolteachers, medical and paramedical personnel, anganwadi workers and opinion leaders of the community, should be trained in giving oral health education. Postgraduate students of community dentistry should provide leadership to community health workers in initiating and implementing oral health care activities at the grass-root level.
- Intensive dental health care program for the public in the form of free dental check-ups and special oral health campaigns should be organized frequently. Dental marathons, long marches, smile and healthy teeth competitions should also be organized.
- Fully equipped mobile dental clinics to provide on-the-spot diagnostic, preventive, interceptive and curative services to the people and school children in far-flung rural areas of the state should be made available.

  In order to provide dental health curative and restorative services along with primary prevention of dental diseases, it is proposed that there should be well equipped mobile dental clinics so that, the services can be rendered to the rural masses at their doorsteps, more so in various remote and inaccessible areas. There should be at least 3-4 mobile dental clinics at each district level catering to a population of 4, 50,000 to 5,00,000. Each mobile dental clinic should have two dental chairs and units, each with air-turbine, micro-motor, ultra-sonic scalers and other equipments. There should be three dental surgeons posted with mobile dental clinic, with one dental technician and three chair-side assistants. Two dental surgeons sequently should look after restorative and curative work of the patients whereas one to devote time on the primary prevention of dental diseases through lectures, participating in discussion using audio-visual aids to educate and motivate the rural masses to follow the primary preventive measures.
- In-house training to dental doctors at government dental colleges and other institutions recommended by the Ministry of Health should be provided to impart oral health education, and to provide preventive, interceptive and curative treatment at the community level.

ADDITIONAL MEASURES SUGGESTED

Continuing Dental Education Program

Each state under the Directorate of Health Services (dental) must identify one or two training centers in the state. The directorate must conduct at least one CDE program every 6 months. This CDE program must be compulsory for each dental surgeon serving in the state health services. Through these CDE programs the dental surgeon's knowledge must be updated regarding the most recent concepts of dental procedures as well as on the various methods and approaches of preventive and curative aspects of the dental diseases. Directorate must ensure not only compulsory attendance of dental surgeons but also their active participation through group discussion/panel discussion/practical training, etc. so that, they must participate with interest. Directorate should involve a system to objectively evaluate (some point system)

the active participation of the dental surgeons in these CDE programs. The directorate should also make arrangements to conduct such CDE programs. The directorate should also make arrangements to conduct such CDE programs for the private practitioners.

Role of Dental Colleges

Each dental college should be given the responsibility to adopt one whole district so as to take care of the preventive oral (dental) health services to the rural and the urban communities of the district effectively using the internship program. The interns working in the dental colleges should be posted compulsorily for two months in the community so as to get oriented to train the school teachers, parahealth workers and anganwadi workers in delivering the oral health preventive package to the masses dental colleges can explore and utilize the special provision of funds available with the planning commission for such like projects for adoption of one district by a dental college community.

Strategies of Oral Health Care in Urban Areas

The dentist population ratio in urban areas is approximately 1:30,000 as compared to 1:1,50,000 in rural areas. However, if the prevalence of dental disease in urban and rural areas is compared, the average number of decayed, missing and filled teeth per child by the age of 16 years in urban areas is approximately 5.0 as compared to 4.0 in rural areas, reported by a number of investigators. Almost 85 to 90 percent of the children and 100 percent adults in both urban and rural areas suffer from gingival and periodontal diseases, respectively. This clearly indicates that no doubt the services of dental specialists are available to the masses in the urban areas but in reality the oral diseases prevalence has not decreased and is rather high. This is probably due to lack of awareness and motivation of the public as well as the dentists in the primary prevention of the oral diseases. It has been seen in a number of developed countries, e.g. Sweden, USA, UK, etc. that only after institution of organized preventive measures in the community, the dental caries could be reduced by almost 50 to 70 percent over a period of 10 to 15 years. So, there is a need to change the attitude of the public as well as the dentists and also to make them aware that the oral diseases are preventable and reversible in the initial stages.

To achieve this, the following needs to be done:

- Reorientation of the dentists working in urban areas.
- Implementation of primary prevention package through the school health schemes in the different urban areas.
- Involvement, education and motivation of the teachers in the various schools/colleges and other educational institutions in the urban areas.
- Exploration and involvement of other voluntary (Rotary Club, Lion's Club, YMCA, YWCA, etc.) and Multinational organizations working in different urban areas in achieving the oral health targets (NGO).

INVOLVEMENT AND REORIENTATION OF THE DENTISTS WORKING IN URBAN AREAS

First of all there is need to involve the dentists, teaching staff posted in the dental colleges, hospitals as well as the private practitioners, two months refresher courses in the concept and implementation of primary prevention of oral diseases, should be started at some recognized institutions in the country to reorient them.

This can be started after the training of the dentists from various states for the implementation of the National Oral Health Policy in the rural areas is completed, i.e. over a period of 1½ years. After that a group of 15 dentists from the various dental colleges and private practitioners from urban areas of the country can be trained at the center identified for this purpose. This can be a continuous program. The dentists so trained can further train the dentists in their own states. All the teaching aids and material can be made available to them.

IMPLEMENTATION OF PRIMARY PREVENTIVE PACKAGE THROUGH THE SCHOOL HEALTH SCHEMES IN THE DIFFERENT URBAN AREAS

Since, very little organized health system is operative in urban areas, it is important to explore all the possible avenues to implement minimum oral health coverage to the urban population. The dentists of the school health schemes are operative in a large number of urban areas. The dentists of the school after proper training can form a good nucleus for the delivery of preventive package.

Involvement, education and motivation of the teachers in the various schools/colleges and other educational institutions in the urban areas for the delivery of primary preventive package to the school/college going children and young adults is essential.

Education is one of the most organized systems prevalent in the urban areas, hence the utilization of this system and involvement of the teachers at various levels starting from small school children to young adults in the colleges and universities would be ideal to create awareness and motivate the population in the formative years towards developing habits leading to prevention of oral diseases. The dentists employed in school health schemes and other hospitals in the preventive areas after proper training can be instrumental in the training of these important components, i.e. teachers in the delivery of the preventive package.

Exploration and involvement of other voluntary (Rotary Club, Lion's Club, YMCA, YWCA, etc.) and health organizations working in different urban areas in the achieving the oral health targets.

The number of other health workers such as family planning workers, social health workers, anganwadi workers and number of voluntary organizations such as Rotary Club, Lion's Club and other health organizations such as child welfare are operating and active in the various urban areas. These are very potential sources, which can be utilized for the delivery of the preventive package.

REORIENTATION OF DENTAL EDUCATION IN INDIA

Community dentistry component in each dental college should be made more dynamic, active and viable. From the planning commission, special funds can be allocated to each dental college for adopting one district to implement oral health care programs, but these programs would have to be standardized, monitored, evaluated and accommodated. Basic dental curriculum should be preventive and community need based.

There would be a need to reorient some of the dental education programs in the various dental colleges according to the national oral health policy. As already envisaged in the plan, two teachers (dentists) from each dental college would be given the training in the center identified for this purpose, who in turn will be responsible for conducting the reorientation programs in their own colleges. One of the important components should be that out of one year internship, two months be spent in the rural areas.

INVOLVEMENT OF OTHER ALLIED DEPARTMENTS

The Department of Education and Social Welfare should be involved to impart correct oral health promoting information to school children at an early age which would help to develop proper attitudes in them. It would be preferable to include chapters giving adequate knowledge about oral diseases and their prevention in the text books of class III, V and VIII.

NATIONAL INSTITUTE OF DENTAL RESEARCH (NIDR)

To give a proper lead to the total health care systems in the country, it is important to set-up apex bodies of national importance in postgraduate dental education and research on the pattern of NIDR (National Institute of Dental Research) in USA and in India, the AIIMS (All India Institute of Medical Sciences) in New Delhi and PGI, Chandigarh. In the beginning at least one such institute of national importance be set-up in oral health where meaningful research applicable to Indian conditions can be carried out systematically on a longitudinal basis.

NATIONAL TRAINING CENTER

Training of the Trainer (TOT)

It is important to calibrate the trainers, viz. dentists from the various states and union territories of India who would be assigned the duty of training the various health teams, posted at the PHC/CHC in their respective states. Union government can identify a center which would have the capacity of training the existing health infrastructure, i.e. doctors, multipurpose workers, health guides, school teachers, etc. for this purpose and also would standardize the various education materials, courses, evaluation criteria for the training of different categories of health workers. The education materials for the education of the community by the health guides and multipurpose workers, school children in various age groups by the school teachers have also to be prepared and standardized.

20 Planning and Evaluation

CM Marya

Program planning is an organized process to address the needs of a specific group of people. Program planning involves a process which is to design, implement and evaluate a clinic or community-based project.

Planning is an integral part of dental care provision that operates at many different levels, i.e. national level, at health authority level and with in a dental practice where dental practitioner and their team members may develop a range of practice policies aimed at improving the services provided.

The benefit of program planning is that everyone involved in the project can make rational choices based on relevant information, previous experiences, and community preferences. Careful planning before a project begins, and can make a significant impact on the success of the project.

DEFINITION

EC Banfield defines plan as "it is a decision about a course of action".

PURPOSE OF PLANNING

A. To match the limited resources with many problems.
B. To eliminate wasteful expenditures or duplication of expenditures.
C. To develop the best course of action, to accomplish a defined objective.

USES OF PLANNING

1. It helps to be proactive in decision-making rather than constantly reacting to pressures and demand.
2. It enables priorities to be set.
3. It identifies where resources can be directed to have the greatest impact.

First Steps

1. Identify the overall issue or concern
2. Establish a committee/task force
3. Identify the overall goal

What are Goals?

Goals are typically broad, sweeping statements which provide a long-term vision for the outcome of the project. Goals should be in agreement with the organization's mission. They should also be achievable within the organization's scope.

Goals are not specific; they do not specify the methods that will be used or the degree of improvement expected (Table 20.1).

A well written goal should be simple, brief and consist of:

- Who is affected, and
- What change will occur as a result of the program.

Table 20.1: Goals vs objectives

Goals	*Objectives*
Broad statement	Specific, limited in scope
Remains stable over the course of the project.	Change as needs of the population or community evolve.
Identifies the long range purpose of the project.	Identifies a measurable outcome of the project.

PLANNING CYCLE

It involves following steps (Fig. 20.1):

1. Need assessment.
2. Identifying priorities.
3. Developing aims and objectives.
4. Assessment of resources.
5. Implementation.
6. Evaluation.

Need Assessment

This is done for identification of oral health problems and concerns of the population.

It helps to:

a. Define the problem and to identify its extent and severity.



Fig. 20.1: The planning cycle

b. Obtain a profile of the community to know the causes of the problem.
c. Develop appropriate goals and objectives for solving the problem.
d. Evaluate the effectiveness of the preventive programs by providing baseline information and comparing progress achieved in solving the problem over a period of time.

It involves:

- Collection of oral health status related.
  This can be done by various techniques such as survey questionnaires, clinical examinations or through personal communication.
- Evaluation of existing dental health programs and their success.
- Gathering information regarding personnel, facilities, resources and funds available
- Knowing social and cultural factors that may affect the outcome of the program.
- Knowing the educational status of the community.

Identifying Priorities

It is agreeing on the target areas for action. Its priorities are not determined, the program may not serve those individuals or groups who need the care most.

It includes:

- Finding out the problem that affects a large number of people.
- More serious problem should be given priority.

With limited resources it becomes necessary to set priorities to allow the most efficient allocation of resources.

High risk dental need groups include:
- Pre-school and school going children.
- Elderly persons.
- Physically/mentally handicapped person.
- Medically comprised person.

Developing Aims and Objectives

Aim is the over all goal to be achieved, where as *Objectives* are the steps needed to reach the aims.

The World Health Organization defines objective as: *"The end result of a program, a project or an institution seeks to achieve. A specific end point, condition or situation one is determined to achieve".*

Benefits of Objectives

- Objectives will provide the framework for the project by setting benchmarks for success.
- Objectives are specific actions to achieve "The Goal". Objectives provide clarity to the team of expected results.

In setting objectives time and resources are important factors. They are not only a guide to action but also help to measure work after it is done. Objectives may be short-term or long-term.

"SMART" Acronym in Setting Objectives

- *S – Specific* – the objective must be specific to the problem identified.
- *M – Measurable* – the objective must be measurable by available data sources.
- *A – Attainable* – the objective must be attainable. Keep it simple and easily attainable.
- *R – Relevant* – the objective must be relevant to the community and based on evidence. For example, as caries prevalence usually does not dramatically decrease in a short period of time, an objective to reduce caries prevalence by 8% in a one year period would not be realistic. Instead, reducing prevalence by 2% in a two-year span might be more appropriate, or reducing incidence (new cases) by 10% in a two-year period might be possible.
- *T – Timely* – the objective should have a definitive timetable, such as reducing caries prevalence by X% in a specific period of time.

Objectives are more specific and they describe:
- *What*: is to be attained
- *Who*: for whom it is to be attained.
- *Extent*: or magnitude of the situation to be attained.
- *Where and when*: the exact location and time of the program.

Assessing Resources and Constraints

It includes identifying the range of resources available to facilitate implementation of the plan, e.g. personnel, materials and equipments.

Resources must be identified for each objective and activity. In either case, organizers must take care to ensure adequate resources are available to carry out the activities that will accomplish the objectives of the plan.

What is Included in Resources

- Personnel
- Space
- Time
- Supplies
- Travel
- Financial need
- In-kind contribution.

Constraints

These are the road blocks or obstacles to achieving a certain goal or objectives. If these obstacles are identified early in the planning then the program can be modified accordingly. Constraints may result from:

- Resources limitation
- Governmental policies
- Inadequate transport system
- Labor shortage
- Inadequate facilities
- Community's socioeconomic, cultural and educational characteristic.

Alternative Strategies

Once the constraints are known the planner should consider alternative course of action to achieve objectives with the available resources. The more the number of alternative strategies the better it is. Out of many the planner can select the best possible strategy.

Implementation

It is turning the plan into action. Planner must know each specific activity to be done to develop an implementation strategy.

Consideration should be given to:

- Definition of roles and tasks.
- Materials, media, methods and techniques to be used.
- Selection, training, motivation and supervision of the manpower involved.
- Chronological sequence of activities.
- Organization and communication.

Many short-comings often appear at this stage. Plan execution depends upon the existence of effective organization.

Evaluation

Evaluation means measuring the changes resulting from the plan. This requires monitoring. It is a continuous process; an observation, recording and reporting of how well the program is meeting its stated objectives. Evaluation measures the progress and effectiveness of each activity.

The classic planning cycle may be summarized in a simple Problem, Objective, Activities, Resources, and Evaluation (*POARE*) format. This format provides an easy, step-by-step process to organize and evaluate the project (Fig. 20.2).

P Problem
- Determine the extent of the problem
- Collect relevant information
- Determine community support
- Gather baseline data

O Objectives
- State SMART objectives
- May be formative, process, or impact
- May be short-term or long-term
- Identify target populations

A Activities
- Outline methods that will achieve objectives
- Only PROVEN strategies should be used
- Identify barriers and strategies to overcome those barriers

R Resources
- Identify personnel, supplies, other financial needs, time, space, travel, or in-kind contributions

E Evaluation
- Implementation and evaluation may be simultaneous
- Plan how objectives will be evaluated
- Qualitative methods may be used to explain "why" or "how" something happened
- Use information to revise objectives.

Fig. 20.2: Poare format

EVALUATION

Evaluation may be defined as an investigation into the performance of a programme in terms of its success or failure to achieve stated aims.

Green (1977) has given a broader view of evaluation and defines it as *'the comparison of an object of interest against a standard acceptability'*. The definition implies that not only the outcome of a program should be monitored but also how it is used.

Purpose of Evaluation

To ensure that a program is fulfilling its purpose.

Types of Evaluation

Evaluation may take one of two forms:

- Formative
  - Implementation
  - Process

- Summative
  - Impact or also known as outcome

There are two broad types of evaluation.

Formative Evaluation

It focuses on the factors involved in the implementation of the program. It ensures monitoring and improving the day to day activities of the program. It is usually carried out to aid in the development of a program in its early phases. It helps the developers to assess the performance of the programme and help decide whether changes should be made to improve program activities. It is done at several points in the developmental life of a project and its activities.

Implementation Evaluation

Assess whether the project is being conducted as planned.

Example: Was appropriate number of staff available for seeing patients in the casualty room?

Progress Evaluation

- Assess progress in meeting the goals.
- It involves collecting information to learn whether or not the benchmarks of participant progress were met and to point out unexpected developments.

  Example: Are patients moving toward the anticipated goals of the project?

Summative Evaluation

It concentrates on collecting information once the program has finished. The aim of summative evaluation is not to influence the outcome of a program but to record failure or success in terms of stated aims and objectives.

Evaluation Methods

Quantitative

- Most evaluation is quantitative in nature, as most evaluation measures the extent to which the objectives were met
- Numerical data is useful for future planning of resources
- Quantitative evaluation does not inform organizers why the program was a success or failure.

For example, a survey may reveal how satisfied participants were with the program, but not why they were satisfied or how the program could be improved.

Methods of Quantitative Evaluation

- Computer searches
- Chart reviews
- Epidemiologic data
- Demographic data
- Surveys
- Screenings

Qualitative

- Interviews with providers, program participants, or community members may divulge strengths or weaknesses in the program that can be used for future planning.
- Observations done during the program can identify problems with program flow, other services that could be incorporated, or reasons for participant satisfaction or dissatisfaction. When using qualitative techniques such as observations or unstructured interviews.
- Focus groups acknowledge the participants' perspectives are meaningful and valuable.
- Checklist of desired topics will ensure relevant information is gained. The list could contain roughly worded questions that can be paraphrased and/or points to cover in the interviews or observations.

Methods of Qualitative Evaluation

- Interviews
- Focus groups
- Observations
- Key informant interviews

REASONS FOR EVALUATION

The main reason for evaluation of a programme is to *assess* the results of expending human and economic resources in a particular way.

This helps to:

- Decide whether the program be continued in its present form.
- To determine that the program is having the desired effect.
- Assess proper use of resources.
- Improve the procedures (can show that a simpler approach may be equally effective).

Four criteria that have been accepted for evaluation of dental services include:

1. *Effectiveness:* If the stated objectives were achieved or not.
2. *Efficiency:* What was the cost of manpower or finance in relation to the output of the program.
3. *Appropriateness:* If the program is acceptable to both community and providers and do the priorities reflect a proper interpretation of the needs of the population?
4. *Adequacy:* Was the intended coverage of the target population achieved.

21 School Dental Health Programs

CM Marya

Schools provide an important setting for promoting health, as they reach over 1 billion children worldwide and, through them, the school staff, families and the community as a whole. Health promotion messages can be reinforced throughout the most influential stages of children's lives, enabling them to develop lifelong sustainable attitudes and skills. Poor oral health can have a detrimental effect on children's quality of life, their performance at school and their success in later life.

School health services contribute to goals of both the education system and the health care system. Coordinated school health programs offer the opportunity to provide the services and knowledge necessary to enable children to be productive learners and to develop the skills to make health decisions for the rest of their lives.

One proven strategy for reaching children at high-risk for dental disease is providing oral and dental health services in school-based health centers… supporting linkages with health care professionals and other dental partners in the community.

MODELS

Throughout the evolution of school health, many different models have been used to delineate the components of school health programs.

THE THREE-COMPONENT MODEL

This model originated in the early 1900s and evolved through the late 1980s. Considered the traditional model of school health, it consists of the following components: (1) health education, (2) health services, and (3) a healthful environment.

THE EIGHT-COMPONENT MODEL

In the late 1980s the three-component model was replaced by the eight-component model. Also known as the model for a "Comprehensive School Health Program", it consists of eight elements.

The Comprehensive (Coordinated) School Health Program (CSHP) model includes the following components (Fig. 21.1):

1. *Health Education:* A planned sequential kindergarten through grade 12 curriculum that addresses the physical, mental, emotional, and social dimensions of health;
2. *Physical Education* that can serve as a means for maintaining cardiovascular and respiratory efficiency, as well as method of self expression, stress relief, and social development;
3. *School Health Services* that promote the health of students through Preventive services, education, emergency care, referral and management of acute and chronic health conditions. It is designed to promote the health of students, identify and prevent health problems and injuries, and ensure care for students.
4. *Nutrition Services:* School nutrition services include integration of nutritious, affordable and appealing meals, nutrition education, and an environment that promotes healthy eating behaviors for all children. Designed to maximize each child's education and health potential for a lifetime.
5. *School Counseling, Psychological and Social Services* Activities that focus on cognitive, emotional, behavioral, and social needs of individuals, groups and families. Activities capable of intervening in areas of assertiveness training, life skills training, peer interaction, problem solving, self esteem, and adolescent rebellion.
6. *Healthy School Environment* focusing on both physiological and psychological surroundings in which students and school personnel are expected to work;
7. *School Site Health Promotion* to support educators and staff that become interested in improving their own health, thus becoming powerful role models
8. *School and Parent/Community Involvement* that establishes and promotes collaborative efforts not only within school but with parents, business, and others interested in the health outcomes of students.



Fig. 21.1: Components of school health programs

Suggested core health services every school should provide: The essential services include:

- Screening, diagnostic, treatment and health counseling services;
- Referrals and linkages with other community providers; and
- Health promotion and injury and disease prevention education.

The WHO Global School Health Initiative consists of four broad strategies:

- Building capacity to advocate for improved school health programs.
- Creating networks and alliances for the development of Health Promoting Schools.
- Strengthening national capacity.
- Research to improve school health programs, health and education of young people, and individual documents in the series encourage schools to address one or more important health issues.

SCHOOL-BASED HEALTH CENTERS, IN PARTNERSHIP WITH COMMUNITY DENTAL PROVIDERS, CAN:

- Enhance *education*
- Enhance dental s*ervice*
- Eliminate barriers *to dental care.*

Comprehensive School Health Education

Comprehensive School Health (CSH) is defined as "a broad spectrum of programs, policies, activities and services that take place in schools and their surrounding communities." The approach is designed to affect not only individual health behaviors, but also to improve the environments where young people live and learn.

Comprehensive School Health Education is an instructional plan to provide young people and their families with critical health information and skills that will encourage positive health behaviors. Comprehensive School Health Education is most effective when it:

- Provides developmentally appropriate, sequential, comprehensive health education lessons at each grade level
- Addresses all of the critical health areas that put children and youth most at risk
- Is aligned to health education standards and content expectations
- Assesses students' level of health knowledge and skills.
- Implemented with all students
- Involves families and communities
- Provides professional development to help teachers stay current on legislation, health content, curriculum, and teaching strategies.

DEFINITION

There are a variety of definitions used to explain school health programs. The following definition of a comprehensive school health program was established by the Institute of Medicine Committee on Comprehensive School Health Programs in Grades K-12.

A comprehensive school health program is an integrated set of planned, sequential, school-affiliated strategies, activities, and services designed to promote the optimal physical, emotional, social, and educational development of students. The program involves and is supportive of families and is determined by the local community based on community needs, resources, standards, and requirements. It is coordinated by a multidisciplinary team and accountable to the community for program quality and effectiveness.

Terminology: Comprehensive Versus Coordinated

The terms "comprehensive" and "coordinated" school health are used frequently in school health literature.

- *Comprehensive:* Comprehensive means inclusive, covering completely and broadly, and refers to a broad range of components. It should be emphasized, however, that programs and services actually delivered at the school site may not provide coverage by themselves but are intended to work with and complement the efforts of families, primary sources of health care, and other heath and social service resources in the community to produce a continuous and complete system to promote and protect students' health.

- *Coordinated:* Coordinated means brought into combined action to cause separate elements to function in a smooth concerted manner. Coordination implies a formal relationship and blurring of boundaries between coordinating partners, although partners can still retain identity and affiliation to their profession.

Four Goals of Comprehensive School Health:
1. To promote health and wellness.
2. To prevent specific diseases, disorders and injury.
3. To intervene to assist children who are in need or at risk.
4. To help support those who are already experiencing poor health.

HEALTH PROMOTING SCHOOLS

The health promoting school is "a place where all members of the school community work together to provide students with integrated and positive experiences and structures which promote their health" (WHO 1996).

Developing a health promoting school means building healthy public policy, creating supportive school environments, strengthening community participation in school programming, developing personal health decision-making skills, and reorienting school health services to focus on prevention.

At the conceptual heart of the health promoting school is the concept of health promotion which according to the World Health Organization's Ottawa Charter for Health Promotion (1986) is:"the process of enabling people to increase control over, and to improve their health. To reach a state of complete physical, mental and social well-being, an individual and group must be able to identify and to realize aspirations, to satisfy needs, and to change or cope up with the environment. Health is, therefore, seen as a resource for everyday life, not the object of living. Health is a positive concept emphasizing social and personal resources, as well as physical capacities. Therefore, health promotion is not just the responsibility of the health sector, but goes beyond healthy lifestyles to well-being."

School is the first formal opportunity, children have to systematically explore health concerns in the company of their peers while under the supervision of a professional educator.

Schools offer a very large proportion of the population access to a professional workforce of teachers educating children and youth at a critical age and stage of development.

Aim of School Dental Services

American Dental Association (ADA) describes them as:
1. To help every school child appreciates the relationship of dental health to general health and appearance.
2. To encourage the observance of dental health practices, including personal care, professional care, proper diet and oral habits.
3. To enlist the aid of all groups and agencies interested in the promotion of school health.
4. To correlate dental health activities with the total school health programs.
5. To stimulate the development of resources to make dental care available to all children and youths.
6. To stimulate dentists to perform adequate health services for children.

The WHO Oral Health Program has prepared an oral health technical document to strengthen the implementation of an oral health component of the Health Promoting Schools program. Reasons for oral health promotion through schools are:

- Pupils and students can be accessed during their formative years, from childhood to adolescence. These are important stages in people's lives when lifelong oral health related behaviour as well as beliefs and attitudes are being developed.
- The schools can provide a supportive environment for promoting oral health. Access to safe water, for example, may allow for general and oral hygiene programs. Also, a safe physical environment in schools can help reduce the risk of accidents and concomitant dental trauma.
- The burden of oral disease in children is significant. Most established oral diseases are irreversible, will last for a lifetime and have impact on quality of life and general health.
- School policies, the physical environment and education for health are essential for attainment of oral health and control of risk behaviors, such as intake of sugary foods and drinks, tobacco use and alcohol consumption.
- Schools can provide a platform for provision of oral health care, i.e. preventive and curative services.

In the USA School Dental Health programs are highly promoted because of the following reasons:

- Dental caries is one of the most common chronic childhood diseases — 5 times more common than asthma and 7 times more common than hay fever.
- Children living in poverty suffer twice as much tooth decay as their more affluent peers, and their disease is more likely to be untreated.
- Fluoridation is the most effective way to prevent dental caries but more than 100 million Americans do not have an optimally fluoridated water supply.
- Over 80 percent of tooth decay in school children is on chewing surfaces of teeth that dental sealants can protect but only 18.5 percent of children and adolescents have at least one sealed permanent tooth.
- 25 percent of children living in poverty have not seen a dentist before entering kindergarten.
- 23 million children are without dental insurance coverage. Uninsured children are 2.5 times less likely than insured children to receive dental care.

OBJECTIVES OF SCHOOL BASED DENTAL HEALTH PROGRAM

- Increase the proportion of children who use the oral health system each year
- Increase the proportion of school-based health centers with an oral health component
- Increase the proportion of low-income children and adolescents who receive preventive dental services each year
- Reduce the prevalence of children and adolescents with untreated dental decay
- Reduce the proportion of children and adolescents who have dental caries in their primary or permanent teeth.

PARTNERS IN SCHOOL ORAL HEALTH PROGRAMS

Various groups and organizations can play an active role in oral health programs in school. Their coordinated efforts can lead to a successful oral health program. The dental schools, the school personnel and various organizations can be important partners in this program (Fig. 21.2). Contribution from the city health department and the policy makers can influence the positive outcome of such a program.

School-based preventive programs include:

SELF-APPLIED FLUORIDES

School-based fluoride mouthrinse programs, fluoride tablet programs, and supervised toothbrushing with a fluoride dentifrice are effective ways of delivering the benefits of fluoride to school-aged children. Cost-effectiveness should be determined based upon the caries rates of the children in the community.



Fig. 21.2: Partners in school oral health program

The safety of fluoride mouthrinse and tablet programs is an important consideration. All personnel mixing and dispensing fluoride should participate in regular training sessions to review proper handling procedures. Fluoride must be stored in a secure place and distribution of mouthrinse and tablets should be monitored.

School Fluoride Mouth Rinsing Program

Fluoride mouth rinsing program are advised for grades 1 to 12 but not below as many younger children cannot master the technique of swishing without swallowing. For kindergarten children plain water can be used as an educational program.

A once-a-week mouth rinse can result in an approximate 20 to 40 percent reduction in dental caries.

School Fluoride Tablet Program

Fluoride tablet programs are easier to carry out in school classroom. Every student is given one 2.2 mg sodium fluoride (1 mg fluoride) tablet which is chewed, swished around the mouth for 1 minute and then swallowed. This swish- and -swallow technique provides the benefits of a topical application (as with mouth rinse) and also provides optimum systemic benefit during the period of tooth development.

Classroom Tooth Brushing

The daily brushing of teeth in classroom may be an ideal method of plaque control but it is an impractical reality. Toothbrushing using a fluoride dentifrice is beneficial in reducing caries incidence rather than toothbrushing alone. Unfortunately usually the focus is on toothbrushing alone and not on the fluoride. Another problem faced is that toothbrushing is usually taught for a few weeks or months and then stopped much before the habit pattern is developed. During this time there should be major emphasis on the reasons for using a fluoride dentifrice when brushing. Most classrooms don't have a water supply and the sinks for classroom brushing. The daily storage and continual replacement of worn-out and lost brushes is another problem.

SCHOOL BASED SEALANT PROGRAM

School-based or school-linked dental sealant delivery programs provide sealants to children unlikely to receive them otherwise. The placement procedure for the sealants is rapid and painless. They are highly effective in protecting the occlusal pits and fissures. Such programs define a target population within a school district; verify unmet need for sealants; get financial, material, and policy support; apply rules for selecting schools and students; enroll students at school; and apply sealants at school or offsite in clinics. Many programs target what are referred to as high-risk children. High-risk children include vulnerable populations less likely to receive private dental care.

- Target grades are often selected for school sealant programs. Children in grades 1, 2, 6 and 7 should be

screened, as they are most likely to have newly-erupted molars that meet the criteria for sealant placement. However, in communities with high caries rates, it is preferable to see all grades each year to evaluate retention of sealants, teeth needing sealants, and referral for decay.
- Portable dental equipment is effective for sealant placement and can be brought to the school site. If transportation is available, children can be taken to the clinic for sealant placement.
- Sealants provided in a school setting are reported as Level II clinical services. These programs generally enhance the clinical dental program. It is important for programs not to view sealants as a one-time event for life. Sealants, like other restorations, need to be monitored.

SCHOOL WATER FLUORIDATION

School water fluoridation is recommended only if the students are coming from the areas which have low fluoride content. Consolidated rural school is ideal for this approach, since all students from kindergarten to high school are housed in the same building. The recommended concentration for school water fluoridation program is 4.5 ppm, in contrast to 1 ppm for community water supply due to *belated* and *abbreviated exposure* to fluoridated water in schools. Studies have shown approximately 40% reduction in dental caries due to school water fluoridation.

Major concerns about school water fluoridation are:
1. Installation cost is very high.
2. Some custodial and backup personnel must be rained and used for continual operation, maintenance and monitoring of the unit.
3. By age 6, all teeth except the 3rd molars are in advanced stage of mineralization, thus reducing the pre-eruptive benefits of fluoride.

TOPICAL FLUORIDE APPLICATION PROGRAM

Children accessing the dental services via school sealant programs can be provided with topical fluoride according to the needs of the individual child. Target those children with new smooth-surface caries, a history of high caries, or handicapped conditions for APF topical procedures.

ORAL HEALTH EDUCATION

Determine if the health education curricula used by the schools in the service area have oral health components. Schools often welcome assistance from dental professionals when evaluating materials. Visits by dental providers to the classroom build good public relations.

The Service Unit Dental Program can assist in the implementation of oral health education programs that address topics of particular concern to American Indian/Alaska Native populations, such as:
- Prevention and cessation of smokeless tobacco use and smoking
- Prevention/treatment of rapidly progressing periodontal disease
- Prevention of Baby Bottle Tooth Decay/Early Childhood Caries (BBTD/ECC).

Classroom instruction by itself should not be expected to influence individuals' behavior such that a group's oral health status improves. However, the value of classroom instruction should not be discounted. It is important that people have sufficient and accurate information about oral disease prevention to make informed decisions regarding personal and community oral health promotion measures as given in Fig. 21.2.

CONSIDERATIONS IN IMPLEMENTING A SCHOOL-BASED DENTAL PROGRAM

- Staff recruitment and retention
- Sustainability –establishing a collaborative business plan
- Electrical capacity- "dedicated line" for dental equipment
- Potential use of portable equipment
- AC/fans for temperature sensitive equipment
- Availability of X-ray machine- if unavailable, then referral service required
- Emphasis on skills training for long-term oral health maintenance
- Securing parent involvement for follow-up and family awareness
- Securing support from dental school and oral health organizations
- Securing support from local health providers involved in providing dental care to underserved populations

GUIDELINES FOR AN IDEAL SCHOOL DENTAL PROGRAM

A comprehensive school dental program should:
- Be available to all children
- Be feasible and administratively sound
- Provide facts about dental health and dental care focusing mainly on self care preventive procedures.
- Help in the development of positive attitude towards dental health.
- Provide an environment for development of skills and technique necessary for maintenance of oral hygiene for example tooth brushing and flossing.
- Include primary preventive dentistry procedures e.g. prophylaxis, pit and fissure sealants, topical fluoride application
- Have screening program for early identification, referral and treatment of identified lesions.

The American Academy of Family Physicians (AAFP) and the American Academy of Pediatric Dentistry (AAPD) recommends that infants be scheduled for a first dental visit within six months of the eruption of the first primary tooth but not later than 12 months of age.

A school health program should include:

Dental screening: Dental screening is an opportunity to detect early dental or oral health problems.

Screening is not a replacement for a complete examination in a dentist's office. However, dental screening can be an important component of an oral health program and an important element of a school health program. The screening should look for the presence of dental caries (tooth decay), periodontal disease (inflammation of gums and supporting structures), malocclusion (irregularity of the teeth or jaw), and trauma from oral injuries.

Dental Health Education

The schools can promote good oral health and prevent oral problems by educating students and parents. Oral health education should focus on:

- Prevention of decay through proper methods of oral hygiene (e.g. brushing, flossing);
- Use of fluoride or fluoridated water;
- Good nutrition including restricting candy and soft drinks; and
- The importance of using mouth-guards in organized high body-contact sports.

Referrals and Follow-up Care

The screening should look for the presence of dental caries (tooth decay), periodontal disease (inflammation of gums and supporting structures), malocclusion (irregularity of the teeth or jaw), and trauma from oral injuries. All children complaining of oral pain, with obvious dental caries, or mild gum disease should be referred to their dentist for a more complete examination. Every attempt should be made by school health personnel to work with parents, encouraging follow-up care with the dentist and getting feedback on any

GUIDELINES FOR SCHOOL-BASED DENTAL PREVENTION PROGRAMS

School-based dental prevention programs should address the following areas:

1. Assess disease burden in the population served and school's needs.
   - Select population-targeting method (reduced and free lunch programs, etc.)
   - Target program based on risk of disease
   - Target school and participants according to economic need.
2. Deliver dental preventive services including oral hygiene instructions, oral prophylaxis, topical fluoride (gel or varnish), the application of dental sealant, and dental radiographs (if possible).
3. Increase education efforts for individual and community awareness of the importance of oral health and the benefits of dental sealants.
4. Referral to and follow-up with community dentists for definitive restorative care.
   - Follow-up with school nurse to evaluate number of referrals completed.
   - Follow-up with local health department for compliance issues and outreach efforts.
5. Quality Assurance program including follow-up.

Table 21.1: Age-related oral health programs and activities used in Denmark school children

Age (Years)	*Oral health topics*	*Materials and visual aids*
0–3	Information to parents about oral health, teething, tooth brushing, breastfeeding, dummies/bottles, nutrition, caries, medicine, dental trauma.	Picture books, posters, slides, video, models, food.
3–5	Teach keeping the mouth clean, brushing the teeth and rinsing the mouth.	Leaflets, models, drawing and coloring sheets, puppet show, role-playing, songs
6	6-year-old teeth, oral hygiene, nutrition/food pyramid, shape and function of different teeth	Picture books, slides, video, puppet shows, models, fishing games, food, jigsaw puzzles, drawing/exercise sheets
7–9	Importance of good dental health to physical health *Dentitions:* Function and structure of teeth, caries process. Body/oral consciousness, hygiene, trauma.	Slides, videos, fishing games, food, leaflets on nutrition, models
10–12	Body, nutrition, hidden sugar and types of sweet, caries process, dental plaque, bacteria, caries registration, self-examination, importance of preventive measures.	Slides, videos, overhead projections, picture books, role-playing, cultivation of bacteria, worksheets, recipes, models
13–15	Health and well-being and oral health in general, structure of the tooth and its supporting tissues, initial caries and oral hygiene, approximal caries, healthy lifestyles, tobacco and nutrition, sweet drinks, hidden sugar	Overhead projections, slides, videos, leaflets, X-rays, newspaper articles, worksheets, music, dental floss, nutrition, computer programs, statistics
16–17	Gingivitis/periodontitis, change to adult dental health care. Oral cancer and preventive measures	Slides, videos, leaflets, newspaper articles, quality-of-life game, computer program

Modified from Stella .YL.Kwan et.al. Health-promoting schools; an opportunity for oral health promotion: Bulletin of the WHO (2005).

SCHOOL DENTAL HEALTH SCREENING INCLUDES

Systematic sequence of visual inspection, using tongue blade and illumination:

1. Face and neck for lesions and palpate for swollen glands
2. Mucous membranes (lips, tongue, soft and hard palate, tonsillar area, and cheeks) for redness, exudates, swelling, blisters and growths
3. Teeth and gums:
   a. Evidence of dental caries
   b. Broken or chipped teeth
   c. Gross malocclusion
   d. Infection or swelling
   e. Bleeding or inflamed gums
   f. Changes in color, texture, position of gums, tissue
   g. Poor oral hygiene
   h. Foul breath

Dental education should be a part of the inspection process.

changes that the dentist recommends, in order for school personnel to make the appropriate educational adjustments.

SCHOOL DENTAL HEALTH PROGRAMS

Save Our Smiles (Screening and Sealant Program)

Save our Smiles is a school-based, preventive dental health program that provides in-school education, screenings, and referrals. Weekly fluoride mouth rinsing and dental sealants are also provided in specific geographic areas. The program is funded through the California Children's Dental Disease Prevention Program.

Save Our Smiles serves Contra Costa County children from preschool through 6th grade, as well as special education students. Services provided include:

- Dental health education for elementary students, including toothbrushing instruction
- School dental health fairs
- Teacher and parent workshops
- Screenings at school sites and health fairs and referrals for treatment
- Sealants
- Weekly fluoride mouth rinsing for communities with sub-optimal fluoridation
- Toothbrushes, toothpaste, and floss for ongoing brushing and flossing (both in-class and at-home).

LEARNING ABOUT YOUR ORAL HEALTH

This oral health program was developed by American Dental Association [ADA] and its consultants in 1971. It was a comprehensive program covering school children (pre-school, primary and secondary).

Aim

- To develop adequate plaque control skills and knowledge among school children
- To increase knowledge regarding diet and dental health
- To stress upon the relationship between sugars and starch with dental caries
- Importance of role of dental professional
- Significance of fluoride and relationship of oral health with total health.

Implementation

It was implemented in 5 levels with each level having defined care material.

The levels are divided by grade:

- Preschool (children too young to read)
- Level I (kindergarten through grade 3)
- Level II (grades 4 through 6)
- Level III (grades 7 through 9)
- Level IV (grades 10 through 12)

Cost of Material

The cost of teaching packet for each level was $8.

Program Evaluation

Evaluation for the program was carried out by Dr. oliver L. Ezell in 1974; second investigation was carried out by Dr. Donald B Stone and colleagues in 1975 which evaluated the cognitive aspects of ADA's level II programs. A third evaluation was carried out by Peterson and Rubinson which were reported in 1982 to determine the effects of the ADA level IV school programs on the knowledge, attitude, practices and dental health status of high school students.

TATTLE TOOTH I PROGRAM

The Tattle Tooth Program was developed in 1974 to 1976 as a cooperative effort between Texas oral health professional organizations, the Texas Education Agency and the Texas department of health through a grant from the department of health and human services to the Bureau of Dental Health.

The program involved teaching of students in the classroom to care for their teeth through brushing flossing and proper diet. Classroom material for the Tattle tooth curriculum were so developed so as to impart activity- oriented, humorus and positive approach to the teaching of preventive dental care for the benefit of the whole person.

Implementation

- It included more than 16000 students from kindergarten through high school and approximately 540 teachers across Texas.

- Separate lesson plan were developed for each of the nine grade levels; kindergarten, six elementary grades, junior high school and senior high school.

Tattle Tooth Package

Each package comprised of 10 lessons of instructions, a package of information called as 'People Facts and 'Dental Facts', which gave instruction on brushing, flossing, nutrition and dental health in general.

Evaluation

Evaluation was based on field testing.

TATTLE TOOTH II PROGRAM

In 1989, the Bureau of Dental Health developed a new program Tattletooth II, a new generation for grades K-6, so named because the characters in the artwork for grades kindergarten through second were from the old curriculum.

Philosophy and Goals

The basic goal of the program is to reduce dental diseases and to develop positive dental habits which would last a lifetime.

Program Implementation

The Texas Department of Health employed hygienists to implement the program. The hygienists were asked to instruct the teachers using videotapes designed for teachers training. In some cases hygienist trained the lead teachers who, in turn, provided training for teachers in their respective schools. Topics covered were correct brushing and flossing techniques, awareness of the importance of safety, factual information relating to dental diseases, its causes and preventive technique.

Teacher's Package

Three videotapes were produced as a part of the teacher training package. These contained teacher's lesson format and contents, brushing and flossing lessons and instructions, and additional background information as a means of preparing teachers to teach the lessons.

Cost of Program

The estimated cost per child was $ 0.60

Program Evaluation

Tattletooth II underwent formative evaluation by teachers in 1988, where a 19-item questionnaire was developed.

In 1989 a statewide summative evaluation of the curriculum was conducted.

THETA PROGRAM

The *Teenage Health Education Teaching Assistants (THETA)* program was developed by the United States Public Health service, division of dentistry.

Goals

To give young children the knowledge and skills to start them on the way to lifetime of preventive dentistry practice.

Implementation

Qualified dental personnel were utilized to train interested high school children to teach preventive dentistry to elementary students. Suggested guidelines and a THETA teacher's manual was forwarded to the interested party.

YUKON CHILDREN'S DENTAL HEALTH PROGRAM

The Yukon Children's Dental Program is a school-based program that provides diagnostic, preventive and restorative dental services to students enrolled onto the Program. Dental therapists who are based in Whitehorse Schools provide the services. Whitehorse-based dental therapists service all rural communities.

Eligibility

Preschool children, home-school children and students from Kindergarten to Grade 8 are eligible for services from the Yukon Children's Dental program in Whitehorse and rural communities with a resident dentist.

Pre-school children, home-schooled children and students from Kindergarten to Grade 12 are eligible for services from the Yukon Children's Dental Program in communities without a resident dentist.

Enrollment

Parents are required to complete the Consent for Examination form annually. Children are eligible to receive:

- Dental Examination
- Diagnostic X-ray films (if required)
- Oral hygiene instruction
- Cleaning and/or scaling of teeth
- Fluoride application
- Sealants

Examination

The initial dental examination is performed by a dentist who also completes a recall examination every two years. In alternate years, the examination will be conducted by a dental therapist.

Treatment

If the child requires dental treatment following the dental examination, consent for treatment will be sent home to inform about the child's dental needs and to obtain the written consent. Treatment cannot be provided without written consent from the parent/guardian. Once this has been provided, the child then receives the dental treatment prescribed, which may include:

- Fillings (Silver amalgam or white composite resins)
- Stainless steel crowns (primary teeth)
- Pulpotomies (primary teeth)
- Extractions if required
- Emergency dental services

Parent/Guardian Meetings

Schedule meetings may be arranged with the dental therapist to discuss the children's dental health concerns.

ASKOV DENTAL HEALTH EDUCATION

Askov is a small farming community in Minnesota. Initial surveys made in 1943 and 1946 showed a very high incidence of dental caries. Minnesota Health Department in 1949-1957 supervised a demonstration School Dental Health Program in Askov including caries prevention and control, dental health education and dental care. All accepted methods for caries prevention were used in demonstration with the exception of communal water fluoridation.

Dental findings were available through a 10-year period which include:

- A 28% reduction in dental caries in deciduous teeth of 3 to 5 yers old
- A 34% reduction in caries in permanent teeth of children 6 to 12-year-old.
- A 14% reduction in children 13 to 14-year-old.

THE MAINE SCHOOL ORAL HEALTH PROGRAM

Description

Tooth decay is the most common chronic disease of childhood. It affects 85% of children. Dental problems can result in failure to thrive, impaired speech development, absence from and/or inability to concentrate in school and reduced self-esteem. Poor oral health has been related to decreased school performance, poor social relationships and less success later in life.

The School Oral Health Program provides grant funding, training and technical assistance to eligible public and private elementary schools with activities being focused in Grades K through 6. Each program is locally designed to meet the needs of the individual students.

ELEMENTS OF SCHOOL ORAL HEALTH PROGRAM

The Four Components of the School Oral Health Program

Education

All children receive oral health education. Practical information to promote healthy behaviors is provided. Some features of the education include:

- Grant funding to support the purchase of educational tools and supplies.
- *Printed curriculum:* A comprehensive and sequential curriculum aligned to the Maine Learning Results.
- Instructional tools such as posters, videos, pamphlets, models and *instructional tubs* as well as technical assistance from the Oral Health Program.

Fluoride

Weekly fluoride mouth rinse is given to children with parental permission. The mouth rinse is swished for one minute and spit out. It strengthens and protects teeth that are already present in the mouth.

Dental Screenings

Dental screenings are conducted by each funded School Oral Health Program at least once during each five years grant cycle. Dental screenings help to identify children who need dental care.

Dental Sealants

Existing School Oral Health Programs may apply for funding to support school-based dental sealant programs. Dental *sealants* are thin plastic coatings that are painted into the deep grooves of back teeth. They help to prevent dental decay by sealing grooves that are most likely to decay. School sealant programs are usually conducted by dental hygienists given in Table 21.2.

The plan of action for dental health program depends upon the circumstances or as per the requirement. For example in schools where the community water supply is deficient in fluorides, the ideal preventive component of the dental health program would include:

1. A school water fluoridation project;
2. A carbohydrate control program;
3. Supervised classroom toothbrushing;
4. A dental examination program,
5. A topical fluoride application program.

In schools where the water supply contains adequate amounts of fluoride, the ideal preventive dental program would include:

Table 21.2: Examples of oral health-related school health policies

Policy areas	*Examples of issues for consideration*
Healthy school environment	• Safe and well-designed school buildings and playgrounds to prevent injuries and avoid "sick building syndrome" • No smoking on the school premises • Fluoridation (e.g. of milk) • A ban on the sale of unhealthy or harmful foods and substances in the close vicinity of the school • Safe water and good sanitation facilities • A caring and respectful psychosocial environment • A protocol for dealing with bullying and violent behavior, as well as interpersonal conflicts
Healthy eating	• Healthy foods must be made available in the school canteen, tuck shop, kiosks and vending machines • Only nutritious meals are served in the school canteen • Promotion of 5-a-day (fruit and vegetables) • Drinking-water fountains throughout the school • Training for cooks and food providers • Assessment and surveillance of nutritional status
No sugar	• A ban on sugary foods and drinks on the school premises
No alcohol	• A ban on alcohol consumption on the school premises
No smoking	• A ban on smoking on the school premises • Smoking cessation services and counseling
Oral health education	• Oral health education should form part of all subjects in the school curriculum • Daily supervised toothbrushing drills • Training for parents about good oral health and encouragement for them to take part in health promotion activities at school • Training for school staff
Oral health service	• Working closely with central or local oral health service providers • Dealing with dental emergencies • Role of teachers in oral health surveillance, screening and basic treatment, e.g. ART (Atraumatic restorative technique) • Monitoring of oral health-related complaints and absenteeism. • Training for school staff
Oral injury	• Accident prevention • Clear protocol of vital actions to be taken without delay • Monitoring incidence of oral trauma
Physical exercise	• Commitment to provide safe facilities for training in sport and leisure activities • Exercise and physical education are a compulsory part of the school curriculum • A protocol, on safe sport, e.g. use of mouth guards

Modified from Stella YL Kwan, et al. Health-promoting schools; an opportunity for oral health promotion: Bulletin of the WHO (2005).

1. A carbohydrate control program;
2. Supervised classroom toothbrushing,
3. A dental examination program.

SOME SCHOOL BASED ORAL HEALTH PROGRAMS IN VARIOUS COUNTRIES

Oral Health Education Program for School Children in MECCA

In 2003, an oral health education program for schoolchildren in the Holy City of Mecca was initiated as a joint venture between the Specialist Dental Center of Alnoor Specialist Hospital and the Directorate of Education in Mecca city. The program was aimed at schoolchildren attending the third and fourth primary classes (8 to10 years old).

A group of school boys and a teacher visited the Dental Centre once a week to receive a comprehensive oral health education package (Fig. 21.3).

A clinic in the Specialist Dental Centre with a dentist and a dental hygienist carried out the program.

The visit started with a tour around the Center for the children and their teacher so as to introduce to the group to the different dental specialities.

Then the dentist presented the oral health education program in the form of clinical demonstration, discussions and tooth brushing instructions.



Fig. 21.3: A group of school children receiving oral health education from dentist

The children and the teacher were given oral health information sheets and in addition, they also received a gift package consisting of tooth brush, paste and a cup.

At the end of the session which lasts about 3 hours, the children and their teachers were awarded certificates signed by the Director of the Dental Centre.

A total of about 350 school children participated in this program during 2003 to 2004 as shown in Figure 21.3.

SMILING SCHOOLS PROJECT IN NAMIBIA

The project was funded by government of Namibia and the WHO. Even though caries among Namibian children is still low (DMFT 12-year-old 1.2 in 1991) many communities were being exposed more to caries causing factors. Caries prevalence increased rapidly with age particularly in the urban population. Therefore there is an urgent need for influencing the oral health habits of the general population, especially the children, who can be educated in correct oral health measures that would prevent the onset of caries and gum diseases.

The project was implemented first in three schools. Toothbrushes were provided to schools and sold to children. Toothpaste was not used during brushing sessions at school, but children were encouraged to use fluoride toothpaste at home. Two oral health monitors/class were trained and tooth-brushing sessions were carried out during breaks under their supervision six times every month. 50 to 95% of the children participated.

- 65 smiling Schools were established all over the country during the period 1996 to 1998.
- 19 facilitators (regional dentist and oral hygienist) from 10 regions were trained.
- 169 teachers were trained where 51,038 primary school children were covered by the program (nearly 13% of the Namibian primary school population).
- 36 nurses from 8 regions were trained.

DENTAL PUBLIC HEALTH PROGRAMS IN SEYCHELLES

The national school oral health program was stared in 1998 to date

Personnel involved were

Dental Therapists with assistance of school staff.

Target

All children of state schools.

Primary Goal

To raise the oral health status of school children (i.e. improve oral hygiene and decrease level of dental caries in that population group)

Main Objectives

- To reduce sugar intake in the group (in terms of both amount and frequency) to a level compatible with oral health
- Give optimal fluoride exposure
- To reduce overall amount of plaque accumulation in the group
- Ensure optimal use of dental service.

Main Components

Dental examination of all the children with follow up appointments for necessary treatment.

Weekly fluoride mouth rinse, and dental health education, individually or as a group at school.

SCHOOL-BASED ORAL HEALTH EDUCATION PROGRAM IN CHINA

The Hubei Province Committee for Oral Health together with the WHO Collaborating Centre for Community Oral Health Programs and Research, University of Copenhagen, Denmark in 1998 conducted projects in primary schools in Wuhan City, China.

Background and Rationale

Oral health education to schoolchildren is given high priority in China. Nation-wide campaign, the 'Love Teeth Day', has been conducted annually since 1989 and it's success emphasises the commitment of China to oral health promotion. Systematic school-based oral health education programs however was yet to be established at national levels. Hence, this demonstration project was implemented in 1998 in the Hongshan District of Wuhan City, Hubei Province, central China. The fluoride content of drinking water in this district was low (0.2 ppm) and dental care was available from one hospital only.

Project Outline

Six primary schools were chosen randomly from this district three experimental and three control schools with three years follow-up. A total of 404 grade1 children and 33 teachers and 399 grade1 children and 336 teachers (740 children and 369 teachers) were included in the experimental and control groups respectively. The experimental schools applied the WHO Health Promoting Schools Project concepts throughout the three year period.

Teachers received oral health education training through workshops conducted by district education officers and dentists.

Classroom-based oral health education, focus on diet and nutrition, and integration of oral health into general health and school education activities.

Students took part in daily oral hygiene instructions by teachers.

Mothers were encouraged to be present during these sessions.

Tooth brushing twice a day with fluoride toothpaste was recommended.

Monthly oral hygiene education was part of the curriculum.

Throughout the project, public health dentists supervised activities in schools.

Conclusion

The program had a positive effect in relation to oral health behavior and education but no improvement on caries situation was demonstrated.

SCHOOL ORAL HEALTH PROGRAM IN KUWAIT

In 1982 Forsyth Research Institute was invited by MOH, Kuwait to study the oral health needs of Kuwaitis. Subsequently in 1983 Forsyth Research Institute was asked to plan a model school oral health program catering to the oral health needs of Kuwaiti school children of Capital governorate. In the same year 10 Kuwaiti dentists were trained at Forsyth Research Institute and later worked in the Program at Capital region.

School Oral Health Program, Kuwait-Forsyth is a comprehensive oral health program serving to the oral health needs of Kuwaiti school children. It is program with preventive, treatment and health educational components. The main area of concentration is primary prevention that is prevention of the disease before its onset.

This program is one of the rare national school-based programs in the world and only one of its kinds in the middle-east where the need for this kind of a program is immense.

Goal

To achieve optimum oral health to the maximum number of children by a comprehensive oral care approach - education, prevention and treatment.

Objectives

Increase the proportion of children benefiting from the Program every year.

Increase the proportion of children receiving preventive oral health care every year to achieve 90% coverage with prevention by the year 2010.

Increase awareness about the importance of oral health among school children, parents and teachers

Reduce the proportion of children with untreated dental decay to minimal.

Increase the proportion of caries free children in permanent and primary dentitions.

SCHOOL ORAL HEALTH PROGRAM IN INDIA

The **Colgate Bright Smiles, Bright Futures** oral health educational program worldwide was developed to teach children oral health habits of basic hygiene, diet and physical activity. This program encourages dentists, public health officials, civic leaders and, most importantly, parents and educators to come together to realize the importance of oral health as part of a child's overall physical and emotional development.

This program is conducted by Colgate-Palmolive, India for children in primary schools who receive instructions in dental care from members of the dental profession and Indian Dental Association. Education is imparted with the aid of audio-visuals and printed literature. Free dental health care packs, comprising 1 toothbrush and 1 toothpaste pack, are also distributed to encourage good oral hygiene. Under this program, since 1976 over 83 million school children in rural and urban parts of the country, in the age group of 6-12 years have been reached out.

Teachers Training Program

The Teachers Training Program is an integral part of the School Dental Health program which includes the basics of oral health care. This helps them to play a significant role in preventive oral care by inculcating good oral care habits in the students. Till date, 2,43,500 teachers have been trained under this program.

INCREMENTAL DENTAL CARE

This involves treatment programs by taking up the youngest available group in the first year and carrying it forward in subsequent years as far as funds permit, adding a new class of children each year at the next earliest available age until an entire child population is being served to as high as the available resources and funds permit.

It is defined as periodic care so spaced that increments of dental diseases are treated at the earliest time consisting of proper diagnosis and operating efficiency, in such a way that there is no accumulation of dental needs beyond minimum.

Advantages

i. It is supposed to avoid high expenditure for initial dental care.
ii. It confines dental diseases to small yearly increments, thus reducing loss of teeth.
iii. It is supposed to inculcate a habit of periodic visit to dental office in subsequent years.
iv. Limits the spread of the disease for example dental caries is treated in initial stages and prevents the involvement of pulp.

Disadvantages

i. Attention to deciduous teeth: importance of deciduous teeth is known but few will assign them a value as great as that of permanent dentition.
ii. Conservative dentistry is more time consuming on a piece meal basis than upon a wholesale basis. The idea is that large operative programs can be handled on the quadrant basis under local anesthesia. This makes for rapid cavity preparation and easy isolation of teeth for filling procedures. More number of teeth can be filled in time required for only 1 to 2 teeth if these are scattered in various parts of the mouth.
iii. A major drawback is that it is usually made to implement the care program at the earliest available age, which coincides with entry of a child into some public health or school health program. The result is that financial resources are usually exhausted even before the elementary school population has been cared for and the high school child receives no maintenance care at all. It is concluded from various studies given limited resources young children should not be sole focus or recipients of the programs but the teenagers should be given at least equal consideration.
iv. It is often seen that children no longer carry on with the habits taught to them by parents and teachers during childhood into similar adult habits of their own. They must be motivated time and again. Teenagers can be reached by reasons much better than young children.

Chapter 22

Dental Council of India

CM Marya

INTRODUCTION

The Dental Council of India — a statutory body was constituted on 12th April, 1949 under an Act of parliament the Dentists Act, 1948 (XVI of 1948). The amendments were made through an ordinance promulgated by the president of India on 27th August, 1992. Through this ordinance, new sections, i.e. Section 10A, Section 10B, Section 10C were introduced in the Dentists Act, 1948 mainly to restrict mushroom growth of dental colleges, increase of the seats in any of the course and starting of new higher courses without the prior permission of the central government, Ministry of Health and Family Welfare. The amendment was duly notified by the Govt. of India in Extraordinary Gazette of India, Part II, Section I on 3rd April, 1993 with effective date 1st June, 1992.

The council is financed mainly by grants from the Govt. of India, Ministry of Health and Family Welfare (Department of Health) though the other source of income of the council is the 1/4th share of fees realized every year by various state dental councils under section 53 of the Dentists Act, inspection fee from the various dental institutions for inspecting under section 15 of the Dentists Act, 1948 and application fee from the organization to apply for permission to set-up new dental college, opening of higher courses of study and increase of admission capacity in dental college.

OBJECTIVES/DUTIES

In consonance of the provisions of the act, Dental Council of India is entrusted with the following objectives:

- Maintenance of uniform standards of dental education—both at undergraduate and postgraduate levels. (a) It envisages inspections/visitations of dental colleges for permission to start dental colleges, increase of seats, starting of new P.G. courses (as per provisions of Section 10A of the Act).
- To prescribe the standard curriculum for training of dentists, dental hygienists, dental mechanics and the conditions for such training.
- To prescribe the standards of examinations and other requirements to be satisfied to secure for qualifications recognition under the Act.

To achieve these, the needs are:

- Uniformity of curriculum standards of technical and clinical requirements, standards of examinations
- A uniform standard of entrance to various courses in dentistry
- Affiliation of every dental college to a university
- Supervision over all the dental institutions to ensure that they maintain the prescribed standards
- Regulation of the profession of dentistry.

Functions

The Dental Council of India is constituted by an Act of Parliament 'The Dentists Act, 1948' (XVI of 1948) with a view to regulate the dental education, dental profession and dental ethics thereto which came into existence in March, 1949.

The council is composed of 6 constituencies representing central government, state government, universities, dental colleges, Medical Council of India and the private practitioners of dentistry. The Director-General of health services is ex-officio member of both of the executive committee and general body. The council elects from themselves the president, vice-president and the members of the executive committee. The elected president and the vice-president are the ex-officio chairman and vice-chairman of the executive committee. The executive committee is the governing body of this organization, which deals with all the procedural, financial and day-to-day activities and affairs of the council. The council is financed mainly by grants from the Govt. of India, Ministry of Health and Family Welfare (Deptt. of Health) though the other source of income of the council is the 1/4th share of fees released every year by various state dental councils under section 53 of the Dentists Act, inspection fee from the various dental institution for inspecting under section 15 of the Dentists Act, 1948 and application fee from the organization to apply for permission

to set up new dental college, opening of higher courses of study and increase of admission capacity in dental colleges under Section 10A of the Dentists Act, 1948 as amended by the Dentists (Amendment) Act, 1993.

CONSTITUTION AND COMPOSITION OF COUNCIL

The central government shall, as soon as may be, constitute a council consisting of the following members, namely:

a. One registered dentist possessing a recognized dental qualification elected by the dentists registered in Part A of each state register;
b. One member elected from amongst themselves by the members of the Medical Council of India;
c. Not more than four members elected from among themselves by:
    i. Principals, deans, directors and vice-principals of dental colleges in the states training students for recognized dental qualifications provided that not more than one member shall be elected from the same dental college;
    ii. Heads of dental wings of medical colleges in the states training students for recognized dental qualifications;
d. One member from each university established by law in the states which grants a recognized dental qualification, to be elected by the members of the senate of the university or in case the university has no senate, by the members of the court, from amongst the members of the dental faculty of the university or in case the university has no dental faculty, from amongst the members of the medical faculty thereof;
e. One member to represent one State, nominated by the government of each such state from among persons registered either in a medical register or a dental register of the State;
(*Explanation:* In this clause, "State" does not include a Union territory)
f. Six members nominated by the central government, of whom at least one shall be a registered dentist possessing a recognized dental qualification and practising or holding an appointment in an institution for the training of dentists in a four Union territories and at least two shall be dentists registered in Part B of a state register;
g. The Director-General of health services, ex-officio;

Provided that pending the preparation of registers the state governments may nominate to the first council members referred to in parts (A) and (E) and the central government members referred to in part (F) out of persons who are eligible for registration in the respective registers and such persons shall hold office for such period as the state or central government may, by notification in the official gazette, specify.

INCORPORATION OF COUNCIL

The council shall be a body corporate by the name of the Dental Council of India, having perpetual succession and a common seal, with power to acquire and hold property, both movable and immovable, and shall by the said name sue and be sued.

MODE OF ELECTION

Elections under this Chapter shall be conducted in the prescribed manner, and where any dispute arises regarding any such election, it shall be referred to the central government whose decision shall be final.

TERM OF OFFICE AND CASUAL VACANCIES

1. Subject to the provisions of this section an elected or nominated member shall hold office for a term of five years from the date of his election or nomination or until his successor has been duly elected or nominated, whichever is longer.
2. An elected or nominated member may at anytime resign his membership by writing under his hand addressed to the president and the seat of such member shall thereupon become vacant.
3. An elected or nominated member shall be deemed to have vacated his seat if he is absent without excuse, sufficient in the opinion of the council from three consecutive ordinary meetings of the council or, in the case of a member whose name is required to be included in a state register, if his name is removed from such register, or if he has been elected under clause (c) of Section 3: (1) if he ceases to hold his appointment as the principal, dean, director or vice-principal of a dental college, or as the head of the dental wing of a medical college, or (2) if he has been elected under clause (b) or (d) of section 3, or (3) if he ceases to be a member of the Medical Council of India or (4) the dental or medical faculty of the university, as the case may be.
4. A casual vacancy in the council shall be filled by fresh election or nomination, as the case may be, and the person elected or nominated to fill the vacancy shall hold office only for the remainder of the term for which the member whose place he takes was elected or nominated.
5. Members of the council shall be eligible for re-election or renomination.
6. No act done by the council shall be called in question on the ground merely of the existence of any vacancy in, or defect in the constitution of, the council.

PRESIDENT AND VICE-PRESIDENT OF COUNCIL

1. The president and vice-president of the council shall be elected by the members thereof from among themselves,

provided that on the first constitution of the council and until the president is elected, a member of the council nominated by the central government in his behalf shall discharge the functions of the president, provided further that for five years from the first constitution of the council, the president shall, if the central government so decides, be a person nominated by the central government who shall hold office during the pleasure of the central government, and where he is not already a member, shall be a member of the council in addition to the members referred to in Section 3.

2. An elected president or vice-president shall hold office as such for a term not exceeding five years and not extending beyond the expiry of his term as member of the council, but subject to his being a member of the council, he shall be eligible for re-election.

THE EXECUTIVE COMMITTEE

1. The council shall constitute from among its members an executive committee, and may so constitute other committees for such general or special purposes as the council considers necessary for carrying out its functions under this Act.
2. The executive committee shall consist of the president and vice-president ex-officio and the Director-General of health services ex-officio and five other members elected by the council.
3. The president and vice-president of the council shall be chairman and vice-chairman, respectively, of the executive committee.
4. A member of the executive committee shall hold office as such until the expiry of his term of office as member of the council but, subject to his being a member of the council, he shall be eligible for re-election.
5. In addition to the powers and duties conferred and imposed on it by this Act, the executive committee shall exercise and discharge such powers and duties as may be prescribed.

RECOGNITION OF DENTAL QUALIFICATIONS

1. The dental qualifications, granted by any authority or institution in India, which are included in Part I of the Schedule shall be recognized dental qualifications for the purposes of this Act.
2. Any authority or institution in India which grants a dental qualification not included in Part I of the Schedule may apply to the central government to have such qualification recognized and included in that Part, and the central government, after consulting the council, and after such inquiry, if any, as it may think fit for the purpose, may, by notification in the official gazette, amend Part I of the Schedule so as to include such qualification therein, and any such notification may also direct that , an entry shall be made in Part I of Schedule against such dental qualification declaring that it shall be a recognized dental qualification only when granted after a speci-fied date.
3. a. The dental qualifications, granted by any authority or institution outside India, which are included in Part II of the Schedule shall be recognized dental qualifications only for the purposes of the registration of citizens of India when the register is first prepared under this Act.
   b. Where any dental qualification granted by any authority or institution outside India, and held by a citizen of India, is recognized for the purposes of the register when it is first prepared, after the commencement of the Dentists (Amendment) Act, 1972 (42 of 1972), the central government may, after consultation with the council, by notification in the official gazette, amend Part II of the Schedule so as to include therein the dental qualification so recognized.
4. a. The dental qualifications granted by any authority or institution outside India, which are included in Part III of the Schedule, shall be recognized dental qualifications for the purposes of this Act, but no person possessing any such qualification shall be entitled for registration unless he is a citizen of India.
   b. Where any dental qualification granted by any authority or institution outside India, and held by a citizen of India, is recognized, except on reciprocal basis, after the commencement of the Dentists (Amendment) Act, 1972 (42 of 1972), the central government may, after consultation with the council, by notification in the official gazette, amend Part III of the Schedule so as to include therein the dental qualification recognized.
5. The council may enter into negotiations with any authority or institution in any state or country outside India which, by law of any such state or country, is entrusted with, the maintenance of a register of dentists, for the settling of a scheme of reciprocity for the recognition of dental qualifications and in pursuance of any such scheme, the central government may, by notification in the official gazette, declare that any such qualification granted by any authority or institution in any such state or country, or such qualification, only when granted after a specified date, shall be a recognized dental qualification for the purposes of this Act, and any such notification may provide for an amendment of the Schedule and may also direct that any such dental qualification as is specified in the notification shall be entered in the Schedule as so amended.
6. The central government may, after consultation with the council, by notification in the official gazette, amend the Schedule by directing that an entry be made therein in respect of any dental qualification declaring that it shall be a recognized dental qualification only granted before a specified date.

NONRECOGNITION OF DENTAL QUALIFICATIONS

In certain cases where any authority or institution is established for grant of recognized dental qualification except with the previous permission of the central government in accordance with the provisions of Section 10A, no dental qualification granted to any student of such authority or institution shall be a recognized dental qualification for the purposes of this Act.

QUALIFICATIONS OF DENTAL HYGIENISTS

Any authority in a state which grants a qualification for dental hygienists may apply to the council to have such qualification recognized, and the council may, after such inquiry, if any, as it thinks fit, and after consulting the government and the state council of the state in which the authority making the application is situated, declare that such qualification, or such qualification only when granted after a specified date, shall be a recognized dental hygiene qualification for the purposes of this Act.

QUALIFICATIONS OF DENTAL MECHANICS

The council may prescribe the period and nature of an apprenticeship or training which shall be undergone and the other conditions which shall be satisfied by a person before he is entitled to be registered under this Act as a dental mechanic.

EFFECT OF RECOGNITION

Notwithstanding anything contained in any other law, but subject to the provisions of this Act:

a. Any recognized dental or dental hygiene qualification shall be a sufficient qualification for enrolment in the appropriate register of any state;
b. No person shall, after the first registers are compiled under this Act, be entitled to be enrolled in any register as a dentist or dental hygienist unless he holds a recognized dental or dental hygiene qualification or as a dental mechanic unless he has undergone training which satisfies the prescribed requirements referred to in Section 12.

WITHDRAWAL OF RECOGNITION

1. When upon report by the executive committee it appears to the council:
   a. That the courses of study and training or the examinations to be undergone in order to obtain a recognized dental hygiene qualification from any authority in a state or the conditions for admission to such courses or the standards of proficiency required from the candidates at such examinations are not in conformity with regulations made under this Act or fall short of the standards required thereby, or
   b. That an institution does not satisfy the requirements of the council, the council may send to the government of the state in which the authority or institution is situated a statement to such, effect, and the state government shall forward it, along with such remarks as it may think fit, to the authority or institution concerned with an intimation of the period within which the authority or institution may submit its explanation to the state government.
2. On receipt of the explanation, or where no explanation is submitted within the period fixed, then on the expiry of the period, the state government shall after consulting the state council, forward its recommendations and those of the state council, if any, to the council.
3. The council, after considering the recommendations of the state government and the state council and after such further inquiry, if any, as it may think fit to make, may declare that the qualification granted by the authority or institution shall be a recognized dental hygiene qualification only when granted before a specified date.
4. The council may declare that any recognized dental hygiene qualification granted outside the states shall be recognized as such only if granted before a specified date.

WITHDRAWAL OF RECOGNITION OF RECOGNIZED DENTAL QUALIFICATION

1. When, upon report by the executive committee or the visitor, it appears to the council:
   a. That the courses of study and training or the examination to be undergone in order to obtain a recognized dental qualification from any authority or institution in a state, or the conditions for admission to such courses or the standards of proficiency required from the candidates as such examinations are not in conformity with the regulations made under this Act or fall short of the standards required thereby, or
   b. That an institution does not, in the matter of staff, equipment, accommodation, training and other facilities, satisfy the requirements of the council, the council shall send a statement to that effect to the central government.
2. After considering such a statement, the central government may send it to the government of the state in which the authority exercises power or the institution is situated, and the state government shall forward it, along with such remarks as it may think fit to make, to the authority or institution concerned, with an intimation of the period

within which the authority or institution may submit its explanation to the state government.

3. After considering the explanation, or where no explanation is submitted within the period fixed, then, on the expiry of that period, the state government shall make its recommendations to the central government.
4. The central government may, after considering the recommendations of the state government and after making such further inquiry, if any, as it may think fit, by notification in the official gazette, direct that an entry shall be made in Part I of the schedule against the qualification granted by the authority or institution declaring that it shall be a recognized dental qualification only when granted before a specified date or that the said recognized dental qualification if granted to students of a specified college or institution affiliated to any university shall be a recognized dental qualification only when granted before a specified date or, as the case may be, that the said recognized dental qualification shall be a recognized dental qualification in relation to a specified college or institution affiliated to any university only when granted after a specified date.

PROFESSIONAL CONDUCT

1. The council may prescribe standards of professional conduct and etiquette or the code of ethics for dentists.
2. Regulations made by the council under sub-section (1) may specify which violations thereof shall constitute infamous conduct in any professional respect, that is to say, professional misconduct, and such provision shall have effect notwithstanding anything to the contrary contained in any other law for the time being in force.

THE INDIAN REGISTER

1. The council shall maintain a register of dentists to be known as the Indian Dentists Register and consisting of the entries in all the state registers of dentists.
2. Each state council shall supply to the council twenty printed copies of the state register as soon as it may be after the 1st day of April of each year, and each registrar shall inform the council without delay of all additions to and other amendments in the state register.

23 The Dentist Act of India and Indian Dental Association

CM Marya

The Act has main objective of regulating standard of dental education, dental profession and dental ethics in the country and also recommend to the government of India to accord permission to start a dental college, start higher education, and to increase seats for students in a dental college.

The Act defined following terms: *Dental hygienist* is described as a person who scales, cleans and polishes teeth or gives instruction in dental hygiene. *Dental mechanic* is a person who makes or repairs denture or dental appliances. Dentistry includes performance of any operation and treatment of disease of jaw or teeth, performance of radiographic work, anesthesia, artificial denture, etc. *Dentist* is the person who practices dentistry.

The Act authorizes the council to give recognition to any degree or diploma in dentistry obtained from India or from foreign countries. Council registers dental hygienist and dental mechanics who have completed prescribed period of training and education. For registration of dental hygienists, mechanists, and dentists, the registers are maintained. The Council appoints an inspector who may inspect any dental college and submit a report which may lead to action and even cancellation of registration of college.

The Act authorizes state governments to constitute state level councils for the fulfillment of the object. False registration or misuse of title during practice is taken as crime and punishable. Name can be removed from the register in case of suppression of fact, or for infamous conduct, or for false registration. Commission of inquiry can be held by 3 persons appointed by central government including one judge from the high court. Punishment may be fine up to Rs 500 to Rs 1000 or imprisonment up to 6 months or both.

THE DENTISTS ACT (29TH MARCH, 1948)

Act's Objective

An Act to regulate the profession of dentistry. Whereas it is expedient to make provision for the regulation of the profession of dentistry and for that purpose to constitute dental councils.

INTRODUCTION

1. a. This Act is called the Dentists Act, 1948.
b. It extends to the whole of India

2. *Interpretation:* In this Act, unless there is anything repugnant in the subject or context:

a. "The council" means the Dental Council of India constituted under Section 3;
b. "Dental hygienist" means a person not being a dentist or a medical practitioner, who scales, cleans or polishes teeth, or gives instruction in dental hygiene;
c. "Dental mechanic" means a person who makes or repairs denture and dental appliances;
d. "Dentistry" includes—
   i. The performance of any operation on, and the treatment of any disease, deficiency or lesion of human teeth or jaws, and the performance of radiographic work in connection with human teeth or jaws or the oral cavity;
   ii. The giving of any anesthetic in connection with any such operation or treatment;
   iii. The mechanical construction or the renewal of artificial dentures or restorative dental appliances;
   iv. The performance of any operation on, or the giving of any treatment, advice or attendance to, any person preparatory to, or for the purpose of, or in connection with, the fitting, inserting, fixing, constructing, repairing or renewing of artificial dentures or restorative dental appliances, and the performance of any such operation and the giving of any such treatment, advice or attendance, as is usually performed or given by dentists;
e. "Dentist" means a person who practises dentistry.
f. "Medical practitioner" means a person who holds a qualification granted by an authority specified or notified under Section of the Indian Medical Degrees Act, 1916 (7 of 1916), or specified in the Schedules to the 1[Indian Medical Council Act, 1956 (102 of 1956)], 2(or specified in any other law for the time being in

force in any state), or who practises any system of medicine and is registered or is entitled to be registered in any state medical register by whatever name called;

g. "prescribed" means prescribed by rules or regulations made under this Act;

h. "State Council" means a State Dental Council constituted under Section 21, and includes a Joint State Council constituted in accordance with an agreement under Section 22;

i. "Register" means a register maintained under this Act;

j. "Recognized dental qualification" means any of the qualifications included in the Schedule;

k. "Recognized dental hygiene qualification" means a qualification recognized by the council under Section 11

l. "Registered dentist", "registered dental hygienist" and "registered dental mechanic" shall mean, respectively, a person whose name is for the time being registered in a register of dentists, a register of dental hygienists and a register of dental mechanics.

THE DENTISTS (AMENDMENT) ACT, 1993 [2ND APRIL, 1993]

An Act further to amend the Dentists Act, 1948. But it is enacted by parliament in the Forty-fourth Year of the Republic of India as follows:

1. a. This Act may be called the Dentists (Amendment) Act, 1993.
   b. It shall be deemed to have come into force on the 27th of August, 1992.
2. After Section 10 of the Dentists Act, 1948 (hereafter, referred to as the Principal Act), the following sections shall be inserted, namely:

10A. 1. Notwithstanding anything contained in this Act or any other law for the time being in force:
   a. No person shall establish an authority or institution for a course of study or training (including a postgraduate course of study or training) which would enable a student of such course or training to qualify himself for the grant of recognized dental qualification; or
   b. No authority or institution conducting a course of study or training (including a postgraduate course of study or training) for grant of recognized dental qualification shall—
      i. Open a new or higher course of study or training (including a postgraduate course of study or training) which would enable a student of such course or training to qualify himself or the award of any recognized dental qualification; or
      ii. Increase its admission capacity in any course of study or training (including a postgraduate course of study or training).

   Except with the previous permission of the central government obtained in accordance with the provisions of this Section.

   Explanation 1: For the purposes of this Section "person" includes any university or a trust but does not include the central government.

   Explanation 2: For the purposes of this Section "admission capacity", in relation to any course of study or training (including a postgraduate course of study or training) in an authority or institution granting recognized dental qualification, means the maximum number of students that may be fixed by the council from time to time for being admitted to such course or training.

2. a. Every person, authority or institution granting recognized dental qualification shall, for the purpose of obtaining permission under subsection (1) submit to the central government a scheme in accordance with the provisions of clause (2) and the central government shall refer the said scheme to the council for its recommendations.
   b. The scheme referred to in clause (a) shall be in such form and contain such particulars and be preferred in such manner and be accompanied with such fee as may be prescribed.
3. On receipt of a scheme by the council under sub-section (2), the Council may obtain other such particulars as may be considered necessary by it from the person, authority or institution concerned, granting recognized dental qualification and thereafter, it may:
   a. If the scheme is defective and does not contain any necessary particulars, give a reasonable opportunity to the person, authority or institution concerned for making a written representation and it shall be open to such person, authority or institution concerned for making a written representation and to rectify the defects, if any, specified by the council;
   b. Consider the scheme, having regard to the factors referred to in subsection (7), and submit the scheme together with its recommendation thereon, to the central government.
4. The central government may, after considering the scheme and the recommendations of the council under sub-section (3) and after obtaining, where necessary, such other particulars as may be considered necessary by it from the person, authority or institution concerned, and having regard to the factors referred to in sub-section (7), either approve (with such conditions, if any, as it may consider necessary) or disapprove the scheme and any such approval shall be a permission under sub-section (1):

   Provided that no scheme shall be disapproved by the central government except after giving the person,

authority or institution concerned granting recognized dental qualification a reasonable opportunity of being heard:

Provided further that nothing in this sub-section shall prevent any person, authority or institution whose scheme has not been approved to submit a fresh scheme and the provisions of this section shall apply to such scheme, as if such scheme has been submitted for the first time under subsection (2).

5. Where within a period of one year from the date of submission of the scheme to the central government under subsection (2), no order passed by the central government has been communicated to the person, authority or institution submitting the scheme, such scheme shall be deemed to have been approved by the central government in the form in which it had been submitted, and, accordingly, the permission of the central government required under subsection (1) shall also be deemed to have been granted.
6. In computing the time-limit specified in sub-section (5), the time taken by the person, authority or institution concerned submitting the scheme in furnishing any particulars, called for by the council or by the central government, shall be excluded.
7. The council, while making its recommendations under clause (b) of subsection (3) and the central government, while passing an order either approving or disapproving the scheme under subsection (4), shall have due regard to the following factors, namely:
   a. Whether the proposed authority or institution for grant of recognized dental qualification or the existing authority or institution seeking to open a new or higher course of study or training, would be in a position to offer the minimum standards of dental education in conformity with the requirements referred to in Section 16A and the regulations made under subsection (1) of section 20;
   b. Whether the person seeking to establish an authority or institution or the existing authority or institution seeking to open a new or higher course of study or training or to increase its admission capacity has adequate resources;
   c. Whether necessary facilities in respect of staff, equipment, accommodation, training and other facilities to ensure proper functioning of the authority or institution or conducting the new course of study or training or accommodating the increased admission capacity have been provided or would be provided within the time-limit specified in the scheme;
   d. Whether adequate hospital facilities, having regard to the number of students likely to attend such authority or institution or course of study or training or as a result of the increased admission capacity have been provided or would be provided within the time-limit specified in the scheme;
   e. Whether any arrangement has been made or programme drawn to impart proper training to students likely to attend such authority or institution or course of study or training by persons having the recognized dental qualifications;
   f. The requirement of manpower in the field of practice of dentistry; and
   g. Any other factors as may be prescribed.
8. When the central government passes an order either approving or disapproving a scheme under this section, a copy of the order shall be communicated to the person, authority or institution concerned.

10B. 1. Where any authority or institution is established for grant of recognized dental qualification except with the previous permission of the central government in accordance with the provisions of Section 10A, no dental qualification granted to any student of such authority or institution shall be a recognized dental qualification for the purposes of this Act.

2. Where any authority or institution granting recognized dental qualification opens a new or higher course of study or training including a postgraduate course of study or training except with the previous permission of the central government in accordance with the provisions of Section 10A, no dental qualification granted to any student of such authority or institution on the basis of such study or training shall be a recognized dental qualification for the purposes of this Act.

3. Where any authority or institution granting recognized dental qualification increases its admission capacity in any course of study or training (including a postgraduate course of study or training) except with the previous permission of the central government in accordance with the provisions of Section 10A, no dental qualification granted to any student of such authority or institution on the basis of the increase in its admission capacity shall be a recognized dental qualification for the purposes of this Act.

Explanation: For the purposes of this section, the criteria for identifying a student who has been granted a dental qualification on the basis of such increase in the admission capacity shall be such as may be prescribed.

10C. 1. If, after the 1st day of June, 1992 and on and before the commencement, of the Dentists (Amendment) Act, 1993 any person has established an authority or institution for grant of recognized dental qualification or any authority or institution granting recognized dental qualification has opened a new or higher course of study or training (including a postgraduate

course of study or training) or increased its admission capacity, such person, authority or institution, as the case may be, shall seek, within a period of one year from the commencement of the Dentists (Amendment) Act, 1993, the permission from the central government in accordance with the provisions of Section 10A.

2. If any person, or, as the case may be, any authority or institution granting recognized dental qualification fails to seek the permission under Sub-section (1), the provisions of Section 10B shall apply, so far as may be, as if permission of the central government under Section 10A has been refused.
3. In Section 20 of the Principal Act, in Sub-section (2), after clause (f), the following clauses shall be inserted, namely:
   "(fa) Prescribe the form of the scheme, the particulars to be given in such scheme, the manner in which the scheme is to be preferred and the fee payable with the scheme under clause (b) of Sub-section (2) of Section 10A;
   (fb) Prescribe any other factors under clause (g) of Sub-section (7) of Section 10A;
   (fc) Prescribe the criteria for identifying a student who has been granted a dental qualification referred to in the expla-nation to Sub-section (3) of Section 10B.
4. 1. The Dentists (Amendment) Ordinance, 1993 is hereby repealed.
   2. Notwithstanding such repeal, anything done or any action taken under the Principal Act, as amended by the said Ordinance, shall be deemed to have been done or taken under the Principal Act, as amended by this Act.

INDIAN DENTAL ASSOCIATION (IDA)

Indian Dental Association was formed in 1946 and was registered in Delhi in 1967 before which it was called as All India Dental Association. The All India Dental Association became IDA in 1946. For the past 60 years, the IDA has been the leading authority in the Indian oral health sector. We have innovated ways to communicate with the public and the government. The IDA remains unchallenged in its efforts to promote oral health through education, patient awareness and advocacy work across the country.

It has 29 state branches and 250 local branches.

Composition (Fig. 23.1)

- Head office
- State branch
- Local branch
- Section defence forces

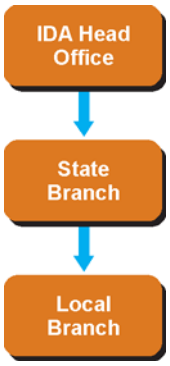


Fig. 23.1: Composition of IDA

The Indian Dental Association is comprised of the head office, i.e. the main office of the association, the state branches at the state level, the local branches at the district level and defence branch comprising of the dental professionals in the defence forces in the country.

Official Relations

- World Health Organization (WHO)
- World Dental Federation (FDI)
- Commonwealth Dental Association (CDA)
- Asian Pacific Dental Federation (APDF)

OBJECTIVES OF IDA

1. To be actively involved in and to help in the promotion, encouragement and advancement of the dental and allied sciences.
2. To encourage IDA members to undertake measures for the improvement of public oral health and dental education in India.
3. To maintain the dignity and honour of the dental profession.
4. To protect the rights and interests of the members of the association.
5. To foster friendship, cooperation and coexistence amongst the members of the association and to implement well formulated schemes for the social security of members of the association.

For the attainment of the objectives the association is involved in the following activities:

a. Hold periodical meetings and conferences for the members of the association and for the dental profession in general.
b. Publish and circulate journals/newsletters which shall be the official voice of the association, being specially adapted to the needs of the dental profession in India and which shall undertake publicity and propaganda work of the association through its columns.
c. Maintain an Association office or offices as herein afterwards provided.

d. Encourage the opening of libraries in head office, state and local branches and procure other relevant materials, books, etc. out of the funds of the association or from donations it receives.
e. Publish from time-to-time papers embodying dental research, conducted by members independently or under the auspices of the association.
f. Encourage research and continuing dental education in the dental and allied sciences, with grants from the funds of the association, by establishment of the scholarships, prizes or awards, in such a manner as may from time-to-time be determined by the association. Maintain contact with national and international associations having similar objectives.
g. Conduct an educational campaign amongst the masses of India on the matter of oral hygiene by cooperating with different public bodies working with similar objectives.
h. Consider and express views on all questions pertaining to the Indian legislation affecting public health, dental profession, and dental education and take such steps from time to time regarding the same, as shall be deemed expedient and necessary.
i. Grant the "IDA Seal of Acceptance" to oral health products, dental instruments, equipment and material with regard to their safety, efficacy and quality, in the interest of the dental profession and the public. This authority is vested with the central council [CC] only.
j. Represent the interest of the dental fraternity, to plead for and to protect its rights, to secure all benefits for its members, to defend their rights and also to liaison with central goverment/state government and various appropriate bodies.
k. Do all such things as are cognate to the objectives of the association or are incidental or conducive to the attainment of the above objectives.
l. Safeguard the professional interest and social security of the individual members as a consumer.
m. Cooperate with other speciality societies and associations having similar objectives.
n. Start and run charitable dental clinics by itself or by cooperating with other charity organizations or government/semigovernment bodies.

TYPES OF MEMBERSHIP

Honorary Members

A person with bright scholastic career and with valuable service record towards the society has been nominated by the Central Council of IDA.

Life Members

Life membership can be achieved through a lifetime registration.

Annual Members

Annual membership can be achieved through yearly registration.

Student Members

An undergraduate from institutions recognized by the Dental Council of India (DCI).

Affiliate Members

Any overseas dental professional.

Defence Section

Members of the Dental Corps, either as an Annual or a Life member. They will be counted as Defence Section and come under the IDA head office. On retirement, they have the option to join either a state or local branch.

HEAD OFFICE

The registered head office [HO] is the main office of the association, having its jurisdiction within the territory of the Republic of India. It overseas all the state branches, local branches and the section of defence forces. It is situated at a place where honorary secretary general resides or practices.

Management of Central Council

The general management of the head office, as a whole, is vested with the central council.

COMPOSITION

Post	*Number*	*Office term*
1. President	1	1
2. President Elect	1	1
3. Vice-Presidents	3	1
4. Honorary Secretary General	1	5
5. Honorary Joint Secretary	1	5
6. Honorary Assistant Secretary	1	5
7. Honorary Treasurer	1	5
8. Editor of the Journal	1	5
9. Chairman of Council of Dental Health	1	2
10. Chairman of Continuing Dental Education Wing	1	2
11. Chairman of Council on Defence	1	2
12. Immediate Past President	–	1
13. Representatives to Central Council from the State Branches	–	1

Functions and Powers

The central council shall direct and regulate the general affairs of the association, and its decision in all matters shall be final and binding, on matters of state/local branches/section defence forces and individual members.

It shall have the following powers:

1. To conduct business at meetings of the central council.
2. To look after the maintenance and the administration of the association library and other properties.
3. To be responsible for the organization and direction of publications of the association.
4. To frame, alter or repeal rules and byelaws of the association by a simple majority vote in the central council, subject to the approval of the annual general Body Meeting (AGM)/Extraordinary General Body Meeting (EOGM) of the Association.
5. To review, revise and recommend membership fees from time-to-time, subject to approval by the AGM or EOGM.
6. To scrutinize the functioning of Subcommittees, including the working committee, constitution committee, the screening and scrutinizing committee and other committees, appointed by the president, in consultation with the honorary secretary general (HSG).
7. To appoint any other subcommittees it considers necessary, subject to the approval of the president.
8. To represent to the government, public bodies, or any constituent authority, any matter in which the interest of the association or the dental profession are involved.
9. To consider and take decisions on applications for direct membership and resignation.
10. To take disciplinary action on the removal of any members for want of qualification.
11. To take necessary disciplinary action against any member or branch.
12. To write off the whole or part of the arrears, or any other outstanding sums, against any individual member or a branch, if considered desirable.
13. To delegate all or some of its powers (apart from the power of altering rules and byelaws), to a working committee, if and when appointed.
14. To appoint or remove salaried employees of the head office of the association.
15. To exercise, in addition to the powers by the rules expressly conferred on it, all such powers and execute all such acts and things as may be done by the association and which are not hereby or by legislative enactment expressly directed or required to be exercised or done by the association in the AGM/EOGM meeting.
16. To purchase, take on lease, sell, mortgage, or otherwise buy or dispose of immovable properties of every description, in particular any land, building, etc. and to form a trust as per goverment regulations for which 2/3 rd majority of central council is required.
17. To purchase, manage, lend and exchange movable properties or rent any accommodation when deemed necessary in the interest of the association.
18. To buy utensils, books, newspapers, periodicals, instruments, fittings, appliances, apparatus, etc. when deemed necessary, in the interest of the association.
19. To erect, maintain, improve or alter and keep in repair any building for utilization of the association.
20. To borrow or raise money in such a manner as the association may think fit and collect subscriptions and donations for the purposes of the association.
21. To invest any funds of the association, not immediately required for any of its objectives, in such a manner as may from time-to-time be determined by the central council.
22. To assist, subscribe to cooperate, affiliate, or amalgamate with any other public body, having objectives partially or completely similar to the association, whether that body is registered or incorporated or not.
23. To approve or derecognize the state/local branches if necessary.
24. To declare or null and void elections, held at the state / local branches, in case of contestant appealing to head office, and questioning the merit of the election, after a detailed enquiry and with a 2/3rd majority amongst the members present.
25. To give a directive to a branch or a member on any issue.
26. To grant the seal of acceptance of the IDA, for oral health products/instruments/dental materials, by 2/3rd majority amongst the members present the power to grant the seal of acceptance is vested only with the central council.
    a. To appoint one conference secretary, in charge of national conferences. The conferences secretary shall be a liaison officer between the central council and the organizing committee and shall be answerable to the central council.
    b. The central council shall be authoritative body for any international conferences held by IDA. The organizing committee, like any other subcommittee, shall work under the guidance of head office.
    c. To approve one chairman; organizing committee, organizing secretary, treasurer, convener; scientific sessions and convener; trade exhibitions for national conferences.
    d. To nominate 10 members of central council to CDH and 10 members to the CDE committee.
    e. If any member does not possess the requisite qualifications to join as a member but has been admitted by any of these, HO/state/local, the central council has the powers to enquire in to the matter and remove the member from the rolls of the association.
    f. To approve the audited balance sheet and propose the budget for the year, before presenting them at the AGM/EOGM.

g. To represent matters pertaining to the Dental Council of India.

STATE BRANCH

Management

Executive Committee (EC)

The general management of the state branch as the whole shall be vested with the EC of the branch, under guidance from HO. No one in receipt of salary or honorarium from the funds of the association can be elected as office bearer of the association.

Composition	*Office term*
1. One President	1
2. One President Elects	1
3. Three Vice-presidents	1
4. One Honorary State Secretary	3
5. One Honorary Joint Secretary	3
6. One Honorary Assistant Secretary	3
7. One Honorary Treasurer	3
8. One Editor of the Journal (optional)	3
9. One Convener CDH	1
10. One Convener CDE	1
11. Immediate Past President	1
12. Members of the EC (without portfolio)	1
13. (The number shall be on the basis of the total strength of the state branch. For every 100 life/annual members or part thereof, there shall be one EC member)	1
14. Representative from state branch to central council HO (it is optional for state branches to decide whether they should be members of the state EC also or not, in addition to their duties as representative of the CC)	1
15. Representative from local branch to state executive	1

Contd...

Functions and Powers

The state branch office will look after all the activities linked to its respective state. It will guide the local branches, which are affiliated to it, in all matters and shall become the medium of communication between local branches and HO.

24 Ethics in Dentistry

CM Marya

The art of dentistry involves the application of dental science and technology to individual patients, families and communities.

Everyday oral health professionals are subject to strict routines and stressful situations which can easily result in decisions or actions that could on reflection seem to be doubtful and maybe even unethical.

What are basic ethical principles in dentistry? They most certainly, coincide with those in medical practice and other health care disciplines which are described as universal ethical principles. Among them are classic ethical principles that are the same since Hippocrates age. During the previous two decades, some new ethical principles have evolved in doctor-patient relationship. Dentist has to be familiar with both classic and modern moral principles, to respect and implement them unequivocally.

Principles of ethics for the dental profession are that "the dentist should act in a manner which will enhance the prestige and reputation of the profession". The principles of ethics are the aspiration goals of the profession. They provide guidance and offer justification for the code of professional conduct and the advisory opinions.

For their significance some of the ethical principles are predominating. These are: avoiding of making any damage to patient; doing well for patient; autonomy of patient; patient's informing. These principles are supplemented by other ethical rules like: altruism, justice, confidentiality, loyalty, truthfulness and other. All noted principles are overlapping in meaning and resulting one from another.

DEFINITION

Ethics is defined as a branch of philosophy that deals with thinking about morality, moral problems and moral judgments.

PRINCIPLES OF ETHICS

The principles of ethics are as follows:

1. Patient autonomy *(self-governance)*
2. Nonmaleficence *(do no harm)*
3. Beneficence *(do good)*
4. Justice *(fairness)*
5. Veracity *(truthfulness)*
6. Fidelity
7. Confidentiality.

Patient Autonomy (Self-governance)

It is based on the principle of respect for persons. Independent actions and choices of an individual should not be constrained by others and they should be respected. The dentist has a duty to respect the patient's rights to self-determination and confidentiality. Professionals have a duty to treat the patient according to the patient's needs, within the limits of accepted treatment, and to protect the patient's confidentiality. The dentist's primary obligations include involving patients in treatment decisions in a meaningful way, with due consideration being given to the patient's needs, desires and abilities, and safeguarding the patient's privacy.

Nonmaleficence (Do No Harm)

The dentist has a duty to refrain from harming the patient.

Professionals have a duty to protect the patient from harm. The dentist's primary obligations include keeping knowledge and skills current, knowing one's own limitations and when to refer to a specialist or other professional, and knowing when and under what circumstances delegation of patient care to auxiliaries is appropriate.

Education

Dental professionals should make sure that they keep their knowledge, skills current and professional performance under review. Dental professionals should make themselves aware of the best practices in the field that they work and provide a good standard of care based on available contemporary evidence and authoritative guidance. They should also make themselves aware of laws and regulations, which affect their work, premises, equipment and businesses, and comply with them.

Consultation and Referral

Dentists shall be obliged to seek consultation, if possible, whenever the welfare of patients will be safeguarded or advanced by utilizing those who have special skills, knowledge, and experience. When patients visit or are referred to specialists or consulting dentists for consultation:

1. The specialists or consulting dentists upon completion of their care shall return the patient, unless the patient expressly reveals a different preference, to the referring dentist, or, if none, to the dentist of record for future care.
2. The specialists shall be obliged when there is no referring dentist and upon a completion of their treatment to inform patients when there is a need for further dental care.

Second Opinions

A dentist who has a patient referred by a third party for a "second opinion" regarding a diagnosis or treatment plan recommended by the patient's treating dentist should render the requested second opinion in accordance with this Code of Ethics. In the interest of the patient being afforded quality care, the dentist rendering the second opinion should not have a vested interest in the ensuing recommendation.

Ability to Practice

A dentist who contracts any disease or becomes impaired in any way that might endanger patients or dental staff shall, with consultation and advice from a qualified physician or other authority, limit the activities of practice to those areas that do not endanger patients or dental staff. A dentist who has been advised to limit the activities of his or her practice should monitor the aforementioned disease or impairment and make additional limitations to the activities of the dentist's practice, as indicated.

Postexposure, Blood Borne Pathogens

All dentists, regardless of their blood borne pathogen status, have an ethical obligation to immediately inform any patient who may have been exposed to blood or other potentially infectious material in the dental office of the need for postexposure evaluation and follow-up and to immediately refer the patient to a qualified health care practitioner who can provide postexposure services. The dentist's ethical obligation in the event of an exposure incident extends to providing information concerning the dentist's own blood borne pathogen status to the evaluating health care practitioner, if the dentist is the source individual, and to submitting to testing that will assist in the evaluation of the patient. If a staff member or other third person is the source individual, the dentist should encourage that person to cooperate as needed for the patient's evaluation.

Patient Abandonment

Once a dentist has undertaken a course of treatment, the dentist should not discontinue that treatment without giving the patient adequate notice and the opportunity to obtain the services of another dentist. Care should be taken that the patient's oral health is not jeopardized in the process.

Personal Relationships with Patients

Dentists should avoid interpersonal relationships that could impair their professional judgment or risk the possibility of exploiting the confidence placed in them by a patient.

Beneficence (Do Good)

The dentist has a duty to promote the patient's welfare.
This principle expresses the concept that professionals have a duty to act for the benefit of others and the dentist's primary obligation is service to the patient and the public-at-large. The most important aspect of this obligation is the competent and timely delivery of dental care within the bounds of clinical circumstances presented by the patient, with due consideration being given to the needs, desires and values of the patient.

Community Service

Since dentists have an obligation to use their skills, knowledge and experience for the improvement of the dental health of the public and are encouraged to be leaders in their community, dentists in such service shall conduct themselves in such a manner as to maintain or elevate the esteem of the profession.

Justice (Fairness)

The dentist has a duty to treat people fairly. Principle of truthfulness comprises dentist's sincerity toward patients, truth telling, never deceiving. This principle expresses the concept that professionals have a duty to be fair in their dealings with patients, colleagues and society and the dentist's primary obligations include dealing with people justly and delivering dental care without prejudice.

Accepting the principle of justice in contemporary ethics is reflected in right to be treated. This right consists of three issues:

1. To be honest with patients
2. To give patients what they deserve
3. To give patients what they have right on.

Patient Selection

While dentists, in serving the public, may exercise reasonable discretion in selecting patients for their practices, dentists shall not refuse to accept patients into their practice or deny dental service to patients because of the patient's race, creed, color, sex or national origin.

Veracity (Truthfulness)

The dentist has a duty to communicate truthfully.

This principle expresses the concept that professionals have a duty to be honest and trustworthy in their dealings with people and the dentist's primary obligations include respecting the position of trust inherent in the dentist-patient relationship, communicating truthfully and without deception, and maintaining intellectual integrity.

Fidelity

It is the obligation to keep implied or explicit promises.

Confidentiality

Dental professionals have a legal and ethical duty to keep patient information confidential. Principle of confidentiality means that a dentist must be discrete. Confidentiality comprises preservation of all information concerning patient, his/her diseases and treatment.

Significance of confidentiality is in feeling of confidence a patient has, in belief that his/her doctor is "silent" despite everything heard or seen.

It is the responsibility of dental professionals to treat any information about patients as confidential and only use it in the context in which it was given. Confidential information should be kept in a secure place at all times to prevent unauthorized or accidental disclosure.

CODE OF ETHICS FOR DENTISTS BY DENTAL COUNCIL OF INDIA

These regulations may be called the Dentists (Code of Ethics) Regulations, 1976. 'Act' means the Dentists Act, 1948 (16 of 1948).

Declaration

Every dentist who has been registered (either on Part A or Part B of the state dentists register) shall, within a period of thirty days from the date of commencement of these regulations, and every dentists who gets himself registered after the commencement of these regulations shall, within a period of thirty days from such registration, make, before the registrar of the State Dental Council a declaration in the form set out for the purpose in the Schedule to these regulations and shall agree to abide by the same.

DUTIES AND OBLIGATION OF DENTISTS TOWARDS PATIENTS AND PUBLIC

Every dentist shall:

A. Be mindful of the high character of his mission and the responsibilities be holds in the discharge of his professional duties and shall always remember that care of the patient and treatment of the disease depends upon the skill and prompt attention shown by him and always remembering that his personal reputation, professional ability and fidelity remain his best recommendations.
B. Treat the welfare of the patients as paramount to all other considerations and shall conserve it to the utmost of his ability.
C. Be courteous, sympathetic, friendly and helpful to, and always ready to respond to, the call of his patients, and that under all conditions his behavior towards his patients and the public shall be polite and dignified.
D. Observe punctuality in fulfilling his appointment.
E. Deem it a point of honour to adhere with as much uniformity as the varying circumstances may admit, to the remuneration for professional services.
F. Not permit consideration of religion, nationality, race, caste and creed, party politics or social standing to intervene in his duties toward his patients.
G. Keep all the information of a personal nature which he comes to know about a patient directly or indirectly in the course of professional practice in utmost confidence; and be mindful that the auxiliary staff, viz. dental hygienists and dental mechanics and other staff employed by him also observe this rule for the reason that knowledge or information of a patient gained during the course of examination and treatment is privileged, and a dentist is not bound to disclose professional secrets, except with the consent of the patient, or on being ordered to do so by a court of law.

DUTIES OF ONE DENTIST TOWARDS ANOTHER

Every dentist shall:

A. Cherish a proper pride in his colleagues and shall not disparage them either by actions, deeds or words.
B. On no account contemplate or do anything harmful to the interest of the members of the fraternity.
C. Honor mutual arrangements made regarding remuneration, etc. when one dentist is entrusted with the care of a patient of another dentist during the latter's sickness or absence.
D. Retire in favor of the regular dentist after the emergency is over, when a dentist called upon in any emergency to treat the patient of another dentist.

   Note: He shall be entitled to charge the patient for his services.
E. Institute correct treatment at once, with the least comment, and in a manner that will avoid any reflection on such other dentist if a dentist is consulted by a patient of another dentist, and if the later finds indisputable evidence that such a patient is suffering from previous faulty treatment.
F. Regard it as a pleasure and privilege to render gratuitous service to another dentist, his wife and family members,

although there is no legal bar to a dentist from charging another dentist for professional service.

UNETHICAL PRACTICES

The following shall be the unethical practices for a dentist, namely:

1. Employment of a dentist in his professional practice of any professional assistant (not being a registered dental hygienist or a registered dental mechanic) whose name is not registered in the State Dentists Register, to practice dentistry as defined in clause (d) of Section 2 of the Act.
2. Styling by any dentist or a group of dentists his/their 'dental clinic' or chamber/s by the name of "dental hospital/s.
3. Any contravention of the Drugs and Cosmetics Act, 1940 (23 of 1940, and the rules made there under as amended from time to time, involving an abuse of privileges conferred there under upon a dentist, whether such contravention has been the subject of criminal proceedings or not.
4. Signing under his name and authority any certificate which is untrue, misleading or improper, or giving false certificates or testimonials directly or indirectly concerning the supposed virtues of secret therapeutic agents or medicines.
5. Immorality involving abuse of professional relationship.
6. Conniving at or aiding in any kind of illegal practice.
7. Promise of radical cure by the employment of secret methods of treatments.
8. Advertising, whether directly or indirectly, for the purpose of obtaining patients or promoting his own professional advantage.
9. Acquiescing in the publication of notice commending or directing attention to the practitioner's skills, knowledge, service or qualifications, or of being associated with or employed by those who procure or sanction such advertising or publication through press reports.
10. Employing any agent or canvasser for the purpose of obtaining patients; or being associated with or employed by those who procure or sanction such employment.
11. Using or exhibition of any sign, other than a sign which in its character, position, size and wording is merely such as may reasonably be required to indicate to persons seeking them the exact location of, and entrance to, the premises at which the dental practice is carried on.
12. Using of sign-board larger than 0.9 meter by 0.6 meter and the use of such words as 'Teeth', 'Painless Extraction' or the like, or notices in regard to practice on premises other than those in which a practice is actually carried on, or show cases, or flickering light signs and the use of any sign showing any matter other than his name and qualifications as defined under clause (j) of Section 2 of the Act.
13. Affixing a sign-board on a chemist's shop or in places where the dentist does not reside or work.
14. Insertion of any paragraphs and notice in the press and also the announcement of names in the trading lists and the display of their names or announcements at places of public entertainments; other than the change of his address.
15. Allowing the dentist's name to be used to designate commercial articles such as toothpaste, toothbrush, toothpowder, liquid cleaners, or the like or on circulars for such items, or permitting publication of his opinion on any such items, in the general or lay papers or lay journals.
16. Mentioning after the dentist's name any other abbreviations except those indicating dental qualifications as earned by him during his academic career in dentistry and which conform to the definition of 'recognized dental qualification' as defined in clause of Section 2 of the Act, or any other recognized academic qualifications.
17. Using of abbreviations like (i) RDP for Registered Dental Practitioner, (ii) MIDA for Member of Indian Dental Association,(iii) FICD for Fellow of International College of Dentists, (iv) MICD for Master of International College of Dentists, (v) FACD for Fellow or American College of Dentists, (vi) MRSH for member of Royal Society of Hygiene, etc. and the like, which are not academic qualifications.

A dentist may issue a formal announcement in the Press, one insertion per paper, regarding the following, namely:

a. On starting practice
b. On change of type of practice
c. On changing address
d. On temporary absence from duty
e. On resumption to practice
f. On succeeding to another practice.

Action for Unethical Conduct

When complaint or information is received by the state dental council that any dentist is resorting to any unethical practice, or is committing a breach of any other of these regulations, the concerned state dental council may call upon him to explain and after giving him a reasonable opportunity of being heard and after making such enquiries, if any, as it may deem fit, decide whether such a practice tantamount to infamous conduct in any professional respect of contravenes any of the provisions of any other of these regulations, and then determine the action to be taken against the dentist under Section 44 of the Act.

GENERAL PRINCIPLES FOR A DENTAL PROFESSIONAL ETHICAL CODE IN THE COUNTRIES OF THE EU [EUROPEAN UNION]

Adopted in Helsinki, May 2002

To safeguard the health of the public and (in that sense) the protection of the consumers and at the same time to guide the EU member associations in their effort to describe a code of

ethics for the dental profession, the EU Dental Liaison Committee has adopted the following code of ethics.

The following four areas of ethics represent the basic ethical requirement and should, therefore, be compiled within the code of ethics of each national dental association:

Dentist-Patient Relationship

A Dentist

- Must safeguard the health of patients irrespective of their individual status.
- Must not prescribe or provide treatment which is not necessary.
- Has the freedom of choice whether to accept or decline to treat a patient, except for the provision of emergency care, for humanitarian reasons.
- Must obtain appropriate agreement or consent from the patient for the treatment which is to be carried out. To this end, information must be provided about the proposed treatment, other treatment options and relevant material risks. The patient must have the opportunity to ask questions. The patient should also be informed of the cost of the proposed treatment, as soon as this is known.
- Must ensure professional confidentiality and the security of personal health information. Accurate, detailed and relevant medicodental records must be kept and the dental staff must be aware of the need for confidentiality. Data must be obtained and processed fairly, for specified, explicit and legitimate purposes and according to data protection principles.
- Must keep all data relating to patients confidential and secure. Where data is stored electronically special security precautions must be taken to prevent access from outside the premises during electronic transfer procedures or remote maintenance of the system.
- May not transmit data on patients to third parties except when it is justified by the written consent of the patient or where it is required under statutory provision. All data passed on to third parties should be recorded as such.
- Must accept responsibility for the treatment he undertakes, within the framework of an undertaking to make best efforts.
- Must refer for advice and/or treatment any patient requiring a level of competence beyond his or her own. He is obliged to refer a patient to a professional colleague for a second opinion, if that is requested by the patient himself.
- Must provide to a patient, or his properly appointed representative, information which is correct and does not mislead.
- Must respond to patient complaints and try to resolve the issue.

Conduct of the Dentist Towards the Public

A Dentist

- Must act in a manner which will enhance the prestige and reputation of the profession.
- Must ensure not to mislead the public in respect of the scope of entitlement to care or limitation of insurance coverage.
- Must not either mislead the public or impugn the professional reputation or integrity of colleagues.
- May provide an information service but this must comply with the professional rules regarding, in particular, the independence, dignity and honour of the profession, professional secrecy and fairness towards the public and other members of the profession.
- Must comply with national legislation and any resulting national ethical code, in relation to e-commerce in his country of establishment, for the provision of information society services.
- May provide unsolicited commercial communication to the public where this is permitted under national legislation. When such communications are permitted dentists must regularly consult and respect opt-out registers in which persons not wishing to receive such communications can register themselves.
- Who is established in a member state where advertising of services is permitted must ensure that any such information is legal, decent and truthful and has regard for professional propriety.

Attitude of Dentists to Professional Colleagues

A Dentist

- Must behave towards all members of the oral health team in a professional manner and should be willing to assist colleagues professionally and maintain respect for divergence of professional opinion.
- Providing any service must not compare his skills or qualifications with the skills and qualifications of other dentists, when a description of care is given.

The Practice of the Profession

A Dentist

- Must practise his mission to promote the health of the individual, and of the public in general, in respect of life and humanity. He must practice his profession according to the acquired facts of science.
- Has to care, with the same awareness, for each of his patients, whatever notably their origin, their morals and family situation, their belonging of or to any ethnic group, nation or determined religion, their handicap or state of health, their reputation or any personal feelings in respect to them.
- Must not abandon the care of his patients, except where the dentist has presented to the patient all the necessary information regarding treatment, has ensured that assistance by another professional is available and has promptly informed the decision to the patient.
- Must take responsibility for the competence and the conduct of his/her staff and must utilize dental auxiliaries strictly according to the law.

- Must continue to develop professional knowledge and skills throughout his professional life so that, the quality of care for his patients will be maintained by such means.
- Must comply with national ethical custom governing the practice of the profession, the use of titles, the establishment, extension or purchase of a dental practice.
- Must not employ or work with an individual whom he knows or suspects to be practising illegally.
- Must at all times avoid false certification, misleading statements, professional misconduct or abuse of normal professional relationships.
- Is obliged to uphold the fundamental rights of dental practice, which includes the freedom to prescribe and treat.
- Must not abrogate the principle of free choice of practitioner by the patient. Whatever the contractual obligations into which the dentist enters, he may not abrogate his professional independence and responsibility to his patient.
- Involved in the treatment of patients must be adequately insured or indemnified against claims for accidents or malpractice
- Must not pay a financial incentive or other form of commission to a third party or organization in return for encouraging or promoting the uptake of dental care by individual members of the public. He should not accept any financial inducement from a third party to recommend any particular dental scheme.

3 Section

Preventive Dentistry

25 Dental Plaque

CM Marya

Dental plaque (also called as microbial plaque, dental plaque biofilm) is a dense, nonmineralized, highly organized complex mass of bacterial colonies in a gel-like intermicrobial matrix. The matrix protects the bacteria from the defensive cells of the body (neutrophils, macrophages, and lymphocytes). It adheres firmly to the acquired pellicle and also to the teeth, calculus, and restorations.

Acquired pellicle is an amorphous layer that forms over exposed tooth surfaces, as well as over restorations and dental calculus. It begins to form within minutes after all external material has been removed from the tooth surfaces with an abrasive. It is composed primarily of glycoproteins from the saliva that are selectively adsorbed by the hydroxyapatite of the tooth surface. Although, pellicle performs a protective function, acting as a barrier to the acids, it also serves the initial site of attachment to the bacteria and begins the first stage of biofilm development.

A biofilm community comprises bacterial microcolonies, an extracellular slime layer, fluid channels, and a primitive communication system. As the bacteria attach to a surface and to each other, they cluster together to form sessile, mushroom-shaped microcolonies that are attached to the surface at a narrow base (Fig. 25.1).

Each microcolony is a tiny, independent community containing thousands of compatible bacteria. Different microcolonies may contain different combinations of bacterial species. Bacteria in the center of a microcolony may live in a strict anaerobic environment, while other bacteria at the edges of the fluid channels may live in an aerobic environment. Thus, the biofilm structure provides a range of customized living environments (with differing pHs, nutrient availability, and oxygen concentrations) within which bacteria with different physiological needs can survive. The extracellular slime layer is a protective barrier that surrounds the mushroom shaped bacterial microcolonies (Fig. 25.2). The slime layer protects the bacterial microcolonies from antibiotics, antimicrobials, and host defense mechanisms. A series of fluid channels penetrates the extracellular slime layer. These fluid channels provide nutrients and oxygen for the bacterial microcolonies and facilitate movement of bacterial metabolites, waste products, and enzymes within the biofilm structure. Each bacterial microcolony uses chemical signals to create a primitive communication system used to communicate with other bacterial microcolonies.

Clinically, plaque presents as a transparent film and therefore, difficult to visualize. It can be detected with an explorer by passing the explorer over the tooth surface near the gingival margin to collect plaque, which makes it easier to see. Plaque disclosing solutions that stains the invisible plaque is used for easy detection of plaque. It stains the plaque and makes it visible to the eyes. These solutions disclose the extent and location of the plaque.

FORMATION OF DENTAL PLAQUE BIOFILMS

Dental bacterial plaque is a biofilm that adheres tenaciously to tooth surfaces, restorations, and prosthetic appliances.

The pattern of plaque biofilm development can be divided into three phases [Figs 25.3A to C]:

1. Attachment of bacteria to a solid surface; (pellicle formation)

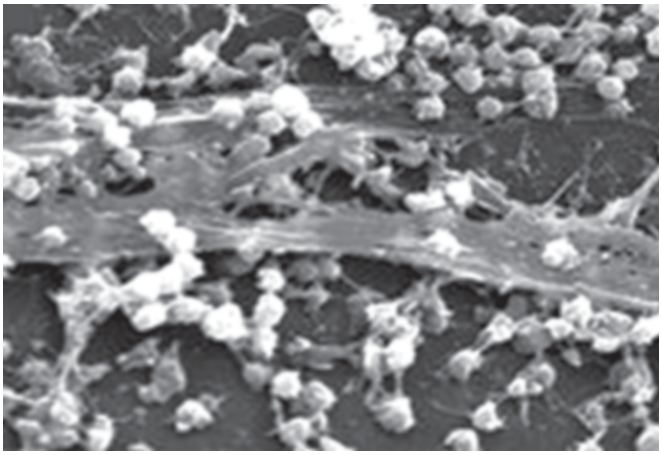


Fig. 25.1: Biofilm (under Electron Microscope)

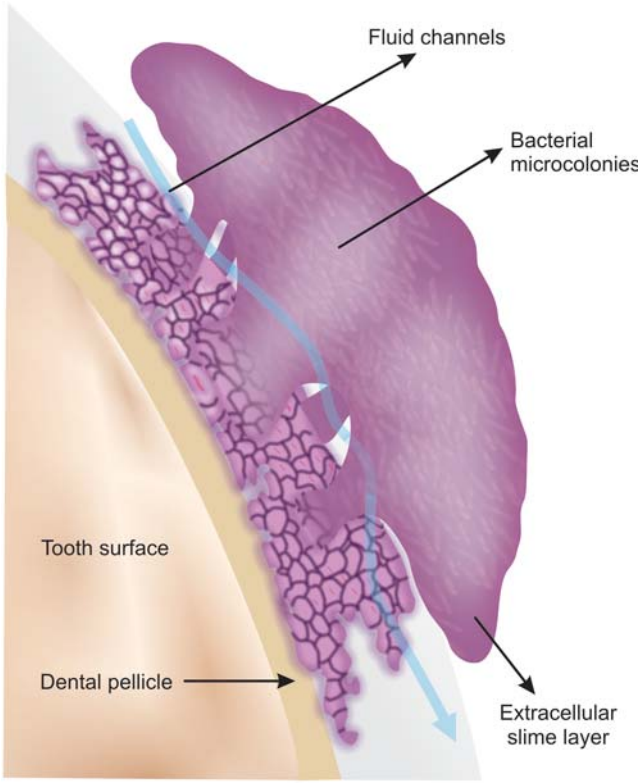


Fig. 25.2: Dental plaque biofilm structure—conceptual illustration

2. Formation of microcolonies on the surface; (initial colonization)
3. Formation of the mature, subgingival plaque biofilm.

Pellicle Formation

The initial attachment of bacteria begins with pellicle formation. The pellicle is a thin coating of salivary proteins that attaches to the tooth surface within minutes after cleaning. This layer is thin, smooth colorless and translucent and is called as acquired salivary pellicle. Initially pellicle is bacteria free. The function of salivary pellicle is mainly protective. Salivary glycoproteins and salivary calcium and phosphate ions are absorbed on to the enamel surface and this process may compensate for tooth loss due to abrasion and erosion. Pellicle also restricts the diffusion of acid products of sugar breakdown. It can bind other inorganic ions such as fluoride which promotes remineralization. The pellicle acts like double-sided adhesive tape, adhering to the tooth surface on one side and on the other side, providing a sticky surface facilitating bacterial attachment to the tooth surface. This layer is thin, smooth colorless and translucent and is called as acquired salivary pellicle. Following pellicle formation, bacteria begin to attach to the outer surface of the pellicle. Accumulation is greatest in sites which are protected from functional friction and tongue movement. The interdental region below the contact area is the site for greatest plaque accumulation.

Bacteria connect to the pellicle and each other with hundreds of hair-like structures called fimbriae. Once they stick, the bacteria begin producing substances that stimulate other free floating bacteria to join the community. Within the first two days in which no further cleaning is undertaken, the tooth's surface is colonized predominantly by gram-positive facultative cocci, which are primarily streptococci species. It appears that the act of attaching to a solid surface stimulates the bacteria to excrete an extracellular slime layer that helps to anchor them to the surface and provides protection for the attached bacteria. Within first few hours species of *Streptococcus* and a little later *Actinomyces* attach to the pellicle and these are the initial colonizers.

Formation of Microcolonies

Microcolony formation begins once the surface of the tooth has been covered with attached bacteria. The biofilm grows primarily through cell division of the adherent bacteria, rather than through the attachment of new bacteria.

Next, the proliferating bacteria begin to grow away from the tooth. Plaque doubling times are rapid in early development and slower in more mature biofilms. Bacterial blooms are periods when specific species or groups of species grow at rapidly accelerated rates. A second wave of bacterial colonizers adheres to bacteria that are already attached to the pellicle. Coaggregation is the ability of new bacterial colonizers to adhere to the previously attached cells. The bacteria cluster together to form sessile, mushroom-shaped microcolonies that are attached to the tooth surface at a narrow base. The result of coaggregation is the formation of a complex array of different bacteria linked to one another. Supragingival plaque formation is also pioneered by bacteria with an ability to form extracellular polysaccharides which allow them to adhere to the tooth and each other and these include *Streptococcus mitior, S. sanguis, Actinomyces viscosus and A. naeslundii* Plaque grows by both internal multiplication and surface deposition. Internal multiplication slows considerably as the plaque matures. The gram-negative cocci such as Neisseria and Veillonella species occupy any remaining interstitial space formed by the bacterial interactions in initial colonization phase.

Maturation

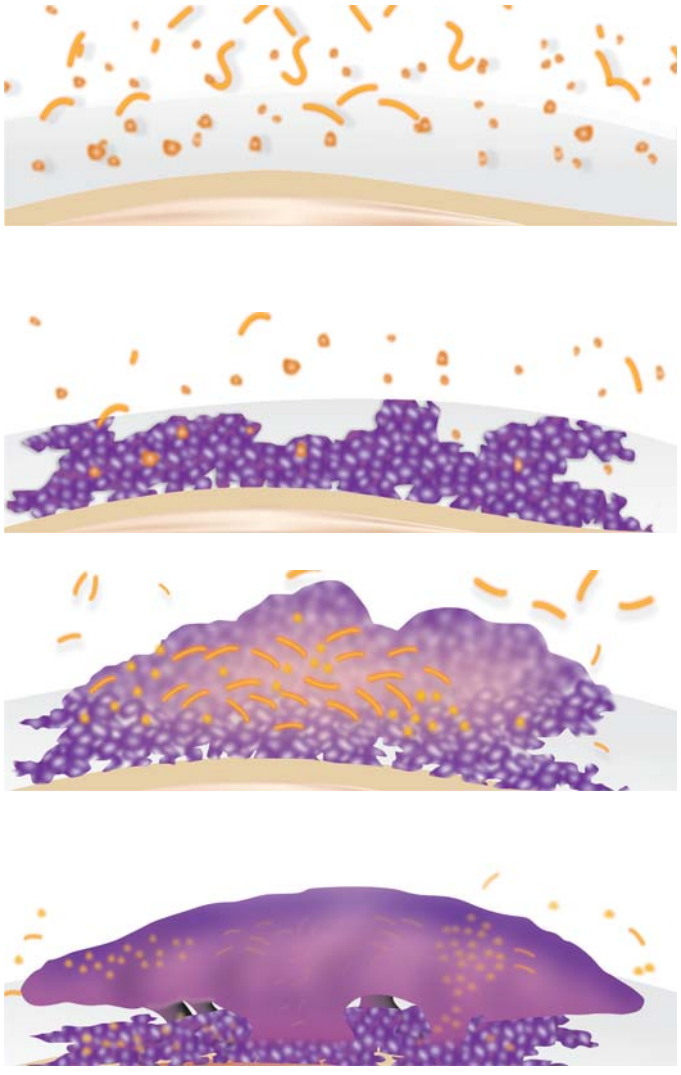
Following a few days of undisturbed plaque formation, the gingival margin becomes inflamed and swollen. These inflammatory changes result in the creation of a deepened gingival sulcus. The biofilm extends into this subgingival region and flourishes in this protected environment, resulting in the formation of a mature subgingival plaque biofilm. Gingival inflammation does not appear until the biofilm changes from one composed largely of gram-positive bacteria to one

containing gram-negative anaerobes. A subgingival bacterial microcolony, predominantly composed of gram-negative anaerobic bacteria, becomes established in the gingival sulcus between 3 and 12 weeks after the beginning of supragingival plaque formation. Most bacterial species currently suspected of being periodontal pathogens are anaerobic, gram-negative bacteria.

Structure and Composition

Dental plaque can be broadly classified as supragingival or subgingival. Supragingival plaque is found at or above the gingival margin and may be in direct contact with the gingival margin. Subgingival plaque is found below the gingival margins, between the tooth and the gingival sulcular tissue.

Approximately 70 to 80 percent of plaque is microbial and the rest represents extracellular matrix. The intracellular matrix which accounts for about 20 percent of plaque mass consists of organic and inorganic materials derived from saliva, gingival crevicular fluid and bacterial products. Organic constituents of the matrix include polysaccharides, proteins, glycoproteins, and lipids. The most common carbohydrate produced by bacteria is dextran. The principal inorganic components are calcium, phosphorus, sodium, potassium, fluoride and some traces of magnesium. Calcium ions may aid adhesion between bacteria and between bacteria and the pellicle. The source of both the organic and inorganic components is primarily saliva and as the mineral content increases, the plaque may be calcified to form calculus.



Figs 25.3A to C: Stages of biofilm: (A) Attachment, (B) Colonization, (C) Mature biofilm

SUPRA AND SUBGINGIVAL PLAQUE

Supragingival Plaque

It can be defined as the community of microorganisms that develops on the tooth surface coronal to the gingival margin (at or above the gingival margin). When it is in direct contact with the gingival margin it is termed as the marginal plaque.

Composition: It typically demonstrates a stratified organization of a multilayered accumulation of bacterial morphocytes. The first cellular material adhering to the pellicle in it consists of the coccoid bacteria with numbers of epithelial cells and polymorphonuclear leukocytes. Gram-positive cocci and short rods predominate at the tooth surface, whereas gram-negative rods and filaments as well as spirochetes, predominate in the outer surface of the mature plaque mass.

The material present between the bacteria in the plaque is called the intermicrobial matrix and accounts for approximately 25 percent of plaque volume.

Fructans (levans) and glucans are the well characterized polysaccharides present in the plaque matrix. Presence of the small amounts of lipids in it is also documented.

Subgingival Plaque

It can be defined as the community of microorganisms that develops on tooth surfaces apical to the gingival margin (found below the gingival margin, between the tooth and the gingival pocket epithelium). Generally, the subgingival microbiota differs in composition from supragingival plaque mainly because of the local availability of blood products and low redox potential which characterizes the anaerobic environment. The apical part of subgingival plaque is predominated by spirochetes, cocci and rods, whereas in the coronal part, more filaments are observed. Between subgingival plaque and the tooth an electron dense organic material is interposed called as cuticle. A characteristic feature of subgingival plaque is the presence of leukocytes interposed between the surface of the bacterial deposit and gingival sulcular epithelium.

Plaque Retention Factors

These are conditions that favor plaque accumulation and hinder plaque removal by the patient and the dental professional. Examples of these are:

- Orthodontic appliances
- Partial dentures
- Malocclusions
- Faulty restorations
- Calculus
- Deep pockets
- Mouth breathing
- Tobacco use
- Certain medications

Table 25.1: Plaque and caries formation

Plaque encourages caries formation by:
1. Enabling bacteria to stick to the teeth.
2. Allowing acids to accumulate around the teeth.
3. Preventing the saliva from reaching the teeth surface, so stopping it from washing them and neutralizing the acid.
4. Providing the cariogenic bacteria with a reserve energy supply, i.e. the polysaccharides which can be used in the absence of sugars.

SIGNIFICANCE OF DENTAL PLAQUE

The role of dental plaque in the initiation of dental caries (Table 25.1) and periodontal infections is now well documented. Dental caries and periodontal disease result from the bacterial products of the plaque flora.

Calculus and its Relationship with Plaque

- Calculus is formed by the deposition of calcium and phosphate salts in bacterial plaque. These salts are present in salivary and crevicular fluids.
- Plaque mineralization begins within 24 to 72 hours and takes an average of 12 days to mature.
- Calculus contributes to the disease by providing foci for plaque accumulation. It is not the causative or etiologic factor, plaque is.
- Calculus is porous and can act as a reservoir or nidus of bacteria and endotoxin related to the disease process.
- Calculus formation has been observed in germ-free laboratory animals but is far more abundant in similar germ-infected laboratory animals. The role of the bacteria in relation to calculus formation is not completely understood.

DENTAL PLAQUE

- Dental plaque is a complex biofilm growing on teeth which is the etiological agent of caries and periodontal disease.
- The movement of saliva around the mouth, mainly as a result of tongue action creates a shear force which limits plaque accumulation to sheltered sites.
- Plaque is initiated by the colonization and subsequent outgrowth of organisms competent to adhere to the tooth pellicle.
- The major "pioneer species" are *Streptococcus oralis*, *Streptococcus mitis* and *Streptococcus sanguis*. Others include *Neisseria* and *Actinomyces*.
- During and following outgrowth, other species colonize the forming biofilm by adhering to the pioneer species. This process of coaggregation can be highly specific.
- As secondary colonization progresses the species diversity of the biofilm increases.
- Eventually, a combination of secondary colonization and cell proliferation, moderated by detachment of organisms from the biofilm by shear force, produces a climax community.
- The climax community is stable and complex yet responsive to changes in the environment.

26 Plaque Control

CM Marya

It is well established that periodontal disease is initiated by bacterial plaque. The organic acids which are the end products of bacterial metabolism of plaque and are in close contact with the tooth surface are responsible for dental caries. Caries is theoretically preventable by regular and careful oral hygiene procedures to remove the plaque. Plaque is the soft, non-mineralized, bacterial deposits which form on the teeth that are not adequately cleaned. It accumulates on the tooth surfaces not exposed to friction from cheeks, lips, tongue and food and its composition varies according to its location. As soon as the plaque is removed from teeth, it immediately begins to build up again. This is so because plaque is composed of salivary residues, bacteria and their end products, all of which are always present in the mouth. Thus, a good plaque control program must be continuous and a daily commitment over a lifetime.

DEFINITION

Plaque control is the removal of microbial plaque and the prevention of its accumulation on the teeth and the adjacent gingival surface.

By far the major part in plaque control must be played by the individual, the responsibility of professional personnel are:

1. To provide information about dental health.
2. To provide information and guidance about the technique of plaque control.
3. To attempt to change the individual's evaluation of dental health (motivate the patient).

GUIDELINES FOR ACCEPTANCE OF CHEMO-THERAPEUTIC PRODUCTS

Council on dental therapeutic guidelines for acceptance of chemotherapeutic products for the control of supragingival dental plaque and gingivitis.

The following should be included in clinical studies of plaque/gingivitis control products:

- Statistically significant reduction of plaque and gingivitis must be demonstrated.
- Characteristics of the study population should represent typical product users.
- Active product should be used in normal regimen and compared with a placebo control or, where applicable, an active control.
- Crossover or parallel designed studies are acceptable.
- Studies should be a minimum of 6 months duration.
- Two studies conducted by independent investigators will be required.
- Microbiological sampling should estimate plaque qualitatively to complement indices that measure plaque quantitatively.
- Plaque and gingivitis scoring and microbiological sampling should be conducted at baseline, at 6 months, and at an intermediate period.
- Microbiological profile should demonstrate that pathogenic or opportunistic microorganisms do not develop over the course of the study.
- The toxicological profile of products should include carcinogenicity and mutagenicity assays in addition to generally recognized tests for drug safety.

APPROACHES IN PLAQUE CONTROL

There are two basic approaches in plaque control.

1. Mechanical:
   - Individual
   - Professional—for subgingival plaque control, e.g. scaling, polishing and root planing.
2. Chemical.

Mechanical Plaque Control

1. Toothbrush
   A. Manual
   B. Electrical
   C. Ionic toothbrushes
   D. Sonic and ultrasonic
2. Interdental oral hygiene aids
   A. Dental floss
   B. Dental floss holder
   C. Toothpicks and toothpick holder

D. Interproximal brushes
E. Single tuft brushes
F. Knitting yarn
G. Gauze strip
H. Pipe cleaner
I. Wedge stimulators

3. Adjunctive aids
A. Irrigation devices (water-pik)
B. Tongue cleaner
C. Dentifrices
D. Mouth rinses (mouthwash)
E. Rubber tip stimulator
F. Denture brush

Chemical Plaque Control

1. Antibiotics
2. Enzymes
3. Phenolic compounds and essential oils
4. Quaternary ammonium compounds
5. Bisguanides
6. Natural products
7. Metal salts
8. Amine alcohols
9. Oxygenating agents
10. Fluorides

Mechanical Plaque Control

1. *Toothbrushes:* Although different cleaning devices have been used in different cultures (toothbrush, chewing stick, etc.) the conventional toothbrush is the instrument most frequently used to remove dental plaque.

The efficacy of brushing with regards to plaque removal depends upon three main factors:

1. The design of the brush.
2. The skill of the individual using the brush.
3. The frequency and duration of use.

If a properly designed brush is used with an effective technique and for a sufficient duration of time, plaque control can be achieved on a long-term basis.

Objectives of Toothbrushing

1. To clean teeth of food, stains and debris.
2. To disturb and remove plaque formation.
3. To stimulate and message the gingival tissue.
4. To apply fluoride dentifrice.
5. Cleaning of tongue.

A. MANUAL TOOTHBRUSHES

History

It is believed that the first brush made of hog's hair was mentioned in the early Chinese literature. By the early nineteenth century, craftsmen in various European countries constructed handles of gold and ivory in which replaceable brush heads could be fitted. The first patent for toothbrush in USA was issued to HN. Wadsworth in the middle of nineteenth century. Nylon came into use in toothbrush construction in 1938. World War II prevented Chinese export of wild boar bristles and synthetic materials were substituted for natural bristles.

IDEAL REQUISITES OF A TOOTHBRUSH

1. Handle size appropriate to user age and dexterity.
2. Head size appropriate to the size of the patient's mouth.
3. Use of end-rounded nylon or polyester filaments not larger than 0.009 inches in diameter.
4. Use of soft bristle configuration as defined by the international industry standards.
5. Bristle pattern which enhances plaque removal in the approximal spaces and along the gum line.
6. Causing minimum damage to soft and hard dental tissue.
7. The brush should be easy to keep and clean.
8. Should be nontoxic.
9. Having a reasonable lifespan.

Parts of a Toothbrush

Total brush length is about 15 to 19 cm (6 to 7.5 inches). The junior brushes for children may be shorter in size.

The Head

It is the working end which consists of tufts of bristles or filaments and the stock where the tufts are secured. The brush head should be small enough to be manipulated effectively everywhere in the mouth. A length of about 2.5 cm for an adult and 1.5 cm for a child is satisfactory (Fig. 26.1). A brush head may be 5-12 tufts in 3-4 rows wide. Tufts may be flat or may vary (rippled, dome, multilevel) as shown in Figure 26.2.

The Handle

It is the part which is grasped in hand during tooth brushing.

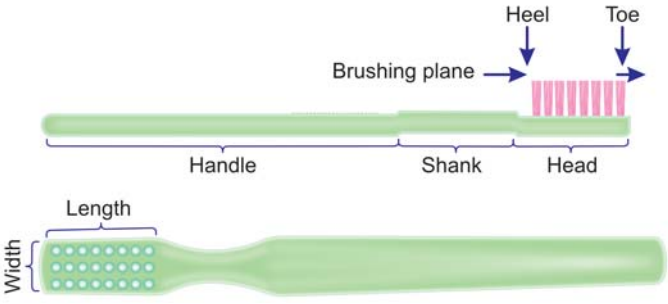


Fig. 26.1: Parts of a toothbrush



Fig. 26.2: Lateral profile of toothbrushes

It is made of a variety of materials such as acrylic and polypropylene. Its flexibility, size and shape must be convenient for manual use in the mouth. The handle must be comfortable and rest securely in the hand. It should be thick enough to allow a firm grip and good control.

Shank

It is the part that connects the head and the handle.

Tufts

Bristles when bunched together are known as tufts.

The Filaments (Bristles)

Nowadays bristles are made of either polyester or nylon. These are polymers with good chemical resistance and are inert so that, they will pass through the body unchanged if swallowed. Nylon is said to wear less rapidly than polyester, and is more hygienic due to its antistatic properties.

The bristles can be classified into three depending upon the diameter of the filaments:

1. Soft 0.15–0.18 mm (0.006″– 0.007″)
2. Medium 0.18–0.23 mm (0.007″– 0.009″)
3. Hard/Extra hard 0.23–0.28 mm (0.009″– 0.11″)

Bristle stiffness also depends upon the length of the filament, its elasticity, whether the brush is used dry or wet and the temperature of the water. Nylon looses approximately 30 percent of its stiffness when wet.

The bristles of children's brushes should always be soft (0.1–0.15 mm). Hard brushes can lacerate the gingival, encourage gingival recession and cause tooth abrasion and their bristle diameter is too large to reach gingival crevice, hence should never be recommended.

Bristles should be of even length so that, they can function simultaneously. Bristles in an adult tooth brush are usually about 10 to 11 mm long. To be as nonabrasive as possible the end of the bristles should be round. The bristles of toothbrushes are usually arranged in about 40 tufts in three or four rows.

B. POWERED TOOTHBRUSHES

They are also called as automatic, mechanical or electric toothbrushes. These were introduced to the market more than 50 years ago. They are now a well accepted part of the home-care regimen. They are potentially faster than manual tooth brushes at cleaning tooth surfaces. In contrast with old electric brushes, using a combination of horizontal and vertical movements, the new ones apply rotary and oscillating-pulsating movements with bristles moving at high frequencies (Figs 26.3A and B). Rotating-oscillating-pulsating toothbrushes have a small round head with stationary tufts that move in a 60-degree counter-rotational motion with approximately 7600 strokes per minute. There are brushes that have three dimensional movements that add a pulsating action of 20,000 to 40,000 movements per minute (Fig. 26.4). Rotating–oscillating and rotating-oscillating-pulsating powered toothbrushes are distinctive in that the brush head is meant to be moved from tooth to tooth instead of using it in manner like a manual toothbrush.

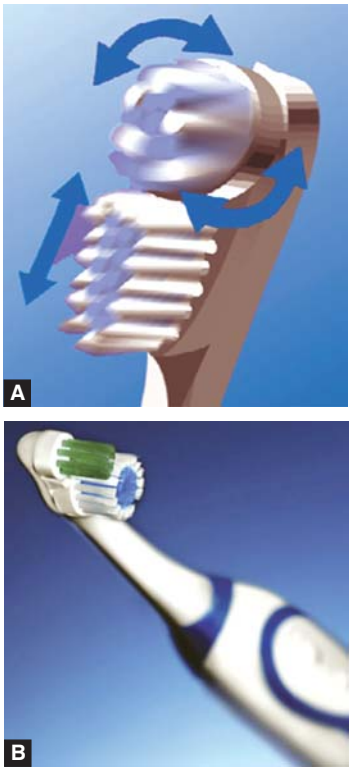


Fig. 26.3: Movement of electric toothbrush

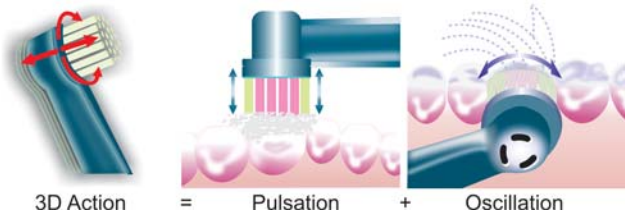


Fig. 26.4: A three dimensional brushing action

TYPES OF POWER TOOTHBRUSHES

The electrical toothbrush designs are categorized by the type of the brush head's shape and movement:

- The first generation of power toothbrushes had a head looking like the one of manual toothbrushes, and moving back and forth to simulate manual brushing. Only few low cost power toothbrushes use this not efficient mode today
- *Rotary toothbrushes:* The next generation moved to a design with a circular head that is rotating in one direction
- *Counter-rotational toothbrushes* with different tufts of bristles rotating in opposite directions
- *Rotating-oscillating toothbrushes* in which a circular head spins back and forth in quick bursts
- *Oscillating-pulsating toothbrushes* have in addition a pulsating motion to enhance the cleaning action

Brush heads of powered toothbrushes tend to be more compact than manual toothbrushes. The bundle of bristles is arranged either in circular pattern or in rows which are mounted in a round head (Fig. 26.5). The bristles are arranged as more compact single tuft, facilitating interproximal cleaning and brushing in less accessible areas of mouth. Studies have shown

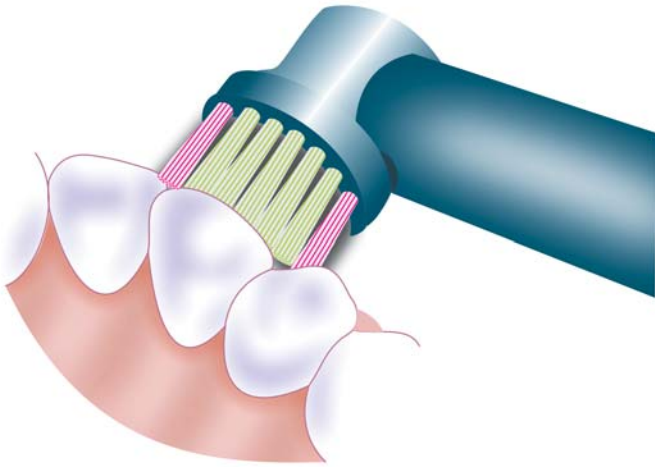


Fig. 26.5: Powered toothbrush

that if properly used both automatic and manual toothbrushes can remove plaque effectively.

Indications:

1. Those with physical or learning disability
2. Fixed orthodontic appliances
3. Young children
4. Aged persons
5. Institutionalized patients who depend upon care providers for brushing
6. Arthritic patients
7. Individuals with poor dexterity
8. Poorly motivated patients.

ELECTRIC TOOTHBRUSH vs. MANUAL TOOTHBRUSH

Electric toothbrush	*Manual toothbrush*
Only minimal skill level is needed to brush properly	Requires manual dexterity and diligence
Will probably clean better where someone lacks the skills needed for manual brushing, has problems making the necessary movements of brushing—people with arthritis and elder people	Not helpful in such a scenario
Tend to brush longer with a power toothbrush, as minimum effort is needed; it can lead to better removal of dental plaque	Efforts needed can cause the person to limit the amount of time spent on brushing
Smaller brush head that is easier to reach all areas of their mouth, even to the back teeth without causing discomfort as some larger brush heads, hence more preferred	Not always true
Less brushing force is required	More force required
Less likely to cause damage to tooth enamel and gums because the majority of them have pressure sensors	Incorrect techniques can often cause damage
Allow you to regulate the brushing time and pressure applied using a built-in timer and pressure sensors	Manual regulation required
Recommended for those who wear braces as it may reach crevices between braces and teeth that are not easily cleaned	Comparatively, cleaning can be a cumbersome task for those who have braces

Generally, the handles of electric toothbrushes are more ergonomic and comfortable for a firm grasp.

C. SONIC AND ULTRASONIC TOOTHBRUSHES

The cleaning action generated by a sonic toothbrush is actually based on two separate mechanisms. One of these is conventional and is similar in nature to that mechanism employed by all other types of toothbrushes. The second cleaning action is based on a new technology that is entirely unique to sonic toothbrushes.

1. The primary mode of cleaning that a sonic toothbrush can provides by the scrubbing action of its brush head's bristles on the surface of the user's teeth. This method of cleaning teeth is not new. All toothbrushes, both electric and manual, rely on this same principle for removing dental plaque.
2. Sonic toothbrushes are also capable of producing a secondary cleaning action, one based upon a new technology developed by the brush's creators. This cleaning action is founded on the intense speed at which the bristles of the sonic toothbrush vibrate. This vibratory motion is able to impart energy to the fluids that surround teeth (such as saliva). The motion of these agitated fluids is capable of dislodging dental plaque, even beyond where the bristles of the toothbrush actually touch. Only a sonic toothbrush can make this claim.

The brush head of sonic toothbrush has been designed to vibrate at more than 30,000 brush strokes per minute. This high speed brushing action in turn creates turbulent fluid dynamics near the tips of its bristles.

The result is the creation of waves of pressure and shear forces in the liquids that surround your teeth, and also the creation of minute bubbles that are propelled forcefully against surfaces where plaque resides. The combination of these various fluid dynamics results in forces that are capable of dislodging dental plaque in those hard to reach areas such as between teeth and below the gum line. The cleaning effect of these fluid forces has been measured to occur at distances of up to 4 millimeters (slightly more than 1/8th of an inch) beyond where the bristles of sonic toothbrush actually touch.

D. IONIC TOOTHBRUSHES

Principle

1. The bonding between the pellicles and bacteria is mediated by Ca^{2+} bridge formation. The anions, supplied by the lithium battery inhibit the bonding between the bacteria and Ca^{2+} and prevent the bacteria from absorbing to the pellicles (Fig. 26.6). Hence, the plaque accumulation is reduced because the above mentioned anions continuously supplied from the tips of the bristles of the ionic toothbrushes prevent the mild electrostatic bonding between the bacteria per se.
2. Instead of using friction or sound (sonic) waves to try to 'blast apart' this bond, ionic technology changes the polarity of tooth surfaces from -ve to +ve. As brushing is done, plaque material is actively repelled by teeth and drawn to the negatively charged bristles, even in hard-to-reach areas of the mouth (Fig. 26.6).

BIONIC TOOTHBRUSH—SOLADEY

Soladey was invented in Japan by Dr Yoshinori Nakagawa. The name originates from the words 'Solar' and 'Dental'.

Mechanism of Action

There is a light-activated titanium rod (semiconductor) inside the handle. When exposed to any good light source the photo-sensitive titanium rod inside Soladey converts light into negatively-charged ions (electrons) which attract the positive ions in the acids in dental plaque. The rod releases these ions, which blend with saliva to attract positive (hydrogen) ions from

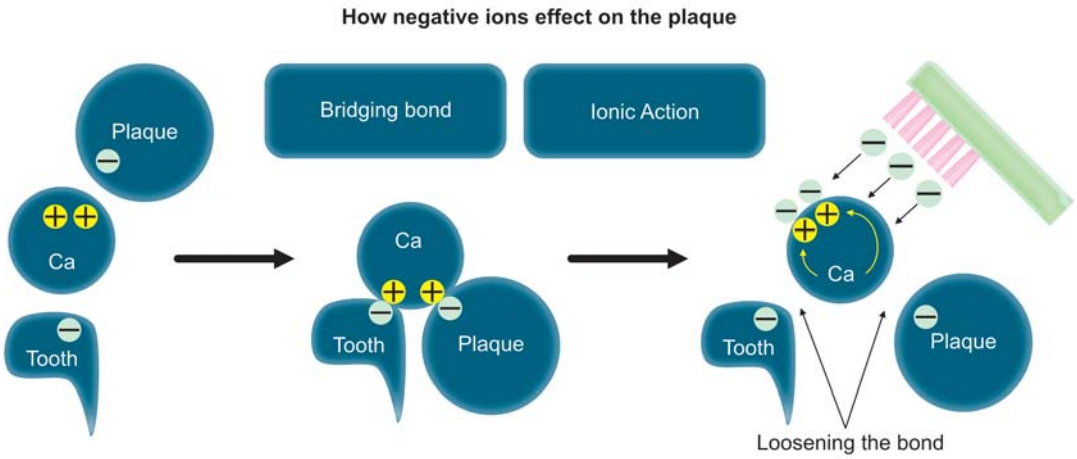


Fig. 26.6: Mechanism of ionic toothbrush: Plaque is bonded to teeth electrically by positive ions. With ionic action (moving negative ions), the bond between tooth and plaque loosens, making it easy to remove plaque

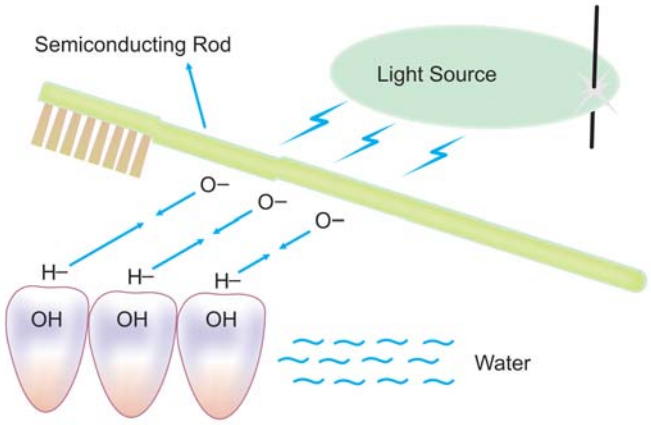


Fig. 26.7: Bionic toothbrush

the acid in the dental plaque on teeth. These ions permeate the saliva to effectively breakdown plaque on a molecular level. The polarity of the tooth surface is temporarily reversed by the ionic action which helps to prevent new plaque from forming. This ionic action disintegrates plaque in places one cannot reach with bristles, rinse, toothpaste or interproximal devices [Fig. 26.7].

TOOTHBRUSHING TECHNIQUES

According to the direction of brushing stroke:

i. Vertical (Leonard's method).
ii. Horizontal.
iii. Roll technique (Modified Stillman / rolling stroke).
iv. Vibrating technique (Charter's, Stillman, and Bass).
v. Circular technique (Fones method).
vi. Physiological technique (Smiths method).
vii. Scrub brush method.

Requirement of a Satisfactory Method of Tooth Brushing

1. The technique should clean all tooth surfaces specially the area of gingival crevice and the interdental region.
2. The movement of brush should not injure the soft or hard tissues. Certain methods, e.g. vertical and horizontal scrubbing methods can produce gingival recession and tooth abrasion.
3. The technique should be simple to use and easy to learn.
4. The method must be well organized so that, each part of the dentition is brushed in turn and no area over looked.

THE BASS METHOD: SULCULAR BRUSHING

It is widely accepted and particularly useful in removing plaque not only at the gingival margin, but also subgingivally.

Indications

1. For plaque removal adjacent to and directly beneath the gingival margin in all individuals.
2. Particularly useful in open interproximal areas, cervical areas beneath the height of contour of the enamel and exposed root surfaces.
3. Postperiodontal surgery.

Procedure

The head of the brush is positioned in an oblique direction towards the apex, in order to introduce the bristles into the gingival sulcus. The bristles are about 45 degrees to the axis of the teeth (Fig. 26.8). The brush is pressed towards the gingival and moved with a small circular motion so that the bristles go into the crevice. 20 strokes are completed in the same position, three teeth at a time. For occlusal surface cleaning, bristles are pressed firmly into the pits and fissures and activate the brush into 20 short back and forth strokes. (Fig. 26.9)

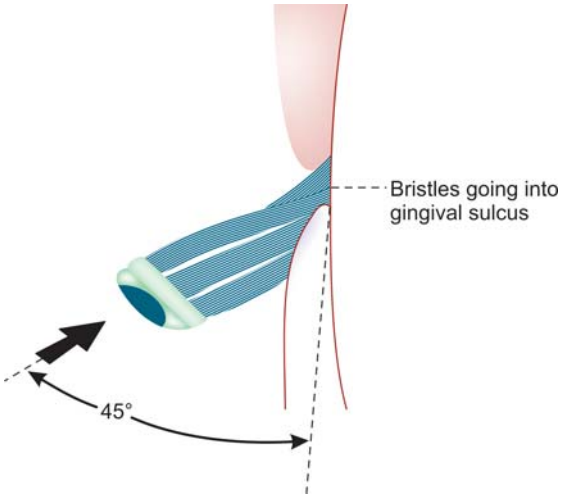


Fig. 26.8: Brush placed at 45 degree

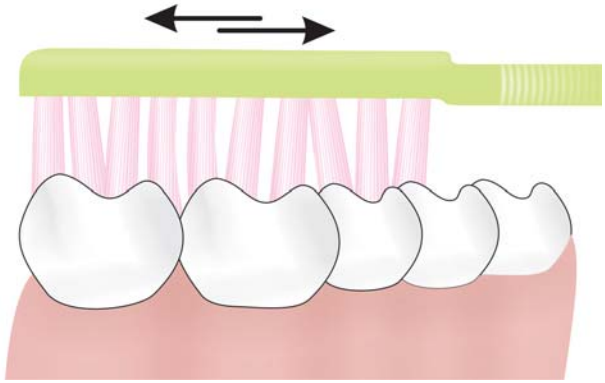


Fig. 26.9: Cleaning of occlusal surface

To reach the lingual surface of anterior teeth, the brush is inserted vertically. The heel of the brush is pressed into the gingival sulci and proximal surface at a 45 degree angle to the long axis of the tooth. The brush is then activated.

MODIFIED BASS TECHNIQUE

The tooth brush is held with bristles at 45 degree to the gingival. Gentle pressure is exerted using short back and forth motion without dislodging the tips of the bristles. The bristles are then swept downwards over the tooth surface occlusally (Figs 26.8 to 26.13).

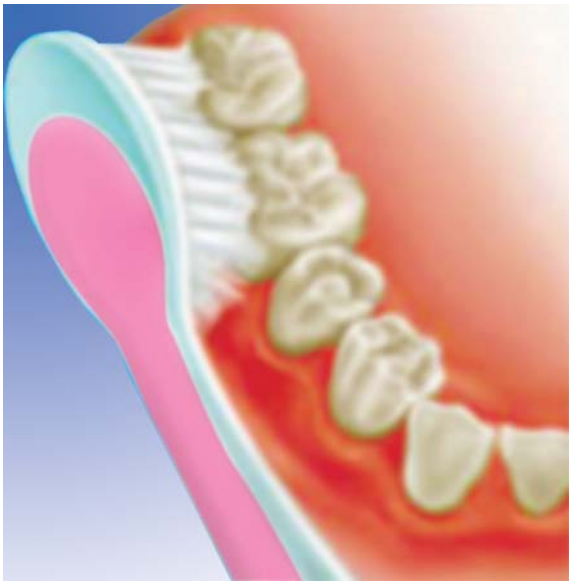


Fig. 26.10: Brushing outer surface

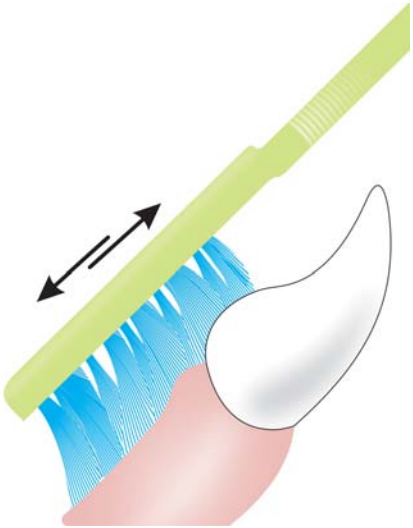


Fig. 26.11: Brushing lingual surface



Fig. 26.12: Brushing anterior teeth



Fig. 26.13: Brushing inner surface

STILLMAN'S METHOD

Indications

As the bristle ends are not directed into sulcus, this method can recommended for individuals with progressive gingival recession.

Technique

This method was originally developed to provide gingival stimulation. The brush is positioned with bristles inclined at a 45 degree angle to the long axis of the tooth, with the bristles placed partly on the gingiva and partly on the cervical portion of the tooth (Fig. 26.14). The strokes are activated in a short back and forth (vibratory) motion, with slight pressure to stimulate the gingiva. Approximately 5 to 10 strokes are completed in each region, and the brush is moved to the next

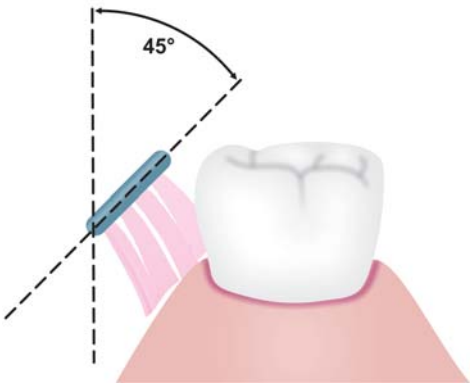


Fig. 26.14: Placement of brush in Stillman's technique

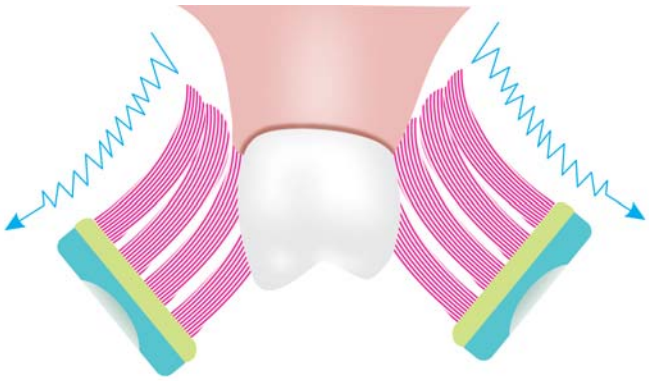


Fig. 26.15: Modified Stillman's technique

area. Brush placement is vertical on the anterior lingual surfaces and the heel of the brush is used.

MODIFIED STILLMAN'S TECHNIQUE

Indications

1. Plaque removal from cervical areas below the height of contour of the crown and from exposed proximal surfaces.
2. For cleaning tooth surfaces and message of the gingival.

Technique

The brush is positioned in a similar manner to the original Stillman's technique, i.e. the bristles pointing apically, directed at an oblique angle to the long axis of the teeth. After applying a small vibratory pressure the bristles are rolled occlusally to clean the entire facial and lingual surfaces after the cervical area is cleaned (Fig. 26.15).

THE ROLLING STROKE

This method is used for cleaning of the gingiva and the teeth of plaque and food debris without emphasis on gingival sulcus.

Indications

1. For children with a healthy gingiva and normal tissue contour when a sulcular technique may seem difficult to grasp.
2. Used in conjunction with vibratory technique, i.e. Bass, Stillman's, or Charter's.

Technique

Bristles are directed apically and parallel to the axis of the tooth. The brush is then rotated deliberately down in the upper jaw and upward in the lower jaw so that, bristle sweep across the gum and tooth in an occlusal direction with rolling motion. If the arch in the anterior segment is narrow the brush can be used vertically.

Disadvantages

1. It fails to clean the junction of the tooth with the gingival margin and the gingival crevice.
2. If toothbrush is positioned too deep in the buccal vestibule, the mucogingival junction and alveolar mucosa can be traumatized.

CHARTER'S METHOD

Purpose and Indications

1. Massage and stimulate marginal and interdental gingiva.
2. Cleaning of orthodontic appliances.
3. Cleaning following periodontal surgery.
4. Fixed prosthetic appliances.
5. Person with exposed root surfaces.
6. Cases with receded interdental papillae.

Procedure

In this technique the bristles are pointed towards the crown of the tooth rather than apically. The bristles are placed at the gingival margin and directed towards the occlusal surface at a 45 degree angle to the long axis of the tooth. A short back and forth motion is used for activation. The process is repeated in a sequence around the mouth until all areas are cleaned (Fig. 26.16).

Disadvantages

1. As brush ends do not engage the gingival sulcus, it does not remove subgingival bacterial accumulation.
2. High digital dexterity required.
3. In some areas such as lingual surface, the correct brush placement is impossible or difficult, therefore, modifications are required adding to complexity of the procedure.

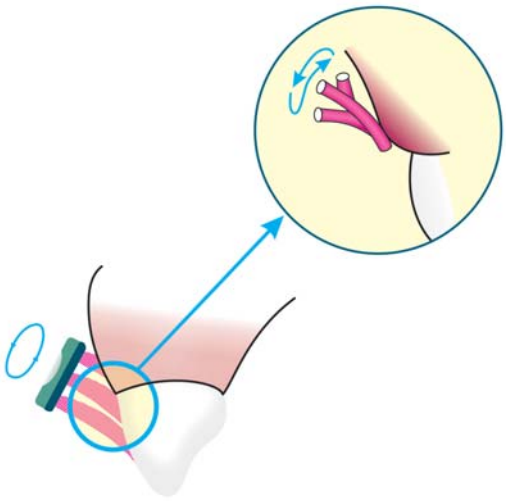


Fig. 26.16: Charter's method

CIRCULAR: THE FONES METHOD

This method may be recommended as an easy to learn technique for young children.

Indication

Young children with primary teeth; otherwise not recommended.

Technique

The brush is placed inside the mouth. With the teeth closed and brush tips contacting the gingiva over the last maxillary molar, bristles are activated in circular motion that sweeps from the maxillary gingiva to the mandibular gingiva.

Disadvantage

- Possible damage to gingiva.

VERTICAL: LEONARD METHOD

Technique

With the teeth edge-to-edge, place the brush with the filaments against the teeth at right angles to the long axis of the teeth. The brush is activated with mostly up and down strokes on the tooth surface. The upper and lower teeth are not brushed in the same series of stroke. This technique is usually not recommended.

PHYSIOLOGIC: SMITH'S METHOD

It was described by Smith. It was based on the principle that the tooth brush should follow the same physiologic pathway that food follows when it traverses over the tissues in a natural masticating act.

Technique

The toothbrush bristles are positioned at the incisal or occlusal surfaces and are swept towards the gingiva. The direction of the brushing motion from the occlusal to the gingiva was like duplicating the nature's self cleansing mechanism.

Scrub Brush Method

It is probably the most commonly used toothbrushing method. The procedure consists of vigorously combined horizontal, vertical and circular strokes with some vibratory motions for certain areas.

Disadvantages

1. Transition to other technique becomes difficult so not recommended.
2. Can cause gingival recession.
3. Can lead to tooth abrasion.

No one manual toothbrush design appears superior for plaque removal. Toothbrush designs continue to be modified by competing manufacturers. New modifications include nylon multi-tufted round-ended bristles for improved efficacy, small-sized head for better access, designs to favor interproximal access and longer to enable a firm grip. However, the latter may increase application force, resulting in gingival irritation and recession. Although brush stroke movements vary (for example, roll, circular, scrub) and should concentrate on the cervical and interproximal areas where plaque is most detrimental, the individual's dexterity and thoroughness are more critical than technique or design in determining efficacy of plaque removal.

Recent well controlled studies report the new electric toothbrushes to be superior in plaque removal to manual toothbrushes but significant improvements in gingival health are yet to be shown.

For small children, toothbrushing should be performed by an adult until the child is about 6 years, when increasing dexterity and cognition may permit supervised brushing until the child is capable of independent brushing.

INTERDENTAL ORAL HYGIENE AIDS

As the interdental region is the most common site of plaque retention and the most inaccessible to the toothbrush, special methods of cleaning are needed. Removal of plaque without injuring the soft tissue should be the aim.

To remove the existing confusion with respect to terms such as approximal, interproximal, interdental and proximal sites, The European workshop on mechanical plaque control in 1999 proposed the following definition,

'*Approximal* (proximal) areas are the visible spaces between teeth that are not under the contact area'.

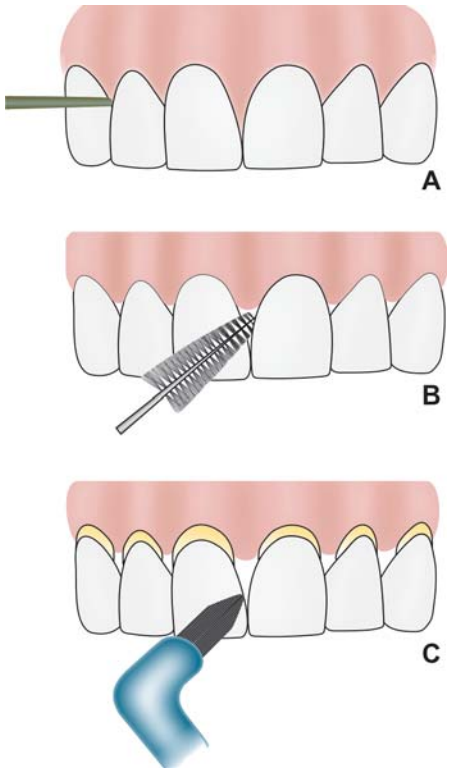
Interproximal and *interdental* may be used interchangeably and refer to the area under and related to the contact point.

Tooth brushing alone cannot effectively control interproximal plaque, and the adjunctive methods of cleaning are to remove from these hard to reach sites. A number of interdental cleaning methods have been used for this purpose, ranging from floss to the recently introduced electrically powered cleaning aids. However, not all interdental cleaning devices suit all patients or all types of dentition.

Factors Effecting Selection of Interdental Aids

1. Contour and consistency of gingival tissue.
2. Probing depth.
3. The size of the interproximal embrasure.
4. Tooth position and alignment.
5. Ability and motivation of the patient.
6. Condition and type of restorative work present.
7. Susceptibility of the person to disease.

Various embrasure types and recommended interdental aids are demonstrated in Figures 26.17A to C.



Figs 26.17A to C: Interproximal embrasure type and corresponding interdental cleansers (A) Type 1—dental floss (B) Type 2—interdental brush (C) Type 3—unitufted brush

A. DENTAL FLOSS

Although, flossing requires more digital skills and is more time consuming than toothpick, but there appears to be no alternative for using a floss or tape (a type of broader dental floss) in cleaning proximal surfaces when a normal healthy papilla fills the interdental space.

Uses of Dental Floss

1. Removes plaque and debris adherent to the teeth, restorations, orthodontic appliances, fixed prosthesis and gingival in the interproximal embrasure.
2. It polishes the surfaces as it removes the plaque.
3. Massaging of the interdental papilla.
4. Helps to identify the presence of subgingival calculus deposits, overhanging restorations and interproximal carious lesions.
5. Maintenance of general oral hygiene and control of halitosis.
6. Reduces gingival bleeding.

Type of embrasure	*Recommended interdental aid*
Type 1: The interdental papilla fills up the embrasure	Dental floss
Type 2: Moderate papillary recession is seen	Miniature interdental Brush wood tips
Type 3: There is complete loss of papilla	Unitufted brushes

Disadvantages of Dental Floss

1. Not easy to perform specially in posterior areas.
2. Requires good manual dexterity.
3. Time consuming.
4. Risk of frequent shredding when passing through contact point.
5. Risk of tissue damage if improperly used.

Types of Dental Floss

1. Twisted or nontwisted.
2. Bonded or nonbonded.
3. Waxed or unwaxed.
4. Thin or thick.

Methods of Using Dental Floss

1. Spool method.
2. Loop or circle method.

Spool Method

It is recommended for teenagers and adults who have acquired the required the level of neuromuscular coordination and mental maturity to use floss correctly.

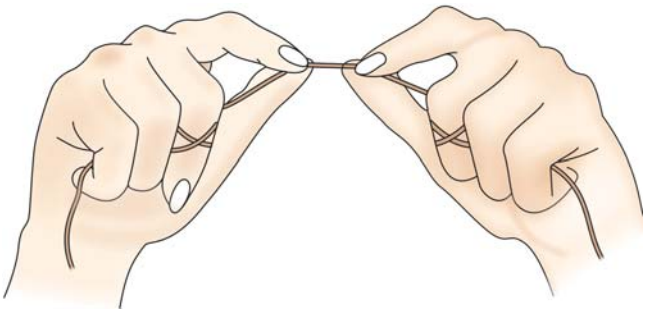


Fig. 26.18: Adaptation of the floss to the fingers

Method

A piece of floss approximately 18 inch long is taken. The bulk of the floss length is lightly wound around the middle finger (Fig. 26.18). The rest of the floss is similarly wound around the same finger of opposite hand. Space should be left between wraps to avoid cutting off circulation to the fingers. The last three fingers are clenched and both hands are moved apart, pulling the floss taut. The thumb and index finger of each hand are free. The floss is then secured with the index finger and thumb of each hand by grasping a length of ¾th to 1 inch in each hand. The finger of opposite hand can wind the floss as it becomes soiled or frayed to permit access to an unused portion.

Loop Method

This method is particularly suited for children as well as adults with less nimble hands or handicaps such as poor muscular coordination or arthritis.

Method

A piece of 18 inch long is made into a circle and tied securely with three knots. All fingers except the thumbs are placed within the loop, so that fingers or thumbs will be ¾th to 1 inch apart. The floss is guided with the two index fingers for mandibular teeth and with two thumbs or one index finger and one thumb for maxillary teeth. As teeth are flossed, the loop is rotated so that, each proximal area receives unused floss for proper cleaning.

To be effective the floss should be pulled around the tooth curvature so that, close contact with tooth surface is made (Fig. 26.19). Patients with tight contact areas need thin unwaxed floss that can be slipped easily between the contact areas, whereas in patients with crowded teeth, heavy calculus deposits, or defective and overhanging restorations, a bonded unwaxed floss or waxed floss is the dental floss of choice because they do not fray as easily as unwaxed floss. Dental tape is recommended when there is considerable interdental space resulting from gingival recession and bone loss.

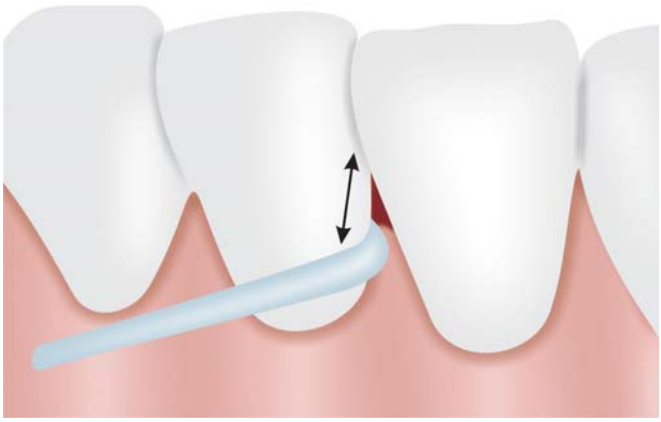


Fig. 26.19: Movement of dental floss

Unwaxed versus Waxed Floss

Studies have shown no difference in the effectiveness of unwaxed versus waxed dental floss. *Unwaxed dental floss* is usually recommended for individuals with normal tooth contacts because it slides through the contact areas easily. *Waxed dental floss* is recommended for individuals with tight proximal tooth contacts, moderate to heavy calculus deposits, crowded teeth or defective and overhanging restorations. It is preferred because of its ability to slide through tight contacts and resist fraying.

Dental tape or ribbon is a waxed dental floss that is wider and flatter than conventional dental floss. The flat-sided surface of dental tape is preferred by some, particularly when the surface area to be flossed is large.

Floss Threader

It is another device designed to assist individuals with flossing. In case of fixed partial dentures, floss cannot be passed through the interdental contacts because this is closed. A floss threader assists in introducing floss into an area such as between an abutment tooth used for support of a fixed bridge and a pontic end of the floss threader is passed under the pontic or fixed partial denture connector from the facial aspect.

Super Floss

It is a type of floss that incorporates a rigid plastic portion that can be introduced under fixed bridge. Distal to rigid plastic portion is a spongy region that is ideal for plaque removal (Fig. 26.20). The terminal portion of superfloss is similar to standard dental floss. The rigid portion is passed into the embrasure space between the retainer and the pontic and pulled through to the lingual aspect. The spongy region is then used in apico-coronal stroke along the interproximal surfaces of the abutment teeth and along the intaglio surface of the pontic.



Fig. 26.20: Superfloss

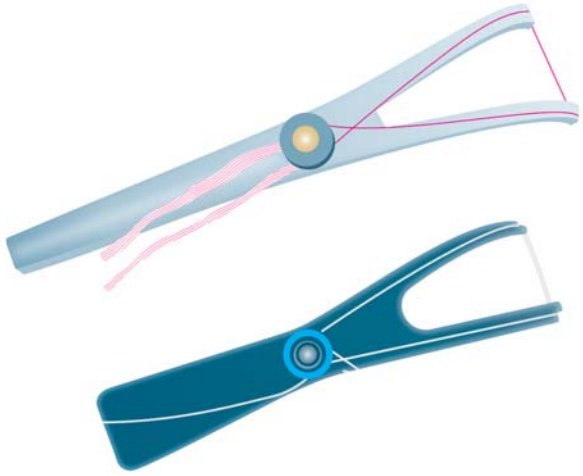


Fig. 26.21: Floss holders

B. FLOSS HOLDER

Indications

1. Patient with physical disabilities.
2. Patient lacking manual dexterity.
3. Individuals with large hands.
4. Individuals with strong gag reflex.
5. Caregivers.
6. Type I embrasures.

Floss holder is a flossing aid. The majority of floss holders consist of a device with a handle with two prongs in Y shape or C shape (Fig. 26.21). The floss is tightly secured between the two prongs. The patient holds the handle of the device to guide it during use (Fig. 26.22).

Disadvantages

1. More time consuming.
2. Unable to maintain tension of floss.
3. Must be rethreaded when the floss becomes soiled or frayed.
4. Need to set fulcrum to avoid floss cuts.

C. TOOTHPICKS

Toothpicks are usually made of softwood and have a triangular, round or rectangular shape. Triangular are said to be superior to the rest as they are ineffective on lingual aspect of proximal surfaces.

Indications

1. Type II and Type III embrasures from facial aspect only.
2. Accessible furcations.
3. Small root concavities.
4. Interproximal open spaces.

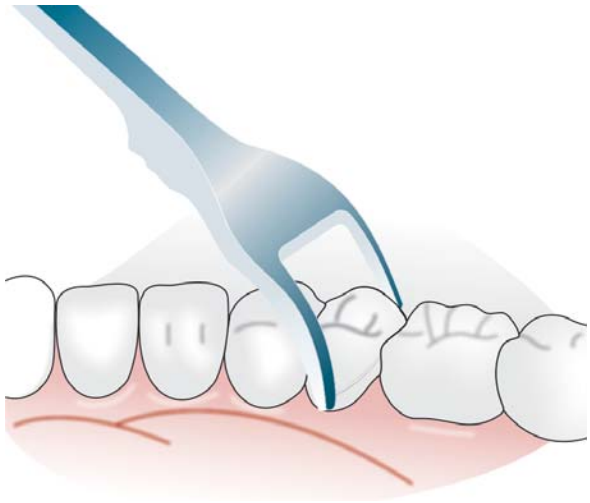


Fig. 26.22: Placement of floss holder

Contraindications

1. Type I embrasures.
2. Healthy gingiva.

Disadvantages

1. Wearing down of papilla and marginal tissues from incorrect usage.
2. Wood ends may cause tissue trauma/ cuts or abrasion.
3. Enamel abrasion from incorrect use.
4. Can force bacteria or debris into gingival attachment if used improperly.
5. May cause opening of the embrasure.

Toothpick Holder

It is also called as periodontal aid. It is an instrument designed to increase patient's application of the traditional toothpick by holding it securely at the proper angle.

Indications

1. Plaque removal along the gingival margin.
2. Type II and Type III embrasures from facial or lingual aspect.
3. Accessible furcations.
4. Concave surfaces in interproximal areas.
5. Fixed prosthetic and orthodontic appliances.
6. Sulcular cleansing in areas of shallow pocketing.
7. Application of fluoride, antimicrobials and desensitizing agents.

D. INTERPROXIMAL BRUSHES

Also called as interdental brushes, proxa brush. They are available in various sizes and shapes. The most common are conical or tapered and designed to be inserted into a plastic or metal reusable handle that is angled to facilitate interproximal adaptation (Figs 26.23A and B). Studies have shown that they are equal to or more effective than floss for plaque removal and for reducing gingival inflammation in Type II and Type III embrasures and exposed furcations areas.

Indications

1. Type II and Type III embrasures.
2. Diastemas.
3. Exposed root furcations.
4. Orthodontic and fixed appliances.
5. Application of fluoride, antimicrobial or desensitizing agents.



Fig. 26.23A

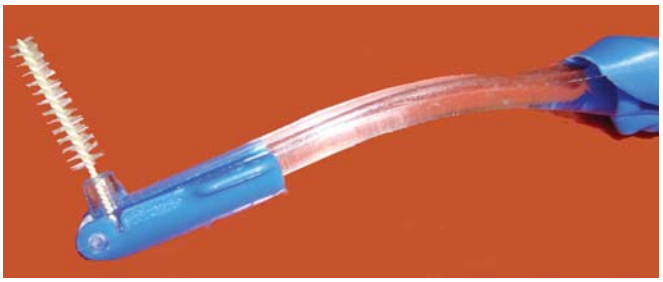


Fig. 26.23B

Figs 26.23A and B: Interproximal brush



Fig. 26.24: Placement of an interproximal brush

Technique

Inserted interproximally and activated with short back and forth strokes in between the teeth (Fig. 26.24).

Disadvantages

1. Different types may be needed to fit different open interproximal spaces.
2. Trauma to tooth or gingiva from sharp wire center of some.

E. SINGLE TUFT BRUSHES

Single tuft or end tuft brushes are small brushes with nylon bristles that are attached to a plastic handle. There are variations in the shape of the tufts and the width and length of the handles. Single tuft brushes are indicated in open embrasure areas where there is little or no papilla. They are used by placing the brush in the interdental area (Fig. 26.25). The brush is then jiggled in a small circular motion and/or use a sweeping motion away from the gingiva.

Indications

1. The single tuft brush is for patients who prefer a longer handle.

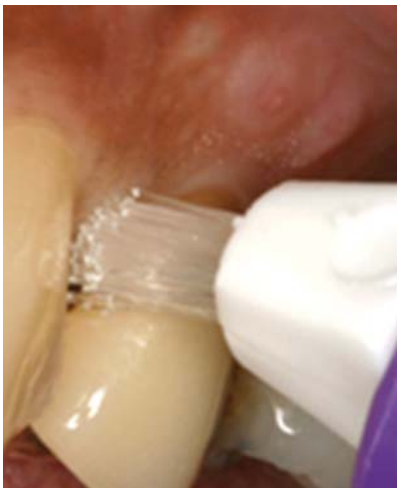


Fig. 26.25: End tuft brush

2. Patients who are not able to change the refills of the interproximal brush.
3. Patients who cannot control the interproximal brush due to manual dexterity or disabilities.

F. KNITTING YARN

It is used to clean proximal tooth surfaces adjacent to wide embrasure spaces. Yarn is used similar to floss.

Indications

1. Type II and Type III embrasures.
2. Isolated teeth.
3. Diastemas.
4. Abutments of partial dentures.
5. Under sanitary pontics.
6. Distal of posterior most teeth in arch.

Disadvantage

- Yarn may catch on appliances and become stuck on rough appliances and removing a stuck yarn may damage the appliance.

G. GAUZE STRIP

It is an effective aid for cleaning the proximal surfaces of teeth specially adjacent to edentulous areas.

Technique

It is used by positioning the gauze edge length wise with the folds towards the gingiva. Any loose ends are folded inwards to avoid gingival irritation. Gauze is adapted by wrapping it around the exposed proximal surface to the facial and lingual line angles of the tooth. A facial-lingual 'shoeshine' stroke is used to loosen plaque and debris (Fig. 26.26).

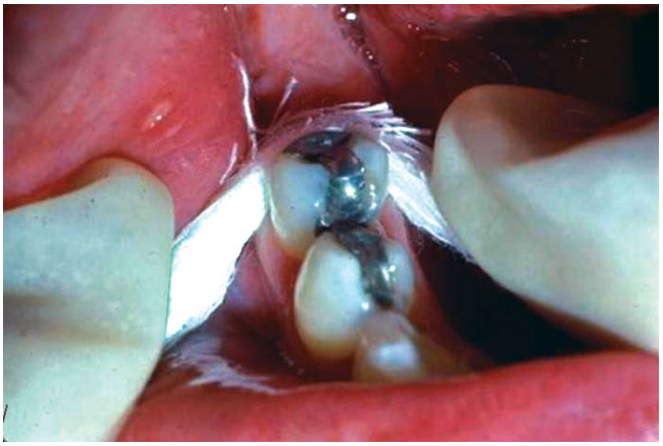


Fig. 26.26: Use of gauze strip

Indications

1. Type III embrasures.
2. Diastemas.
3. Teeth adjacent to edentulous areas.
4. Implant abutments.

Disadvantage

The patient may damage an appliance while removing stuck gauze.

H. PIPE CLEANER

They are another useful adjunct to dental flossing for the removal of plaque and debris. A pipe cleaner with soft covering and with a minimum exposed wire should be selected. It used by passing between exposed roots of a furcations and a bucco-lingual movement is used for cleaning.

Indications

1. Type III embrasures.
2. Exposed root furcations.
3. Malpositioned or separated teeth (areas of bone loss and severe loss of tissues).
4. Exposed proximal surfaces.

Disadvantage

Sharp wire center can damage the cementum or can cause trauma to gingiva.

I. WEDGE STIMULATOR

Wooden and plastic sticks or wedge stimulators reduce bleeding and inflammation when used to reduce plaque. They are wooden or plastic oral hygiene devices designed for interdental cleansing and stimulation. These devices are made of balsa, bass, birch, or linden wood or plastic. Some of the wood sticks

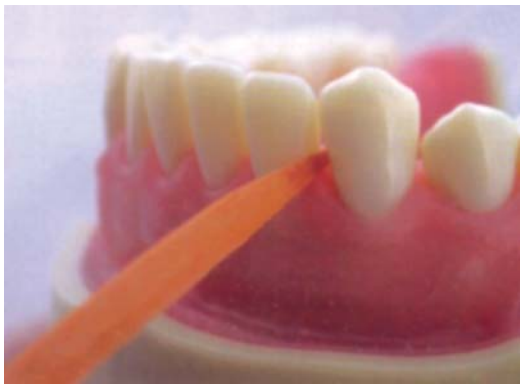


Fig. 26.27: Wedge stimulator

are treated with xylitol. They are recommended for use only from the facial aspect, where the proximal surfaces are exposed to avoid traumatizing gingival tissue. Wooden and plastic sticks or wedge stimulators reduce bleeding and inflammation when used to reduce plaque.

Most wedge stimulators are triangular. They are inserted interdentally, with the base of the triangle resting on the gingival side, the pointing occlusally or incisally and the sides of the triangle against the adjacent tooth surfaces. Such a placement of base of triangle against the tissues prevents damage such as gingival cuts and clefts, to the interdental papilla and gingival margins (Fig. 26.27).

One of the most commonly used tools; toothpicks differ from the wooden triangular sticks in their shape and size and may not be as effective in plaque removal in open embrasures.

Indications

1. Type II and Type III embrasures from facial aspect only.
2. Accessible furcations.
3. Application of fluoride, antimicrobial or desensitizing agents.

Disadvantages

1. Wearing down of papilla and marginal tissues from incorrect use.
2. Enamel abrasion from incorrect use.
3. Splaying of wood ends may cause tissue trauma or abrasions.
4. Improper use can force bacteria or debris into gingival attachment leading to abscess formation.

4. ADJUNCTIVE AIDS

1. Dental Irrigation Devices (Water-Pik)

These are powered dental irrigation devices (Fig. 26.28) that are designed to eliminate plaque and soft debris through the mechanical action of a jet stream of water (Fig. 26.29). Irrigation devices may be used with water or with antimicrobial agents.

ORAL HYGIENE AIDS

Toothbrushes	The most important features are the size of the head, medium texture filaments and rounded ends to the bristles
Electric toothbrushes	May be of particular benefit in patients with reduced manual dexterity
Single tufted brushes	Cleaning around lone-standing teeth, partially erupted third molars, proximal spaces adjacent to saddle areas in partially dentate patients. Also, useful in localized areas of recession and exposed portions of dental implants
Floss	Waxed or unwaxed. Waxed may be easier for first-time users
Tape	Broader than floss, it passes between teeth more easily. May be beneficial where interproximal restorations are present
Superfloss	Used for cleaning under bridge pontics
Floss threader	Used to pass floss beneath pontics, cheaper than using superfloss
Interproximal	The method of choice for interdental cleaning when (bottle) brushes space permits. Available in a range of sizes; choose the largest size which passes between the teeth without causing discomfort
Wooden sticks	Not as effective as interproximal brushes

Using the device on full strength may be hazardous. It is possible for the impact of the fluid to drive pocket bacteria into the tissues and produce a periodontal abscess.



Fig. 26.28: Irrigation device (Water-Pik)

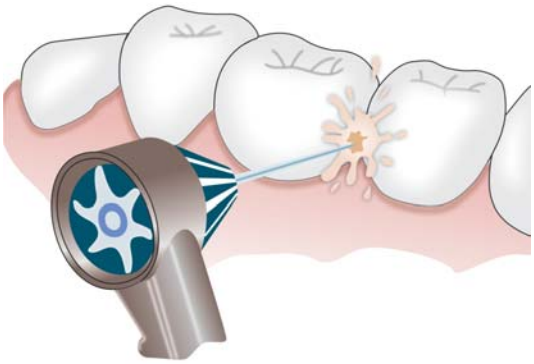


Fig. 26.29: Jet stream of water from Water-Pik)

Indication

- Type I embrasure and healthy tissues.

2. Tongue Scrapers

The dorsum surface of tongue harbors a great number of bacteria. This may serve as a source of bacterial dissemination to other parts of oral cavity. It may also be the source of bad breath. Therefore, tongue brushing and the use of tongue scrapers should be recommended as part of daily home oral hygiene together with toothbrushing and flossing (Fig. 26.30).



Fig. 26.30: Different tongue cleaners

Suggestion for the Tongue-Cleaning Procedure

i. Place the tongue as far out of the mouth as possible.
ii. Observe the location of the debris accumulation. Unfortunately, the debris is usually on the most posterior aspect of the dorsum of the tongue.
iii. Place the tongue cleaner/scraper as far posterior as possible, and apply force on the scraper to flatten the tongue, making sure that it will make contact with the whole of the tongue. Many individuals gag at this time, and practice is required to find the right positioning to minimize the gag response.
iv. Pull the tongue cleaner forward slowly to the front of the mouth.
v. Remove the debris from the cleaning device by placing it under a stream of running water.
vi. Repeat the scraping procedures several times until further debris cannot be removed.

3. Dentifrices

A dentifrice is usually used in combination with toothbrushing with the purpose of facilitating plaque removal and applying preventive and therapeutic agents to the tooth surfaces. A toothpaste is defined as a semi-aqueous material for removing naturally occurring deposits from teeth and is supposed to be used simultaneous with a toothbrush.

The primary purpose of brushing the teeth with a dentifrice (*dens* — tooth, *fricare* — to rub) is to clean the accessible tooth surfaces of dental plaque, stains and food debris. Tooth cleaning with dentifrices dates back over 2000 years, while cleaning with toothpicks and brushes is an even older practice. Abrasive dentifrice materials came to be used when it was found that brushes, while facilitating the cleaning of soft deposits from teeth, were inadequate for the removal of harder deposits and stains. Dentifrices have been prepared in several forms such as powders, pastes and gels. The most popular forms are the pastes and gels.

It is a substance used in conjunction with a toothbrush or interdental cleaner to facilitate bacterial plaque biofilm removal, or as a vehicle for transporting therapeutic or cosmetic agents to the tooth and its environment.

A dentifrice is usually used in combination with toothbrushing with the purpose of facilitating plaque removal and applying preventive and therapeutic agents to the tooth surfaces.

The dentifrice can either be:

Cosmetic which cleans and removes material alba, plaque biofilm, food debris and stains from tooth surfaces and polishes.

Therapeutic which transports the drug substance to the tooth surface or the oral tissue. It is suppose to reduce some disease process in the mouth. Therapeutic effect is to reduce caries incidence, gingivitis, calculus formation, or tooth sensitivity.

INGREDIENTS

Dentifrices were originally used for their cosmetic effect, i.e. for removal of extrinsic stains (end products of bacterial metabolism) present on the surface of tooth. Exact composition of a particular dentifrice varies with each manufacturer but most toothpaste contains several or all ingredients shown in Table 26.1.

ABRASIVES

It is the largest component of dentifrice.

The characteristic of an abrasive agent used in a dentifrice depends upon:

- Inherent hardness of an abrasive.
- Shape and size of the abrasive particle.

Table 26.1: Composition of a typical dentifrice

Ingredients	*Percent*
Abrasive	40-50
Humectant	20-30
Water	20-30
Binding agent	1-2
Foaming agent (Detergent)	1-3
Flavoring agent	1-2
Preservative	0.05-0.5
Therapeutic agent	0.5-2
Sweetening agent	—

The effect of polishing agent (abrasive potential) used during the use of a dentifrice is also influenced by the brushing force applied, brushing technique, type of bristles(hardness), properties of abrasive, surface being polished (enamel or dentine).

The harder the abrasive and sharper the particle, the more the wear of the tooth surfaces. Calcium carbonate (chalk) and calcium phosphates were the most commonly used abrasives previously. But these agents specially calcium reacted adversely with fluoride and due to their interaction fluoride ions were not available to react with the tooth enamel. Most fluoride dentifrices no longer use calcium carbonate and instead silicon oxides, insoluble sodium metaphosphate are being used now days.

Abrasives often dull the tooth luster and to compensate this polishing agents like small size particle of aluminum, calcium, tin, magnesium are added to the dentifrice.

HUMECTANT

The primary function of humectant in a dentifrice is to prevent loss of water or retain moisture, thus prevents hardening of the paste when it is exposed to air. It helps to maintain the consistency of the paste. The most commonly used agents are glycerol, sorbitol and propylene glycol. Both glycerol and sorbitol have a sweet taste and hence may also work as a sweetening agent.

WATER

Water is one of the important ingredients. Deionized or distilled water is used.

BINDING AGENT

The function of a binding agent is to prevent the separation of liquid and solid phases of a dentifrice and provide a stable suspension specially during storage. All binders are hydrophilic colloids which disperse or swell or absorb water to form a viscous material. The first material to be used as a binder was starch. Gum Arabic, gum karaya and gum tragacanth are natural tree exudates and are also used as binders. Irish moss extracts and alginates (seaweed colloid) have also been widely used binders specially in USA. Synthetically, prepared water-dispersible derivatives of cellulose such as methyl cellulose and carboxymethyl cellulose are increasingly being used for economic reasons.

DETERGENTS

These are the agents which clean the tooth surface. They lower the surface tension, penetrate and loosen surface deposit and emulsify and suspend the debris which is then removed from the tooth surface by the dentifrice. Natural soaps used earlier have been replaced by newer synthetic compounds. These compounds /detergents are soluble in water, function in acid or alkaline solution and does not form precipitates in hard water or saliva. These are compatible with many cleaning and polishing agents. Detergents cause the foaming action of a dentifrice, which gives a pleasant sensation. The commonly used detergents are sodium lauryl sulfate, sodium N-lauryl sarcosinate, sodium cocomonoglyceride sulfonate. Of these sodium lauryl sulfate is the most commonly used as it has an excellent detergent property and also possesses some antibacterial effect.

FLAVORING AGENT

The acceptability of toothpaste by a consumer is influenced by its taste, smell and consistency. For taste acceptance the flavor must be pleasant, provide an immediate taste sensation and the flavor should be long lasting. The important factor to be considered is that the selected flavor ingredient must be compatible with the other ingredients of the toothpaste and must remain unchanged during manufacture and storage of the paste.

The commonly used essential flavoring oils are peppermint, spearmint, wintergreen, cinnamon, anise, clove, caraway, pimento, menthol and eucalyptus.

PRESERVATIVE

Humectants and certain organic binders in a paste can permit bacterial or mold growth. Therefore, preservatives such as sodium benzoate, dichlorophene, formaldehyde or paraben are added in toothpaste.

THERAPEUTIC AGENT

These are the agents which are added in a dentifrice to produce a beneficial effect upon the oral tissue. The most commonly used agent is fluoride to prevent dental caries. (See therapeutic dentifrices for detail).

SWEETENING AGENTS

Earlier honey and sugar was used as sweetening agent in the dentifrices. Nowadays synthetic sweeteners such as saccharin

are used. Sorbitol and mannitol are also used which serve the role of sweetening agent as well as humectants. Chloroform was also used routinely but in 1976, the Food and Drug Administration [FDA] banned the use of chloroform in the foods and drugs and cosmetics because chloroform was found to be carcinogenic.

THERAPEUTIC DENTIFRICES

A therapeutic dentifrice is one that contains a drug substance that has been incorporated into the formulation in an effort to produce a beneficial effect upon the oral tissues.

The beneficial effect may include:
- Reduction and prevention of dental caries.
- Prevention and reversal of gingival diseases.
- To reduce hypersensitivity.

Various therapeutic products tried in the past include chlorophyll and antibiotics such as penicillin. Penicillin dentifrices were used experimentally but were not accepted and major deterrent for their routine use possible allergic sensitization, development of resistant strains of microorganism and over growth of unwanted microorganisms.

ANTICARIES

Fluorides

Fluoride containing dentifrices have been approved by American Dental Association (ADA) which provides protection against dental caries. Commercially available dentifrices contain sodium fluoride [NaF] 0.22%, stannous fluoride [SnF2] 0.4% or sodium monofluorophosphate [MFP] 0.76%. All dentifrices currently marketed in the US are formulated to contain either 1000 or 1100 ppm F, mostly in the form of NaF and MFP. There is evidence of an improved anticaries effect with higher F concentrations for both MFP and NaF.

Calcium/Phosphate

Calcium and phosphate supplementation in a dentifrice will increase the concentration of these ions in the oral cavity. This has been reported to improve remineralization and increase fluoride uptake.

Sodium Bicarbonate

Several studies have shown that bicarbonate is one of the salivary components that potentially modify the formation of caries. It increases the pH in saliva, and in this way creates an unsuitable environment for the growth of aciduric bacteria. Sodium bicarbonate can also prevent caries by reducing enamel solubility and increase remineralization of enamel.

ANTI-PLAQUE AGENTS

Sodium Lauryl Sulfate (SLS)

It has been shown that the enzymes glucosyltransferase and fructosyltransferase are incorporated in an active form into the pellicle; and by synthesizing glucan *in situ* from sucrose, can provide a surface for colonization by *Streptococcus mutans*. These enzymes can be inhibited by SLS, and hence retard the regrowth of plaque.

Triclosan

Triclosan is a synthetic nonionic chlorinated phenolic agent with antiseptic qualities. Triclosan has a broad-spectrum efficacy on gram-positive and most gram-negative bacteria. It is also effective against mycobacterium and strictly anaerobic bacteria, and against the spores and fungi of the Candida species. The mechanism of its antiseptic action is by acting on the microbial cytoplasmic membrane, inducing leakage of cellular constituents and thereby causing lysis of the microorganisms. Inspite of its activity *in vitro*, clinical plaque studies have revealed only moderate levels of antiplaque activity.

Evidence has accumulated to suggest that triclosan in itself does not produce optimal plaque inhibitory effects without the addition of other chemicals which increase its antibacterial effect. Most commonly used are copolymer PVM/MA and zinc citrate. They enhance surface retention of triclosan.

ANTICALCULUS

These dentifrices are formulated to inhibit the development of new calculus and which contains, among other ingredients, either pyrophosphate or zinc. It has no effect on existing calculus.

Pyrophosphate

"Antitartar" toothpastes contain soluble pyrophosphates which prevent calcification of plaque. The percentage reduction in supragingival (but not subgingival) calculus is between 32 percent and 45 percent.

Pyrophosphate has recently been introduced in dentifrices to inhibit the formation of supragingival dental calculus. Pyrophosphate is added as tetrasodium pyrophosphate, tetrapotassium pyrophosphate or disodium pyrophosphate. It has been shown that pyrophosphate has high affinity to hydroxyapatite (HA) surfaces, probably by an interaction with Ca^{2+} in the hydration layer. By interacting with HA and the enamel surface, pyrophosphate reduces their protein-binding capacity. It also has the ability to inhibit calcium phosphate formation. It is therefore conceivable that pyrophosphate introduced in the oral cavity through dentifrices may affect pellicle formation.

ANTIHYPERSENSITIVITY

The condition is also referred to as "dentine hypersensitivity". The sensitivity of dentine is caused by fluid-filled tubules in communication with the pulp. It is a sensation of pain affecting many individuals resulting mainly from thermal and/or tactile stimuli on exposed dentine.

Potassium Salts

Potassium ions (potassium nitrate) are thought to act by blocking action potential generation in intradental nerves. It is claimed that potassium salts in dental preparations increase the concentration of potassium ions around the pulpal nerves, and thereby depolarizes the nerve. This can inhibit a nerve response from different stimuli.

Other Agents

Other commonly used agents include strontium chloride, sodium citrate, etc. (Table 26.2).

WHITENING AGENTS

Whitening toothpastes simply remove surface stains with abrasives or special chemical or polishing agents, or prevent stain formation.

Abrasives

Some whitening toothpastes contain coarse abrasives that can damage the dental tissue. An abrasive is required for the effective removal of a discolored pellicle. Abrasives provide a significant whitening benefit, particularly on smooth surfaces, but are of limited use for areas along the gum line and interproximally.

Dimethicones

They cause a smooth surface on the tooth that prevents stain formation. Dimethicones are versatile substances that ranges from low molecular weight polydimethylsiloxane fluids to high molecular weight polymers that are gum-like in nature.

Table 26.2: Desensitizing agent and their mode of action

Desensitizing agent	*Mode of action*
Potassium nitrate	Nerve inactivator
Oxalates	Tubule obtundent
Fluorides	
Sodium citrate	
Strontium chloride	
Silver nitrate	Protein precipitant
Formaldehyde	
Glutaraldehyde	

Papain

Papain is a sulfhydryl protease consisting of a single polypeptide chain, extracted from the *Carica papaya* plant. It is used in toothpastes as nonabrasive whitening agent.

Sodium Bicarbonate

It is claimed that dentifrices containing high concentrations of sodium bicarbonate are more effective in removing intrinsic tooth stain than those not containing sodium bicarbonate.

Factors Affecting Dentifrice Effectiveness

In addition to the inherent properties of a fluoride dentifrice product, biological and behavioral factors can modify its anticaries effectiveness. All of these factors interplay in what can be described as the "application" phase (the initial interaction of relatively high concentrations of fluoride with the tooth surface and plaque), and the "retention" phase (the fluoride remaining in the mouth after brushing that is retained in saliva, plaque and plaque fluid, the tooth surface, and oral soft tissue reservoirs). Behavioral factors include the frequency of dentifrice use, length of brushing, rinsing practices after brushing, the time of day that dentifrice is applied, and amount of dentifrice applied to the brush. It is well established that the frequency of use has a major influence on effectiveness. Bushing twice perday or more has a greater preventive effect than once perday. Length of the brushing time (application phase) determines how long the relatively high fluoride concentration in the dentifrice slurry stays in contact with the teeth and plaque, allowing fluoride uptake to take place. The higher the fluoride concentration, the greater the driving force for fluoride diffusion through plaque toward the tooth surface. Rinsing behaviors after toothbrushing affect the amount of fluoride retained in the mouth and have been reported to affect caries experience. Physiologic (biological) factors, mainly salivary flow rate during and after fluoride application influence the rate of fluoride clearance. Bedtime use of fluoride dentifrice results in longer fluoride retention than daytime application due to greatly decrease salivary flow during sleep. The amount of fluoride applied to the toothbrush (dose) is not as important as the concentration of available fluoride in a dentifrice. Reduced fluoride concentration dentifrices are not as effective as regular concentration products. The fluoride dose is, however, important in regard to enamel fluorosis in children under six years of age because of dentifrice ingestion. For this reason, reducing the amount of fluoride applied is a better strategy than lowering the dose of products intended for use by children.

4. Mouthrinses (Mouthwash)

A mouthwash is defined as a nonsterile aqueous solution used mostly for its deodorant, refreshing or antiseptic effect. Mouthwashes or rinses are designed to reduce oral bacteria, remove food particles, temporary reduce bad breathe and

provide a pleasant taste. Many types of mouthrinse active ingredients have been evaluated for their plaque reducing effectiveness and ability to reduce mutans streptococci, including chlorhexidine, essential oils, triclosan, cetylpyridinium chloride, sanquinarin, sodium dodecyl sulphate, and various metal ions (tin, zinc, copper).

Mouthrinses are generally classified by FDA as either *cosmetic* or *therapeutic* or a *combination of the two*. The cosmetic mouthrinses are over-the-counter products that are mainly intended as mouth fresheners. Therapeutic rinses are available on prescription or over-the counter products that have an added active ingredient and are marketed as antiplaque/antigingivitis and anticaries drug products.

Cosmetic rinses are commercial over-the-counter products that help remove oral debris before or after brushing, temporary suppress bad breath, diminish bacteria in the mouth and refresh the mouth with a pleasant taste.

Therapeutic rinses often have the benefits of their cosmetic counterparts, but also contain an added active ingredient, for example. fluoride or chlorhexidine, that help protect against some oral diseases.

The amount of the different components in mouthwashes varies from product to product.

Some practically have the same composition as toothpastes, although they do not contain abrasives. Distinct from toothpastes most mouthrinses contain alcohol, as a preservative and a semiactive ingredient. The amount of alcohol is usually ranging from 18 to 26 percent.

Mouthrinse formulations are generally much simpler than dentifrices, and compatibility problems are not as large an issue as they are with dentifrice products.

The oldest and simplest used mouthrinse has been a dilute saline solution.

Ideal properties of oral rinses include the following:

- Safety
- Access to bacteria even in difficult areas
- Palatability
- Low-cost
- High solubility within the formulation
- Effective antibacterial impact
- Broad spectrum preferably
- Selectivity
- Adequate bioavailability (plaque penetration and reactivity)
- Specificity with regard to oral bacteria
- Minimal side effects
- Ability to reach and provide adequate retention in sites of disease initiation
- Stability in storage

Ingredients

Humectant: For example, sorbitol and glycerin to prevent drying.

Surfactant: Helps to keep ingredients in solution.

Alcohol: To enhance antibacterial activity and taste. Also to help keep flavoring agents in solution.

Antibacterial agents: The most commonly used antimicrobial agent is the quaternary ammonium compounds such as cetylpyridinium chloride, benzethonium chloride and povidine-iodine, sodium lauryl sulphate, zinc citrate trihydrate, triclosan, metal salts.

Sweetening agents: saccharin

Flavoring agents: Spearmint, peppermint, eucalyptus and menthol are often used as flavoring agents mouthwashes. The flavoring agents are solubilized and dispersed through liquid via the detergent.

Therapeutic Rinses

Fluoride containing: Sodium fluoride [NaF] mouthrinse has been used as 0.2 percent for weekly rinse and 0.05 percent for daily rinsing. It is the most widely used fluoride rinse because of its low cost, convenience in handling and pleasant taste.

Chlorhexidine Rinses

Chlorhexidine digluconate, useful in decreasing gingivitis and plaque buildup, is an active ingredient in certain ADA-approved commercial mouthrinses. It is one of two mouthrinse shown to reduce gingivitis in long-term clinical trials and appears to be the most effective antiplaque and antigingivitis agent known today.

But since the effect of chlorhexidine is influenced by anionic tensides such as sodium lauryl sulphate, when using a toothpaste containing sodium lauryl sulphate you should wait for at least 30 minutes between brushing and rinsing with a CHX mouthrinse.

CHX 0.2 percent is suitable as supportive measure during treatment of gingivitis and periodontitis, but it should not be used for longer than two weeks. After this, however, it is important to restore healthy oral flora.

5. Rubber Tip Stimulator

It consists of a conical, flexible, rubber or plastic tip attached to a handle or to the end of a toothbrush. Rubber or plastic tips are recommended for gingival stimulation and for plaque removal in open embrasures. When using these devices for plaque removal, the tip is placed at a 90° angle in the interdental area next to the gingival margin (Fig. 26.31). The tip is then moved with a sweeping motion from the gingival margin toward the incisal edges or moved from buccal to lingual using short back and forth strokes. Patients should be careful not to traumatize the tissue with the tip.

Indications

1. Type II and Type III embrasures.
2. Reshape or recontour the gingiva following periodontal surgery.

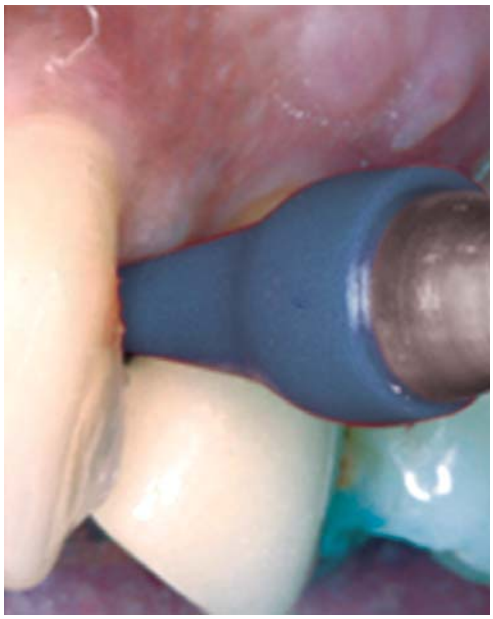


Fig. 26.31: Rubber tip stimulator

3. Exposed furcations.
4. To increase epithelial keratinization of the interdental tissue.

Contraindications

1. Type I embrasures.
2. Healthy gingiva.

Disadvantage

It can cause tissue trauma specially when used with excessive pressure.

6. Denture Brush

These have been designed with firm nylon filaments to clean dentures. Because the prosthesis is removable and cleaned outside the mouth, the firmer filaments do not cause destruction of gingival tissues. Some have double-end. Flat side is used for cleaning the tooth side of the denture and the pointed bristle end for tissue side. Preferably used with nonabrasive denture paste to avoid scratching (Fig. 26.32).

DISCLOSING AGENTS

Disclosing agents are materials used to make the presence of plaque biofilm visible. Since dental plaque is white, it cannot easily be identified particularly if it is not thick enough. A disclosing agent stains dental plaque and thus makes it fully evident to the individual (Fig. 26.33). They are available in liquid or tablet form (Figs 26.34 and 26.35). *Solutions* can be applied as a concentrate with a cotton swab or diluted with water in a cup to be used as an oral rinse. *Tablets* are chewed

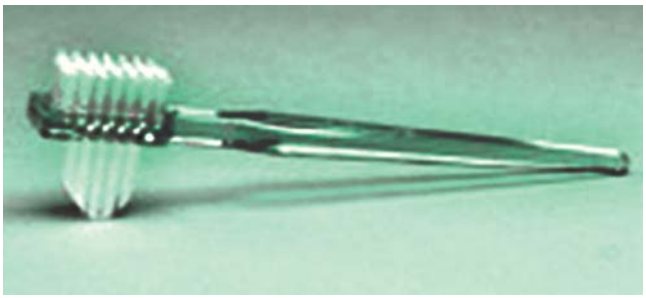


Fig. 26.32: Denture brush



Fig. 26.33: Disclosed supragingival plaque after using disclosing agent



Fig. 26.34: A bottle of 2-tone solution



Fig. 26.35: Plaque disclosing tablets (*Courtesy* Oral-B)

and swished around in the mouth. Pellicle, plaque, debris and calculus absorb the disclosing agent.

Ideal requirement of a disclosing agent:
1. It should distinctly stain only the plaque.
2. It should have a pleasant taste.
3. It should be biocompatible.
4. Preferably it should stain new and old plaque in different colors for identification.
5. The color should remain in the plaque for about 15-30 minutes (instruction period) and should not be removed by saliva.
6. It should have antiseptic and astringent properties.

Chemicals Used as Disclosing Agents

A. Iodine solutions
B. Erythrosine
C. Basic fuchsin
D. Fast green — FD&C Green No-2.5 percent or 3.5 percent
E. Bismark Brown
F. Mercurchrome preparations
   1. Mercurochrome solution (5%)
   2. Flavored mercurochrome disclosing solution
G. Merbromin
H. Fluorescein FD&C Yellow No 8.
I. 1-3 Tetrazolium compound with methylene blue.
J. 2-Tone
   FD&C Green No 3 and FD&C Red No 3
   FD&C — Food Drug and Cosmetic.

Interpretation

- Clean tooth surfaces do not absorb any colouring agent.
- When pellicle and dental biofilm are present they absorb the disclosing agent and become stained.
- Pellicle stains as a thin relatively clear layer and dental biofilm appears darker, thicker and more opaque.
- 2-Tone disclosing solution stains:
- Red—newly formed biofilm usually supragingival and is thin.
- Blue—older biofilm which is thicker and more tenacious usually seen at and just below the gingival margin, specially on proximal surfaces. It may be associated with calculus deposit.

Uses

1. Patient instruction and motivation.
2. Self evaluation.
3. To carry out plaque index.
4. To evaluate the effectiveness of oral hygiene maintenance.
5. In research, to evaluate the effectiveness of plaque control devices like dentifrices, toothbrushes, etc.

Contraindications

1. Should not be used on teeth with glass ionomer and resin filling to prevent the staining of these filling.
2. Should not be used in patients with known allergy to any type of disclosing agent.

CHEMICAL PLAQUE CONTROL

Chemical Plaque Control

Although, mechanical removal of plaque biofilm remains the most widely accepted mechanism for plaque control, the bacterial etiology of periodontal disease justifies supportive use of antimicrobial agents. Success of local drug delivery system to treat periodontal infection depends upon;
1. Delivering the antimicrobial agent to the site of action.
2. Maintaining a bacteriostatic or bactericidal concentration.
3. Maintaining the agent at the diseased site for a sufficient duration of time.

Chemical control of plaque deposition may be achieved in a number of ways:
1. Suppression of the oral flora.
2. Inhibition of bacterial colonization of the tooth surface.
3. Inhibition of plaque-forming factors, e.g. dextran
4. Dissolution of established plaque.
5. Prevention of mineralization of plaque.

VEHICLES FOR DELIVERY OF CHEMICAL AGENTS

The carriage of chemical agents into the mouth for supragingival plaque control involves a varied range of vehicles. These include:
1. *Toothpaste*: It is the ideal vehicle for the carriage plaque control agents by virtue of its common usage.
2. *Mouthrinses*: A mouthwash is defined as a nonsterile aqueous solution used mostly for its deodorant, refreshing or antiseptic effect. Mouthwashes or rinses are designed to reduce oral

bacteria, remove food particles, temporary reduce bad breathe and provide a pleasant taste. Most chemical plaque control agents are formulated as mouth rinse. They usually require the addition of flavoring, coloring agents and preservatives such as sodium benzoate. Ethyl alcohol is commonly used both to stabilize certain active ingredients and to improve the shelf life of the product.

Mouth washes are commonly mixtures of:

- *An antibacterial agent:* 0.2 percent chlorhexidine gluconate appears to be the most effective. Quaternary ammonium salts are frequently used, e.g. cetylpyridinium chloride.
- Alcohol is used to enhance antibacterial activity and taste, and to help keep flavoring agents in solution.
- A humectant, e.g. Sorbitol to prevent drying out.
- A surfactant, which helps to keep ingredients in solution.
- Flavoring and coloring agents.
- Preservatives.
- Water as the vehicle.

Concerns over the possible association of alcohol intake and pharyngeal cancer have been extended to include alcohol containing mouth rinses. When correctly prescribed the risk from contained alcohol is probably minuscule.

3. *Spray*: Sprays have the advantage of focusing delivery on the required site. The dose is hence reduced and for antiseptics such as chlorhexidine this has taste advantage. Chlorhexidine sprays were found particularly useful for plaque control in physically and mentally groups.
4. *Irrigators*: These were designed to spray water, under pressure, around the teeth. As such they only removed debris, with little effect on plaque deposits. Antiseptics and other chemical plaque control agents such as chlorhexidine have been added to the reservoir of such devices. Taste disturbances a known side effect of chlorhexidine can be reduced by reducing the concentration of chlorhexidine and to achieve an effective dose an oral irrigator can be used to deliver larger volumes.
5. *Chewing gum*: Chewing gum has been employed to deliver a variety of agent for oral health benefits. There appears to be significant benefit to dental health through the use of sugar-free chewing gum. Chewing gums alone appear to have little benefits in plaque control, but when used as an adjunct to normal tooth brushing reduction in plaque levels has been seen.

   The use of sugar-free chewing gum as a mechanical salivary stimulant after eating can accelerate the clearance of dietary substances and microorganisms, promote buffers to neutralize plaque acids and provide antibacterial substances. Chewing sugar-free gum for about 20 minutes after eating reduces the fall in plaque pH . This action reduces the time for demineralization and enhances the potential for remineralization of early carious lesions. The saliva flow rate is stimulated three to ten folds above the resting level and may be prolonged for over 30 minutes.

   This approach may enhance saliva function in those with low flow rates such as elderly sufferers of xerostomia or provide symptomatic relief from dry mouth. However, effects on gingivitis or calculus formation have not been demonstrated. The popularity of sugar-free chewing gums offers convenient delivery for chemotherapeutic agents. Gums promote salivation and require hydration to release the agent, which can then be effective for longer periods of time than rinses or dentifrices. Clinical studies with CHX acetate (Chlorhexidine) or CHX-xylitol chewing gums used twice daily showed CHX is released after chewing and can reduce plaque and gingivitis. However, the widespread clinical value of these formulations for the prevention of gingivitis awaits epidemiological studies. A popular non-cariogenic sugar substitute, the sugar alcohol xylitol, also has antibacterial action, reducing plaque acidogenicity following a sucrose rinse and reducing mutans streptococci levels. Gum containing sodium fluoride (0.25mg fluoride) can release fluoride and promote salivation, complementing fluoride dentifrices and rinses in patients with xerostomia or rampant caries. The fluoride released tends to accumulate on the chewing side rather than distributing around the oral cavity.
6. *Varnishes*: Varnishes have been used to deliver antiseptics including chlorhexidine, but mainly used to prevent root caries rather than as a reservoir for plaque control throughout the mouth.

ANTIBIOTICS

Despite evidence for efficacy in preventing caries and gingivitis, antibiotics should not be used either topically or systemically as preventive agents against these diseases. The risk-to-benefit ratio is high. Antibiotics have their own side effects not all of which can be avoided by topical application. Most important among those is the development of bacterial resistance and hypersensitivity reactions.

ENZYMES

They fall into two groups:

a. Those in first group are not truly antimicrobial agents but more plaque removal agents as they have the potential to disrupt the early plaque matrix, thereby dislodging bacteria from the tooth surface,e.g. dextranase, mutanase and various protease. Such agents had poor substantivity and had local side effects such as mucosal erosion.
b. The second group of enzymes employed glucose oxidase and amyloglucoxidase to produce hydrogen peroxide from dietary fermentable carbohydrates. The aim was to catalyze the conversion of endogenous and exogenous thiocynate to hypothiocynate via the salivary lactoperoxidase system. The hypothiocynate produces inhibitory effect upon oral bacteria, particularly streptococci, to interfere with their metabolism.

GROUPS OF AGENTS USED IN THE CONTROL OF DENTAL PLAQUE / GINGIVITIS

	Group	*Agents*	*Action*
1.	Antibiotics	Penicillin Vancomycin Kanamycin Niddamycin Spiromycin	Antimicrobial
2.	Enzymes	Protease Lipase Nuclease Dextranase Mutanase Glucose oxidase	Plaque removal Antimicrobial
3.	Bisguanides	Chlorhexidine Alexidine Octenidine / bispyridines	Antimicrobial
4.	Quaternary ammonium compounds	Cetylpyridinium chloride Benzalconium chloride Benzethonium chloride	Antimicrobial
5.	Phenols and essential oils	Listerine Hexylresorcinol Eucalyptol Thymol Triclosan	Antimicrobial Anti-inflammatory
6.	Natural products	Sanguinarine	Antimicrobial
7.	Metal salts	Tin Zinc Copper	Antimicrobial
8.	Amine alcohols	Octapinol Delmopinol	Plaque matrix inhibition
9.	Oxygenating agents	Hydrogen peroxide	Antimicrobial
10.	Fluorides	Sodium fluoride Sodium monofluorophosphate Stannous fluoride	Antimicrobial

PHENOLS AND ESSENTIAL OILS

Phenols and essential oils have been used in mouth rinses and lozenges for many years.

Triclosan is a noncationic, chlorinated phenol. It was widely used in number of medicated products including soaps, and recently it has been formulated into toothpaste and mouth rinses. In simple solutions, at a relatively high concentration (0.2%) and dose triclosan has moderate plaque inhibitory action.

The activity of triclosan appears to be enhanced by the addition of zinc citrate or the copolymer, polyvinylmethyl ether maleic acid. The copolymer appears to enhance the retention of triclosan whereas the zinc is a highly substantive antimicrobial agent and it is formulated with citrate to reduce its metallic taste. When combined with triclosan it exhibits synergistic action. Triclosan and copolymer dentifrices reduce plaque by 12 to 59 percent and gingivitis by 20 to 30 percent.

Listerine is an essential oil mouthrinse and it is a mixture of three phenolic-derived essential oil- thymol, menthol and eucalyptol combined with methylsalicylate in a hydroalcoholic vehicle.

Mechanism of action appears to be related to alteration of the bacterial cell wall. It has got moderate antiplaque and antigingivitis effects.

Side effects include burning sensation, bitter taste and staining.

Administration and Use

It is recommended that a person rinse for 30 seconds with half ounce of listerine after brushing and flossing twice a day. It is advised to the patients with extensive fixed prosthesis, implants, overdentures, splinting, orthodontics, individuals with poor manual dexterity.

Due to its high alcohol content (original listerine formula contains 26.9% alcohol) it should not be recommended for person with xerostomia, children, or persons on medications that interact with alcohol.

QUATERNARY AMMONIUM COMPOUNDS

Benzylconium chloride and cetylpyridinium chloride are the most studied of this family of antiseptics. Cetylpyridinium is used in a variety of antiseptic mouthrinse either alone or in combination at a concentration of 0.05 percent. At oral pH these antiseptics are monocationic and absorb readily and quantitatively to a greater extent, than chlorhexidine to oral surfaces. But the substantivity cetylpyridinium chloride appears to be only 3 to 5 hours.

Mechanism of Action

It is related to increased bacterial cell wall permeability that favors lysis, decreased cell metabolism, and a decreased ability for bacteria to attach to tooth surfaces. These agents are categorized as cationic, which favors their attraction to tooth surfaces and bacterial plaque.

BISBIGUANIDE ANTISEPTICS

Chlorhexidine is by far the most studied and most effective antiseptic for plaque inhibition and the prevention of gingivitis. Other bisbiguanides such as alexidine and octenidine have similar activity but bring with them no improvement in local side effects and have less toxicity data available.

Chlorhexidine

It is a bisbiguanide (Fig. 26.36), developed in 1940's by Imperial Chemical Industries, England and marketed in 1954 as an antiseptic for skin and mucous membrane. Plaque inhibition by chlorhexidine was first investigated in 1969 by Schroeder, but a definitive study was performed by Loe and Schiott in 1970. Now, it is the most effective antiplaque and antigingivitis agent approved for clinical use. It has been shown to reduce plaque by 55 percent and gingivitis by 45 percent. It is available as 0.12 percent solution and 0.2 percent solution. It is more effective in preventing plaque accumulation on a clean tooth surface than in reducing pre-existing plaque deposits.

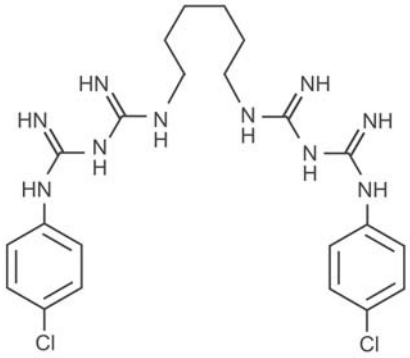


Fig. 26.36: Structure of chlorhexidine

Substantivity of Chlorhexidine

The ability of drugs to absorb onto and bind to soft and hard tissues is known as *substantivity*. Substantivity is influenced by the concentration and pH of the medication, temperature and length of time of contact of the solution with the oral structures. This property of chlorhexidine is associated with its ability to maintain effective concentrations for a prolonged period of time. Chlorhexidine remains available in an active form for 8 to 12 hours in the mouth.

Mode of Action

The mode of action of chlorhexidine is to bind to hydroxyapatite and glycoprotein to prevent pellicle formation. The antiseptic binds strongly to bacterial cell membranes. At low concentration this results in increased permeability with leakage of intracellular components including potassium.

At high concentration, chlorhexidine causes precipitation of bacterial cytoplasm and cell death. It also absorbs to the bacterial cell surface and may interfere with cell attachment.

Administration and Use

Chlorhexidine mouthwashes available in UK contain 0.02 percent chlorhexidine and 10 ml volume per rinse is recommended, and in USA they contain 0.12 percent chlorhexidine and recommended as a 15 ml volume per rinse. The effectiveness of these mouthwashes is based on the dose of chlorhexidine delivered. 10 ml of 0.2 percent solution delivers 20 mg and 15 ml of 0.12 percent solution delivers 18 mg, both of these amounts are above the therapeutic dose and hence equally effective.

It is recommended that the individual should rinse for 60 seconds after brushing and flossing twice a day. The person should allow at least 30 minutes between toothbrushing and rinsing because of interaction (and inactivation) between chlorhexidine and sodium lauryl sulfate, a common ingredient in dentifrices. Patient should not rinse with water immediately after it is used.

Side Effects

Chlorhexidine has been reported to have a number of side effects. Majority of side effects are of local nature. These side effects are:

1. Brown discoloration of the teeth, margins and surface of composite and glass ionomer restorations.
2. Unpleasant taste and disturbance in taste sensation.
3. Brown discoloration of dorsum of tongue, due to interaction between locally adsorbed chlorhexidine and factors derived from diet such as tannin-like substances in red wine, tea and coffee.
4. Unilateral or bilateral parotid swelling [mechanical obstruction of parotid duct]. An extremely rare occurrence.
5. Desquamative lesion of oral mucosa in some individuals.
6. Enhanced supragingival calculus formation. This effect may be due to the precipitation of salivary proteins on to the tooth surface, thereby increasing pellicle thickness and/or precipitation of inorganic salts on to the pellicle layer.

Chlorhexidine Products

Chlorhexidine has been formulated into a number of products such as:

1. *Mouthwashes:* Available as 0.12 percent and 0.2 percent mouthrinses.
2. *Gel:* Available as 1 percent gel for use with tooth brush or in trays. Now available as 0.2 percent and 0.12 percent gels.
3. *Sprays:* 0.1 percent and 0.2 percent chlorhexidine in sprays are available. Specially useful for physically and mentally handicapped groups and care givers.
4. T*oothpaste:* Difficult to formulate into toothpaste but 1 percent chlorhexidine toothpaste has been formulated.
5. *Varnishes:* Chlorhexidine varnishes has been used mainly for prophylaxis against root caries.
6. *Chewing gum:* Chlorhexidine has also been incorporated into a sugar-free chewing gum.

NATURAL PRODUCTS

Sanguinarine, a benzophenathridine alkaloid is an alcohol extract from the root of the plant Saguinaria canadensis or bloodroot. Sanguinarine contains the chemically reactive iminium ion which is probably responsible for its activity.

The activity of sanguinarine is attributed to its ability to interfere with bacterial glycolysis and bind to plaque to prevent adherence of microorganisms. It is less active than chlorhexidine and no side effects are seen. Zinc salts are also added, which makes it difficult to evaluate the efficacy of sanguinarine alone. Mouthwash is a much more effective plaque-inhibitory agent than the toothpaste. Effectiveness is enhanced when both the mouthrinse and the dentifrices are used. Recently, sanguinarine containing mouthrinse have shown to increase the likelihood of oral precancerous lesions almost ten folds even after cessation of mouthrinse use.

METAL SALTS

A number of metal ions have been studied for their effect on plaque. Zinc, copper and tin have shown to possess plaque inhibitory effects but are dependent on its concentration. Essentially, polyvalent metal salts alone are effective plaque inhibitors at relatively high concentration when taste and toxicity problems may be of concern. Both copper and tin suffer from local side effects such as staining. Zinc and other metal ions have shown synergistic effect when combined with other antiseptics like triclosan and sanguinarine. Copper also causes dental staining but is not available in oral hygiene products. Zinc alone has little or no effect on plaque except at higher concentration. At low concentrations, it has no side effects and is used in a number of toothpaste and mouth rinses.

AMINE ALCOHOLS

Several substituted amine alcohols have been shown to inhibit plaque inhibition such as octapinol hydrochloride. *Octapinol* was an effective antiplaque agent but was withdrawn for toxicological reasons.

Delmopinol

Studies on delmopinol hydrochloride both in *vitro* and *in vivo* have shown that it inhibits plaque growth and reduces gingivitis. Delmopinol at 0.1 percent and 02 percent in mouthrinse was shown to be effective plaque inhibitor. The mode of action of delmopinol appears to be the inhibition in formation or disruption of the matrix of early plaque forming bacteria. Side effects include tooth discoloration, transient numbness of the mucosa (particularly tongue) and burning sensation of the mouth.

Oxygenating Agents

Oxygenating agents such as hydrogen peroxide and buffered sodium peroxyborate and peroxycarbonate in mouthrinses have a beneficial effect on acute ulcerative gingivitis. Studies have shown no beneficial effects on reduction in bacterial plaque and gingivitis. Safety is also a concern as chronic use of hydrogen peroxide causes serious side effects such as carcinogenesis, tissue damage, hyperkeratosis, oral ulceration and hyperplasia.

FLUORIDES

Stannous Fluoride

It has more antiplaque properties than sodium fluoride. It is the stannous ion, not the fluoride, which is responsible for antimicrobial effect. Tin from the stannous ion enters the cell,

impairs the metabolism and affects the growth and adherence properties of bacteria. Increased tooth staining and weak antiplaque activity significantly limit the potential application of stabilized stannous fluoride formulations. Stannous fluoride is also available in a gel formulation.

ORAL HYGIENE PROMOTION

Oral hygiene promotion involves any combination of educational, organizational, economic and environmental supports for behavior conducive to oral health. Health promotion involves more than health education. Health education is transmission of the knowledge and skills to maintain a healthy lifestyle and improve quality of life. Promotion also includes manipulation of the environment of a population to favor health. The maintenance of oral health requires a motivated patient. Although, the dental profession has the knowledge to virtually prevent and control caries and periodontal disease, these diseases are still universally prevalent. The failure to integrate these health messages with community programs and a lack of uptake of these messages has resulted in inadequate information. Although, the first step is awareness at individual and community levels, providing knowledge on oral hygiene and health alone is not enough to alter behavior and requires individual motivation.

To motivate a person, the message should be relevant to their condition, be from a reliable source, command attention (for example, demonstrating plaque and gingival bleeding in a mirror), and be positive and reinforced or rewarded. Patients revert to previous habits in the postinstruction period and reinforcement is essential.

To motivate a population, public policy and community programs to change social attitudes, encourage self-care and increase awareness of the benefits of good oral hygiene are required. The media could enhance public awareness and oral health should be incorporated into general health education programs to have more impact, be continuous (not limited to brief campaigns) and stress upon tooth cleanliness as part of body hygiene. The role of the mouth in social interaction can be a strong motivator to encourage oral hygiene to maintain oral health.

Promoting Oral Hygiene to Children

Childhood, particularly the preschool years, is a critical time to learn oral hygiene skills. If oral hygiene skills are acquired and maintained in early childhood, these skills can become established habits and are less liable to change. Mothers play a key role in the development of the oral hygiene habits of their children and it is essential that parents be dentally aware. For example, teaching pregnant or nursing mothers the importance of oral hygiene through prenatal classes, home health visitors, nurses, midwives and auxiliaries at child health centers and hospitals can establish sound oral hygiene practices later in childhood and adolescence.

As children spend much time in school, teachers can assist with dental health education programs. These programs have proven successful in improving knowledge and motivating oral hygiene practices via activities such as group participation, coloring/activity books, films, interactive computer programs and parent-child information sessions. Behavioral modeling by authority figures in a child's life such as a teacher, dentist, auxiliary or sibling can be a powerful tool.

Community dental health programs using theater and festive environments can be effective means of positively influencing and improving the oral hygiene practices of children and teens. Health booths could include active participation and entertainment in association with educational components and could contain literature, toothbrushes, toothpaste, floss and stickers. Children's dental health shows could be arranged for schools. Regular oral hygiene segments could be included in children's TV entertainment, using original approaches to oral health promotion.

During adolescence, oral hygiene habits tend to remain stable. The parents play a dominant role. Dentists and the media can be influential, while peer groups and school play a lesser role. Many adolescents brush their teeth for cosmetic reasons and to feel clean and their oral hygiene habits are strongly influenced by lifestyle and social behavior. Oral health advice must be adapted and individualized to accord with these influences.

Oral Hygiene Promotion to Adults and the Elderly

Interaction with colleagues and peers may positively influence an individual's personal oral hygiene measures. Government or employer sponsored workplace oral hygiene promotion programs could be incorporated into overall health programs. These programs should foster continuity and reinforcement of oral hygiene education, skills development and confidence in choosing oral hygiene approaches.

Nowadays older populations retain more of their teeth, hence the greater is the possible impact of periodontal diseases and caries. Older people are less likely to have received preventive education early in life when the establishment of oral hygiene habits is most efficacious. These habits are more resistant to change in later life. In the elderly, the consequences of poor oral hygiene can lead to poor oral health, reduced dietary intake, malnutrition, embarrassment, social withdrawal and depression.

Elderly patients may not associate oral health with general health and the oral hygiene practices of many elderly do not extend beyond toothbrushing.

Oral health promotion programs, therefore, must focus on enhancing older people's perception of the importance of oral health by helping them integrate dental knowledge into their belief systems. Oral health education of the elderly requires special attention and more time should be allowed for them to absorb new ideas and make decisions.

Teaching new skills using multiple presentation modes and slow, clear verbal instructions accompanied by simple, written steps should be tailored to the individual's capabilities and level of dependency. For the active elderly, programs should be conducted in social environments such as social clubs, recreational centers, libraries, medical centers and old age homes. Older people's accessibility to dental services is another factor that needs to be addressed. Successful oral health education programs should be based on older people's lifestyles at readily accessible forums.

Incorporation of oral hygiene issues into senior citizen health promotion programs/campaigns could be encouraged through liaison with community resource staff. For carers, improved training and education in oral hygiene is essential.

Oral Hygiene Promotion to the Community

At the community level, health promotion attempts to reduce inequalities and maximize health opportunities for all. Health promotion programs must take into account the characteristics, abilities and lifestyle of the community, with realistic expectations. Strong working relationships between planning and implementation groups, the dental profession, schools, community and health organizations and government departments are essential for coordinated action in health promotion. The removal of financial barriers will foster equity and it is essential to make available reduced cost product for low income earners. Industry donation of oral hygiene products and resources, development of educational materials and an upto date and accurate oral hygiene web-based information system should be there. The oral hygiene messages should be scientifically based and consistent across related disciplines (for example, dietary messages for oral health must agree with dietary messages for general health.

To promote healthy periodontal and dental tissues, current mechanical and chemotherapeutic approaches to oral hygiene aim to modify the oral microflora. Current oral hygiene measures, appropriately used in conjunction with regular professional care, are capable of virtually preventing caries and most periodontal disease and maintaining oral health. The challenge for oral hygiene promotion is effective delivery of these measures combined with effectual motivation of individuals and communities to aspire to oral health.

ORAL PROPHYLAXIS

The technical term is *oral prophylaxis,* which means prevention of oral disease. One way to prevent oral disease is to remove harmful plaque and tartar (calculus) both above and below the gumline.

Oral prophylaxis refers to those specific treatment procedures aimed at removal of local irritants to gingiva including complete removal of calculus and bacterial debridement.

The oral prophylaxis should consist of supragingival and subgingival (below the gumline) removal of plaque, calculus, and stain. The dental hygiene process (assessment, diagnosis. planning, implementation, evaluation) should be employed when delivering the oral prophylaxis.

Oral prophylaxis sometimes referred to as teeth cleaning. This involves scaling the removal of hard calculus deposits above (supragingival) and below (subgingival) the gumline. These deposits aid the development of the bacterial colonies that cause periodontal (gum) disease, and can cause loose teeth and root decay.

The American Academy of Periodontology presents the most comprehensive definition of the oral prophylaxis as the "removal of plaque, calculus and stain from exposed and unexposed surfaces of the teeth by scaling and polishing as a preventive measure for the control of local irritational factors".

The oral prophylaxis is performed on patients with normal, healthy mouths to maintain health and prevent the initiation of dental diseases.

A dental prophylaxis is performed not only to clean the teeth, but also to evaluate the oral cavity for any other problems that might be present. The cleaning not only includes what you can see, but also the area under the gumline, which is the most important part. In addition, if the teeth are not polished, which as we know will leave the cleaned surface rough and increase the adherence of plaque bacteria and hasten dental disease.

STEPS IN ORAL PROPHYLAXIS

Step 1: Supragingival Cleaning

This is cleaning the area above the gumline. It is usually accomplished by mechanical scalers. This increases the speed that the cleaning can be performed.

Step 2: Subgingival Cleaning

This is cleaning the area under the gumline. The subgingival plaque and calculus is what causes periodontal disease. This is the most common ailment diagnosed in all patients.

Step 3: Polishing

The mechanical removal of the plaque and calculus causes microscopic roughening of the tooth surface. This roughening increases the retentive ability of the tooth for plaque and calculus, which will build-up faster and increase the rapidity of periodontal disease progression. Polishing will smooth the surface and decrease the adhesive ability of plaque.

Step 4: Subgingival/Sulcal Lavage

The scaling and polishing of the teeth will cause a lot of debris to become trapped under the gums. This will cause local inflammation, as well as increase the chance of future periodontal disease. For this reason the gingiva is gently flushed with an antibacterial solution, or if periodontal disease is present, saline solution is used.

Step 5: Fluoride Treatment

This is the use of fluoride foam to impregnate the teeth with fluoride. The benefits of fluoride are that it hardens the dentin, decreases tooth sensitivity and anti-plaque.

Step 6: Treatment Planning

This step is where the teeth and entire oral cavity are evaluated, using not only our eyes, but a periodontal probe to determine if there is a periodontal pocket. Finally, dental radiographs are taken to determine the extent of the disease process present. Using, all of these modalities, a plan is developed to re-establish the patient's oral health.

Step 7: Dental Charting

All of the pertinent oral findings and treatment rendered and planned in the future is placed on a dental chart in the patient's permanent medical record. This will allow the dentist to follow the patient's progress (or regression) through the years.

These are the steps that are followed to ensure that the patient leaves with a clean mouth. However, dental care does not end there. Within 24 hours, plaque has already started to form on the teeth, and the periodontal disease process starts over. This is where home care comes in.

27 Diet and Dental Caries

CM Marya

Dental caries is a highly prevalent chronic disease and its consequences cause a lot of pain and suffering. A dynamic relation exists between sugars and oral health. Diet affects the integrity of the teeth; quantity, pH, and composition of the saliva; and plaque pH. Sugars and other fermentable carbohydrates, after being hydrolyzed by salivary amylase, provide substrate for the actions of oral bacteria, which in turn lower plaque and salivary pH. The resultant action is the beginning of tooth demineralization (Fig. 27.1).

Dental caries occurs due to demineralization of enamel and dentine by organic acids formed by bacteria in dental plaque through the anaerobic metabolism of sugars derived from the diet. Despite improved trends in levels of dental caries in developed countries, dental caries remains prevalent and is increasing in developing countries undergoing nutrition transition.

Sucrose and starches are the predominant dietary carbohydrates in modern societies. While the causal relationship between sucrose and dental caries development is indisputable, the relationship between food starch and dental caries continues to be debated.

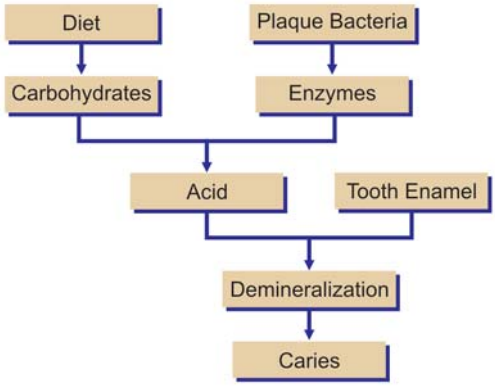


Fig. 27.1: The caries mechanism

ROLE OF DIET

There is abundant epidemiological evidence that dietary sugars are the major dietary factor affecting dental caries prevalence and progression.

Sugars, particularly sucrose, are the most important dietary etiological cause of caries. Both the frequency of consumption and total amount of sugars is important in the etiology of caries. The evidence establishing sugars as an etiological factor in dental caries is overwhelming. Caries is associated with increase in the proportions of acidogenic and acid tolerant bacteria, especially Streptococcus mutans. These bacteria are able to rapidly metabolize dietary sugars to acid, creating locally a low pH. They grow and metabolize optimally at low pH and under such conditions become more competitive, whereas most bacterial species associated with enamel health are sensitive to acidic conditions. It is indisputable that mutans streptococci's role in caries development is conditional upon a frequent intake of fermentable sugars. (Fermentable carbohydrate: any carbohydrate that can be hydrolyzed by salivary amylase in the initial stage of carbohydrate digestion and subsequently fermented by bacteria).

Streptococcal mutans are able to rapidly metabolize dietary sugars to acid, creating locally a low pH. High frequency of fermentable carbohydrate intake with regular pH drops favors the proliferation of mutans streptococci and there is a direct effect of sucrose on the numbers of these micro-organisms in the mouth. As the pH falls, calcium and phosphate ions are lost from the enamel. The drop in pH below 5.4, the critical pH, is sufficient to decalcify enamel and dentine.

Sucrose appears to be the most cariogenic sugar, (Cariogenic: foods and drinks containing fermentable carbohydrates that can cause a decrease in plaque pH to <5.5 and demineralization of underlying tooth surfaces) not only because its metabolism produces acid, but also because

MS (Mutans streptococci) utilize this sugar to produce the extracellular polysaccharide glucan. Glucan polymers are believed to enable MS to both adhere firmly to teeth and to inhibit diffusion properties of plaque.

The critical pH value for demineralization varies amongst individuals, but is in the approximate range of 5.2 to 5.5. Conversely, tooth remineralization can occur if the pH of the environment adjacent to the tooth is high due to: (1) lack of substrate for bacterial metabolism; (2) low percentage of cariogenic bacteria in the plaque; (3) elevated secretion rate of saliva; (4) strong buffering capacity of saliva; (5) presence of inorganic ions in saliva; (6) fluoride; and (7) rapid food clearance time. However, if demineralization over time exceeds remineralization, an initial carious lesion (the so-called "white spot" lesion) can develop and may further progress to a frank cavity.

ROLE OF SALIVA

Saliva is one of the mouth's natural defences against this process. Saliva promotes deposition of minerals in porous areas where demineralization of enamel or dentine has occurred (remineralization). Saliva is super- saturated with calcium and phosphate at pH-7. This favors the deposition of calcium i.e. if a demineralized lesion is formed it will be remineralized. Although this is a slow process and it competes with factors that cause demineralization. If the pH in the mouth remains high enough for sufficient time then complete remineralization of enamel may occur. But if the acid challenge is too great, demineralization dominates, causing the enamel to become more porous and resulting finally in a carious lesion. The rate of demineralization is affected by the concentration of hydrogen and fluoride ions. Caries occurs when demineralization exceeds remineralization.

The development of caries requires sugars and bacteria to occur but is influenced by the susceptibility of the tooth, the type of bacteria, quantity and quality of saliva and the time for which the fermentable carbohydrates are available for bacterial fermentation.

Complex carbohydrates such as starch interacts to a lesser extent with oral bacteria including mutans streptococci and produce less acids than sugars, suggesting that they are not as acidogenic as sucrose.

CARIES MECHANISM

Caries Mechanism

Dental caries is a simple process in concept, but complicated in detail. In outline, the caries mechanism can be described as follows:

1. Acidogenic (acid-producing) oral plaque bacteria ferment carbohydrates that are taken into the mouth, thereby producing organic acids, including lactic, formic, acetic, and propionic.
2. These acids diffuse into the enamel (Featherstone, 1983), dentine, or cementum, partially dissolving the mineral crystals (composed of carbonated hydroxyapatite (Le Geros, 1991) as they travel.
3. Mineral (calcium and phosphate) diffuses out of the tooth, leading eventually to cavitation if the process continues.
4. Demineralization can be reversed by calcium and phosphate, together with fluoride, diffusing into the tooth and depositing a new veneer on the crystal remnants in the non-cavitated lesion (this is remineralization).
5. The new mineral crystal surface is much more resistant to acid as compared with the original carbonated hydroxyapatite mineral.
6. The process of demineralization and remineralization generally occurs numerous times daily, leading either to cavitation, to repair and reversal, or to maintenance of the *status quo*.

Evidence of role of sugars in diet and dental caries by various studies—the studies providing the evidence can be by various types of studies like:

1. Human observational studies
2. Human interventional studies
3. Animal experiments
4. Enamel slab experiments
5. Plaque pH experiments
6. Incubation experiments

HUMAN OBSERVATIONAL STUDIES

These studies demonstrate the link between caries and diet.

Total Consumption

This group includes various studies which were solely based on observation in the change in DMFT count with sugar exposure. Caries experience in group of people before and after increase in sugar consumption.

- *Primitive population:* population living on starchy foods and consuming low levels of sugars had low incidence of caries and when sugar was introduced into their diet, the incidence of caries increased.
- *Eskimos :* Eskimos living on their natural diet (fish and fat) had low caries experience ,but when these populations came into contact with trading stations and had access to high sugars 'Western Diet' their dental health declined rapidly. Dental caries used to be virtually unknown but by 1977 the mean DMFS of 7-year-old was 20 and the mean DMFS of 14 years old was 19.
- *Tristan da Cunha :* The inhabitants of this remote, rocky island in the South Atlantic had diet very low in sugar prior to 1940 consisting mainly of potatoes, vegetables, meat and fish. They had a very low caries rate. After dramatic increase in consumption of imported sugary foods a steady deterioration in their dental health was seen, faster in children than in adults. Percentage of decayed teeth increased from 5 to 30%.

- *Hopewood house:* : Hopewood house is a home in New South Wales, Australia which gave shelter to 81 children of low socioeconomic background. Eighty one children of low socioeconomic background living in this home in Australia were studied. Children entered the house soon after birth and remain under close supervision until about 12 years of age. Dental examination was conducted annually between 1947 and 1962. Their diet consisted primarily of whole meal bread, biscuits, porridge, vegetables, eggs and milk. Sugars and white bread were virtually excluded from diet. Their fluoride intake was estimated to be low and oral hygiene measures were virtually absent. (Harris R;1963)
  The dental examinations were conducted annually between 1947 and 1962. The dental surveys revealed a very low prevalence and severity of dental caries; much lower than children of the same age and socio-economic back ground attending state schools in New South Wales. Up to the age of 12 years the caries prevalence was very low. 46 % of Hopewood house 12 years old children were caries free as compared to only 1% in the state school. However the rate of caries development increased in the Hopewood house children after 12 years of age when they left school and consumed a more traditional diet.
- *Hereditary fructose intolerance:* subjects with this rare hereditary condition are unable to metabolize fructose or sucrose because they do not possess a liver enzyme [Fructose1-phosphate-splitting aldolase] which causes severe nausea . Such patients never consume fructose or sucrose. It was seen that dental caries prevalence was extremely low in these persons.

HUMAN INTERVENTIONAL STUDIES

Alteration in diet was made intentionally in these studies.

Frequency and Form of Carbohydrate

Frequency means the number of times per day, the sugary foods are eaten.

Form means the physical constituency of foods. [Liquid and sticky foods]

- *The Vipeholm study:* [Gustafsson et al 1954] a total of 436 adult mental patients at Vipeholm hospital near Lund in the south of Sweden were studied over a period of 5 years. Vipeholm is a hospital for mentally deficient people located near Lund, Sweden a total of 436 adult mental patients were studied for a period of 5 years. The effect of liquid and sticky foods given at meal times and between meals on caries was observed. There was one control and six main test groups. These were: sucrose group, bread group, chocolate group, caramel group, eight-toffee group and 24- toffee group (Table 27.1).

The main conclusion was:

1. Consumption of sugars, even at high levels, is associated with only a small increase in caries increment if the sugar is taken with meals and none between meals.
2. Increase in sugar intake increases caries activity.

Table 27.1: Description of control and study groups in Vipeholm Study

Control group	*Sucrose group*	*Bread group*	*Chocolate group*	*Caramel group*	*8 toffee group*	*24 toffee group*
60 samples received low received carbohydrate and high fat diet free from sugar Caries increment was nil.	57 males received 300 grams of sugar in solution at meals	41 males and 42 females received 345 grams bread (50 grams sugar) with afternoon coffee daily for first 2 years.	47 males with 300 grams sucrose at meals during 2 years.	62 males received 22 caramels daily in two portions between meals	40 males males with low carbo- hydrate and high fat diet in first year	48 males and 39 females 24 toffees between meals during Increase in caries marked.
After 2 years- replacement to ordinary diet with 110 grams sugar/day at meal time	Reduced to 75 grams during last 2 years. Nothing in between meals.	No demonstrable increase in caries. During second 2 years, 4 portions of sweet bread daily with all meals.	Reduction to 110 gram with 65 grams chocolate milk during second 2 years.	Changed to 22 caramel in 4 portions between meals. Significant increase in caries.	Then, 8 toffees a day during break-fast and lunch in second year. Later changed to in between meals.	Third and fourth year-Greatest increase in caries increment during this time period.
Small but significant rise in caries	No significant increase in caries increment.	Significant increase in caries	Caries increment low in the initial 2 years but increased significantly in second period.	Led to the withdrawal of caramels in fifth year.	Increase in caries increment was obtained during all years with greatest during third year.	Followed by withdrawal during fifth year.

3. Consumption of sugar both between meals and at meals is associated with marked increase in caries increment.
4. The risk of caries is greater, if the sugar is consumed in form which is sticky and its oral clearance time is prolonged.
5. The increase in caries activity varies widely from person to person under uniform experimental conditions.
6. The increase in caries activity disappears on the withdrawal of the sugar rich foods.
7. Carious lesion occurred despite avoidance of sugars.

- *The Turku Sugar Study* [Scheinin and Makinen]: A clinical study was conducted in Turku Finland (1975) to study the effect of total substitution of sucrose in a normal diet with either fructose or xylitol on dental caries increment. 125 subjects were allocated to three groups; Sucrose, Fructose and Xylotol. Base line scores were same in all the 3 groups.

  Results: DMFS scores were much less in the xylitol group after 24 months.

  Rekola examined the radiographs from the turku study to consider the changes in the approximal carious lesions. It was observed that the carious lesions increased in sucrose group but no changes were obtained in the xylitol group.

  There was no difference between sucrose and fructose group regarding cariogenicity for the 1st year but sucrose was more cariogenic after 24 months.

  Conclusion: data analysis indicated that substitution of xylitol for sucrose in a normal diet resulted in very much lower caries increment of both cavities and precavitation lesions. Substitution of dietary sucrose by fructose did not lead to a clear cut reduction in caries increment.

  It was found that the only side effect of xylitol consumption appeared to be osmotic diarrhea. The symptoms had reduced in the subjects during the study and only one subject withdrew from it.
- *Palmer [1971]* demonstrated that children who had bed time snacks had higher levels of decay than those who did not.

ANIMAL EXPERIMENTS

Various animal experiments were conducted to evaluate the effect of sugar on dental caries.

These experiments show the effect of:

Frequency

A controlled feeding experiment was conducted by Konig. It was demonstrated that there was a direct relationship between the frequency of sugar consumption and occurrence of dental caries.

Result of studies clearly shows a positive correlation between frequency of taking a cariogenic diet and severity of caries. Also levels of caries severity indicated that frequency of eating a cariogenic diet is more important than the total amount of diet consumed.

Concentration of Sugar

It was obtained that the caries increment was more in the rats consuming 5 percent concentration as compared to those with 1 percent.

Studies found that caries was higher in animals receiving more concentration of sugar in diet.

Types of Sugar

The caries potential of glucose, fructose, lactose or maltose were almost same as of starch but sucrose was much more cariogenic.

ENAMEL SLAB EXPERIMENTS

Various appliances were used to hold the enamel slabs like full dentures, partial dentures and orthodontic appliances. The demineralizing or remineralizing effect of diet was assessed.

PLAQUE pH STUDIES

It has been proven by the acidogenic theory of caries that with the increase in acidogenicity of the food more demineralization of the tooth takes place. The cariogenic potential of various food items was studies by the plaque pH before, during and after food. With such studies the emphasis was given on the acidogenicity of the food than cariogenicity.

INCUBATION EXPERIMENTS

The ability of the plaque microorganisms to metabolize a test food to acid was examined. In such experiments the saliva containing the microorganisms or pure culture of microorganisms was collected in the test tube with the food to be tested and the sectioned teeth, powdered enamel or hydroxyapatite. Rapid acid production indicated the acidogenic potential of the food.

EVIDENCE

Experimental

IN VITRO: Artificial mouth-extracted teeth can be demineralized by incubating with sugar in saliva.

ANIMALS: Caries cannot be induced in germ free animals even if a carbohydrate rich diet is given to them.

If animals with an oral flora of bacteria of known cariogenicity are fed a carbohydrate rich diet, and if the diet is passed directly into the stomach by a tube the animal remains caries free.

IN VIVO: Stephan (1944) used miniature electrodes to demonstrate that a sugar mouth rinse produced a rapid fall in the pH of bacterial plaque on tooth surfaces in man.

Stephan produced the well known curve called as the '**Stephan's Curve**' which is in use today for illustrations of rapid decrease in pH after sucrose is eaten.

THE BASIC STEPHAN CURVE

The Stephan Curve describes the change in dental plaque pH in response to a challenge. The type of challenge does not matter but it is usually some element of the diet. On the other hand the challenge could be an inert substance placed in the mouth with the aim of determining its effect on plaque pH. For example: mechanical stimulation of the salivary glands caused by masticating chewing-gum base. This would be of interest in an investigation into the effect of saliva flow on the pH, while studying the changes happening in plaque after a challenge by a cariogenic food.

The characteristics of the Stephan Curve are shown in Figure 27.2, after rinsing the mouth with 10 ml of 10% sucrose solution for 10 seconds.

Characteristically the Stephan Curve reveals a rapid drop in plaque pH, followed by a slower rise until the resting pH is attained. The time course varies between individuals and the nature of the challenge.

The initial drop is usually rapid with the lowest pH being attained within a very few minutes. However, pH recovery can take anything between 15 and 40 minutes depending to a large extent on the acid-neutralizing properties of the individual's saliva.

The initial rapid drop in pH: It is due to the speed with which plaque microbes are able to metabolize sucrose. Larger carbohydrates, such as starch, would diffuse into plaque more slowly and would need to be broken down before assimilation by the microbes. In the case of starch, salivary amylase would produce a mixture of glucose and maltose together with incompletely digested material comprising the branch points of the starch molecule (limit dextrins). The glucose and maltose would then be taken up by plaque bacteria and metabolized. The rate of starch breakdown slows up glycolysis

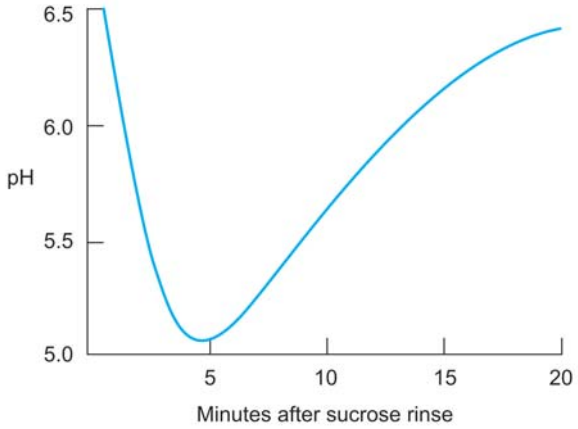


Fig. 27.2: The Stephan curve

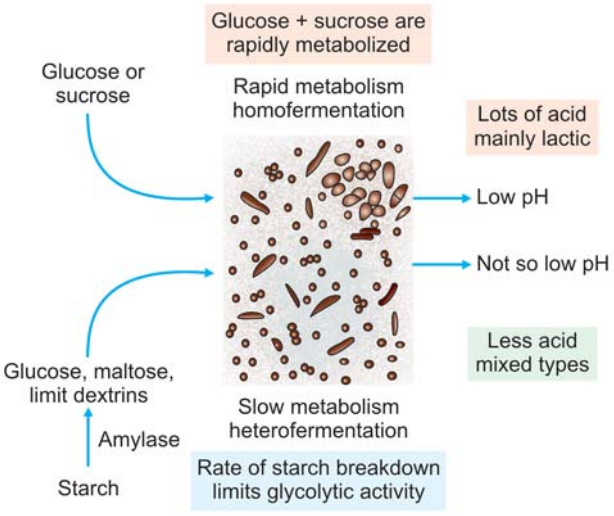


Fig. 27.3: Plaque metabolism

and, therefore, acid production producing a less steep drop in pH (Fig. 27.3).

The lowest pH achieved depends greatly on:

1. The microbial composition of the dental plaque
2. The nature of the fermentable carbohydrate source
3. The rate of diffusion of substrates and metabolites into and out of the plaque.

Microbial Composition

The presence of significant numbers of acidogenic bacteria in plaque, present in a sheltered site with a low diffusion rate coupled with a readily fermentable carbohydrate such a sucrose or glucose would produce the lowest pH. Under these conditions a pH in the region of 4.5, or even lower, might be attained (Fig. 27.4).

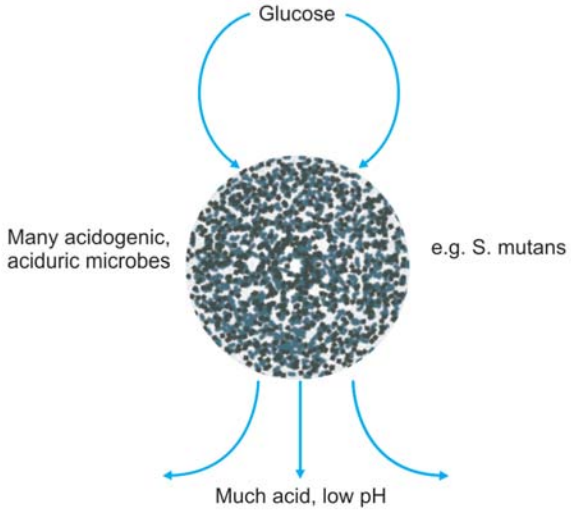


Fig. 27.4: Effect of microbial composition

Carbohydrate Nature

Conversely, a challenge with a carbohydrate which is metabolized more slowly by a plaque community with fewer, acidogenic microbes would result in less acid production and a higher terminal pH.

Rate of Diffusion

The rate of diffusion of material into and out of plaque is governed by the density of the plaque and access by saliva. Thus, less dense plaque fully exposed to saliva flow will more rapidly exchange metabolites with the surroundings. This will enable substrates to diffuse into the plaque rapidly and at the same time allow microbial by-products to diffuse out. The terminal pH following a challenge to the plaque will reflect the relative rates of diffusion of both substrate and metabolites.

The lowest pH attained is also determined by the rates of diffusion of substrates and metabolites. Molar fissures are the most caries-prone sites because they are sheltered from saliva flow. The deepest parts are often inaccessible to toothbrushes, which mean that fissures frequently contain impacted food for extended periods of time. If the food contains carbohydrate, the plaque is likely to have a lower resting pH than that found at other sites in the mouth. This lower resting pH will encourage the growth of aciduric microbes such as *S. mutans*. In fact, research has shown that fissure plaque has a greater proportion of aciduric microbes including *S.mutans* and lactobacilli (Fig. 27.5).

The rise in pH

The pH starts to rise after a few minutes due to:

1. Acid by-products diffusing out of the plaque.
2. Salivary bicarbonate diffusing into the plaque and neutralizing the acid by-products.

In addition, the low pH produced will inhibit microbial metabolism and thereby slow the rate of acid production. This will allow the processes of diffusion and neutralization to exert a greater effect on plaque pH. Also, as before, plaque which is less dense and fully exposed to saliva flow will show a faster rate of pH recovery.

It normally takes at least 20 minutes for the plaque pH to reach its resting value but it can take considerably longer depending on the factors described above (Fig. 27.6).

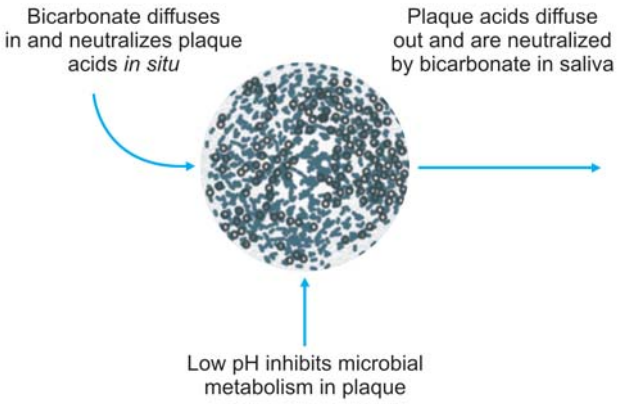


Fig. 27.6: Effect of saliva on diffusion

Saliva Flow Rate

One of the most important factors governing the overall shape of a Stephan Curve, but particularly the pH recovery, is saliva flow rate (Fig. 27.7).

Saliva exerts two effects. First, it dilutes and carries away metabolites diffusing out of the plaque. Second it supplies bicarbonate ions which diffuse into plaque and neutralize the by-products of fermentation (organic acids) *in situ*. The bicarbonate-mediated acid neutralization effect is enhanced by the increase in salivary bicarbonate associated with increased saliva flow which coincides with eating.

$$HCO_3^- + H^+ \xrightarrow{\text{Carbonic anhydrase}} H_2O + CO_2\uparrow$$

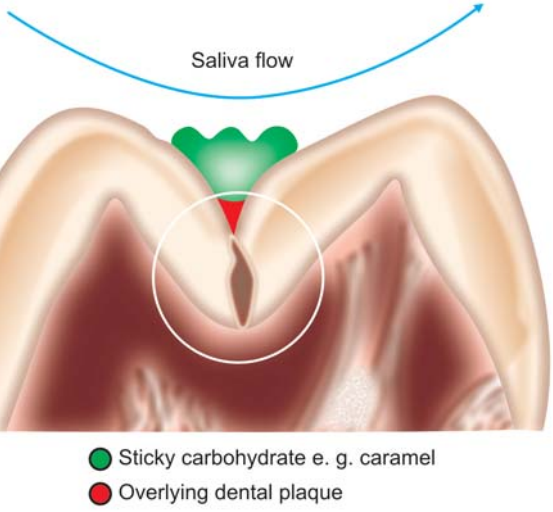


Fig. 27.5: Rate of diffusion

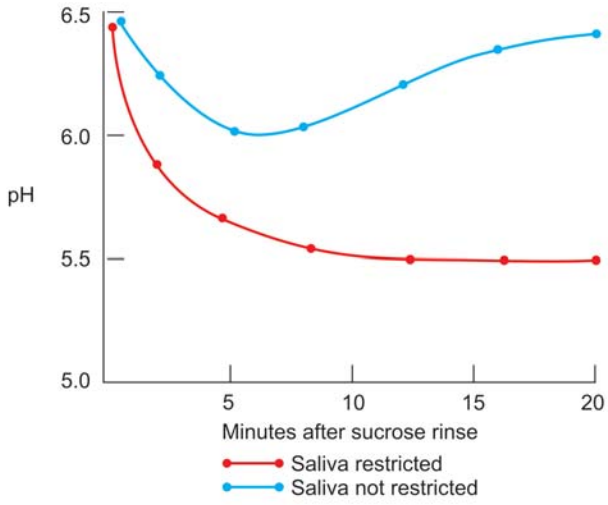


Fig. 27.7: Stephan curve: Effect of saliva

Acid neutralization by bicarbonate is accelerated by salivary carbonic anhydrase. This is secreted by acinar cells of the parotid and submandibular glands and is the only example of a secreted carbonic anhydrase in mammals.

STEPHAN CURVE: CLINICAL RELEVANCE

Value of Stephan Curve

The value of the Stephan Curve is that it provides a means by which the cariogenic challenge to a tooth may be measured. Actually, it only measures the potential cariogenic challenge because the critical pH value varies between individuals.

The cariogenic challenge (cariogenicity) is measured as the area delimited by the Critical pH and the Stephan Curve shown in red in Figure 27.8.

ACIDS PRODUCED WHEN CARBOHYDRATE ARE METABOLIZED BY BACTERIA

- Lactic
- Formic
- Proprianic
- Acetic
- Butyric

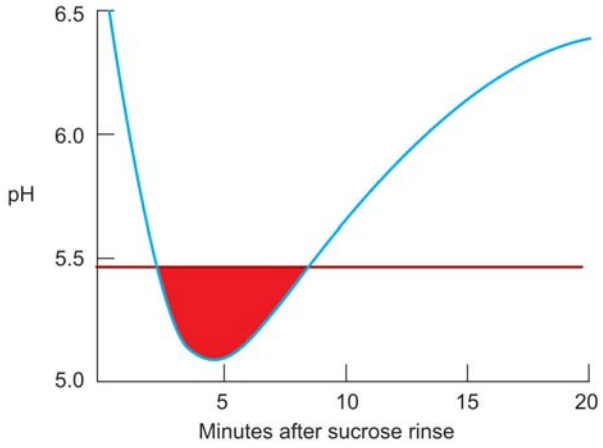


Fig. 27.8: Measuring cariogenicity

DIETARY FACTOR AND DENTAL CARIES

Frequency and Amount of Ingestion of Dietary Sugars and Dental Caries

Data from animal studies have shown that dental caries experience increases with increasing frequency of intake of sugars, even when the absolute intake of sugar was the same. Since the pH of dental plaque falls each time sugars are ingested, so more times in a day sugar is consumed, the more times the plaque pH will be depressed to a level at which dental enamel may dissolve.

Human studies as opposed to animal experiments have shown a very strong correlation between frequency of intake of sugar and weight of sugar consumed. As one rises the other rises too and vice-versa. Hence both the frequency of consumption and total amount of sugars are important in the etiology of caries because frequency of intake and amount of sugars ingested are closely related. An increase in frequency of sugary intakes of more than 4 per day increased the risk of caries.

Food Form

The form of the fermentable carbohydrate directly influences the duration of exposure and retention of the food on the teeth. Prolonged oral retention of cariogenic components of food may lead to extended periods of acid production and demineralization and to shortened periods of remineralization.

Duration may also be influenced by the frequency and amount of fermentable carbohydrate consumed. Liquid sugars, such as those found in beverages and milk drinks, pass through the oral cavity fairly quickly with limited contact time or adherence to tooth surfaces. However, fluid intake patterns can influence the caries risk of the beverages. Holding sugar containing beverages in the oral cavity for a prolonged time or constant sipping of a sugared beverage increases the risk of caries. Long-lasting sources of sugars, such as chocolates, hard candies and lollipops, have extended exposure time in the oral cavity because the sugars are gradually released during consumption.

Oral Clearance

Oral clearance properties vary by individual person and depend on metabolism by microorganisms, adsorption onto oral surfaces, degradation by plaque and salivary enzymes, saliva flow and swallowing. Most carbohydrates will be cleared by these simultaneous mechanisms. Retentiveness of foods is not the same as stickiness. A caramel or jellybean may be sticky, but its retentive properties are fairly low and they are cleared from the oral cavity faster than are retentive foods such as cookies or chips. Studies have shown that, the longer the foods are retained in the oral cavity, the greater the potential the starch has to break down into sugars and contribute to the caries process. The initial content of sugars was not the culprit; rather, it was the type of starch and extent of starch retention time in the oral cavity that determined the relative cariogenic risk of the food.

Frequency

The frequency of consumption seems to be a significant contributor to the cariogenicity of the diet, although Bowen et al concluded that it is not the frequency of ingestion per second that is related to the development of caries but the time that sugars are available to microorganisms in the mouth. The importance of frequency is clear when caries is regarded as the outcome of the alternation of demineralization and remineralization.

Higher frequency means more demineralization and less remineralization.

The duration of the decrease in pH after intake of a cariogenic food is an important confounder in this relation.

Acid Content

The acidity of individual foods can precipitate erosion. The erosive potential, however, depends also on whether the oral buffer systems can neutralize the food. Because the critical pH for enamel dissolution is 5.5, any food with a pH lower than 5.5 may contribute to or stimulate erosion. In persons with adequate saliva and good oral hygiene habits, these fluids and foods pose minimal risk when consumed as part of a balanced diet.

Sugar Alcohol-based Products

Sugar-free gums can stimulate saliva, increasing the clearance of sugars and other fermentable carbohydrates from the teeth and the oral cavity and increasing buffer capacity. Tooth-friendly polyols include sorbitol, xylitol, mannitol, erythritol, and isomalt.

However, xylitol—a 5-carbon sugar that oral microflora cannot metabolize—has additional anticariogenic effects attributable to antimicrobial action, stimulation of saliva resulting in increased buffer activity and an increase in pH, and enhanced remineralization. Sorbitol-sweetened gums simulate saliva without causing a drop to the critical pH and have been shown to be equal to xylitol gum in terms of caries control.

CARIOGENICITY OF SUGARS

Earlier studies investigating the relationship between dental caries and sugar focused mainly on sucrose. Animal studies show that there is not much difference between cariogenicity of mono and disaccharides except that of lactose. Plaque pH studies have shown that less acid is produced by plaque bacteria from lactose, compared to other sugars. The cause of dental caries is the consumption of fermentable carbohydrates (sugars). There is a dose- response relationship between the quantity of the sugar consumed and the development of dental caries. It is suggested, at levels below 10 kg/person per year dental caries will not develop. [15kg/person per year in fluoridated areas].

Sugars are classified into *Intrinsic* and *Extrinsic* based on physical location of sugars (Fig. 27.9). *Intrinsic Sugars* located within the cellular structure of food, make them unavailable for metabolism by the oral bacteria, and hence are harmful to teeth. *Extrinsic sugars* are located outside the cellular structure of the food and include 'Milk Sugar' (lactose present naturally in milk is not harmful to teeth) and 'Non-Milk Extrinsic Sugars' (NMES). These added sugars, added by the manufacturer, cook or consumer, are better called non-milk extrinsic sugars - nicely shortened to NME or 'enemy' are harmful to teeth (Table 27.2). The World Health Organization

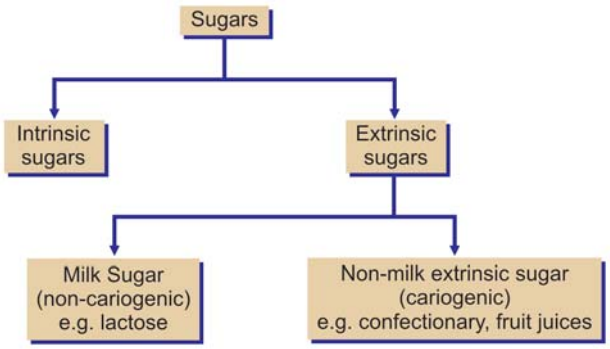


Fig. 27.9: Classification of sugar

Table 27.2: Caries producing NME sugars

Names with potential to cause dental caries
• Sucrose • Glucose • Maltose • Fructose

(WHO) calls these sugars 'free' sugars and WHO recommends that, first, there is no nutritional need for these NME or free sugars and, second, that consumption should be less than 10% of total food energy intake

The intake of extrinsic sugars beyond four times a day leads to an increase risk of dental caries. The current dose-response relationship between caries and extrinsic sugars suggests that the sugars level above 60 g/person/day for teenagers and adults increases the rate of caries. For pre-school and young children the intake should be proportional to those for teenagers; about 30 g/person/day for pre-school children. There is no evidence that sugars naturally incorporated in the cellular structure of foods (intrinsic sugars) or lactose in milk or milk products (milk sugars) have adverse effects on health. Foods rich in starch, without the addition of sugars, play a small role in coronal dental caries.

CARBOHYDRATES AND DENTAL CARIES (TABLE 27.3)

Dietary Carbohydrates

A. Sugars

Dietary carbohydrates can be divided into simple sugars and complex carbohydrates, e.g., starches.

B. Starches

Starches are also a major component of the human diet. Cereal grains are often a primary source of calories, proteins, minerals, and vitamins

Classifications

There are a variety of interrelated classification schemes. The most useful classification scheme divides the carbohydrates

Table 27.3: Sugars; their caries promoting activity and food sources

Category	*Chemical structure*	*Examples*	*Caries-promoting potential*	*Food sources*
Sugars				
	Monosaccharide	Glucose, dextrose, fructose	Yes	Most foods, fruit, honey
		High-fructose corn dyrup	Yes	Soft drinks
		Galactose	No	Milk
	Disaccharide	Sucrose, granulated or powdered or brown sugar	Yes	Fruit, vegetables, table sugar
		Turbinado, molasses	Yes	
		Lactose	Yes	Milk
		Maltose	Yes	Beer
Other carbohydrates				
	Polysaccharide	Starch	Yes	Potatoes, grains, rice, legumes, bananas, cornstarch
	Fiber	Cellulose, pectin, gums, beta-glucans, fructans	No	Grains, fruits, vegetables
	Polyol-monosaccharide	Sorbitol, mannitol, xylitol, erythritol	No	Fruit, seaweed, exudates of plants or trees
	Polyol-disaccharide	Lactitol, isomalt, maltitol	No	Derived from lactose, maltose, or starch
	Polyol-polysaccharide	Hydrogenated starch, hydrolysates, or malitol syrup	No	Derived from monosaccharides
High-intensity sweeteners				
	Saccharine	Sweet and low	No	
	Aspartame	Nutrasweet, Equal	No	
	Aceulfame-K	Sunett	No	
	Sucralose	Splenda	No	

into groups according to the number of individual simple sugar units. **Monosaccharide** contain a single unit; **disaccharides** contain two sugar units; and **polysaccharides** contain many sugar units as in polymers—most contain glucose as the monosaccharide unit.

Monosaccharides	*Carbohydrates disaccharides*	*Polysaccharides*
Glucose	Sucrose	Starch
Galactose	Maltose	Glycogen
Fructose	Lactose	Cellulose
Ribose		
Glyceraldehyde		

Sugars are a form of fermentable carbohydrate. Fermentable carbohydrates are carbohydrates (sugars and starch) that begin digestion in the oral cavity via salivary amylase. Sugars enter the diet in 2 forms: those found naturally in foods (e.g., fruit, honey, and dairy products) and those that are added to foods during processing to alter the flavor, taste, or texture of the food. Starches are subsequently digested by salivary amylase to oligosaccharides, which may be fermented by the oral microflora. According to Lingstrom et al, only the gelatinized starches are susceptible to breakdown by salivary amylase into maltose, maltotriose, and dextrins.

STARCHES AND DENTAL CARIES

Starch constitutes a heterogeneous food group. It may be highly refined or consumed in its natural state. It may also be consumed raw (fruits and vegetables) but is mainly consumed in a cooked form. Animal studies have shown that raw starch is of low cariogenicity. Cooked starch causes caries but only about half the amount caused by sucrose. Enamel slab experiments in humans have shown that raw starch does not cause remineralization. Epidemiological studies have shown that starch is of low risk for causing dental caries. People who consume high-starch/low-sugar diet generally have low caries experience than people who consume low-starch/high-sugar diets.

After an extensive review on the relationship between starchy foods caries Rugg-Gunn and Rugg-Gunn and Nunn concluded that:

- Cooked staple starchy foods such as rice, potatoes, and bread are of low cariogenicity in humans.
- The cariogenicity of uncooked starch is very low but, since this is seldom eaten by humans, this finding is of little relevance.
- Finely ground and heat-treated starch can cause dental caries, but the amount of caries is less than caused by sugars.
- The addition of sugar increases the cariogenicity of cooked starchy foods. Foods containing cooked starch plus substantial amounts of sucrose, appear to be as cariogenic as a similar quantity of sucrose.

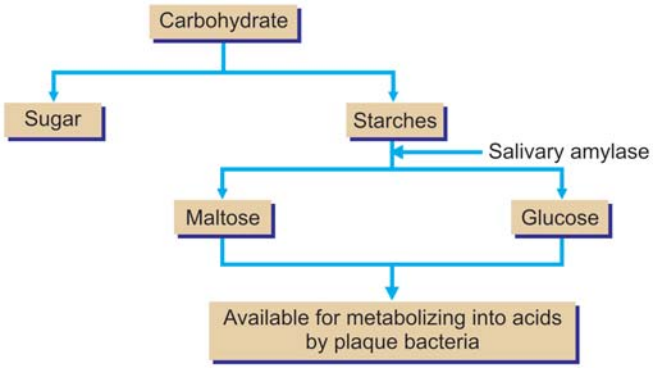


Fig. 27.10: Conversion of starch by salivary amylase

Starch is converted by salivary amylase to maltose and glucose (Fig. 27.10). This is a slow process and hence dietary starch alone is much less important than dietary sugars as a cause of dental caries.

FRUITS AND DENTAL CARIES

There is little evidence to show fruit to be an important factor in the development of dental caries when it is consumed as a part of the mixed human diet. A number of plaque pH studies have found fruits to be acidogenic, although less than sucrose. The extent of this varies according to texture and sugar content of the fruit. However, plaque pH studies measure acidogenicity and not cariogenicity and do not take into account the protective factors in fruits. Animal studies have shown that all fruits cause less caries than sucrose. Epidemiological studies have also shown that fruits which are habitually consumed are of low cariogenicity.

Dried fruits may potentially be more cariogenic since the drying process breaks down the cellular structure of the fruit, releasing free sugars; also the dried fruits tend to have a longer oral clearance. Increasing consumption of fresh fruits in order to replace non-milk extrinsic sugars in the diet is likely to decrease the level of dental caries.

PROTECTIVE FACTORS AND CARIES

Some constituents of diet help to protect teeth against dental caries.

Cheese

Studies have shown that several types of cheese are not only non-cariogenic but also have anti-cariogenic properties. Cheese stimulates salivary secretion and increases plaque calcium concentration, and causes adsorption of protein (casein) on to the enamel surface thereby physically slowing the caries process.

Milk

Cow's milk and human milk contain lactose which may be classified as cariogenic. But lactose is least cariogenic of the dietary sugars and milk also contains calcium, phosphorus and casein which inhibit caries. Evidence from animal experiments show that cow's milk is not only non-cariogenic, but also has an anti-cariogenic effect.

Fibrous Foods

Fibrous foods protect the teeth because they mechanically stimulate salivary flow. Other foods that are good gustatory and/or mechanical stimulants to salivary flow are peanuts, hard cheese.

Black Tea

Black tea contains fluoride, polyphenols and flavanoids. Black tea extract increases plaque fluoride concentration and reduces the cariogenicity of a sugar rich diet.

Sugars are a form of fermentable carbohydrate. Fermentable carbohydrates are carbohydrates (sugars and starch) that begin digestion in the oral cavity via salivary amylase. Sugars enter the diet in 2 forms: those found naturally in foods (e.g. fruit, honey, and dairy products) and those that are added to foods during processing to alter the flavor, taste, or texture of the food.

EFFECT OF FLUORIDE ON SUGAR–CARIES RELATIONSHIP

Fluoride alters the resistance of the teeth to demineralization and the speed of remineralization of the enamel surface after an acid attack. Post eruptive effect of fluoride includes:

- Reduces and inhibits demineralization.
- Remineralization of enamel
- Affects plaque by inhibiting bacterial metabolism of sugars.

It has been shown that without any dietary modification topical fluorides reduces caries in children by 20 to 40%, but does not eliminate dental caries.

Widespread use of fluoride largely accounts for the decline in dental caries that has been observed in developed countries over the past three decades. Where there is a good exposure to fluorides, sugar consumption is a moderate risk factor for dental caries in most people. Sugar consumption is a major indicator for risk of caries in people who are not exposed regularly to fluoride. With widespread use of fluoride, sugar consumption still has a role to play in the prevention of caries but this role is not as strong as it is without exposure to fluorides.

NON-SUGAR SWEETENERS AND DENTAL CARIES

These can be classified into two:

1. Intense sweeteners
2. Bulk sweeteners

A large numbers of sweet compounds are known but a few are permitted to be used on foods in and these vary from country to country.

Intense Sweeteners

These are not metabolized to acids by oral micro-organisms and hence cannot cause dental caries. These are not chemically related to sugars. They are hundred to thousand times sweeter than sucrose but have a negligible energy value.

Saccharine

It has a bitter taste in concentration over 0.1 percent. It is used as table-top sweetener and in sweetening tablets.

Acesulfame Potassium

It is chemically synthesized sweetener. It is stable in aqueous solutions of wide ranging pH and does not break down on heating. Hence a useful sweetener in reduced energy soft drinks, boiled sweets, confectionary, chewing gum and other foods.

Aspartame

It is moderately stable in solutions and breaks down on prolonged heating. It is used extensively in soft drinks, chewing gum, frozen foods. It is banned in children less than 12 years of age as it causes neurotoxicity.

Thaumatin

It is a naturally occurring intense sweetener, which is extracted from a plant found in West Africa. It is mainly used in pharmaceutical products.

LIMITATIONS OF INTENSE SWEETENERS

- Poor taste quality
- Instability
- Lack of bulk

USES OF INTENSE SWEETENERS

- Used in food products like soft drinks, beer, confectionary, desserts, ice-cream and jams.

BULK SWEETENERS

These are chemically similar to sugars, and they add volume and sweetness to a product. They are 0.5 to 1.0 times as sweet as sucrose. The various bulk sweeteners are sorbitol, mannitol, isomalt, xylitol, lactitol and hydrogenated glucose syrup. Bulk sweeteners have negligible cariogenicity as compared to sugars (Table 27.4).

Xylitol is a sugar-substitute with sweetness equal to that of table sugar (sucrose), but with 40% fewer calories. It is a member of the sugar alcohol or polyol family, which includes other common dietary sweeteners such as sorbitol, mannitol, and maltitol. Xylitol is produced commercially from birch trees and other hardwoods containing xylan. More recently, to reduce production cost, commercial xylitol is being produced from corn cobs and the waste of sugarcane or other fibers using biotechnology. Xylitol can be found in small quantities in fruits and vegetables and is produced as part of human metabolic processes.

Table 27.4: Properties of natural sugars and sugar substitutes

	Nutritive value (calories/g)	*Cariogenic*	*Sweetness*
Natural sugars			
Sucrose	4	Yes	1.0
Glucose	4	Yes	.7
Fructose	4	Yes	1.5
Lactose	4	Yes	.2
Sugar substitutes			
Sugar alcohols/polyols			
Xylitol	2.4	No	1.0
Sorbitol	2.6	No	.6
Mannitol	1.6	No	.5
Maltitol	2.1	No	.9
Artificial sweeteners			
Aspartame	0.0	No	180
Saccharin	0.0	No	300
Sucralose	0.0	No	600
Acesulfame potassium	0.0	No	200

(Modified from Kiet A. Ly et al. Xylitol, Sweeteners, and Dental Caries. Pediatr Dent 2006;28:154-163)

Xylitol is widely used in sugar-free products such as chewing gums, candies, and toothpastes and are frequently combined together with small amounts of high intensity artificial sweeteners such as saccharin or aspartame to improve the flavor and sweetness of products.

Microorganisms do not readily metabolize xylitol into energy sources, and its consumption has a minimal effect on plaque pH. Xylitol has been shown to have a protective effect and to reduce tooth decay in part by reducing the levels of Strep-tococcus mutans in plaque and saliva and by reducing the level of lactic acid produced by these bacteria.

Studies have shown that a range of 6 to10 g divided into at least 3 consumption periods per day is necessary for xylitol to be effective with chewing gum as the delivery system.

Xylitol has been approved by the FDA since the 1960s and is safe for use with children. Polyols are absorbed slowly by the human gastrointestinal tract. The main side effect associated with most polyol consumption is osmotic diarrhea which, for xylitol, only occurs when it is consumed in large quantities,4 to 5 times that needed for the prevention of dental caries.

The available evidence indicates that the level of dental caries is low in countries where the consumption of free sugar is below 15 to 20 kg/ person/year. This is equivalent to a daily intake of 40 to 55 gm and the value equates to 6 to 10% of energy intake.

A number of countries have adopted policies for free sugars (non-milk extrinsic or refined) intake. The 1990 WHO report ' Diet, Nutrition and the Prevention of Chronic Diseases' also recommended that free sugars should contribute to no more than 10% to energy intake. Individuals should be advised to reduce the frequency of consumption of foods containing free sugars to four times a day thereby limiting the amount of free sugars consumed. Food manufacturers can contribute to products rich in free sugars, including drinks by producing low sugar/sugar-free alternatives.

28 Caries Risk Assessment

CM Marya

Caries is not the consequence of a single event (as is a classical infectious disease for example) but it is rather a sequel of a series of processes happening over a longer period of time. The etiological factors which can be diagnosed today, that is, the risk of caries, do not necessarily have to be identical with the causative factors which led to the development of a carious lesion.

In scientific studies various so-called 'predictors' for the risk of caries have been investigated. These could be clinical signs of caries or risk indicators, such as factors associated with the development of caries. Their effects on the development of caries can be either causative or modifying. Causative relationships are often identified as risk factors. An individual with an increased risk of caries may, therefore, be a person with a higher than average exposure to the causative risk factors mentioned below.

Several studies have attempted to determine risk factors that can be reliably used to assess the level of risk of caries progression in individual patients. Studies still are underway, and there is no definitive formula yet available. It has been established that high-risk patients include those who have a high bacterial challenge, which may consist of a combination of high numbers of mutans streptococci, lactobacilli or both. Although fluoride has excellent properties in terms of balancing caries challenge, if the challenge is too high, then fluoride—even at increased concentrations, with increased use or both—cannot balance that challenge. Therefore, in case of high bacterial challenge, the bacterial infection must be dealt with, typically with a chlorhexidine rinse, as well as the enhancement of salivary action by topical delivery of fluoride. These principles apply equally well to adults and children. Accurate detection of early caries can increase the reliability of caries risk assessment, particularly if those measurements are made at three- or six-month intervals and caries progression can be measured. In case of caries progression, obviously, intervention is needed either antibacterially, with fluoride or with other techniques.

Beck offered a definition for risk factors that was adopted for the World Workshop on Periodontics

Risk factor: an environmental, behavioral, or biologic factor confirmed by temporal sequence, usually in longitudinal studies, which if present directly increases the probability of a disease occurring, and if absent or removed reduces the probability. Risk factors are part of the causal chain, or expose the host to the causal chain. Once disease occurs, removal of a risk factor may not result in a cure.

This definition is longer than the one offered by Last, but it is much clearer.

The key contributions of this definition are (a) the emphasis on a temporal sequence of events preceding the outcome; (b) the unequivocal acceptance that a risk factor is part of a causal chain; and (c) the acceptance that risk factors are involved in the onset of disease but not necessarily in its progression or resolution.

GOALS OF CARIES RISK ASSESSMENT

The goals of caries risk assessment can be summarized as follows:

a. Screen out low risk patients (to allow safe recommendation of long recall intervals).
b. Identify high risk patients before they become caries-active.
c. Monitor changes in disease status in caries-active patients.

The aim is to identify caries-active individuals and to convert them to caries-inactive status, so that they become low risk for the disease (Bevenius J, 1997)

CARIES DISEASE INDICATORS

Caries disease indicators are clinical observations that tell about the past caries history and activity. They are indicators or clinical signs that either disease is present or that there has been recent disease. These indicators say nothing about what caused the disease or how to treat it. They simply describe a clinical observation that indicates the presence of disease. These are neither pathological factors nor are they causative in any way. They are simply physical observations (cavitations, white spots, radiolucencies).

The four caries disease indictors are: (1) frank cavitations or lesions that radiographically show penetration into dentine; (2) approximal radiographic lesions confined to the enamel only; (3) visual white spots on smooth surfaces; and (4) any restorations placed in the last three years.

CARIES RISK FACTORS

Caries risk factors are biological factors that contribute to the level of risk for the patient of having new carious lesions in the future or having the existing lesions progress. The risk factors are the biological reasons or factors that have caused or contributed to the disease, or will contribute to its future manifestation on the tooth. These we can do something about.

The best indicators for increased risk of dental caries are:

- Medium or high MS and LB counts
- *Visible heavy plaque on teeth:* This indicates poor oral hygiene and/or prolific plaque growth by the individual and is an indirect indicator that there are likely to be high levels of cariogenic bacteria.
- Inadequate exposure to fluoride
- *Frequent (>three times daily) snacking between meals:* If a person is snacking greater than 3 times daily between meals on foods or beverages that contain sucrose, glucose, fructose, or cooked starch (cookies or bread), this increases the acid challenge to the teeth to a high level. Xylitol-containing gum or mints should be recommended as a substitute for these snacks.
- Deep pits and fissures
- Lower socioeconomic status
- Recreational drug use
- *Inadequate saliva flow by observation or measure-ment:* Saliva reducing factors (medications/radiation/systemic) Saliva flow rate can be measured by having the patient chew and spit into a measuring cup and calculate the number of milliliters (mL) per minute. A value less than 0.7 mL/minute is low, whereas 1 to 4 mL/minute is normal
- Exposed roots
- *Orthodontic appliances:* The presence of fixed or removable appliances in the mouth such as orthodontic brackets or removable partial dentures leads to undue accumulation of plaque and an increase in the percent of cariogenic bacteria. These appliances will generally place the patient at high risk of new carious lesion in the future.
- Any physical or mental illness and any oral application or restoration that compromises the maintenance of optimal oral health.

CARIES PROTECTIVE FACTORS

These are biological or therapeutic factors or measures that can collectively offset the challenge presented by the previously mentioned caries risk factors. The more severe the risk factors, the higher must be the protective factors to keep the patient in balance or to reverse the caries process. As industry responds to the need for more and better products to treat dental caries, the current list is sure to expand in the future.

The protective factors are:

1. Lives/work/school located in a fluoridated community.
2. Fluoride toothpaste at least two times daily.
3. Fluoride mouthrinse (0.05 percent NaF) daily.
4. 15,00 ppm fluoride toothpaste daily.
5. Fluoride varnish in last six months.
6. Office fluoride topical in last six months.
7. Chlorhexidine prescribed/used daily for one week each for last six months.
8. Xylitol gum/lozenges four times daily in the last six months.
9. Calcium and phosphate supplement paste during last six months.
10. Adequate saliva flow (ml/min stimulated).

Fluoride toothpaste frequency is included since studies have shown that brushing twice daily or more is significantly more effective than once a day or less. Any or all of these protective factors can contribute to keep the patient "in balance" or even better to enhance remineralization, which is the natural repair process of the early carious lesion.

Caries Susceptibility

This is the susceptibility (or resistance) of a tooth to a caries-producing environment. The risk of developing a lesion, however, is individual and varies, depending on the tooth, its localization, surfaces, previous fluoride exposure etc.

Caries Activity

Caries activity is a measure of the speed of progression of a carious lesion. Retrospectively it can be determined as caries incidence, that is, new carious lesions over time of an individual or population.

Caries-risk

Generally speaking, risk is defined as the probability of incidence of an event within a certain period of time. The caries-risk, therefore, is the risk of an individual developing a carious lesion. Increased risk may be the result of several caries-producing factors coinciding or of insufficient defense mechanisms leading to different caries prevalence. By definition, risk is aimed at assessing developments in the future. It can, however, be assessed only on the basis of symptoms present at, or having manifested themselves by, the time of assessment.

The following factors should be considered when assessing caries risk primarily for an adult as shown in Table 28.1 (Caries risk assessment tool):

Table 28.1: Caries risk assessment tool for an adult

Risk factors	*High risk*	*Low risk*
Clinical/oral evidence	• Previous caries • New lesions • Unsealed deep pits and fissures • Fixed orthodontic appliances • Prosthesis • Exposed root surfaces • Premature extraction of teeth • Multiple restorations • Caries in anterior teeth	• Very few restoration • No new carious lesion • Sealants in pits and fissures • No orthodontic appliances • No prosthesis to care for • Exposed root surfaces with special fluoride application regularly • Nil extraction for caries • Sound anterior teeth
Dietary habit	• Frequent sugar intake • Frequent snack in between meal	• Infrequent sugar intake • Rare in between meals snacks • Use of xylitol gum
Medical history	• Medically compromised • Physical disability/handicapped • Xerostomia • Radiation therapy	• No medical problems • No physical problems or handicaps • Normal salivary flow • No long-term medication for chronic diseases
Social history	• Low knowledge of dental disease • Irregular dental visits • Low dental aspiration • High caries in sibling • General poor oral care in family	• Dentally aware • Regular appointments with dentist • High dental aspiration • Low caries in siblings • Good oral care by family
Plaque/biofilm control	• Irregular brushing • Ineffective cleaning • Poor manual dexterity or handicap • High biofilm scores • Orthodontic appliance and prosthesis care	• Frequent effective cleaning using toothbrush • Use of dental floss • Good dexterity; no handicap • Low biofilm scores • No orthodontic or prosthesis care requirement
Saliva	• Low flow rate • Low buffering capacity	• Flow rate normal • High buffering capacity
Use of fluoride	• No fluoride supplement • Non-fluoridated drinking water • Use of non-fluoridated toothpaste or irregular brushing with a fluoridated toothpaste • Does not use a fluoridated mouthwash	• Use of fluoride supplement • Drinking water fluoridated • Fluoride toothpaste used • Use of fluoride mouthwash
Moderate risk	• Individuals who do not clearly fit into high or low risk categories are considered to be at moderate risk.	

Adapted from the table cpompiled by Professor Edwina Kidd for the Faculty of General Dental Practitioners Guidelines.

- Clinical evidence of previous disease
- Dietary habits, especially frequency of sugary food and drink consumption
- Social history, especially socio-economic status
- Use of fluoride
- Plaque control
- Saliva
- Medical history
- Clinicians should be aware of individuals with a medical or physical disability for whom the consequences of dental caries could be detrimental to their general health. These patients should receive intensive preventive dental care.

FACTORS RELEVANT TO ASSESSMENT OF DENTAL CARIES

Clinical Evidence

The patients with following oral characteristics are at high risk.

- Multiple new lesions in past 12 months
- Unsealed pits and fissures
- History of premature extraction for caries
- Multiple restorations
- Exposed root surfaces
- Anterior caries or restorations

Dietary Habits

It is seen that all patients who have high sugar intake develop dental decay. Frequent smokes in-between meal are also considered as risk factors.

Medical History

Medically compromized and handicapped people may be at high risk of caries. Many medicaments, such as Antidepressants, Antipsychotic, Tranquilizers, Antihyper-tensive and Diuretics cause dry mouth. Patients who have radiotherapy in salivary gland region for head and neck malignancy or removal of salivary gland suffer from xerostomia. Patients with rheumatoid arthritis may also have Sjogren's syndrome, which affect salivary and lacrimal gland, leading to dry mouth and dry eyes.

Social History

The following features of social history may also be present in high risk patient

- Caries in sibling is high
- The patient possesses little knowledge
- Irregular dental visits to dentist and dental awareness are low
- The patient's access to snacks is high
- Poor oral care in family.

Plaque Control

Dental plaque is the most important risk factor for dental caries. The patients who do not clean their teeth frequently and effectively or have poor manual dexterity may be at high risk. Orthodontic appliances and dental prosthesis are a major source of plaque accumulation which needs to be cleaned effectively to prevent plaque accumulation.

Saliva

Many features of saliva affect the risk of dental caries like:

- Low buffering capacity (as acids are not neutralized)
- Low quantity
- High S. mutans and Lactobacillus count
- Xerostomia is a known predisposing factor.

Use of Fluorides

Fluoride has been a known factor which delays the progression of dental caries; thus patients who do not have fluoridated water or use fluoridated toothpaste may be at risk.

XEROSTOMIA

Xerostomia is defined as a subjective complaint of dry mouth that may result from a decrease in the production of saliva.

To assess the risk for caries involvement due to xerostomia, the clinical evidence of hyposalivation must be identified. Dry lips, dryness of buccal mucosa, absence of saliva in response to gland palpation, and a high number of decayed, missing, or filled teeth have been cited as an easily assessed set of clinical parameters for identifying most patients with salivary gland dysfunction

XEROSTOMIA AND DENTAL CARIES

A major complication of xerostomia is the promotion of dental caries (Fig. 28.1). This process is accelerated owing to a reduction in oral irrigation and an inability to clear foods from the oral cavity rapidly, particularly if proteins and electrolytes that inhibit cariogenic microorganisms and buffer oral acids, respectively, are diminished. The development of rampant caries, particularly at the cervical area, has been observed within a few weeks after radiation therapy to the head and neck.

CAUSES OF XEROSTOMIA

Primary Sjögren's syndrome
Secondary Sjögren's syndrome
Surgical removal of glands due to neoplasm

CONNECTIVE TISSUE DISEASE

- Rheumatoid arthritis
- Systemic lupus erythematosus
- Systemic sclerosis
- Mixed connective tissue disease

OTHER CONDITIONS

- Radiation therapy
- Primary biliary cirrhosis
- Vasculitis
- Chronic active hepatitis
- HIV
- AIDS
- Bone marrow transplantation
- Graft-vs-Host disease
- Renal dialysis
- Anxiety or depression.

DRUGS THAT DECREASE SALIVARY FLOW

- Anticholinergics
- Antihistamines
- Antianxiety
- Diuretics
- Antidepressants
- Anticonvulsants
- Narcotics

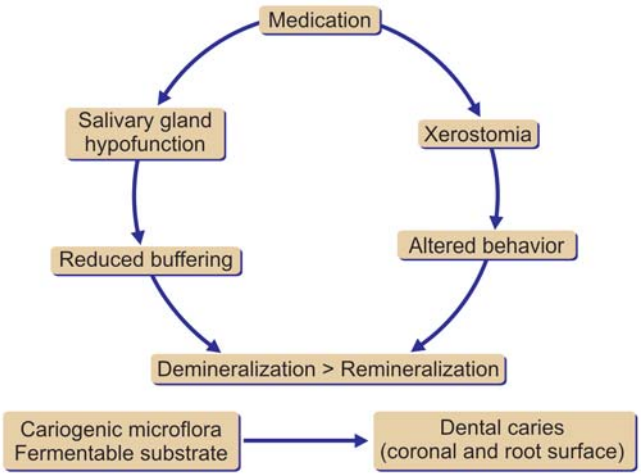


Fig. 28.1: Theoretical model of the relationship between medication, salivary gland hypofunction, xerostomia and dental caries

Much progress has been achieved in the prevention of dental decay over the past decades. Epidemiological studies have demonstrated high caries active individuals in the same population as moderate or low caries active individuals. Caries prevalence indicators can be used for assessing either caries activity or the risk of future caries. However, caries-risk does not remain constant throughout life and may be modified by preventive intervention both by the patient and by the dentist.

CLASSIFICATION

A 'high caries-risk' group is defined as a sub-group of the population which is at greater risk of acquiring caries than the average population. The borderline between low, moderate or high risk is not precise, but depends on the prevalence within the population and on additional factors. When there are only a few caries-risk factors present, then the evaluation is of a 'low caries risk', when there are many risk-factors present the classification is of a 'high caries-risk,' and the moderate caries-risk group falls in between (Box 28.1).

CARIES RISK ASSESSMENT

For individual patients, the objective clinical judgment of the dentist, their ability to combine and use these risk factors and their knowledge of the patient has been shown to be one of the most powerful predictors of that individual's caries risk. In particular, the dentist's subjective judgment of the size of the 'Decayed', 'Missing' and 'Filled' increment (newly developing caries) over subsequent years is also a relatively strong predictor.

In diagnosing caries risk, no single test can simultaneously measure host resistance, microbial pathogens, and cariogenicity of the diet. Multiple predictor models (including mutans scores, baseline caries prevalence, fissure retentiveness score, dietary habit index, salivary buffering and flow rate) are necessary to classify a person according to caries risk.

Several studies have attempted to determine risk factors that can be reliably used to assess the level of risk of caries progression in individual patients. Studies still are under way, and there is no definitive formula yet available. It has been established that high-risk patients include those who have a high bacterial challenge, which may consist of a combination of high numbers of mutans streptococci, lactobacilli or both. Although fluoride has excellent properties in terms of balancing caries challenge, if the challenge is too high, then fluoride—even at increased concentrations, with increased use or both—cannot balance that challenge. Therefore, in the case of high bacterial challenge, the bacterial infection must be dealt with, typically with a chlorhexidine rinse, as well as the enhancement of salivary action by topical delivery of fluoride. These principles apply equally well to adults and children. Accurate detection of early caries can increase the reliability of caries risk assessment, particularly if those measurements are made at three- or six-month intervals and caries progression can be measured. In the case of caries progression, obviously, intervention is needed either antibacterially, with fluoride or with other techniques.

FACTORS IN LOW, MODERATE AND HIGH CARIES RISK ASSESSMENT

Determination of caries-risk is important for:

- Assessment of the individual etiological factors of existing carious lesions and of the caries risk situation
- Repeated determination of the caries-risk allows an evaluation of the success of, or the need for, modification of preventive measures
- Indications of an increased caries-risk in specific children in community preventive programs will allow selection of an individual preventive program in order to minimize the development of carious lesions.

The prevalence and incidence of caries influences the predictability of the caries-risk assessment. The identification of subjects with high caries-risk is relatively accurate where children and adolescents are concerned and when sufficient base-line data is available. The situation is different where adults are concerned because they receive more dental treatment but lack preventive programs. Since secondary caries is the most frequent cause of replacement of restorations and root caries becomes a problem for adults, caries-risk assessment and, when needed, preventive intervention is also necessary for adults.

In the clinical situation the accurate prediction of caries is not as important as the assessment of the individual caries risk and risk factors. Even with routinely available clinical and sociodemographic information at clinical examination a dentist can identify high caries risk subjects with good accuracy.

In order to arrest the development of caries as early as possible it is important that caries-risk status be assessed. For children in kindergarten a simple assessment of previously acquired lesions will suffice.

BOX 28.1: FACTORS IN CARIES RISK ASSESSMENT

Children

Low risk

- No new or incipient carious lesions in the past year

Moderate risk (any of the following)

- One new, incipient or recurrent carious lesion in the past year
- Deep or noncoalesced pits and fissures.
- High caries experience in siblings
- History of pit and fissure caries
- Early childhood caries
- Frequent sugar exposures
- Decreased salivary flow
- Compromised oral hygiene
- Irregular dental visits
- Inadequate fluoride exposure
- Proximal radiolucency

High risk

Two or more new, incipient or recurrent carious lesions in the past year, or two or more of the following:

- Deep or noncoalesced pits and fissures
- Siblings or parents with high caries rate
- History of pit and fissure caries
- Frequent sugar exposures
- Decreased salivary flow
- Compromised oral hygiene
- Irregular dental visits
- Inadequate fluoride exposure
- Proximal radiolucency

Adults

Low risk

No new or incipient lesion

Moderate risk (any of the following)

- One to two new, incipient or recurrent carious lesions during the past three years
- History of numerous or severe caries
- Deep or noncoalesced pits and fissures
- Frequent sugar exposures
- Decreased salivary flow
- Irregular dental visits
- Inadequate fluoride exposure

High risk

Three or more carious lesions in the past three, or two or more of the following:

- History of numerous or severe caries
- Deep or noncoalesced pits and fissures
- Frequent sugar exposures
- Decreased salivary flow
- Irregular dental visits
- Inadequate fluoride exposure
- Compromised oral hygiene

Caries management by risk assessment now is receiving considerable attention, and software programs are being developed that will aid practitioners in assessing risk and lead them to the use of current and new technologies by specifying treatments recommended for the various risk categories (Box 28.2).

CARIOGRAM (FIG. 28.2)

Cariogram is an interactive version for estimation of caries risk and for understanding the interactions of various factors causing caries. In simple terms, Cariogram is a way to illustrate interactions between caries related factors, by a computer version which presents a graphical picture that illustrates the overall risk scenario. It was developed by D. Bratthall, L. Allander and K. Lybegard in 1997.

The Cariogram serves the purpose of demonstrating the caries risk graphically in terms of:

- Risk for *developing new caries* in the future
- Chance to *avoid new caries* in the near future

Cariogram helps to understand the multi-factorial aspects of dental caries and can be used as a guide in attempts to estimate caries risk

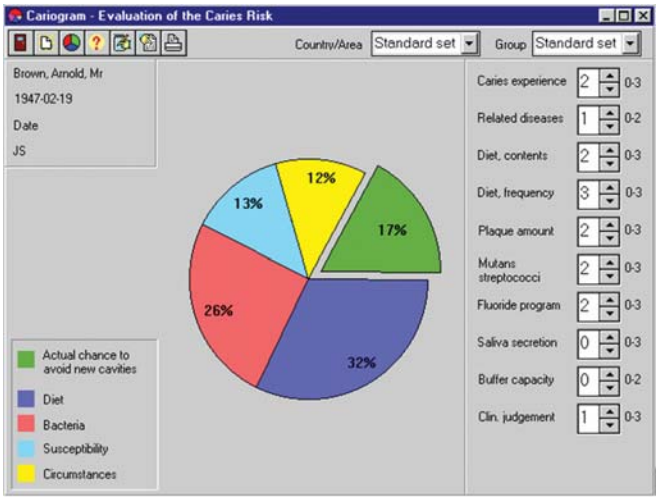


Fig. 28.2: Cariogram

The idea is to:

a. Identify those persons who will most likely develop caries and
b. Provide these individuals proper preventive and treatment measures to stop the disease.

BOX 28.2: CARIES RISK ASSESSMENT PROFORMA FOR CHILDREN

S No.	Factors: Risk factor to consider	Caries Risk: High	Moderate	Low	Finding
1.	Child has visible decay	Yes		No	
2.	Caries restored (time lapsed in last restoration)	<12 months	12-24 months	>24 months	
3.	Visible heavy plaque/debris on teeth of child	Yes		No	
4.	Frequency of between meal snacks/sugars by the child	>3	1-2	Meal time only	
5.	Presence of conditions that impairs/reduce saliva (dry mouth) in child	Yes		No	
6.	Family socio-economic status	Low	Mid-level	High	
7.	Child has orthodontic/oral appliance in the mouth	Yes		No	
8.	Deep pits & fissures/enamel defects	Yes		No	
9.	White spot lesion/areas of enamel demineralization	>1	1	None	
10.	Gingivitis	Present		Absent	
11.	Levels of mutans streptococci or lactobacilli	High	Moderate	Low	
12.	Child's exposure to fluoride				
	A. Daily use of fluoride toothpaste	No	Yes	Yes	
	B. Drinking water fluoridated	No	No	Yes	
	C. Daily use of fluoride mouthwash or gel	No	No	Yes	
	D. Intake of fluoride supplements	No	No	Yes	
13.	Child needs special health care	Yes		No	
14.	Childs's frequency of tooth brushing per day	Irregular or <1	1	2 Times	

But the idea of caries risk assessment is highly varied, as dental caries is a multi-factorial disease. On account of several studies performed, one could define three main approaches for risk assessment, which are based on:

i. past caries experience
ii. socioeconomic factors and
iii. biological factors

So, in view of the fact, a new model for understanding the interactions of various factors was proposed and a graphical model, the Cariogram, was drawn up to illustrate the fact that caries can be controlled by several different means. Cariogram was originally developed as an educational model but later on served as a routine caries assessment tool.

The Cariogram presents caries risk profile of an individual graphically, simultaneously taking into account the interaction off different causative factors/parameters of caries. It also provides recommendations for target preventive measures one could implement, in order to overcome new caries formation.

APPLICATIONS

- Illustrates the interaction of caries related factors.
- Illustrates the chance to avoid caries.
- Expresses caries risk graphically.
- Recommends targeted preventive actions.
- Can be used in the clinic and as an educational program.

The Cariogram, a pie-circle diagram, is divided into five sectors, in the following colors:

- The Dark blue sector 'Diet' - Based on a combination of diet contents and diet frequency.
- The Red sector 'Bacteria' - Based on a combination of amount of plaque and mutans streptococci.
- The Light blue sector 'Susceptibility'- Based on a combination of fluoride program, saliva secretion and saliva buffer capacity.
- The Yellow sector 'Circumstances' - Based on a combination of past caries experience and related diseases.
- The Green sector shows an estimation of the 'Actual chance to avoid new cavities'.

The bigger the green sector, the better from a dental health point of view. Smaller the green sector means low chance to avoid caries = high caries risk. For the other sectors, the smaller the sector, the better from dental health point of view.

29 Caries Activity Tests

CM Marya, Vandana Dahiya

Tests in the laboratory for susceptibility to and for activity of dental caries have intrigued the dental profession since 1890. An accurate assessment of the patient's oral status in relative immunity or susceptibility to caries could be used daily in the education of patients and could aid dentists during their planning and supervision of treatment.

The tests of activity have been categorized according to the property or constituents of the oral environment that is measured to obtain the findings. The various test have been classified by Stolpe J.R (1970) as (1) those test concerned with the chemical properties of saliva, (2) those test concerned with the bacterial constituents of saliva, (3) those tests which measure certain changes in chemical properties produced by bacterial metabolism.

OBJECTIVES OF CARIES ACTIVITY TESTS

These tests measure the degree to which the local environmental challenge favors the possibility of carious lesions.

Caries activity tests are essential to:

i. Establish an initial base-line level of cariogenic pathogens as a basis for future evaluation and preventive dentistry counseling.
ii. Ensure a low level of caries activity before starting any extensive restorative procedure.
iii. To monitor patients behavior towards reducing the number of streptococcus mutans and lactobacilli as a part of counseling to restrict sucrose intake.

ADVANTAGES OF CARIES ACTIVITY TESTS

i. Permits public-health dental personnel to screen large segments of the population for example school children.
ii. Permits the identification of individuals with a higher probability of developing caries and institute intensive and effective primary-preventive measures designed to arrest and to reverse the caries process.
iii. Permits the researchers to understand the caries process better and to develop better caries control measures by testing new preventive agents.
iv. These provide a patient with an objective evaluation of caries risk and an individual preventive program to be implemented before extensive restorative procedures are started.

CRITERIA OF AN IDEAL CARIES ACTIVITY TESTS

i. It should be reproducible: this means that repeated results of any chemical or bacteriological tests should be in the same order of magnitude if taken from same specimen or from different specimens collected at different times under standardized conditions.
ii. The test should be valid.
iii. There should be minimal occurrence of false responses.
iv. There should be a high correlation between the caries activity scores and the DMFS incidence or prevalence scores for an individual.
v. The test should be simple and inexpensive to perform.
vi. The test should not require special equipment or training.
vii. Should be non-invasive, easy to evaluate and applicable to any clinical setting.

CARIES ACTIVITY AND CARIES SUSCEPTIBILITY

Caries activity refers to the increment of active lesions (new recurrent lesions) over a stated period of time. It is a measure of the speed of progression of a carious lesion. Retrospectively it can be determined as caries incidence, that is, new carious lesions over time of an individual or population.

Caries susceptibility: This is the susceptibility (or resistance) of a tooth to a caries-producing environment. It refers to the inherent tendency of the host and target tissue (tooth) to be afflicted by caries process. The risk of developing a lesion, however, is individual and varies, depending on the tooth, its localization, surfaces, previous fluoride exposure etc.

Tests Which Measure Caries Activity

1. Lactobacillus colony count.
2. Streptococcus mutans level in saliva.
3. Dip slide method for s.mutans count.
4. S.mutans screening tests.
5. Alban test.
6. Dewar test.
7. Swab test.
8. Salivary buffer capacity.

Tests Which Measure Caries Susceptibility

1. Snyder's colorimetric test.
2. Enamel Solubility test.
3. Dewar test.
4. Fosdick calcium dissolution test.
5. Salivary reductase test.

VARIOUS CARIES ACTIVITY TESTS

1. Lactobacillus colony count test.
2. Colorimetric Snyder's test.
3. Alban test.
4. Reductase test.
5. Fosdick calcium dissolution test.
6. Dewar test.
7. Ora test.
8. Swab test.
9. Buffer capacity test.

Lactobacilli Counts

This test was first described by Hadley in 1933.

Procedure

1. Serial dilutions of saliva, collected by chewing a 1 gm paraffin wafer.
2. 1 ml aliquot from each dilution is then placed in a series of Petri dishes.
3. Approximately 10 ml [45°C] Ragosa's lactobacilli selective medium is added.
4. After incubation for 4 days, the number of colonies are counted (Fig. 29.1).
5. Caries activity is described from little or none to marked depending upon the number of colonies (Table 29.1). Counts are scored 1–4 depending upon whether they fall within the following ranges

With the increase in score, there was an increase in caries score for a group of individual.

Snyder's Test

Colorimetric method of measuring production of acid (Snyder's Test) was developed by Snyder in 1951 as a simple method for estimating the reactive numbers of lactobacilli in the saliva.



Fig. 29.1: Lactobacillus colony count test

Table 29.1: Scores and interpretation of lactobacilli count test

No of lactobacilli per ml of saliva	Caries activity
0 – 1000	Little or none
1000 – 5000	Slight
5000 – 10,000	Moderate
10,000 and above	Marked

It is based on the fact that acid is produced by lactobacilli and the amount of acid produced in a medium is proportionate to the number of lactobacilli in the inoculum.

A specimen of saliva is obtained with paraffin stimulation. The medium is prepared by adding 1 lt of boiling water to 61 gm of the powdered Snyder's medium and adjusting pH with glacial acetic acid. Approximately each sterile test tube is filled with 5 ml of medium and stored in refrigerator.

To evaluate visually the rapidity and extent of acid production, bromocresol-green glucose is added into the medium to indicate pH change.

Procedure

i. Saliva is collected before breakfast by chewing paraffin.
ii. A tube of Snyder glucose agar is melted and then cooled to 45°C.
iii. Saliva is shaken vigorously and 0.2 ml of saliva is added to agar tube and immediately mixed by rotating the tube.
iv. The tube is then incubated for 72 hours at 37°C.
v. The color change from green to yellow of the indicator is observed after 24, 48 and 72 hours of incubation (Fig. 29.2).

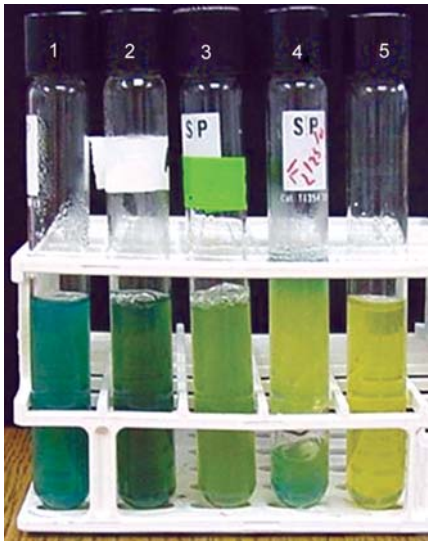


Fig. 29.2: Color change (Snyder's test)

Tube 1: Uninoculated Synder tube.
Tube 2: No color change indicates little or no susceptibility to forming dental caries.
Tube 3: Sight color change indicates mild susceptibility to forming dental caries.
Tube 4: Significant color change indicates moderate susceptibility to forming dental caries.
Tube 5: Complete color change indicates high susceptibility to forming dental caries.

Results

Interpretation
Interpretation is based upon the color change seen after 24 to 48 and 72 hours (Table 29.2).

Advantages
1. It is a simple test and needs only one tube of medium and no serial dilutions.
2. Has a moderate cost.

Disadvantage
Needs controlled temperature, best accomplished in a laboratory environment.

Table 29.2: Interpretation of Snyder's test

24 Hours	*48 Hours*	*72 Hours*
If yellow **Marked** caries susceptibility If green continue to incubate and observe at 48 hours	If yellow **Definite** caries susceptibility If green continue to incubate and observe at 72 hours	If yellow **Limited** caries susceptibility If green Caries inactive

Alban's Test (Modified Snyder's Test)

Snyder's test was modified by Arthur L Albans (1970) to carry out caries activity test for routine dental office use. This method uses the same media with the exception that less agar is added. This modification permits an easier permeation of bacterial metabolic end products throughout the agar column.

Procedure

i. A 5 ml tube of semisolid agar is taken from refrigerator but it is not heated.
ii. Patient is asked to spit unstimulated saliva directly into the tube until there is a thin layer of saliva covering the surface of the green agar. In small children a cotton swab can be rubbed across the tooth surface and the swab inserted just beneath the surface of the agar.
iii. The tube is then incubated for 4 days.
iv. Color changes produced by acidogenic or aciduric organisms are recorded daily.

Results

The color changes are scored from 0–4 based on the amount of color changes occurring from top to bottom (Table 29.3).

Alban's test is more predictive when the scores reflect either an extreme maximum or minimum challenge. Scores recorded as 4+ at the end of 24 hrs –very susceptible and zero at the end of 96 hrs – very resistant.

Advantages

i. Ideal for patient education.
ii. Good test to follow patient cooperation – to see the effect of diet modification and plaque control procedures, which are reflected within a few weeks.

Reductase Test

It was developed by RAPP in 1962. The biological activities of bacteria responsible for products harmful to the teeth are produced or controlled by enzymes. This test measures the activity of *enzyme reductase*. Reductase acts on the reagent diazoresorcinal to change blue color.

The test measures the rate at which an indicator molecule, *diazoresorcinol*, changes from blue to red to colorless or leuko

Table 29.3: Scoring criteria of Alban's test

Score	*Color change*
0	No color change
1+	Yellow color in top ¼ of the tube
2+	Yellow color in top half of the tube
3+	Yellow color in ¾ of the tube
4+	Yellow color in entire length of agar column

form on reduction by the mixed salivary flora. The reductase test comes in a kit [Treatex Test].

Procedure

i. Saliva is collected by chewing special flavored paraffin and expectorating into the collection tube, till saliva reaches the calibration mark [5 ml].
ii. The reagent cap is replaced (the reagent is placed on the inside of the tube's cap)
iii. The sample is mixed with diazoresorcinol, the reagent upon which the reductase enzyme is to react.
iv. The color change after 30 seconds and 15 minutes is taken as a measure of caries activity (Table 29.4).

Fosdick's Calcium Dissolution Test

A test for caries activity was developed by Fosdick (1937).

The test measures the milligrams of powdered enamel dissolved in four hours by acid formed when the patient's saliva is mixed with glucose and powdered enamel and incubated at 37°C.

Procedure

i. 25 ml of gum stimulated saliva is collected. Saliva is stimulated by chewing gum or paraffin. The use of chewing gum to stimulate saliva produces sugar; if the paraffin is used, about 5 percent glucose is added. (As presence of glucose is required for the test).
ii. Part of this saliva is analyzed for calcium content.
iii. The rest is placed in an eight-inch sterile test tube with about 0.1 gm of powdered human enamel.
iv. The tube is sealed and shaken for four hours at body temperature after which it is again analyzed for calcium content.
v. The amount of enamel dissolution increases as the caries activity increases.

Disadvantages

1. Test is not simple.
2. Complex equipment is required.
3. Trained personnel are required.
4. Cost is high.

Table 29.4: Interpretation of reductase test

Score	*Color*	*Time*	*Caries activity*
1	Blue	15 min	Non conducive
2	Orchid	15 min	Slightly conducive
3	Red	15 min	Moderately conducive
4	Red	Immediately	Highly conducive
5	Pink or white	Immediately	Extremely conducive

Dewar's Test

Dewar (1950) modified Fosdick's calcium dissolution test by determining, at the end of four hours incubation, the pH of the saliva-glucose enamel mixture. This test is similar to the Fosdick's Calcium Dissolution test except that the final pH after four hours is measured instead of amount of calcium dissolved.

Ora Test

It was developed by Rosenberg in 1989. It is a simple, economical, non-invasive and less time consuming test for estimating the oral microbial level.

Principle

It is based on the rate of oxygen depletion by microorganisms. Under aerobic condition the bacterial enzyme, aerobic *dehydrogenase* transfers electron or protons to oxygen. Once oxygen gets utilized by the aerobic organisms, an anaerobic environment is attained. Methylene blue (redox indicator) acts as an electron acceptor and gets reduced to leucomethylene blue. The metabolic activity of the aerobic microorganisms is reflected by the reduction of Methylene blue to leucomethylene blue.

The test is based on rinsing the mouth with sterile milk which dislodges the microorganisms and also produces a substrate for their further metabolism. The formation of Leukomethylene blue can be easily observed because of white color of milk

Advantages

1. Simple, inexpensive, non-invasive, time consuming, reproducible and requiring no trained personnel.
2. Use to monitor mouth rinse regime, dental hygiene, gingival inflammation.
3. Good educational and motivational tool for patients, schools and community dental health programs.
4. Vehicle of the test is non-toxic (milk).
5. Anticipate the onset of caries.
6. Results can provide the dentist to command the patients to reinforce motivation, plaque control and behavior.

Disadvantages

1. It does not identify a specific group of microorganism in a specific disease.
2. It can not accurately differentiate between the healthy state and between initial and progressive carious lesion.
3. Does not approach dental caries in a holistic manner like other caries activity test.
4. Lack of specificity since positive observation can be obtained in gingivitis and other oral diseases.

Armamentarium

- Sterilized milk
- 0.1 percent aqueous solution of methylene blue
- Mirror
- Sterile beakers
- Screw cap test tubes
- Water
- 5 ml disposable syringes
- Sterile pipettes
- Test tubes

Method

i. Patient is asked to rinse his mouth vigorously for 30 seconds with 10 ml of ultra-high temperature sterilized cow's milk containing 3 percent fat.
ii. Expectorate is collected in a sterile beaker.
iii. 3 ml of solution is immediately transferred with a disposable syringe to a screw cap test tube (contains-.12 ml of .1% methylene blue).
iv. The expectorated milk and methylene blue are thoroughly mixed.
v. Test tube is placed on a stand in a well illuminated area.
vi. Mirror is used to detect any color change (blue to white) in the bottom of test tube every 5 minutes and results interpreted (Table 29.5).

Swab Test

It was introduced by Grainger in 1965.

Principle

Acidogenic and acidouric element of the oral flora are measured after appropriate incubation periods by employing a color indicator in the test medium and by recording the pH directly on a pH meter.

Procedure

i. Oral flora is sampled by swabbing the buccal surface of the teeth with a cotton applicator.
ii. Subsequently incubated in the medium
iii. Change in the pH after 48 hr. incubation period is read and color changes read by color comparator.
iv. Interpretation is done as shown in Table 29.6.

Table 29.5: Interpretation of ora test

Color change seen after	*Caries active*
1. 5–10 min	Marked active
2. 15–20 min	Moderate active
3. 20–30 min	Slight active
4. 60 min	Inactive

Table 29.6: Interpretation of Swab test

pH 4.1 and <4.1	Marked caries activity
pH 4.2 to 4.4	Active
pH 4.5 to 4.6	Slightly active
pH 4.6 and over	Caries inactive

Advantages

1. No collection of saliva is required.
2. Test is of value in predicting caries increments, particularly in children with low or no previous caries experiences.

Buffer Capacity Test

Dreizen in 1946 studied the capacity of saliva to buffer acid and the relationship of this ability to caries-experience. He proposed capacity for buffering as a test of activity.

Procedure

To a 5 ml sample of saliva is added one-tenth normal lactic acid until a pH of 7.0 is obtained. The amount of lactic acid necessary to change the pH from 7.0 to 6.0 was accepted as indicative of the ability of the saliva to buffer acid.

STREPTOCOCCUS MUTANS SCREENING TEST

1. Plaque/toothpick method.
2. Saliva/tongue blade method.
3. Streptococcus mutans adherence method.

Plaque/Toothpick Method

The test involves a simple screening of a diluted plaque sample streaked on a selective culture method.

Procedure

Plaque samples collected from the gingival third of buccal tooth surfaces (one from each quadrant) are placed in Ringer's solution. The sample is then shaken until homogenized. The plaque suspension then shaken until homogenized. Then the plaque sample is streaked across a mitis-salivarius agar plate with a platinum loop. After aerobic incubation at 37°C for 72 hours the cultures are examined under low power microscope. Total colonies in 10 fields are recorded.

Saliva/Tongue Blade Method

This test was developed for use with large numbers of school children and it avoids the necessity of collecting saliva. The test estimates the number of S.mutans in mixed paraffin stimulated saliva when cultured on mitis-salivarius bacitracin [MSB] agar.

Procedure

The subject is asked to chew a piece of paraffin wax for 1 minute to displace plaque microorganisms. This increases the proportions of plaque microorganisms in the saliva. The subjects are then asked to rotate a sterile tongue blade in their mouth approximately 10 times, so that both sides of the tongue blade are thoroughly inoculated by the subject's flora. Excess saliva is removed by withdrawing the tongue blade through closed lips. Both sides of the tongue blade are then pressed onto an MSB agar in a disposable contact Petri dish, which is then incubated at 37°C for 48 hours.

Counts of more than 100 Colony-Forming Units [CFU] by this method are proportional to greater than 10^8 CFU of S.mutans per ml of saliva by conventional methods.

For field studies the plates can be placed into plastic bags containing expelled air which are then sealed and incubated at 37°C. This simplified method does not require any transport media or dilution steps.

Streptococcus Mutans Adherence Method

This test categorizes salivary samples based on the ability of S.mutans to adhere to glass surfaces when grown in sucrose-containing broth.

Procedure

Unstimulated saliva (0.1 ml) is inoculated in MSB broth. [MSB broth is available in a form which permits storage without deterioration. The broth is marketed in a sealed vial, to which is added a strip of paper bearing bacitracin, tellurite and crystal violet. These ingredients elute within 10 minutes after which the broth is ready to use].

Inoculated tubes are set at 60° angle and incubated aerobically at 37°C for 24 hours. After the growth is seen, the supernatant medium is removed and the cells adhering to the glass surface are examined macroscopically and scores are given.

Scores

-	No growth expressed	] S. mutans less than 10^4 CFU/ ml saliva.
+	A few deposits ranging from 1-10	
++	Scattered deposits of smaller size	
+++	Numerous minute deposits with more than 20 large size deposits	] S. mutans more than 10^5 CFU/ ml saliva

30 Fluorides in Dentistry

CM Marya

Dental caries is an ancient disease which has affected humans at least from the time that the agriculture replaced hunting. It's often referred to as a disease of civilization due to the prevailing pattern of caries during 20th century: high prevalence in the developed countries, low prevalence in the developing countries, although improving educational levels and eating habits have improved the situation. Fluoride ranks as a primary influence in better oral health because it has demonstrated that caries was inevitable.

The caries-preventive effect of fluoride has been known since the 1930s, when the differences in caries prevalence between communities were attributed to naturally occurring fluoride levels in the drinking water. Scientists have discovered that fluoride helps to protect teeth from dental decay; most of the work in caries prevention has been based on some type of fluoride use. Due to its safety, efficacy and cost-effectiveness in preventing caries the use of fluorides in various forms thus remains cornerstone of most caries prevention programs. In the past few years a better understanding of the mechanism of caries has led to an appreciation of the importance of fluoride in the remineralization.

HISTORY OF WATER FLUORIDATION

Introduction

The history of fluoridation began in 1901 when a dentist in Colorado Dr Frederick McKay first described a mystery staining of the teeth and the same was reported independently in Naples in 1902 by Dr JM Eager, an American dentist stationed in Italy. Over the following years, McKay became aware of several cases that suggested that the water supply might be responsible for the staining. He also noted that decay rates were much lower in areas with endemic dental staining than they were in other adjacent areas.

In the United Kingdom, an Essex dentist Mr. Norman Ainsworth had found dental staining similar to McKay's description of "Rocky Mountain Mottled Teeth". As part of a study for the Medical Research Council in 1925, Ainsworth examined over 4,000 children and, for the first time, produced a statistical comparison of decay rates between populations with the staining and those without. This study showed that those living in areas where mottled teeth were commonest tended to have much less dental decay.

HV Churchill a chief chemist for ALCOA (The Aluminium Company of America), became concerned in 1931. ALCOA was concerned that there was a possibility that there was a link between this staining and the presence of aluminium in drinking water. The staining had appeared in the town of Bauxite, Arkansas, where ALCOA mined most of their aluminium. Churchill analyzed water by spectrographic study from several areas where the staining was endemic for unusual element concentrations and found elevated levels of fluoride in all samples. The supply in Bauxite itself was measured at 13.7 ppm (parts per million).

Ainsworth was aware of Churchill's research and decided to compare the water supplies from the endemic staining area around Maldon in Essex with that of the nearby town of Witham. The Witham water proved to have 0.5 ppm fluoride, the samples from around Maldon ranged from 4.5 to 5.5 ppm.

It seemed clear that fluoride levels in water were related to both the staining of the teeth and reduced decay levels. The US Public Health Service was anxious to investigate this relationship and appointed a dentist, Dr HT Dean, to carry out the research. In a series of classic shoe-leather epidemiological investigations, culminating in his famous "21-City Study", Dean established that mottling of the teeth was extremely rare at fluoride levels of 1 ppm or below, while the greater part of the caries preventive effect was to be seen at 1 ppm. Dean published the results of his work in 1942.

During the Second World War, children from South Shields, an industrial town on the river Tyne in north eastern England, were evacuated to the Lake District. The Senior School Dentist for Westmoreland noted that the evacuees had far better teeth than local children. Robert Weaver, a dentist working for the Ministry for Education, was aware of the work being carried out in America and had the fluorine content of South Shields

water analyzed. It proved to be around 1.4 ppm, much higher than is present in most water supplies. He had North Shields (on the other bank of the Tyne) water analyzed; this proved to have a fluoride content of 0.25 ppm. In 1944, Weaver examined 1,000 children on either side of the Tyne. This study demonstrated much lower decay rates in both permanent and deciduous teeth in South Shields. This study was the first to describe the effects on the primary dentition.

The History of Artificial Water Fluoridation

Water naturally fluoridated at 1 ppm clearly benefited dental health. Following Dean's studies, the health authorities in the United States sought to reproduce this effect in low-fluoride areas by adding fluoride. No obvious negative health effects had been noted in populations served by naturally fluoridated water.

A number of tests or pilot schemes were set up to see whether the idea could work in practice. On 25th January 1945, *Grand Rapids, Michigan,* became the first town in the world to be artificially fluoridated, with *Muskegon* as a control. The previous year, a baseline study comparing Grand Rapids with the neighboring town of Muskegon had found similar decay levels in deciduous and permanent teeth in both areas. Six years later, surveys indicated that decay levels in 6-year-old children (i.e. those born since fluoridation commenced) in Grand Rapids was almost half of that of Muskegon.

In July 1951, city officials in Muskegon decided to fluoridate that town's water supply.

Other pilot fluoridation schemes in the USA were those in *Newburgh*, *New York*, with *Kingston* as a control which started fluoridating in May 1945. Also *Evanston, Illinois*, which began fluoridating in January 1946., with *Oak Park, Illinois* as control in order to measure the effectiveness of the fluoridation scheme. In both cases, significant reduction in dental decay rates was described in the fluoridating towns, with little or no change in the controls.

Several important studies carried out outside of the USA in the early days include the Brantford-Sarnia-Stratford study in Canada (1945–1962), the Tiel-Culemborg study in the Netherlands (1953–1969) and the Hastings study in New Zealand (1954–1970). As in the case of the American studies, significant reductions in decay experience were reported in artificially fluoridated areas.

The Department of Health in the United Kingdom became interested in this work. Three sites were selected for the initial fluoridation schemes in 1955; Watford, Kilmarnock and part of Anglesey. The areas selected as controls were Sutton, Ayr and the remaining part of Anglesey. Studies carried out after 5 years of fluoridation demonstrated much lower caries levels in the fluoridated areas in 5-year-old children.

In the Republic of Ireland, the Fluoridation of Water Supplies Act 1960 allowed for the fluoridation of all public water supplies. The two major cities of Dublin and Cork eventually commenced fluoridation in 1964, following the rejection by the Supreme Court of a constitutional challenge to the 1960 Act. Local, regional and national studies carried out in the decades since have all confirmed that children and adults living in fluoridated areas in Ireland have significantly fewer decayed teeth.

Currently, some 40 countries have artificial water fluoridation schemes in existence. In some cases, only a small proportion of the population is covered by the schemes. Most recently published estimates of population coverage include: USA (64%), Canada (43%), Panama (18%), Republic of Ireland (73%), Australia (61%), New Zealand (61%), Israel (75%), Malaysia (70%), United Kingdom (10%), Singapore (100%), Brazil (41%), Argentina (21%), Chile (40%), Spain (10%), Columbia (80%). Hong Kong is also fluoridated, with 100 percent population coverage. Recently there have been major extensions announced in the USA (particularly California) and Brazil.

FLUORIDE IN ENVIRONMENT

Fluorine is never seen in nature in the elemental form because it's the most electro negative of all chemical elements. Combined chemically in the form of fluorides, fluorine is 17th in the order of frequency of occurrence of elements, and represents about 0.06–0.09 percent of the earth crust. In rock and soil, fluoride may occur in a wide variety of minerals, including fluorspar, cryolite, apatite, mica and a number of pigmatites such as topaz and tour maline.

Waters with high fluoride content are usually found at the foot of high mountains and in areas with geographical deposits of marine origin. Examples are the geographical belt from Syria, Jordan, Egypt, Libya, Algeria, Morocco and Rift valley. Another belt stretches from Turkey through Iraq, Iran and Afghanistan. to India, northern Thailand and China.

Most of fluoride is firmly bound to minerals and other chemical compounds and is therefore not biologically available in its usual form. Fluoride concentration of soil increases with depth. In high mountain areas the fluoride content of the soil is usually higher.

FLUORIDE IN WATER AND ATMOSPHERE

All water contains fluorides in varying concentrations. Sea water contains significant quantities of fluoride at levels 0.8–1.4 mg/lt. In water from lakes, rivers, and artesians wells the fluoride content is usually below 0.5 mg /lt although concentrations as high as 95 mg /lt have been recorded in Tanzania. The highest natural fluoride concentration ever found in water was 2800 mg/lt, recorded in Lake Nakuru in the Rift valley in Kenya. There are significant variations in fluoride content of different wells even with in one village community, probably because of the local hydrological conditions.

Additional fluoride are widely distributed in the atmosphere, originating from dust of fluoride-containing soils from gaseous industrial waste, from the burning of coal fires in populated

areas and from gases emitted in areas of volcanic activity in nature. The principal source of pollution are industries and mining of phosphate and fluorspar, where fluoride rich dust travel long distances by wind and enter food chain by depositing on plants. Pesticides containing fluoride can have a similar effect.

FLUORIDE IN BIOSPHERE

There is a little relationship between fluoride concentrations in soil and plants. The uptake of fluoride varies among plant species, being influenced by soil, use of fertilizer, age of the leaf, irrigation and other factors.

A few species of plants are known to accumulate several hundred parts per million of fluoride, e.g. tea. Tea plant has a fluoride concentration ranging from 3.2 to 400 mg/kg. Vegetation grown in vicinity of industrial facilities may show elevated fluoride concentrations as a result of the absorption of particulate and gaseous fluoride impinging on leafy surfaces. Concentration decreases with increasing distance from the source.

In countries with water fluoridation programs, fluoridated water may raise the fluoride content of the processed food if fluoridated water is used for food processing more than that of the products for which non fluoridated water has been used.

FLUORIDE METABOLISM

The humans are exposed to fluoride in a number of ways. In order to understand the biological effects of fluoride on the human organism knowledge of fluoride metabolism is necessary. This can be divided into absorption, distribution and elimination (Fig. 30.1).

Fluoride Intake

The major sources of fluoride are food, drinking water, beverages, and fluoride-containing dental products. The atmosphere carries some fluoride, but it supplies only a small fraction of the daily exposure except in heavily polluted areas. Most foods have fluoride concentrations less than 0.5 ppm (Taves, 1983), the major exception being marine fish, which have concentrations that range from about 6 to 27 ppm. Beverage fluoride concentrations reflect those in the water used for preparation. In general, they range from 0.1 to about 1.4 ppm except for tea, which contains up to 7 ppm.

The average daily intake of dietary fluoride by young children whose water supply is optimally fluoridated is approximately 0.5 mg or 0.04–0.07 mg/kg *per* day (McClure, 1943; Ophaug *et al,* 1985; Featherstone and Shields, 1988).

Dental products have fluoride concentrations that range from 230 ppm in over-the-counter mouthrinses to 12,300 ppm in APF gels which are applied topically to the teeth by dental professionals. Toothpastes, the most frequently used dental products, contain fluoride at 1000–1500 ppm either as sodium fluoride or disodium monofluorophosphate.

Fluoride-containing dental products intended for topical application of fluoride to the teeth, especially dentifrices because of their widespread use, are an important source of ingested fluoride for both children and adults.

Fluoride Absorption

Approximately 75 to 90 percent of the fluoride ingested each day is absorbed from the alimentary tract. Fluoride may also be inhaled from air borne fluoride. Peak plasma concentration usually occurs with in 30–60 minutes. Readily soluble fluoride compounds such as NaF tablets or aqueous solution of NaF are completely absorbed where as compound with lower solubility such as CaF_2, MgF and AlF_3 are less completely absorbed. The ingestion of fluoride with food retards its absorption. Absorption from stomach occurs readily and is inversely related to the pH of the gastric content. The absorptive process occurs by passive diffusion. The absorption of fluoride is unusual in that it can occur from the stomach to a considerable extent. The rate of gastric absorption is directly related to the acidity of the contents so that, for any given dose, the peak plasma level is higher and occurs sooner when the contents are more acidic (Whitford and Pashley, 1984). Most of the fluoride that escapes absorption from the stomach will be absorbed from the proximal small intestine.

Fluoride in Plasma

Plasma is the biological fluid into which and from which fluoride must pass for its distribution elsewhere in the body and for its elimination from the body.

There are two general forms of fluoride in human plasma. The ionic form (also called as inorganic fluoride or free fluoride) and the non ionic or bound fluoride. Ionic form is of significance in dentistry and public health and is detected by ion-specific electrode. Together the ionic and non ionic fraction is called "total" plasma fluoride.

Ionic fluoride is not bound to proteins, to other components of plasma or to soft tissue. The concentration of ionic fluoride in soft and hard tissue is directly related to the amount of ionic

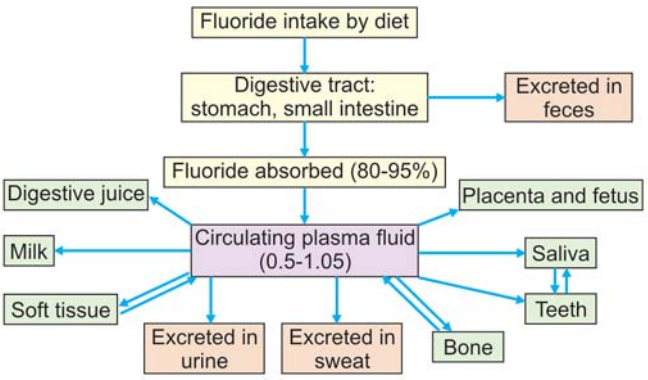


Fig. 30.1: Metabolism of fluoride in human body

fluoride intake. Since plasma fluoride levels are not homeostatically regulated, there is no 'normal' physiologic concentration. Plasma fluoride levels increase with age. Fluoride balance in infants can be positive or negative during the early months of life, depending on whether intake is sufficient to maintain the plasma concentration that existed at the time of birth.

Soft Tissues

Based on results from short-term studies with radioactive fluoride in laboratory animals, it has been shown that intracellular fluoride concentrations are from 10–50 percent lower than those of plasma, but they change simultaneously and in proportion to those of plasma (Whitford et al, 1979). The tissue-to-plasma ratios of radioactive fluoride are consistent with the hypothesis that HF is the form in which fluoride migrates and establishes diffusion equilibrium across cell membranes. Since the pH gradient across the membranes of most cells can be decreased or increased by altering extracellular pH, it is possible to promote the net flux of fluoride into or out of cells. This is the basis for the suggestion that alkalinization of the body fluids is a useful adjunct in the treatment of acute fluoride toxicity.

Fluoride in Calcified Tissues

Approximately 99 percent of the body burden of fluoride is associated with calcified tissues. The fluoride concentration in bone is not uniform. In long bones, for example, the concentrations are highest in the periosteal region (Weatherell et al, 1977). They decline sharply within a few millimeters of the periosteal surface and increase slightly as the endosteal region is approached. Cancelous bone has higher fluoride concentrations than compact bone. Dentine and bone appear to have similar fluoride concentrations which increase with age, while that of enamel is markedly lower.

Surface enamel fluoride concentrations tend to decrease with age in areas subjected to tooth wear but increase in areas that accumulate plaque (Weatherell et al, 1972). Dentine fluoride levels decline progressively from the pulpal surface to the dentine-enamel junction (DEJ). Enamel fluoride concentrations are highest at the surface and decline progressively toward the DEJ Bulk enamel (all the enamel from a tooth) fluoride concentrations mainly reflect the level of fluoride exposure during tooth formation, while dentine and bone fluoride concentrations are generally proportional to the long-term level of intake (Weatherell, 1969).

Fluoride Excretion

Urine

Fluoride is excreted primarily via urine. Fluoride is freely filtered through the glomerular capillaries and then undergoes a variable degree of tubular re-absorption. The percentage of the filtered fluoride reabsorbed from the renal tubules can range from about 10 to 90 percent. The degree of reabsorption depends largely on the pH of the tubular fluid, urinary flow and renal function (Ekstrand et al, 1980, 1982; Whitford, 1996). Urinary fluoride clearance increases with urine pH due to a decrease in the concentration of HF. Among the halogens, the renal clearance of fluoride is unusually high.

Numerous factors (e.g. diet and drugs) can affect urine pH and thus affect fluoride clearance and retention. The renal clearance of fluoride in the adult typically ranges from 30 to 50 ml/min, whereas clearance rates of the other halogens (chloride, iodide and bromide) are usually less than 1.0 ml/min. The excretion of fluoride in urine is reduced in individuals with impaired renal function.

Feces

It is generally accepted that most of the fluoride in the feces is not absorbed. Fluoride present in faeces results from two sources: the ingested fluoride that is not absorbed and the absorbed fluoride that is reexcreted into the gastrointestinal tract. Fecal fluoride usually accounts for less than 10 percent of the amount ingested each day.

Sweat

Usually, only a few percent of the fluoride intake is excreted in the sweat. However, under excessive sweating as much as 50 percent of the total fluoride excreted may be lost via perspiration.

Saliva

Less than 1 percent of absorbed fluoride is reported to appear in the saliva. The concentration of fluoride in saliva is about two-thirds of the plasma fluoride concentration and seems to be independent of flow rate, in contrast to the situation for most electrolytes.

In fact, saliva does not represent true excretion, because most of the fluoride will be recycled in the body. However, the fluoride content of the saliva is of major importance for maintaining a fluoride level in the oral cavity.

PHARMACOKINETICS OF FLUORIDE

The absorption, distribution and excretion of fluoride are simultaneous. A pharmacokinetic analysis of the plasma fluoride concentration curve after intake of a single dose of fluoride provides important information about the kinetics of fluoride in the human body.

By plotting the plasma concentration of fluoride as a function of time on a semilogarithmic scale, three exponential phases can be distinguished; an *initial increase* followed by *a*

rapid fall for about 1 hour and there after *a slower decline*. These phases represent absorption, distribution and elimination. Figure 30.2 shows the major features of fluoride metabolism. After ingestion, plasma fluoride levels increase measurably within the first few minutes and reach a peak concentration within 20–60 minutes.

The initial increase in plasma fluoride concentration reflects the absorption of fluoride from the gastrointestinal tract into the blood. The peak concentration depends on the amount ingested, rate of absorption, volume of distribution, and the rates of fluoride clearance from plasma by the kidneys and skeleton.

When the plasma peak is reached, the absorption gradually decreases and the distribution of fluoride from the blood to the tissues increases.

Fluoride is rapidly distributed to well perfused tissues as heart, kidneys, liver and bone. (Central compartment) and slowly distributed to skeletal muscles and adipose tissues which are poorly perfused.

Fluorides can be used systemically and topically. When given systemically they provide a low concentration of fluoride to the teeth over a long period during their development, i.e. Pre-eruption and also after they erupt. Best fluoride uptake takes place during late pre-eruption and early post-eruption phase (Fig. 30.3).

Topical fluorides are directly placed on to the tooth surface. Some fluoride preparations can provide both systemic and topical effects, e.g. fluoride chewable tablets, which can be swished around and then swallowed.

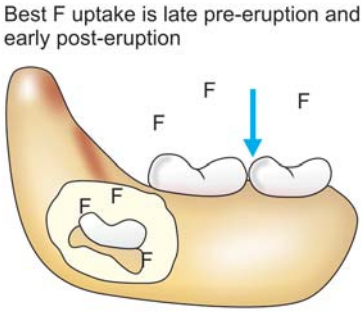


Fig. 30.3: Fluoride uptake

ARTIFICIAL FLUORIDATION (CONTROLLED STUDIES)

Controlled fluoridation field trials began in 1945 in the United States and Canada, in which the fluoride concentrations in the water supply of the test communities were brought up from negligible to 1.0–1.2 mg/L. The purpose of these field trials was to test the hypothesis that addition of fluoride to low concentration drinking waters would reduce caries experience.

The four studies were:

1. *Grand rapids–muskegon study:* This study began on 25th Jan 1945 when Sodium fluoride was added to grand rapids water supply, with near by Muskegon as the control city. The results after six and half years of fluoridation showed

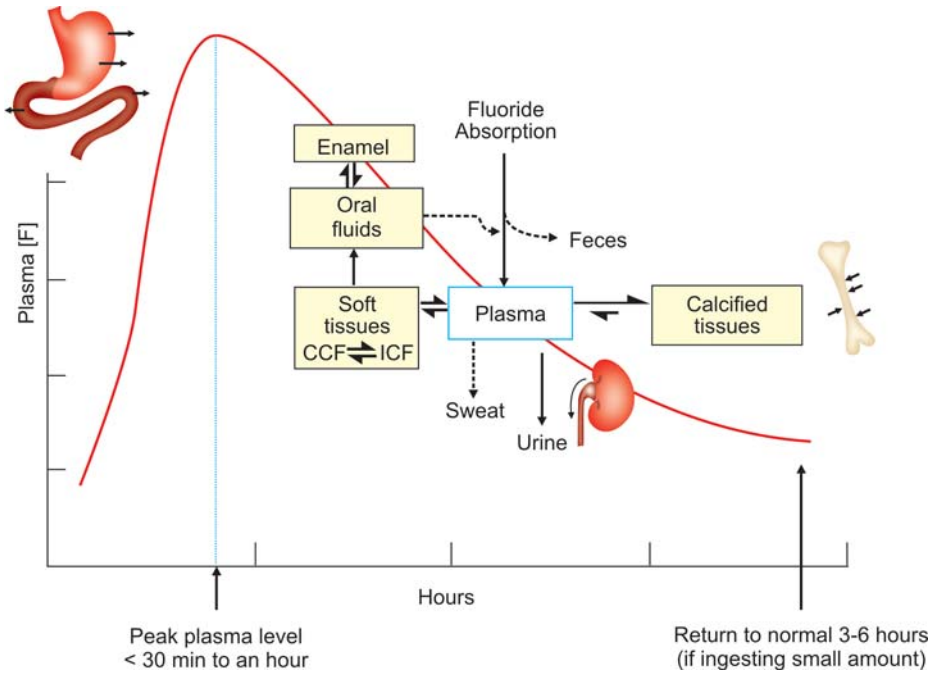


Fig. 30.2: A typical plasma concentration curve after the ingestion of a small amount of fluoride and the major features of fluoride metabolism

that caries experience of 6-year-old Grand Rapids children was almost half that of 6-year-old Muskegon children, as reported by Arnold, Dean and Knutson (1953).

2. *Newburgh-kingston study:* Newburgh, New York began fluoridation on 2nd May 1945. Sodium fluoride was added to the drinking water. Kingston town situated 35 miles away was chosen as a control town. Clinical examination after 10 years showed that D M F rate had fallen from 23.5 to 13 percent, while caries experience had changed little in similarly aged Kingston children.
3. *Evanston-Oak Park study:* Fluoridation began in January 1946 in Evanston, Illinois and a nearby community of Oak Park acted as control. The study showed a reduction of 49 percent in DMF values.
4. *Canadian studies:* In Canada water supplies in the town of Brantford, Ontario was fluoridated in June 1945; with Sarnia as a control. Naturally fluoridated Stratford was also included in this study as an auxillary control. 1.3 ppm of fluoride was naturally present in the drinking water of Stratford. After 17 years of fluoridation in Brantford, caries experience was almost similar to Stratford (naturally fluoridated) and was 55 percent lower than Sarnia (Control).

All these studies appear rather crude. None were longitudinal and all used a sequential cross-sectional design. The only true longitudinal study of fluoridation effect was the Tiel–Culemborg study the Netherlands.

Dutch Study (Tiel-Culemborgh Study)

Tiel was fluoridated in 1953. Fluoride level was 1.1 ppm and Culemborg with a fluoride concentration of 0.1 ppm served as a control. The examination in 1969 provided data on 15-year-old children who had been born with in the 1st year after the introduction of fluoridation 16 years back. Overall there was 56 percent less caries in Tiel although it varied on different anatomical sites, i.e. approximal, smooth surface, etc.

EFFECTIVENESS OF WATER FLUORIDATION

There is an extensive literature on the effectiveness of water fluoridation, with studies carried out in different parts of world. A review of fluoridation studies among children prior to 1980 reported caries reduction in children's permanent teeth ranging from 40 to 70 percent. Based on studies, reduction in the prevalence of dental caries in primary teeth ranged from 40 to 50 percent and in permanent teeth was 50 to 60 percent approximately.

In those countries where fluoridation is widespread, differences in caries experience between children in fluoridated and non fluoridated communities are now more commonly in the range of 18 to 35 percent, clearly less than approximately 50 percent difference reported earlier.

An apparent reduction is likely to be due to the phenomenon of declining caries prevalence recognized throughout the developed world since mid 1970, and influence of fluoride coming from other sources, e.g. use of fluoride toothpaste and supplements. Also due to indirect exposure to fluoride from food and beverages processed in fluoridated areas called as "Halo effect". This **Halo effect** described by Newbrun occurs when residents of non fluoridated communities are exposed to the benefits of fluoridation to some degrees by consuming food and beverages manufactured and processed in fluoridated communities.

WORLD STATUS OF FLUORIDATION

By 1984, there were 34 countries reporting fluoridation projects reaching 246 million people not including naturally occurring fluoride according to FDI (Federation Dentaire Internationale) 1984. Virtually 100 percent of the population of Singapore and Hong Kong receive fluoridated water as do over 50 percent of those in Australia, Malaysia, New Zealand and USA. Ireland remains the only nation to have a mandatory fluoridation laws. Fluoridation is technically not feasible for much of Asia and Africa because there is absence of municipal water system.

Currently, some 40 countries have artificial water fluoridation schemes in existence. In some cases, only a small proportion of the population is covered by the schemes. Most recently published estimates of population coverage include: USA (64%), Canada (43%), Panama (18%), Republic of Ireland (73%), Australia (61%), New Zealand (61%), Israel (75%), Malaysia (70%), United Kingdom (10%), Singapore (100%), Brazil (41%), Argentina (21%), Chile (40%), Spain (10%), Columbia (80%). Recently there have been major extensions announced in the USA (particularly California) and Brazil. There is no fluoridation at all in Germany, Austria, France, Belgium, Italy, Denmark, Sweden and Norway.

APPROPRIATE LEVELS OF FLUORIDE IN DRINKING WATER

Dean's research from 50 years ago established 1.0 mg/l as the most appropriate concentration of fluoride in drinking water. 'MOST APPROPRIATE' meant the concentration at which maximum caries reduction could be achieved while limiting dental fluorosis to acceptable levels of prevalence and severity. Because people in hot climates drink more water than do those in moderate climates, this figure of 1.0 mg/l was modified into a range (0.7 –1.2 mg/l) as per WHO. The higher the average temperature in a community, the lower is the recommended level of fluoride in drinking water.

By the 1990s, however it became clear that these standards were not appropriate for all parts of the world. It was found that the prevalence and severity of fluorosis in several Asian regions were unduly high when these ranges of fluoride were used. Hong Kong has reduced its water fluoride levels on several occasions to its current levels of 0.5 mg /l.

To determine the amount of fluoride that should be added to water Galagan and Vermillion (1957) developed an emperic formula for estimating the amount of daily fluid intake based

on body weight and climatic conditions, using the mean annual maximum daily air temperature as follows:

$$\text{ppm F} = 0.34 / E$$

where $E = 0.038 + 0.0062 \times t$ (temperature of the area in °F).

E is the estimated daily water intake of children in oz/ lb of body weight. 't' is the mean maximum daily air temperature in degrees Fahrenheit of the area.

FLUORIDE COMPOUND USED IN WATER FLUORIDATION

1. Fluorspar: It is a mineral containing calcium fluoride [CaF_2].
2. Sodium fluoride.
3. Silicofluorides.
4. Sodium silicofluorides: Most commonly used due to its low cost. Solutions of this compound are corrosive hence materials for piping, etc. should be chosen accordingly.
5. Hydrofluosilicic acid.
6. Ammonium silicofluoride [$(NH)_2SiF_6$].

METHODS OF WATER FLUORIDATION

There are three main systems used for water fluoridation.

A. The Saturator system.
B. The Dry-feeder system.
C. The Solution feeder system.

A. The Saturator System

In this system a 4 percent saturated solution of sodium fluoride is produced and injected at desired concentration at the water distribution source with the aid of a pump (Fig. 30.4).

Saturators

- *Upflow Saturator:* Generally used in smaller community water systems (those that serve 10,000 people or fewer).
- *Downflow Saturator:* Generally used in smaller community water systems (those that serve 10,000 people or fewer). Not used nowadays.
- *Venturi Saturator:* Generally used in extremely small community water systems (such as villages, trailer courts, or individual school buildings), although not used widely.

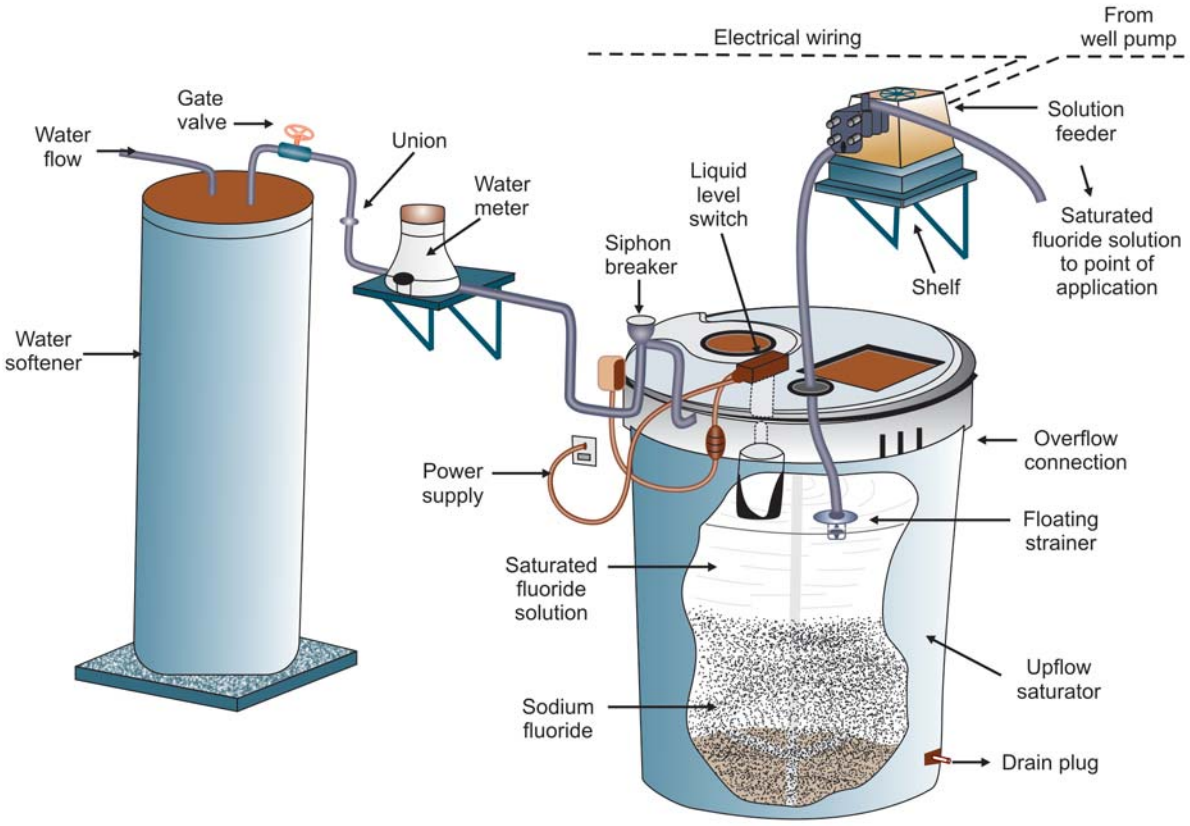


Fig. 30.4: Saturator system for water fluoridation

B. The Dry-feeder

Here sodium fluoride or silicofluoride in the form of powder is introduced into a dissolving basin automatically thus maintaining desired amount of fluoride in the water supply.

Dry Fluoride Feeders-Generally used in mid-size community water systems (those that serve approximately 10,000–25,000 people).

- *Gravimetric Feeders* (Belt-Type) as shown in Figure 30.5.
- *Volumetric Feeders* (Roll-Type or Screw-Type).

C. The Solution Feeder

This involves a volumetric pump permitting the addition of a given quantity of hydrofluosilicic acid in proportion to the amount of water treated (Fig. 30.6).

Diaphragm Solution Feeder-Generally used in larger community water systems (those that serve approximately 25,000 or more people).

FEASIBILITY OF WATER FLUORIDATION IN INDIA

It has been more than 60 years when the first artificial fluoridation of water was started at Grand Rapids in USA. In India no efforts have been undertaken to initiate water fluoridation. Water fluoridation seems to be a distant dream in a country were a major percentage of the population is devoid of potable drinking water.

The other reasons for not initiating the process of water fluoridation in India are:

1. No centralized water supply.
2. Great diversity in the fluoride concentration of water over the vast geographic expanse of the country.
3. Initial cost of setup of the plant may be high.
4. Oral health has been a low priority in the country.
5. The burden of dental caries is not as high as that in the developed world.
6. It may be difficult to reach a political consensus in a country like India.

Thus the use of topical fluorides in the form of tooth paste is a more feasible option. The efforts should be directed towards lobbying for availability of affordable fluoridated toothpaste for the Indian population especially the lower socioeconomic strata.

MECHANISM OF ACTION OF FLUORIDES

By the early 1990s it was well understood that fluoride is most effective in caries prevention. It is accepted that fluoride action in preventing caries is multifactorial. It is seen that anti caries effect is most pronounced when a low level fluoride is constantly maintained in the oral cavity, though the respective roles of pre-eruptive and post-eruptive fluoride continues to be debated.

Today the most important anti-caries effect is claimed to be due to the formation of calcium fluoride (CaF_2) in plaque and on the enamel surface during and after rinsing or brushing

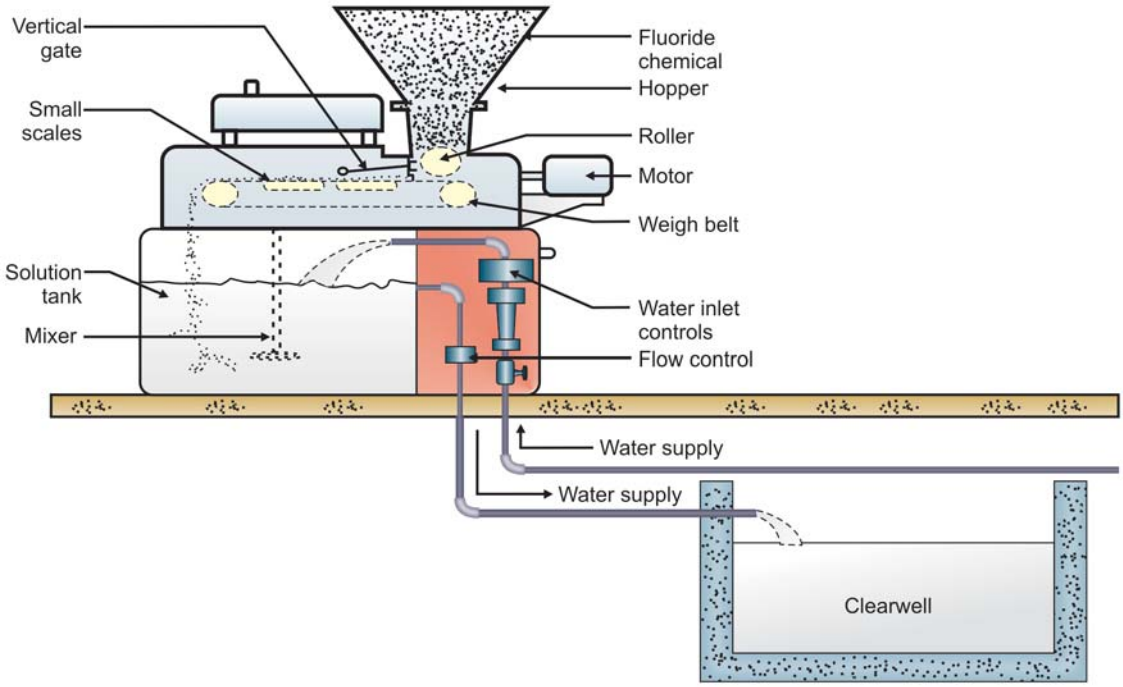


Fig. 30.5: Belt type of gravimetric feeder

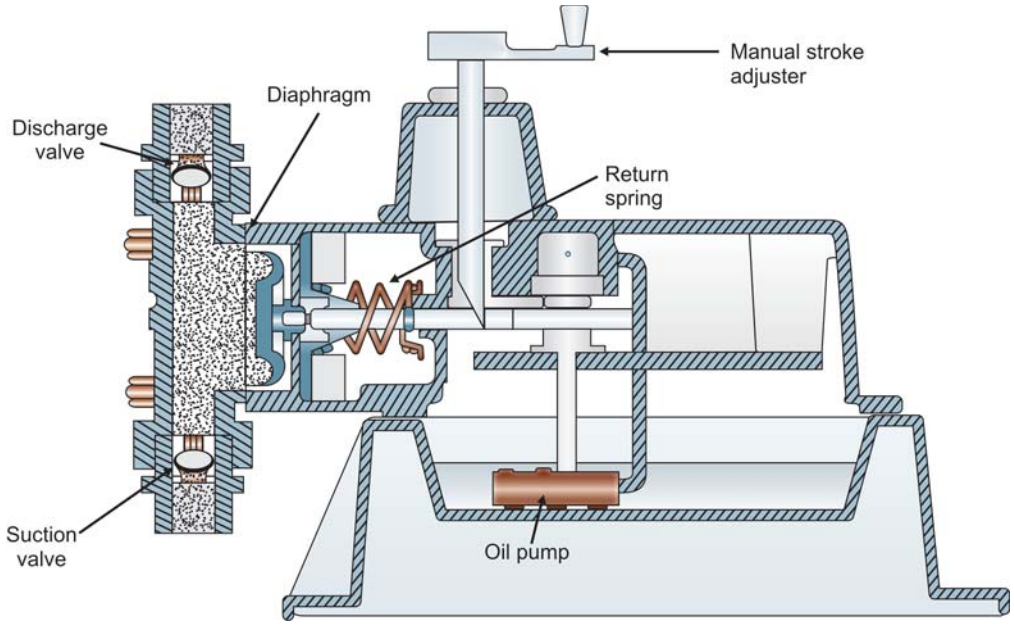


Fig. 30.6: Solution feeder

with fluoride. CaF_2 serves as a fluoride reservoir. When the pH drops, fluoride and calcium are released into the plaque fluid. Fluoride diffuses with the acid from plaque into the enamel pores and forms fluoroapatite (FAP). FAP incorporated in the enamel surface is more resistant to a subsequent acid attack since the critical pH of FAP (pH=4.5) is lower than that of hydroxyapatite (HA) (pH=5.5). Fluoride decreases the demineralization and increases the remineralization of the enamel between pH 4.5–5.5, and hence the demineralization period is shortened. It is suggested that fluoride has anti-bacterial actions. In an acidic environment, if fluoride is present, hydrogen fluoride (HF) is formed. HF is an undissociated, week acid that can penetrate the bacterial cell membrane. The entry of HF into the alkaline cytoplasmic compartments results in dissociation of HF to H^+ and F^-. This has two separate, major effects on the physiology of the cell. The first is that the released F^- interacts with cellular constituents, including various F^- sensitive enzymes. The second effect is an acidification of the cytoplasmic compartment caused by the released protons. Normally protons are pumped out of the cell, but fluoride inhibits these processes. The decreased intracellular pH will make the environment less favorable for many of the essential enzymes required for cell growth.

Pre-eruptive Systemic Effects

Fluoride is absorbed through the gastrointestinal system. The rate and degree of absorption depend on the solubility of the source and the amount ingested at a given time. Once absorbed into the bloodstream, fluoride is either deposited into bones and developing teeth or excreted in the urine. The major sources of systemic fluoride are water fluoridation and dietary supplements; food sources are a lesser but potentially important source. During tooth development, fluoride is incorporated into the developing tooth's mineralized structure. Although this is no longer believed to be the most important reason for the effect of fluoride in dental caries, the presence of fluoride in the dental enamel probably increases resistance to demineralization when the tooth surface is exposed to organic acids.

Systemic fluoride may enhance the resistance of the tooth by way of:

1. An alteration in tooth morphology, and
2. A conversion of the hydroxyapatite mineral to a fluoridated state with an attendant reduction in solubility and an enhancement of the remineralization phase of the caries process.

Post-eruptive Systemic Effects

After tooth eruption, fluoride is no longer involved systemically in tooth formation. However, consumed fluoride is excreted through the saliva and can aid in tooth protection throughout the lifetime.

Post-eruptive Topical Effects

Providing fluoride only before tooth eruption does not afford maximum protection against caries. In fact, topical mechanisms are now considered the primary means by which fluoride imparts protection to teeth. Thus, topical fluorides are now considered important in caries prevention independent of the provision of systemic fluorides. The post-eruptive beneficial effect of fluoride likely occurs primarily from the presence of fluoride in the fluid

phase at the tooth surface. Fluoride is responsible for decreasing demineralization when the tooth is exposed to organic acids and for increasing the rate of remineralization.

The frequency of fluoride exposure to the tooth surface is of prime importance to maintain the high fluoride concentration that is necessary in the fluid phase of enamel surfaces to prevent caries and enhance the remineralization of early carious lesions. Topical fluoride may be particularly important in the prevention of root caries, coronal caries, and tooth loss in adults and the elderly.

In addition to its direct mineralizing effect on enamel, fluoride may affect oral plaque bacteria. These bacteria secrete acids onto tooth surfaces (the byproducts of carbohydrate fermentation), which initiates tooth demineralization. The entry of fluoride into the bacterial cell interferes with acid production, thus reducing potential enamel destruction. This, however, is not considered to be an important determinant of fluoride's beneficial effect in reducing caries.

Fluoride can be provided topically to teeth via rinses, dentifrices, or gels at home, at school, or in the dental office. Fluoridated water and chewable dietary fluoride supplements are also thought to provide notable topical benefit. Thus, people of all ages benefit from the topical effects of fluoride, whether or not they consumed fluoridated water or fluoride supplements as children.

The following mechanism of action has been identified:

Mechanisms of Fluoride Action

Scientists have proposed that fluoride has several functions (Fig. 30.7):

1. Increased enamel resistance or reducing enamel solubility [acid dissolution].
2. Interferes in the formation and functioning of dental plaque microorganisms.
3. Increases the rate of post-eruptive maturation.
4. Remineralization of incipient lesions.
5. Improves tooth morphology.

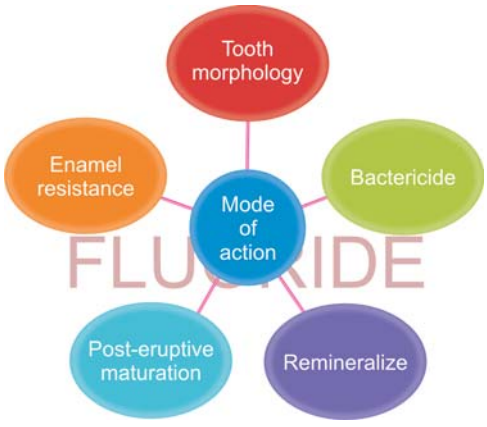


Fig. 30.7: Mechanism of action of fluoride

INCREASED ENAMEL RESISTANCE

Fluoride reduces the solubility of dental enamel by both systemic and topical action. Fluoride ingested prior to tooth eruption enhances the development of fluorapatite at the enamel surface and that this fluorapatite is resistant to the demineralizing acids that initiate the carious process.

The systemic action of fluoride on caries is due to stabilization of the apatite lattice. Such stabilization is a result of hydroxyapatite having inherent voids due to missing hydroxyl group. Fluorides ions fill these voids and add their hydrogen bonding tendency to the forces which hold the crystals together.

The topical effect of fluoride in reducing enamel solubility occurs during the repeated cycles of demineralization and remineralization in the early stages of carious lesion. When tooth is exposed to a pH of about 5.5 or lower enamel dissolution starts. This occurs beneath bacterial plaque. The concentration of calcium, phosphate and other ions increases in the solution. When the pH returns back to normal the dissolved minerals get precipitated. Hence, carious dissolution of enamel is a cyclic phenomenon consisting of phases of demineralization when precipitation occurs. The presence of low levels of in the plaque leads to a gradual establishment of well-crystallized and more acid resistant apatite in enamel surface.

The other mechanisms which have been postulated in rendering decreased enamel solubility are:

- That under the influence of fluoride, larger crystals are formed with fewer imperfection thus stabilizing the lattice and presenting a smaller surface area/unit volume for dissolution [Jenkins 1967]
- Enamel which mineralizes under the influence of fluoride has a lower carbonate content thus giving a reduced solubility [Moreno et al 1977].

Inhibiting Demineralization

The mineral of our teeth (enamel, cementum, and dentine) and bones is a carbonated hydroxyapatite that can be approximately represented by this simplified formula:

$$Ca_{10-x}(Na)_x(PO_4)_{6-y}(CO_3)_z(OH)_{2-u}(F)_u$$

The substitutions in the hydroxyapatite crystal lattice (the arrangement of atoms and ions in the crystal) occur as the mineral is first laid down during tooth development, with the carbonate (CO_3) ion in particular causing major disturbances in the regular array of ions in the crystal lattice. During demineralization, the carbonate is lost, and during remineralization it is excluded from the newly formed mineral. The calcium-deficient, carbonate-rich regions of the crystal are especially susceptible to attack by the acid hydrogen ions during demineralization, as has been shown by several investigators. The carbonated hydroxyapatite, or CAP, of teeth is much more soluble in acid than hydroxyapatite, or HAP.

(HAP = $Ca_{10}(PO4)_6(OH)_2$), and that in turn is much more soluble than fluorapatite, or FAP.

(FAP = $Ca_{10}(PO4)_6F_2$) in which the OH^- ion in pure hydroxyapatite is completely replaced by an F^- ion. The resulting mineral FAP is highly resistant to dissolution by acid.

Fluoride inhibits demineralization. Sound enamel, except in its outer few micrometers, generally contains fluoride at levels of about 20 to 100 parts per million, or ppm, depending on the fluoride ingestion during tooth development. Teeth in children who lived in areas with fluoridated drinking water during tooth development have fluoride content toward the higher end of this range. The outer few micrometers of enamel can have fluoride levels of 1,000 to 2,000 ppm.

Fluoride in the solution surrounding CAP crystals has been shown to be much more effective in inhibiting demineralization than fluoride incorporated into the crystals at the levels found in enamel. Fluoride incorporated during tooth mineral development at normal levels of 20 to 100 ppm (even in areas that have fluoridated drinking water or with the use of fluoride supplements) does not measurably alter the acid solubility of the mineral. Even when the outer enamel has higher fluoride levels, such as 1,000 ppm, it does not measurably withstand acid induced dissolution any better than enamel with lower levels of fluoride. Only when fluoride is concentrated into a new crystal surface during remineralization is it sufficient to beneficially alter enamel solubility. The fluoride incorporated developmentally—that is, systemically into the normal tooth mineral—is insufficient to have a measurable effect on acid solubility.

In contrast to the lack of effect of fluoride incorporated into the CAP crystals of tooth mineral developmentally, as little as 1 ppm of fluoride in the acid solution reduced the dissolution rate of CAP to a rate equivalent to that of HAP. Further increases in fluoride in the acid solution in contact with the CAP mineral surface decreased the solubility rate logarithmically. These results indicate that if fluoride is present in the aqueous solution surrounding the crystals, it is adsorbed strongly to the surface of CAP carbonated apatite (enamel mineral) crystals and thus acts as a potent protection mechanism against acid dissolution of the crystal surface in the tooth's subsurface region. If fluoride is in the plaque fluid at the time that the bacteria generate acid, it will travel with the acid into the subsurface of the tooth and, therefore, adsorb to the crystal surface and protect it against being dissolved.

INHIBITION OF BACTERIAL ENZYME SYSTEM

Fluoride interferes with oral bacteria in two ways. In high concentrations it acts as bactericidal and in low concentration it decreases acid production.

Fluoride inhibits glycolysis—the process by which fermentable carbohydrates are metabolized by cariogenic bacteria to produce acids.

Plaque fluoride can inhibit the production of extracellular polysaccharides by cariogenic bacteria—this is necessary for plaque adherence to smooth enamel surfaces.

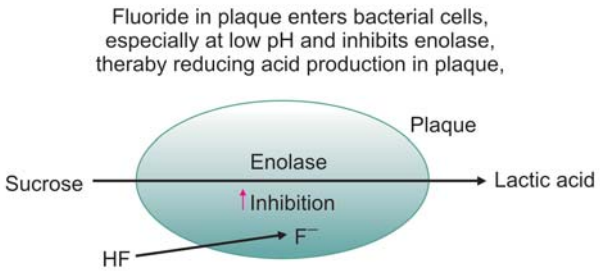


Fig. 30.8: Inhibition of bacterial enzyme system

Fluoride is concentrated with in the plaque. It can accumulate in dental plaque in concentrations above 100 ppm. Fluoride normally present in plaque is largely bound [thus unavailable for antibacterial action], only 2–5 percent being in ionic form. When the pH of plaque decreases, i.e. acid is produced by plaque organism the bound fluoride dissociate to ionic fluoride. Thus when caries process starts and acids are formed, plaque fluoride in ionic form may serve to interfere with further acid production by plaque microorganism.

Several investigators have reported that the ionized form of fluoride, or F^-, cannot cross the cell wall and membrane but can rapidly travel into the cariogenic bacterial cells in the unchanged form as HF. When the pH in the plaque falls as the bacteria produce acids, a portion of the fluoride present in the plaque fluid then combines with hydrogen ions to form HF and rapidly diffuses into the cell, effectively drawing more HF from the outside. (HF forms from H^+ and F^- ions as the bacteria produce acids during the metabolism of fermentable carbohydrates. Once inside the cell, the HF dissociates, acidifying the cell and releasing fluoride ions that interfere with enzyme activity in the bacterium. Fluoride inhibits enolase, an enzyme necessary for the bacteria to metabolize carbohydrates and produce acids necessary to cause demineralization. As fluoride is trapped in the cell, the process becomes cumulative (Fig. 30.8).

INCREASED RATE OF POST-ERUPTIVE MATURATION

At the time of tooth eruption the enamel is not completely calcified and undergoes a post-eruptive period of approximately 2 years during which enamel calcification continues. Throughout this period-period of enamel maturation' there is continuous accumulation of fluoride as well as other elements in the superficial part of enamel.

ENHANCING REMINERALIZATION

As the saliva flows over the plaque and its components neutralize the acid, raising the pH, demineralization is stopped and reversed. The saliva is supersaturated with calcium and phosphate, which can drive mineral back into the tooth. The partially demineralized crystal surfaces within the lesion act as

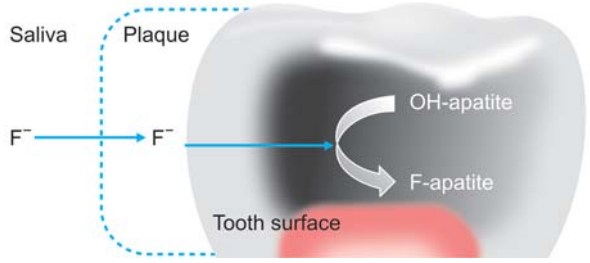


Fig. 30.9: Enhancing remineralization

"nucleators", and new surfaces grow on the crystals. These processes constitute remineralization—the replacement of mineral in the partially demineralized regions of the carious lesion of enamel or dentine (including the tooth root). Fluoride enhances remineralization by adsorbing to the crystal surface and attracting calcium ions, followed by phosphate ions, leading to new mineral formation. The newly formed "veneer" excludes carbonate and has a composition somewhere between HAP and FAP as described above.

FAP contains approximately 30,000 ppm F and has a very low solubility in acid. The new remineralized crystal now will behave like low-solubility FAP rather than the highly soluble CAP of the original crystal surface.

In summary, fluoride in solution from topical sources enhances remineralization by speeding up the growth of a new surface on the partially demineralized subsurface crystals in the caries lesion. The new crystal surface veneer is FAP-like, with much lower solubility than the original CAP tooth mineral. Subsequent acid challenges must be quite strong and prolonged to dissolve the remineralized enamel (Fig. 30.9).

IMPROVES TOOTH MORPHOLOGY

It has been reported by a number of investigators, although not universally accepted that posterior teeth from fluoridated areas have a distinct gross morphology. This is shown in Figure 30.10 in schematic and exaggerated form: the cusps are rounder; the fissures are more shallow and the fissural approximation abrupt and tight. In contrast, fluoride-deficient teeth have less rounded cusps, steep inclines, and unfavorable fissural approximation. The latter is troublesome, because the less well-fused fissures serve as an excellent trap for food debris, bacteria and bacterial byproducts.

FLUORIDE ADMINISTRATION

These can be administered systemically or applied topically for preventive effect:

A. Systemic: These are ingested and delivered to the oral cavity via the blood stream.

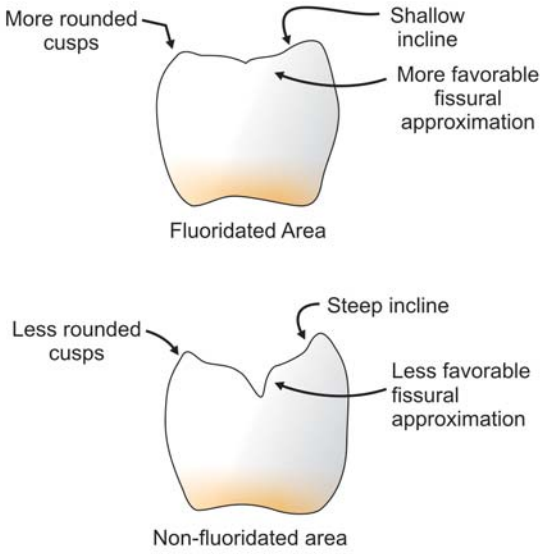


Fig. 30.10: Comparison of gross morphology of posterior tooth: Fluoridated and non-fluoridated areas

B. Topical: Topical fluorides are utilized intraorally for variable amount of time, provide fluoride to exposed crown and root surfaces. These contain relatively large concentration of fluoride that is applied locally or topically to exposed tooth surfaces to prevent dental caries.

A. Systemic.
   1. Water fluoridation.
      a. Community water fluoridation.
      b. School water fluoridation.
   2. Dietary supplements.
      a. Fluoride tablets and drops.
      b. Fluoridized salts.
      c. Fluoride vitamins preparation.
      d. Fluoridized milk and fruit juices.

B. Topical.
   1. Those applied by professional.
      a. Topical solutions and gels.
      b. Fluoride containing varnishes.
      c. Fluoride prophylaxis paste.
      d. Restorative materials containing fluoride.
      e. Fluoride containing devices (Slow Release).
   2. Self applied fluoride agents.
      a. Fluoride dentifrices.
      b. Fluoride rinses.
      c. Fluoride gels.

Goals of Fluoride (F) Administration (Fig. 30.11)

1. Do not harm the patient.
2. Prevent decay on intact dental surfaces.
3. Arrest active decay.
4. Remineralize decalcified tooth surfaces.

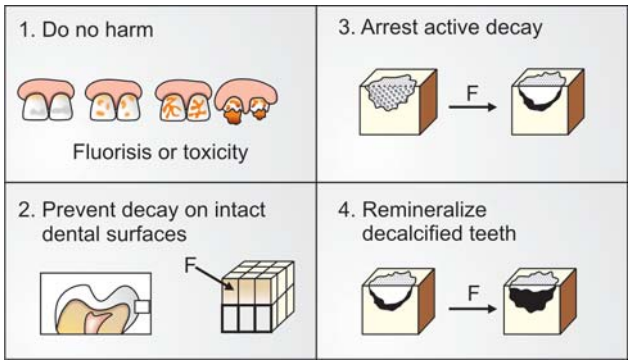


Fig. 30.11: Goals of fluoride administration

For the sake of simplicity the fluoride can be divided into two main sections; the effect of fluoride topically, and the application of fluoride topically in the form of solutions, mouthrinses, etc.

Systemic fluoride provides systemic effect, i.e. accruing from ingestion and absorption of fluoride and this can occur post-eruptively via saliva and crevicular fluid.

A. SYSTEMIC FLUORIDES

Advantages and disadvantages of systemic water fluorides.

Advantages

1. Low cost.
2. No motivation or behavioral changes necessary.

Disadvantages

1. Political and/or emotional objections to water additives.
2. Possibility of mild to moderate fluorosis if other sources of fluoride are ingested inadvertently.
3. Alleged toxicity.

WATER FLUORIDATION

A. Community Water Fluoridation

Fluoridations is the controlled adjustment of a fluoride compound to a public water supply in order to bring the fluoride concentration up to a level which effectively prevents caries. Fluoridation is not a targeted approach caries prevention as it reaches everybody.The studies Dean and others up to 1943, shown that fluoride was associated with a lower prevalence of caries, and that there was a sound basis for hypothesis that the introduction of fluoride into a water supply would result in a lower communal prevalence of caries. All the studies upto this stage were retrospective as they looked at communities where fluoride was already present in water. The 1984 WHO [World Health Organization] guidelines suggested that in areas with a warm climate, the optimal fluoride concentration in drinking water should remain below 1 mg/liter (1 ppm or part per million), while in cooler climates it could go up to 1.2 mg/liter. [A range of 0.7–1.2 ppm]. The differentiation derives from the fact that perspiration is more in hot weather and consequently water intake is more.

The guideline value (permissible upper limit) for fluoride in drinking water was set at 1.5 mg/liter, as a level at which dental fluorosis should be minimal (WHO, 1984). The 1.5 mg/l fluoride guideline value that was set in 1984 was subsequently re-evaluated by WHO and it was concluded that there was no evidence to suggest that it should be revised (WHO, 1996, 2004). The 1.5 mg/l guideline value of WHO is not a "fixed" value but is intended to be adapted to take account of local conditions (e.g. diet, water consumption, etc.). 1 mg/liter (1 ppm or part per million).

REQUIREMENTS FOR WATER FLUORIDATION

1. A level of dental caries in the community that is high or moderate, or a firm indication that the caries level is increasing.
2. Attainment by the country [or area of a country] of a moderate level of economic and technological development.
3. Availability of a municipal water supply reaching a large proportion of homes.
4. Evidence that people drink water from the municipal supply rather than water from individual wells or rain water tanks.
5. Availability of the equipment needed in a treatment plant or pumping station.
6. Availability of a reliable supply of fluoride chemical of acceptable quality.
7. Availability of trained workers in the water treatment plant, who are able to maintain the system and keep adequate records.
8. Availability of sufficient funds for initial installation and running costs.

ECONOMICS OF FLUORIDATION

Major advantage of water fluoridation as a method of exposing a whole community to the benefits of fluoride is its cost-effectiveness.

Factor which influence the per capita cost are:

- The size of the community; bigger the population, lower the per capita cost.
- The number of fluoride injection points required.
- The amount and type of equipment to be used.
- The amount and type of fluoride chemical used its price, plus the cost of transportation and storage.
- The expertise of water plant personnel.

The average annual cost of water fluoridation in the US in 1989 was calculated as some 51 cents/person per year [assuming an existing water system], though in any one community the annual cost ranged from 12 cents to $ 5.41 per person.

In India the cost would approximately come out to be Rs. 0.25/year per person and the expected caries reduction would be 50 percent, much cheaper than the cost of restoration.

Feasibility of Water Fluoridation in India

It has been more than 60 years when the first artificial fluoridation of water was started at Grand Rapids in USA. In India no efforts have been undertaken to initiate water fluoridation. Water fluoridation seems to be a distant dream in a country were a major percentage of the population is devoid of potable drinking water.

The other reasons for not initiating the process of water fluoridation in India are:

1. No centralized water supply.
2. Great diversity in the fluoride concentration of water over the vast geographic expanse of the country.
3. Initial cost of setup of the plant may be high.
4. Oral health has been a low priority in the country.
5. The burden of dental caries is not as high as that in the developed world.
6. It may be difficult to reach a political consensus in a country like India.

Thus the use of topical fluorides in the form of tooth paste is a more feasible option. The efforts should be directed towards lobbying for availability of affordable fluoridated toothpaste for the Indian population especially the lower socioeconomic strata.

MEDICAL ASPECT OF WATER FLUORIDATION

Medical aspect or safety of water fluoridation was a research concern from the time of fluoride's identification in water in 1931. According to World Health Organization's [WHO] monograph 'fluoride and human health' there is evidence that ingestion of fluoride at recommended levels presents no danger to humans.

Health benefits and risk of fluoridation has been the subject of searching reviews by expert committees throughout the world including the WHO. None has found evidence that drinking water with a concentration of around 1 ppm is harmful to health. Infact other than dental fluorosis only endemic skeletal fluorosis is known to result from long-term ingestion of water containing high levels of fluoride. To protect against skeletal fluorosis the US Environmental Protection Agency [EPA] has set a maximum contaminant level [MCL] for fluoride in water at 4.0 ppm. However in Europe the maximum admissible concentration [MAC] for fluoride in water is 1.5 ppm, and the WHO guidelines value for fluoride in water is also 1.5 ppm. [WHO1993].

In October 2005, the Australian Research Center for Population Oral Health (ARCPOH) hosted a Workshop on the Use of Fluorides in Australia. ARCPOH hosted the workshop at the request of the National Advisory Committee on Oral Health (NACOH). The committee suggested for Australia that the level of fluoride in the water supply should be within the range 0.6–1.1 mg/L with variation within that range according to the mean maximum daily temperature.

In recent years opponents of fluoridation have attempted to link fluoridation with a wide range of diseases, e.g. cancer, Alzheimer diseases or that it interferes with the immune function. But there is overwhelming agreement between the scientific, medical and dental community world wide that fluoridation of water is a safe and effective public health measure.

FLUORIDATION AND THE LAW

Legislation authorizing water fluoridation is of two types:

Mandatory: Which makes it compulsory for Ministry of Health or communities to fluoridate the public water supplies which are fluorine deficient. For example Brazil, Bulgaria, Ireland and some states of USA.

Permissive or *Enabling*: Which gives the ministry of health or a local government the authority to institute fluoridation. Such legislation does not automatically bring about fluoridation but makes the way for health officials or units of local government to act. Countries with enabling legislation are several states of the USA and Australia, Israel, New Zealand, Canada and United Kingdom.

Legal Issues in Fluoridation

Deliberate fluoridation of public water supply for the express purpose of preventing dental caries, is an issue of debate from the legal point of view. Though there is enough scientific evidence to support the role of water fluoridation in prevention of dental caries there have always been legal arguments in this regard.

The debate starts with the fact that fluoride supplementation may be considered as mass medication. Water fluoridation which is the artificial addition of fluoride may be considered as a violation of the constitutional right of individual citizen to refuse medical treatment. US supreme court has found that the forcible injection of medications into a patient without their consent 'represents a substantial interference with the person's liberty'. Considering the fact that dental caries is neither communicable nor contagious there is objections raised to the issue of need of mass medication.

Water fluoridation also lacks a rational basis as the anti fluoridation proponents have suggested that the benefits of water fluoridation is mainly on the children with developing teeth and flouride may pose a potential threat to the elderly prone to skeletal problems.

Though there is evidence to substantiate the claims that water fluoridation is effective in reducing the caries rate, European countries have shown decline in dental caries in the absence of water fluoridation. Alternative methods of fluoride delivery may be a more apt mode of delivery of fluoride

considering the fact that it does not infringe the rights of the citizen. Economically systemic fluoride to children is better than fluoridating water for the entire community.

Fluoride is not considered as an essential human nutrient. The issue of safety is raised by the anti fluoridation lobby. Fluoride is considered as a toxin at higher doses. Fluoride is also ingested from other modes like pesticides and fertilizers. Fluoride accumulates in the body. Water fluoridation also leads to increase in lead uptake from plumbing. Other than dental and skeletal fluorosis excessive fluoride ingestion has been shown to be associated with hyperparathyroidism and neurologic dysfunction. The groups that are more at risk to excess fluoride include the elderly, individuals with deficiencies of Vitamin C, Calcium or magnesium, cardiovascular patients and those with kidney diseases.

The following are some of the legal cases related to water fluoridation:

- De Aryan Vs Butler
- Dowell Vs City of Tulsa
- Kraus Vs City of Cleveland
- Teeter Vs Municipal City of La Porte
- Chapman Vs City of Shreveport
- Paduano Vs City of New York
- Denial Vs Equal protection under the Law.

REASONS FOR CESSATION OF FLUORIDATION

1. *Political reason:* includes.
   - Decision by government not to persue fluoridation in the face of antifluoridation activity, e.g. in Netherland, Czech Republic and Finland.
   - Decisions by water suppliers not to reinstate fluoridation after interruption for technical reason, e.g. Wales.
2. *Economic reason:* includes.
   - Reassessment of the cost and benefits of fluoridation in the light of generalized reduction in caries prevalence, i.e. when benefit : cost ratio is unfavorable.

Several communities have ceased fluoridation schemes after a few years. The decision to discontinue fluoridation is usually complex. Opponents of fluoridation usually state that evidence of adverse effects is the reason for it but there is no evidence to support such claims.

ETHICS OF WATER FLUORIDATION

Ethics of water fluoridation does not differ from consideration of ethical issues related to any other aspect of health care. Four prima facie moral principles are: *autonomy*, *beneficence*, *non-maleficence* and *justice.*

Autonomy

Respect for autonomy is the moral obligation to respect the personal freedom of others. In society generally some dimunition of individual freedom is accepted for the general good. Most laws and regulations depend on this. It is not whether we are entitled to impose fluoridation on unwilling people, but are unwilling people entitled to impose the risks, damage and costs of failure to fluoridate on the whole community.

Beneficence and Non-maleficence

Beneficence (to help others) and Non-maleficence (to do no harm) can be considered simultaneously, since when we try to help others we inevitably risk harming them. With regards to fluoridation we must consider not only those who will benefit but also those in community who will receive no benefit, e.g. edentulous population. So one must be as sure as possible that fluoridation will do no harm to them. Fluoridation is safe from medical aspect.

Justice

Equality and fairness are the essence of justice. Water fluoridation as a public health measure follows this principle. Fluoridation benefits those with natural teeth but the greatest benefits are obtained by children and socially deprived communities. It also benefits those responsible for managing limited health care resources in the most cost effective way possible. Fluoridation is the most cost effective public health measure available for reduction of unacceptably high levels of dental caries.

PRE-ERUPTIVE EFFECT OF WATER FLUORIDATION

The most thorough investigation into the relative importance of pre and post-eruptive exposure to fluoride was undertaken by Van Eck [1987]. He used the collected data during the Tiel-Culemborg fluoridation study in the Netherlands. The maximum caries in approximal caries of molars, premolars and upper incisors was 65 percent [fluoridation began 7 years before tooth eruption], whereas only 30 percent reduction was observed in teeth which erupted in the same year as fluoridation began and the teeth subjected to post-eruptive fluoride only. He concluded that fluoridated water consumed continuously from birth results in the greatest beneficial effect of fluoride. Pre as well as post-eruptive consumption are both necessary to gain maximum benefits from water fluoridation.

WATER FLUORIDATION AND ROOT SURFACE CARIES

There is now increasing evidence that fluoride is especially effective in controlling root surface caries. Data from USA showed that root caries prevalence was inversely related to the concentration of fluoride in the drinking water, and recent data from Ireland confirm these results according to WHO. In Ireland, the percentage of exposed root surfaces with caries in person aged 65 yrs or older was 11.7 in fluoridated areas compared with 18.9 in non-fluoridated areas.

Current estimates are that fluoridation reduces coronal and root caries over a life time by 20 to 40 percent [Newbrun 1989].

B. School Water Fluoridation

An alternative to community water fluoridation is the fluoridation of school drinking water. It's most applicable in rural schools, where fluoridation of community water is not feasible. Reduction in dental caries was found to be about 40 percent.

Disadvantages

- The children do not receive the benefits until they begin school [belated exposure]
- Children consume the fluoridated water only when the school is in session [abbreviated exposure].

To compensate for this belated and abbreviated exposure, the school water is usually fluoridated at 4.5 times the optimum concentration recommended for that place (Table 30.1).

There are two major concerns about school water fluoridation:

1. By age 6 all teeth expect 3rd molars are in an advanced stage of mineralization, thus reducing the pre-eruptive benefits of fluoride.
2. There are no data to indicate expected caries incidence following graduation.

Table 30.1: Effect of fluoride in water on human health when consumed for longer durations

Fluoride concentration (mg/L)	*Effects*
<1.0	Safe limit
1.0–3.0	Dental Fluorosis
3.0–4.0	Brittle and stiff bones and joints
4.0–10	Dental fluorosis, skeletal fluorosis (pain in neck bones and back)

DIETARY SUPPLEMENTS

A. Fluoride Tablets, Lozenges and Drops

Fluoride dietary supplements were first introduced in the late 1940's and were intended as a substitute for fluoridated water for children in non-fluoridated areas. They are also called as 'fluoride supplements' because they are manufactured as tablets or drops for swallowing. Tablets for chewing or lozenges intended to be sucked slowly in the mouth (Fig. 30.12).

Supplements contain a measured amount of fluoride typically 0.25 mg, 0.5 mg or 1.0 mg usually as sodium fluoride but acidulated phosphate fluoride, potassium fluoride or calcium fluoride may also be used. The original pills have been joined by chewable tablets and lozenges, the latter intended to be chewed or sucked before swallowing with the intent of getting both systemic and topical effects.

Effectiveness

The studies on effectiveness of fluoride tablets and drops can be broadly grouped into two groups.

A. Those where the fluoride supplements were given daily at home and were started before school age.
B. Those where tablets have been distributed in school, on school days only usually without additional supplementation during holidays or before school age.

Primary Teeth

The studies consistently concluded that a caries-preventive effect of about 50–80 percent was found when the initial age was 2 years or younger.

Permanent Teeth

In studies on the permanent dentition, the initial age of the subject and the duration of the fluoride tablets varied widely. In only four studies the fluoride supplements were taken from birth to at least 7 years of age. In these studies the reported caries reduction varied from 39–80 percent. It has been shown that sucking tablets, for as long as possible, rather than immediately swallowing gives better results in caries prevention.

Prenatal

Very few trials have been conducted. In all these trials the percentage caries reduction was greater in children whose mother received fluoride tablets in pregnancy. But it was concluded that fluoride that administration should begin as soon after birth as possible.

Type of Fluoride Compound

Sodium fluoride [NaF] is the most commonly used compound as Acidulated phosphate fluoride [APF] tablets are considerably



Fig. 30.12: Fluoride tablets, lozenges and drops

more expensive than NaF and have almost same effectiveness. Greater salivary flow caused by low pH of the APF tablets is likely to reduce the concentration of fluoride around the teeth and hasten its clearance from the mouth.

Dosage

The objective of any systemic fluoride administration is to obtain the maximum caries preventive effect with a low risk of fluorosis. Fluoride from tablets is ingested and absorbed at one time of the day, and this is different physiologically different from ingestion of fluoride from water where absorption is spread throughout the day.

Animal experiments have shown that fluoride given once a day is more likely to cause fluorosis than the same amount of fluoride given intermittently throughout the day.

In Europe, it is recommended that a dose of 0.5 mgF/ day should be prescribed only to individual at risk and starting only at age of 3 years, and that supplement had no place as a public health measure.

Current dosage schedule for fluoride supplements in the UK in relation to fluoride concentration in drinking water.

Fluoride supplements schedule [mgF/day] recommended by the American Dental Association, 1994. Fluoride Supplement Dosage Schedule—1994.

Table 30.2 shows fluoride supplement schedule approved by the American Dental Association, American Academy of Pediatrics and American Academy of Pediatric Dentistry (AAPD).

Important Considerations when Using Dosage Schedule

- If fluoride level is unknown, drinking water should be tested for fluoride content before supplements are prescribed. For testing of fluoride content, contact the local or state health department.
- All sources of fluoride should be evaluated with a thorough fluoride history.
- Patient exposure to multiple water sources can make proper prescribing complex.
- Ingestion of higher than recommended levels of fluoride by children has been associated with an increase in mild dental fluorosis in developing, unerupted teeth.

Fluoride supplements require long-term compliance on a daily basis.

It is believed that if fluoride tablets are taken at night, a higher saliva fluoride level is possible than if taken during the day, probably due to:

A. Fluoride saliva concentrations are higher in unstimulated saliva.
B. Glomerular filtration is reduced during sleep, resulting in higher blood levels.

The British Society of Pediatric Dentistry (BSPD) has made the following recommendations for fluoride supplements:

Table 30.2: Recommended dosage schedule for children by AAPD

Age	*Fluoride Ion Level in Drinking Water (ppm)**		
	<0.3 ppm	*0.3-0.6 ppm*	*>0.6 ppm*
Birth-6 months	None	None	None
6 months-3 years	0.25 mg/day**	None	None
3-6 years	0.50 mg/day	0.25 mg/day	None
6-16 years	1.0 mg/day	0.50 mg/day	None

* 1.0 ppm = 1 mg/liter
** 2.2 mg sodium fluoride contains 1 mg fluoride ion.

Table 30.3: Recommended dosage schedule for children by BSPD

Age	*Fluoride dosage [mg Fluoride per day]*
6 months-3 years	0.25 mg/day
3 years up to 6 years	0.50 mg/day
6 years and above	1.0 mg/day

- Dietary fluoride supplements are not generally a public health measure. They should be recommended only for individual children who are at risk and living in areas with less than optimal water fluoride levels.
- For children living in areas with water supplies containing less than 0.3 ppm fluoride and who are considered to be high risk, the recommended dosage schedule is prescribed (Table 30.3).

Fluoride Drops: They are available as 0.125, 0.25 and 0.50 mg drops. Drops are used to supplement fluoride intake until a child is old enough to swallow, the easier to administer fluoride tablets. Drops are usually administered by use of a plastic dropper bottle where 10 drops equal 1 mg of fluoride. When 10 drops are placed in a liter of water containing no fluoride, there is a resultant concentration of 1 ppm of fluoride.

B. Salt Fluoridation

It is the controlled addition of fluoride, usually as sodium or potassium fluoride, during the manufacture of salt for consumption (Fig. 30.13).

Fluoridated salt was first used in Switzerland in 1955. In many communities municipal water supply was not possible because of mountaneous nature of the country. Fluoridated salt as a means of preventing caries was first suggested by Wespi who was a gynecologist concerned with prevention of goitre in Switzerland. The Swiss studies began with salt fluoridated to 90 mgF/kg salt. [or 90 ppm]. It was first used in 1955. It was later increased to the current standard of 250 mg F/kg. Estimates of the most appropriate concentration have been made from studies of 24 hours urinary fluoride excretion. Caries preventive effectiveness of fluoridated salt is substantial, approaching that



Fig. 30.13: Fluoridated salt pack sold in Mexico

of fluoridated water. In most recent years salt fluoridation has been adopted in France, Germany, Costa Rica, Jamica and Mexico.

Advantages of Salt Fluoridation

- Wide coverage
- Needs little conscious action by the individual
- Low cost
- Freedom of choice is available for consumers as both fluoridated and non-fluoridated salt is available
- It is safe as toxic levels of salt are reached long before that of contained fluoride
- No supervised water works, or water distribution system is necessary, making it a practical method for many countries
- Minimum possibilities of fluorosis as children use very little salt.

Limitations/Disadvantages

- Community wide caries –preventive impact is clearly related to the extent of public acceptance. Salt fluoridation needs to be accompanied by public education and promotion.
- There is not as precise a control on individual consumption as is possible with water fluoridation, since salt intake varies greatly among people.
- International efforts are on to reduce sodium intake to help control hypertension.
- Consumption of fluoridated salt is lowest during early life when the need for fluoride is the maximum.

Indications

The WHO has laid down certain criteria for use of salt fluoridation:

- It should be used where water fluoridation is not possible.
- Where there are low levels of fluoride in water.
- Where there is not the political will to introduce water fluoridation.
- Where there is a centralized salt production system with strong technical support.
- Appropriate labelling of the salt packages is essential.

C. Fluoride Vitamin Preparation

Dietary fluoride supplements may be obtained as fluoride vitamin combinations. There is no evidence that vitamins enhance the effect of fluoride. The determining factor in choosing a fluoride vitamin combination should be a clear indication that a vitamin supplement is needed. If a need does not exist then a fluoride supplement without vitamins should be prescribed.

Disadvantage

Disadvantage of fluoride vitamin combination in capsule form is that they cannot provide a topical effect to the erupted teeth because they have to be swallowed directly.

D. Fluoridized Milk and Fruit Juices

Milk fluoridation is the addition of a measured quantity of fluoride to bottled or packaged milk to be drunk by children. Both bovine and human milk contain low level of fluoride about 0.03 ppmF. Because milk is recommended as a good food for infants and children and is widely available both at home and in school in many countries, it was considered to be a suitable vehicle for supplementing childrens'fluoride intake. Milk fluoridation was suggested as a possible alternative to water fluoridation in the USA in the early 1960s and in the UK from the late 1960s.

School milk fluoridation schemes in which children consume 200 ml of milk fluoridated at a level of 5 mg/l [5.0 ppm] daily have been introduced in Bulgaria, Chile, and the Russian federation and the UK.

Ericsson (1958) showed that fluoride was absorbed in the gut just as readily from milk as from water, refuting the suggestion that the high calcium content of milk would render the fluoride unavailable. However the binding of added fluoride to calcium or protein might reduce the topical fluoride effect in the mouth compared with fluoride in water.

The rationale for milk fluoridation:

a. This procedure 'targets' fluoride directly to children, and thus would be less expensive than fluoridating the drinking water.
b. Having both fluoridated and non-fluoridated milk available also maintains consumer's choice.

Disadvantages

A. Consumption of milk varies considerably particularly among those in different socioeconomic groups.

B. Consumption of milk tends to decrease with age therefore long-term benefits of milk fluoridation may be less than those by fluoridated water.
C. Requires a high level of technical expertise.
D. Slow absorption means no topical effect.
E. Procedure can be relatively costly.

In warm climates fluoridized fruit juices may be a practical alternative to fluoridized milk. Encouraging results have been reported with milk fluoridation but more studies are required.

B. TOPICAL FLUORIDES

The term topical fluoride therapy refers to the use of systems containing relatively large concentrations of fluoride that are applied locally or topically, to the erupted tooth surface to prevent the formation of dental caries.

Rationale for the Use of Topical Fluorides

Water fluoridation is the most effective, efficient and economical measure for the prevention of dental caries. But fluoridated water is available to only a few percent of the population, hence alternative methods for the fluoride therapy is required.

At the time of tooth eruption, the enamel is not yet completely calcified and undergoes a post eruptive period, approximately 2 years, during which enamel calcification continues [enamel maturation period]. During this period fluoride deposition takes place in the superficial layer of enamel. This fluoride is derived from saliva and also from exposure of teeth to fluoride- containing water and food. Thus most of fluoride incorporation into enamel occurs during the pre-eruptive period (by systemic fluoride) and the post eruptive period of enamel maturation. As immediately after eruption, the enamel is porous and immature it acquires fluoride rapidly (Fig. 30.14). Application of topical fluorides immediately after eruption hastens fluoride uptake and makes enamel more resistant to dental caries.

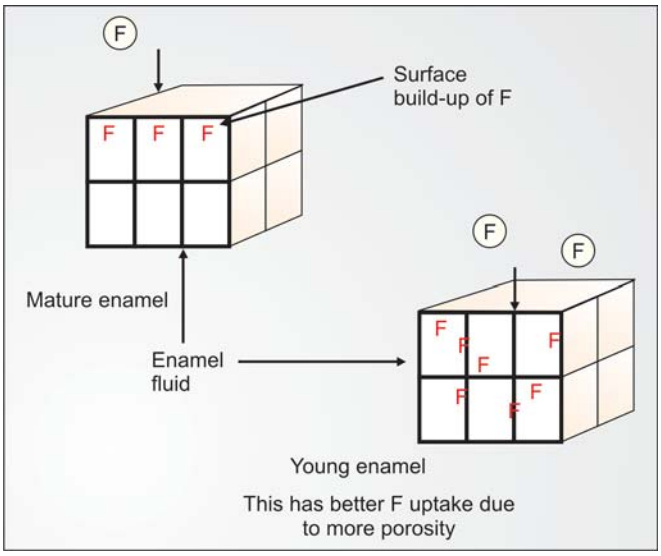


Fig. 30.14: Fluoride deposition during enamel maturation

ADVANTAGES AND DISADVANTAGES OF TOPICAL FLUORIDES

Advantages

1. Does not cause fluorosis.
2. Cariostatic for people of all ages.
3. Available only to people who desire it.
4. Easy to use.

Disadvantages

1. Person must remember to use.
2. Per capita cost is high compared to water fluoridation.
3. More concentrated professional use products can cause short-term side effects like nausea immediately after use.

Not all fluoride agents and treatments are equal. Different fluoride compounds, different vehicles, and vastly different concentrations of fluoride have been used with different frequency and duration of application. All of these variables influence the clinical outcome with respect to caries prevention. The efficacy of topical fluoride depends on:

a. The concentration of fluoride used.
b. The frequency with which it is applied and the duration of application.
c. The specific fluoride compound used (Table 30.4).

Table 30.4: Range of therapeutic fluoride concentrations used to prevent caries

Method/vehicle	Fluoride concentration (ppm F)
Water supplies	0.7–1.2
Fluoridated salt	200–250
0.05% NaF Mouthrinse, **Once daily**	230
0.2% NaF Mouthrinse, **Once weekly**	920
Dentifrices, children	250–500
Dentifrices, adult **Twice daily**	1,000–1,500
1.1% NaF gels **Once daily**	5,000
Professionally applied solutions (2 % NaF)	9,200
Professionally applied solutions, gels, foams (1.23% APF)	12,300
Professionally applied solutions (8% SnF2)	19,500
Professionally applied varnishes (5% NaF)	22,600

MECHANISM OF ACTION

The presence of elevated concentration of fluoride in enamel surface makes tooth surface more resistant to development of dental caries. Fluoride ions when substituted into the hydroxyapatite crystals fit more perfectly than do hydroxyl ions. Also the greater bonding potential of fluoride makes the apatite crystals more compact and more stable, thereby more resistant to the acid dissolution. When concentrated topical fluoride agent reacts with enamel there is formation of calcium fluoride:

$$\underset{\text{Hydroxyapatite}}{Ca_{10}[PO_4]_6[OH]_2} + 20F^- \leftrightarrow \underset{\text{Calcium fluoride}}{10\ CaF_2} + 6[HPO_4^-]^3 + 2[OH]^-$$

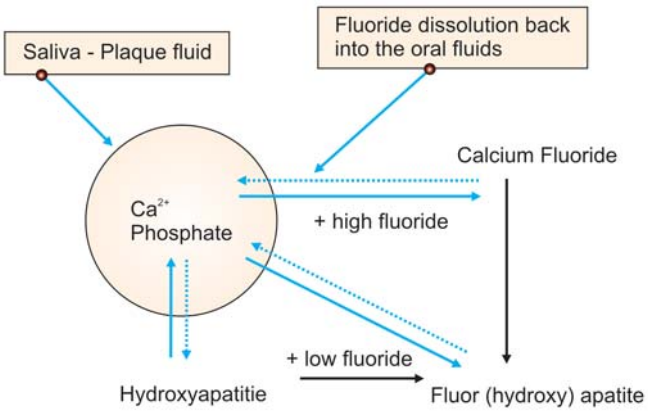


Fig. 30.15: Mechanism of action of fluoride on enamel

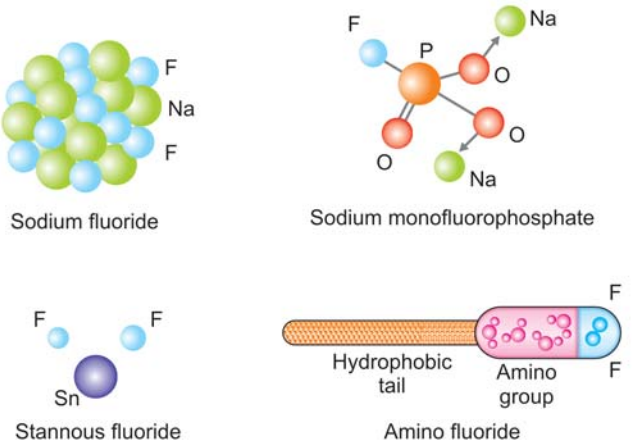


Fig. 30.16: Various types of fluoride

Most topical fluoride agents have a fluoride ion concentration of between 10,000–20,000 ppm which leads to the formation of calcium fluoride and eventually Fluor hydroxyapatite (Fig. 30.15).

Commonly used topical fluoride agents include Sodium fluoride, Sodium monofluorophosphate.

Stannous fluoride and Amine fluoride (Fig. 30.16).

CLASSIFICATION

Fluorides Applied by Dentist/ Professionally Applied

A. Aqueous solutions
   - Sodium fluoride - 2 %
   - Stannous fluoride - 8%

B. Fluoride Gels
   - Acidulated phosphate fluoride - 1.23 %

C. Fluoride varnishes
   - Duraphat
   - Fluorprotector

D. *Fluoride prophylactic paste*

E. Restorative materials containing fluoride

F. Fluoride containing devices (slow release)

Self Applied

- Fluoride dentifrices
- Fluoride mouth rinses.

PROFESSIONALLY APPLIED FLUORIDES [PATF]

Dental personnel have been applying fluoride agents on teeth since 1940. It was seen that when fluoride was applied to teeth, it gets deposited in the outer enamel, making it more resistant to dissolution by acids. Although it is now known that frequency and availability of low concentration of fluoride is more important in caries prevention, but studies have shown to support the beneficial effect of infrequent professional application of agents for prevention of dental caries. Topical fluoride applications are indicated for patients with active smooth surface caries and those patients in high caries risk groups (Table 30.5). This includes special patient groups, such as those undergoing orthodontic treatment. In high-risk groups.

A. Aqueous Solutions

Sodium Fluoride: 2% [Knutson's Technique]

Available in both powder and liquid form. The compound is recommended for use in a 2 percent concentration.

Method of preparation: It can be prepared by dissolving 0.2 gm of powder in 10 ml [20 gm in 1 liter] of distilled water. The prepared solution has a basic pH and is stable if stored in plastic bottle. If stored in glass bottle, the fluoride ion of prepared solution can react with silica of glass forming SiF_2 [silicon fluoride], thus reducing the availability of free active fluoride. Hence reducing its anti caries action.

Table 30.5: Indications for use of professionally applied topical fluorides

Indications
• Patients who are at high risk for caries on smooth tooth surfaces
• Patients who are at high risk for caries on root surfaces
• To reduce tooth sensitivity
• White spots
• Active decay
• Special patient groups, such as:
– Orthodontic patients
– Patients undergoing head and neck irradiation
– Patients with decreased salivary flow
• Children whose permanent molars should, but cannot be sealed
• Additional protection if necessary for children in areas without fluoridated drinking water

Recommended ages: It is recommended that a series of 4-weekly applications of 2 percent NaF be given at ages 3,7,11 and 13, coinciding with the eruption of different groups of primary and permanent teeth.

Method of application

1. Cleaning and polishing of teeth is done.
2. Teeth are isolated with cotton rolls and dried with compressed air.
3. Teeth can be selected quadrant wise.
4. 2 percent aqueous NaF solution is applied with cotton applicator for 3 minutes.
5. Procedure is repeated for remaining quadrants until all of the teeth are treated.
6. Second, third and fourth applications are recommended at intervals of approximately 1 week and they are preceded by cleaning and polishing.
7. Patient is advised to avoid rinsing, drinking and eating for next half hour.

Mechanism of Action of Sodium Fluoride

When sodium fluoride solution is applied on the tooth surface it reacts with hydroxyl apatite crystals rapidly to form calcium fluoride. This initial rapid reaction is followed by drastic reduction in its rate and the phenomenon is called as 'choking off'. As a thick layer of calcium fluoride gets formed it interferes with the further diffusion of fluoride from aqueous solution to react with hydroxy apatite.

The calcium fluoride reacts with hydroxyl apatite to form fluoridated hydroxy apatite. This increases the concentration of surface fluoride, making the tooth structure more stable, and surface more resistant to caries attack. It also helps in remineralization of the initial decalcified areas.

The chemical reaction involved is:

$$Ca_{10}[PO_4]_6[OH]_2 + 20\ F^- \leftrightarrow 10CaF_2 + 6PO_4^- + 2OH^-$$

$$CaF_2 + 2Ca_5[PO_4]_3\ OH \rightarrow 2Ca_5[PO_4]_3F + Ca(OH)_2$$

Advantages

1. Relatively stable when stored in plastic containers.
2. Taste is acceptable.
3. Non-irritating to gingiva and does not cause discoloration of tooth structures.

Disadvantage

Patient has to make four visits in relatively short period of time.

Stannous Fluoride-8 percent [Muhler's Technique]

Available in powder form either in bulk containers or pre-weighed capsules. The recommended and approved concentration is 8 percent.

Method of Preparation

The solution has to be freshly prepared as they are not stable. It can be prepared by dissolving 0.8 gm of powder in 10 ml of distilled water. The solution is acidic, with a pH of about 2.4–2.8. the left over solution should be discarded after application.

Method of Application

1. Cleaning and polishing of teeth is done.
2. Teeth are isolated with cotton rolls and dried with compressed air.
3. Freshly prepared SnF_2 solution is applied using cotton applicator. Care should be taken that all teeth surfaces are treated.
4. Repeated loading of cotton applicator should be done and swabbing is continuously done so as to keep tooth surface moist for 4 minutes.
5. Patient is allowed to expectorate after cotton rolls are removed.

Recommended Schedule

A six monthly interval treatment schedule is advised.

Mechanism of Action

Stannous fluoride reacts with hydroxy apatite and in addition to fluoride the Tin of solution also reacts with enamel and forms Stannous tri-fluorophosphate, which is more resistant to carious attack.

Chemical reaction *at low concentration* is:

$$Ca_5[PO_4]_3OH + 2SnF_2 \rightarrow 2CaF_2 + Sn_2[OH]PO_4 + Ca_3[PO_4]_2$$

At High concentration:

$$Ca_5[PO_4]_3OH + 16SnF_2 \rightarrow CaF_2 + \underset{\text{[Tin Trifluorophosphate]}}{2Sn_3F_3PO_4} + \underset{\text{[Tin hydroxyl phosphate]}}{Sn_2[OH]PO_4} + \underset{\text{[Calcium trifluorostannate]}}{4CaF_2[SnF_3]_2}$$

Tin hydroxy phosphate gets dissolved in oral fluids and is responsible for the metallic taste. Tin trifluorophosphate which is the main end product is responsible for making the tooth structure more stable and less susceptible to decay.

Calcium fluoride [CaF_2] so formed further reacts with hydroxy apatite and some fluorhydroxyapatite also gets formed.

Advantage

Recommended frequency is 6–12 months interval much less than as in case of sodium fluoride.

Disadvantages

1. Solution has to be freshly prepared each time before use.
2. A bitter metallic taste.
3. Can cause gingival irritation.
4. It causes brown pigmentation of teeth particularly in hypocalcified areas and around margins of restorations.

B. Fluoride Gels

Fluoride gels and foams contain a high concentration of fluoride, typically up to 12.3 mg/g fluoride.

Acidulated Phosphate Fluoride 1.23 percent [Brudevolds Solution]

This is available as either as a solution or gel. Both are stable (Fig. 30.17).

Method of Preparation

Solution: It is prepared by dissolving 20 gms of sodium fluoride in 1 liter of 0.1 M phosphoric acid. To this is added 50 percent hydrofluoric acid to maintain a pH of 3.0 and fluoride ion concentration at 1.23 percent.
Gel: for preparation of gel [APF], a gelling agent methylcellulose or hydroxyethyl cellulose is added to the solution and the pH is adjusted 4-5.

Another form of APF Thixotropic gels is available. Thixotropic denotes a solution that sets in a gel like state but is not a true gel. Upon the application if pressure, thixotropic gels behave like solutions.

Recommended Frequency

Recommended frequency of APF application is twice a year topically.

Procedure for the Application of Fluoride

Solution

a. Oral prophylaxis is done.
b. Teeth are isolated with cotton rolls and dried with compressed air.
c. Fluoride solution is then applied continuously with cotton applicator so as to keep teeth moist with fluoride solution for 4 minutes.
d. After all the teeth are treated patient is asked to expectorate and instructed not to rinse, drink or eat for next half hour.

Procedure for the Application of Fluoride Gel

a. Mouth trays should be tried in the patient's mouth. It may be necessary to adapt or trim trays.
b. Patient should be seated upright and suction should be used during the procedure.



Fig. 30.17: Topical APF gel

c. Teeth should be air-dried before gel application. For caries prevention, cleaning or prophylaxis is unnecessary prior to APF.
d. Enough gel, or foam, should be used to completely cover the teeth, but should be no more than 2–2.5 grams per tray or 40 percent of the tray's volume.
e. Upper and lower trays should be inserted separately.
f. Fluoride should be applied for 4 minutes, not 1 minute.
g. Patient should expectorate for 1–2 minutes after tray removal.
h. Patient should not rinse, eat, or drink for at least 30 minutes after the procedure

For patients with porcelain or resin restorations, neutral sodium fluoride is recommended to prevent etching of restorations.

CLINICAL APPLICATION

The frequency of gel application varies based on the caries risk level of the patient, and is usually provided at least every 6 months. Gel application is uncomplicated and can be performed by a dental auxiliary.

The four-minute application of fluoride gel is recommended based on studies of enamel fluoride uptake. When contact time is reduced to one minute, enamel fluoride uptake is significantly less.

A considerable amount of fluoride may be retained after gel application, even if suction devices are used (on average 7.7 mg in children). The risk of fluoride ingestion with fluoride foam is reduced, compared with gel, because a smaller amount is needed for applications. The exposure to and retention of fluoride foam by the patient may be significantly less compared with APF gel application.

Mechanism of Action

APF when applied on teeth initially leads to dehydration and shrinkage in the volume of hydroxyapatite crystals. There is further hydrolysis and formation of dicalcium phosphate dehydrate [DCPD], which is highly reactive. The fluoride ions start penetrating into the deeper crystalline structure of enamel and forms fluorapatite which is stronger to acid dissolution.

Advantages

1. It is stable when stored in a plastic container.
2. No staining of teeth.
3. Gels can self applied.

Disadvantages

1. Cannot be stored in glass container because it may remove minerals from the glass [etch].
2. Repeated exposure of porcelain or composite restorations to APF can lead to loss of material leading to surface roughening and cosmetic changes hence not advisable to use acidic topical fluoride agent in patients with these type of restorations.
3. It has an acidic taste.
4. Repeated application necessitates the use of suction, limiting its use in field programs.

Guidelines for the Application of Topical Gels

These are designed to minimize the amount of fluoride that may be swallowed.

1. Limit the amount of gel placed in each commercially available disposable mouth tray to no more than 2 ml or 40 percent of the tray capacity.
2. Limit the amount of gel placed in each custom fitted mouth tray to 5–10 drops.
3. Sit the patient in an upright position with the head inclined forward.
4. Use suction throughout the gel application procedure.
5. Instruct the patient to expectorate, or use a saliva ejector for 30 seconds after the gel application.
6. Keep the container out of reach of the patient.
7. Never leave the patient unattended.

C. Fluoride Varnishes

A fluoride varnish is a professionally applied adherent material. It is not intended to be as permanent as a fissure sealent, the purpose is to hold fluoride in close contact with the tooth for a period of time. They permit the application of high fluoride concentrations in small amounts of material (Fig. 30.18).

The use of fluoride varnish increases the fluoride concentration in saliva, which remains significantly higher 2 hours after its application than after the use of other fluoride agents.



Fig. 30.18: Fluoride varnish

The evidence also supports the view that varnish application can arrest existing lesions on the smooth surfaces of primary teeth and roots of permanent teeth. Much of the evidence of effectiveness is derived from studies which have used sodium fluoride 22,600 ppm varnish for application. Fluoride varnish for use as a topical treatment has a number of practical advantages. It is well accepted and considered to be safe. Further, the application of fluoride varnish is simple and requires minimal training. While a thorough prophylaxis is not essential prior to application, removal of gross plaque is advised.

The use of Duraphat is contraindicated in patients with ulcerative gingivitis and stomatitis. There is a very small risk of allergy to one component of Duraphat (colophony), so for children who have a history of allergic episodes requiring hospital admission, including asthma, varnish application is contraindicated.

There are two types of fluoride varnish:

1. *Duraphat [NaF]:* It was first fluoride varnish to be tested. It contains 2.26 percent NaF or 22.6 mgF/ml. It is a viscous, resinous lacquer which should be applied to dry, clean tooth. Duraphat hardens into a yellowish brown coating in the presence of saliva. Majority of clinical trials conducted to see the efficacy of Duraphat during 1970 have reported the effectiveness between 30 to 45 percent (Fig. 30.19).
2. *Fluor protector [Silane fluoride]:* It was developed in 1970. It contains Silane fluoride 0.7 percent [7000 ppm fluoride] in polyurethane—based lacquer. Fluor protector leaves a clear transparent film on the teeth. Another varnish that has been tested in Norway called CAREX, contains a lower fluoride concentration [1.8% fluoride]. The caries preventive efficacy of this new varnish was found to be equivalent to that of Duraphat (Fig. 30.20).

Mechanism of Action

When varnish is painted on the tooth surface, it acts as a fluoride depot from which fluoride ions are continuously released. These ions react with hydroxyapatite over a longer period of time as varnish is not quickly washed away by saliva. This leads to deeper penetration and significant anticaries effect.



Fig. 30.19: Duraphat varnish



Fig. 30.20: Example of fluor protector varnishes

Method of Varnish Application

1. Oral prophylaxis is done.
2. Teeth are dried and but not isolated with cotton rolls as varnish sticks to cotton.
3. First lower arch is taken up for application and then upper arch as saliva collects rapidly on the lower arch.
4. Dispense a small amount of varnish (0.3 ml to 0.5 ml, or 2 drops, for the entire primary dentition) to the applicator dish or pad.
5. Application is done with single tufted brush starting with proximal surfaces (Dental floss can be used to ensure that the varnish reaches interproximal areas) (Fig. 30.21).
6. Since varnish sets rapidly when they come in contact with saliva, no drying is necessary.
7. After application, patient is made to sit with mouth open for 4 minutes.
8. Patient is instructed not to rinse or drink anything for 1 hour, and not to eat anything solid and avoid brushing till next morning. Patient is advised to take liquids or semisolids only, as contact between varnish and tooth surface is maintained for about 18 hours. It is for prolonged interaction between fluoride and enamel.

Recommended Dosage

A total of 0.3–0.5 ml of varnish is required to cover the full dentition. 0.5 ml Duraphat contains 11.3 mgF and 0.5 ml of Fluor protector contains 3.1 mgF.

It is seen that inspite of lower Fluoride content in Fluor protector [0.7%] as compared to Duraphat [2.26%], the fluoride deposited in enamel is twice as more and on the contrary its ability to inhibit caries is far less than Duraphat. Arands and Schuthof [1975] showed that silane fluoride of Fluor protector reacts with water to produce considerable amount of Hydrofluoric acid [HF] which penetrates into enamel more rapidly than F^- suggesting a possible mechanism of greater fluoride deposition. The fact that Ca dissolution is reduced more with Duraphat than Fluor protector suggest that part of fluoride deposited after treatment with Fluor protector may be in some form other than the bound form, i.e. fluorapatite.



Fig. 30.21: Application of fluoride varnish

Fluor protector a high viscosity varnish penetrates the porosities of enamel forming tags 0.5–1 mm long which acts as a fluoride reservoir accounting for more fluoride deposition in enamel. On the other hand these tags further block the pathways for fluoride and do not let remineralization of initial lesion occur explaining the less caries inhibition. An additional factor may be a chemical alteration of enamel by the presence of silane agent.

Fluoride varnish has a high fluoride concentration, but its safety is acceptable. Varnish is fast setting, fluoride is slowly released, and a small amount is needed for the complete dentition. Measurements of fluoride after topical treatments with varnish show levels far below those considered toxic. Consequently, varnishes may be a better alternative to fluoride gels, especially for young children.

The only disadvantage of sodium fluoride varnishes is that they cause a temporary change in tooth color, which dental professionals need to inform their patients of.

The Public Health Perspective

Fluoride varnish offers important advantages in the public health setting.

This is especially so in the context of increasing concerns about the devastating effects of Early Childhood Caries (ECC)

and the difficulties many children affected by the disease have gaining access to care. APF gel treatments are difficult, if not impossible, to do on many young children and there is considerable risk of over ingestion of fluoride. Fluoride varnish can be successfully applied in most young children and there is no risk of overingestion of fluoride. These advantages make it possible to apply fluoride varnish safely to the newly erupting teeth of high-risk infants and young children in an effort to control bottle caries or generalized ECC.

The varnishes are more convenient than the bottles of gel and trays to take into field situations. Intraoral suction is not required for the application of varnish. And there is no messy cleanup and disposal problem following a varnish application.

D. Fluoride Prophylactic Paste (Fig. 30.22)

The major functions of prophylactic paste are:

1. To clean the tooth surface through the removal of all exogenous deposits.
2. Polish the dental hard tissues, including restorations.

Prophylactic paste contains abrasive particles which abrade the deposits and debris from tooth surface. Studies date back to 1946 when NaF prophylactic paste was tried. Stannous fluoride prophylactic paste was developed in 1960. Now a days APF-silicone dioxide paste and SnF_2 - Zirconium silicate paste are also available.

Studies have shown that their use alone cannot be considered as an effective cariostatic method. Tooth cleaning with a fluoride prophylactic paste should not supplement topical fluoride application with fluoride solution or gels for children who require professional fluoride applications. A thorough polishing may remove a thin, but highly mineralized outer layer of enamel. If prophylaxis is required for periodontal reasons or cosmetic reasons then fluoride prophylactic paste is recommended, as it may help replenish the minerals that are abraded during polishing. They may have a modest cariostatic effect.



Fig. 30.22: Fluoride prophylactic paste

E. Restorative Materials Containing Fluoride

Fluorides releasing dental restorative material are also available, that provide site specific protection. In general, the rate of fluoride release from such materials is not constant but exhibits a relatively rapid initial rate, which decreases with time. These materials may feature greater longevity, a reduced incidence of marginal failure, an elevated concentration of fluoride in contingent plaque, together with an antibacterial action when compared with non-fluoride releasing materials.

The purpose of adding fluoride to restorative material is to capture its anticariogenic property. A major reason for the failure of restorations is recurrent or secondary caries. Secondary caries has been reported as being the most common reason for replacement of restorations. However, incorporation of fluoride into restorations may be beneficial because of the observed cariostatic action of fluoride.

The fluoride ions are slowly released from the materials. One difficulty with these materials is controlling the rate of fluoride release. Fluoride has also been added to amalgam in an attempt to reduce the risk of recurrent caries at restoration margins.

Fluoride may be released from dental restorative materials as part of the setting reaction, or it may be added to the formulation with the specific intention of fluoride release. Fluoride containing restorative materials includes glass ionomer cements, resin modified glass ionomer cements, polyacid modified resin composites (compomers), resin composites, fissure sealants and dental amalgam (Fig. 30.23).

Fluoride releasing components have included fluoro-aluminosilicate glasses (FAG), stannous fluoride (SnF_2), organic amine fluorides (CAFH) and ytterbium fluoride (YbF).



Fig. 30.23: Restorative materials containing fluoride

F. Fluoride Containing Devices (Slow Release)

As the current scientific consensus regards a constant supply of low levels of fluoride, especially at the biofilm/ saliva/dental interface, as being of the most benefit in preventing dental caries, it is reasonable to expect a positive effect on caries prevalence of a treatment able to raise intraoral F concentrations at constant rates, without relying on patient compliance.

Considering that intraoral levels of F play a key role in the dynamics of dental caries, it has been suggested that the use of controlled and sustained delivery systems can be considered as a means of controlling dental caries incidence in high-risk individuals. Thereafter, a topical system of slow and constant F release were considered.

There are three types of slow-release F devices: the copolymer membrane type, developed in the United States, and the glass bead, developed in the United Kingdom. More recently, a third type, which consists in a mixture of sodium fluoride (NaF) and hydroxyapatite.

Copolymer Membrane Device

This type of slow-release fluoride device was developed by Cowsar, et al (1976), consisting of a small pellet which could be attached on or near the tooth surface. This system was designed as a membrane-controlled reservoir-type and has an inner core of hydroxyethyl methacrylate (HEMA)/methyl methacrylate (MMA) copolymer (50:50 mixture), containing a precise amount of sodium fluoride (NaF). This core is surrounded by a 30:70 HEMA/MMA copolymer membrane which controls the rate of fluoride release from the device. When the matrix becomes hydrated, small quantities of granulated NaF are diluted until the matrix itself becomes saturated. The precise water absorption rates by the inner and the outer cores enables the devices to act accurately and reliably as a release controlling mechanism.

The device is approximately 8 mm in length, 3 mm in width, and 2 mm in thickness as shown in Figure 30.24, and is usually attached to the buccal surface of the first permanent molar by means of stainless steel retainers that are spot welded to plain, standard orthodontic bands or are bonded to the tooth surfaces using adhesive resins.

Glass Device

The original device was dome shape, with a diameter of 4 mm and about 2 mm thick, being usually attached to the buccal surface of the first permanent molar using adhesive resins (Fig. 30.25). Due to the low retention rates of the original device, it was further substantially changed to a kidney-shaped device, being 6 mm long, 2.5 mm in width and 2.3 mm in depth, and it was proven to be effective regarding both F release and retention rate.

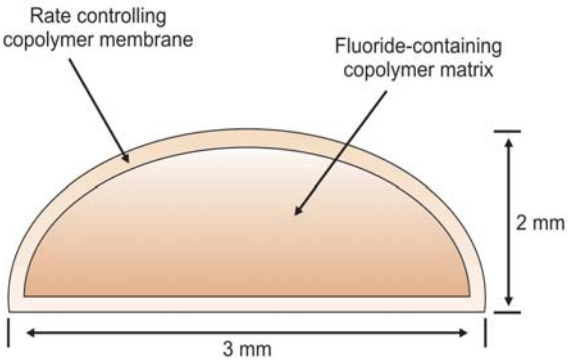


Fig. 30.24: Schematic cross-sectional view of the copolymer device, 8 mm in length, 3 mm in width, and 2 mm in thickness (Modified from Mirth et al, 1982)

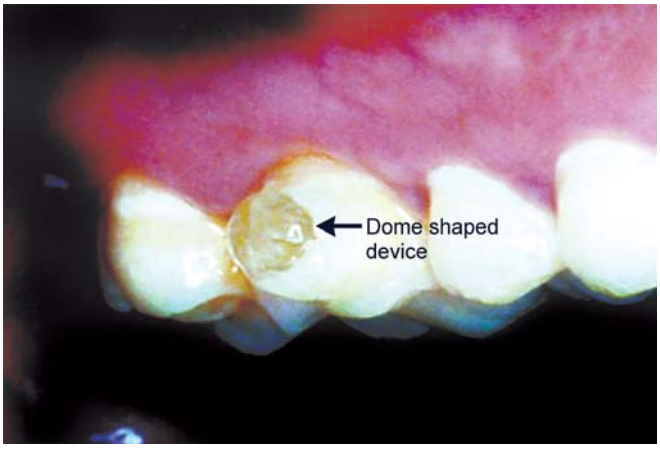


Fig. 30.25: Original glass device attached to the buccal surface of the first upper right permanent molar

Hydroxyapatite-Eudragit RS100 Diffusion Controlled F System

This is the newest type of slow-release F device, which consists of a mixture of hydroxyapatite, NaF and Eudragit RS100; it contains 18 mg of NaF and is intended to release 0.15 mg F/ day. Altinova YB, Alaçan A, Aydin A, Sanisoglu SY (2005), demonstrated that the use of this device is able to significantly increase salivary and urinary F concentrations for at least 1 month.

Fluoride Ingestion and Toxicity of Professionally Applied Topical Fluoride [PATF]

Fluoride applications must be carefully monitored because the potential for over ingestion and toxicity does exist. Fluoride is rapidly absorbed in the gastrointestinal tract and young children are particularly vulnerable. Patients should not be left unattended during the application of PATF.

A considerable amount of fluoride may be retained after gel application, even if suction devices are used (on average 7.7 mg in children). The risk of fluoride ingestion with fluoride foam is reduced, compared with gel, because a smaller amount is needed for applications.

The exposure to and retention of fluoride foam by the patient may be significantly less compared with APF gel application. Fluoride varnish has a high fluoride concentration, but its safety is acceptable. Varnish is fast setting, fluoride is slowly released, and a small amount is needed for the complete dentition.

Measurements of fluoride after topical treatments with varnish show levels far below those considered toxic. Consequently, varnishes may be a better alternative to fluoride gels, especially for young children.

PATF is not a risk factor for dental fluorosis when used at 6 months intervals, and if precautions are taken to minimize ingestion.

FLUORIDE APPLICATION TECHNIQUES

Professional Fluoride Application

Polishing is not necessary before fluoride application. Acidulated phosphate fluoride should not be used on patients with porcelain and composite restorations. Since all fluoride products are diluted when mixed with saliva, a dry field ensures more effective fluoride uptake.

Tray Technique

The tray procedure allows simultaneous application to both maxillary and mandibular teeth, and is the most appropriate method for gels and foams.

- Patient should be seated upright to minimize the gagging reflex and inadvertent ingestion of fluoride.
- Choose trays that comfortably cover the patient's dentition.
- Teeth should be isolated using cotton rolls to maintain a dry field, and then dried with air syringe (Fig. 30.26).
- Fluoride gel or foam is placed in to trays without overloading. The biting process will cause the product to flow sufficiently to cover tooth surfaces.
- Mandibular tray is inserted into the mouth, pressing the tray aginst the occlusal, facial, and lingual surfaces to force the product to flow.
- Maxillary tray is then inserted, using the same pressing technique.
- A saliva ejector should be placed in the mouth. It is generally most effective to place the saliva ejector between the trays as shown in Figure 30.27.
- Patient is instructed to close mouth and bite gently on trays, explaining that this will help ensure complete fluoride coverage of tooth surfaces.
- Trays should be left in place for 1 to 4 min, according to the manufacturer's recommendations.

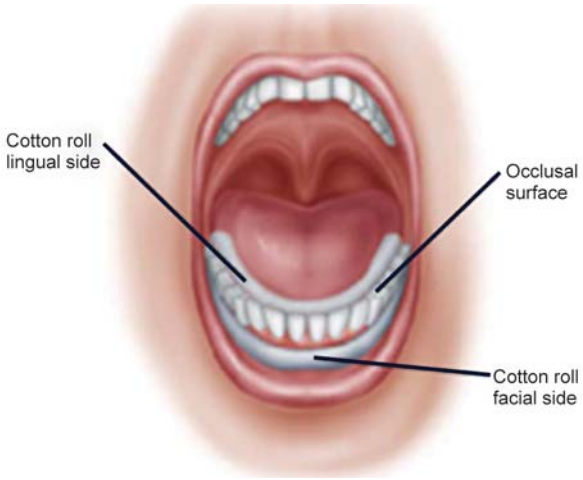


Fig. 30.26: Isolation with cotton rolls

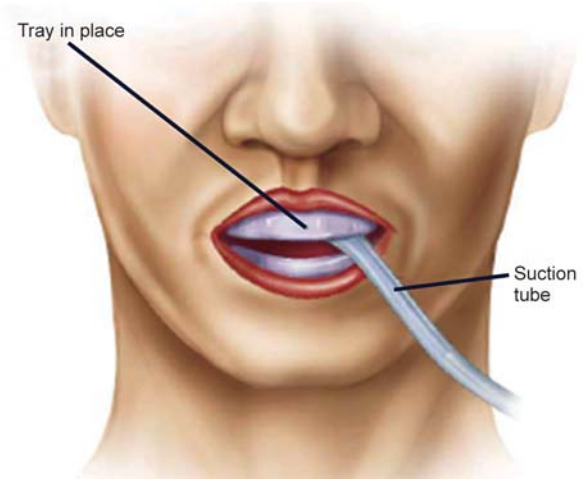


Fig. 30.27: Placement of trays

- The trays should be removed by asking the patient to tilt chin downward. This causes excess product to flow forward and avoids ingestion.
- Patient should be asked to expectorate, and any residual fluoride should be removed from the mouth with saliva ejector (Fig. 30.28).
- Patient should be instructed not to eat, drink, or rinse for at least 30 min and avoid brushing teeth at night.

Paint on Technique

For patients who cannot tolerate tray application, the paint on technique is indicated. While more time consuming, the gag reflex is greatly reduced. It is the most appropriate method when fluoride solutions are used, but may also be used with gels and foams.

- Seat patient upright.
- Isolate teeth on one side of mouth by inserting cotton rolls where needed. A cotton roll holder and/or salivary duct pads may aid in maintaining a dry field.

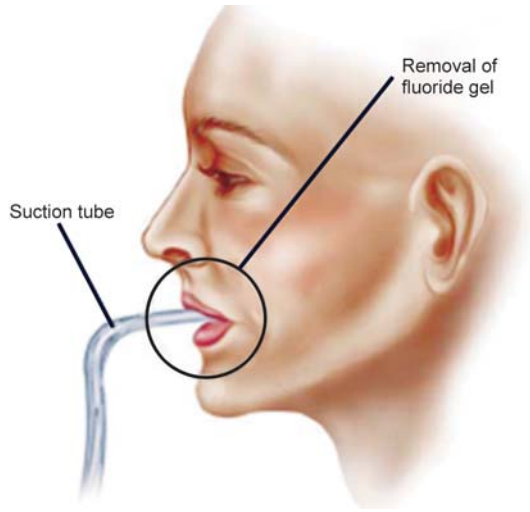


Fig. 30.28: Residual fluoride removal with saliva ejector

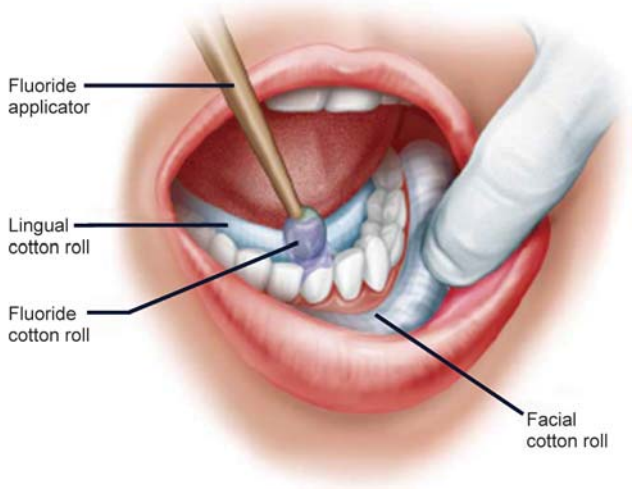


Fig. 30.30: Application of fluoride with cotton tip applicator

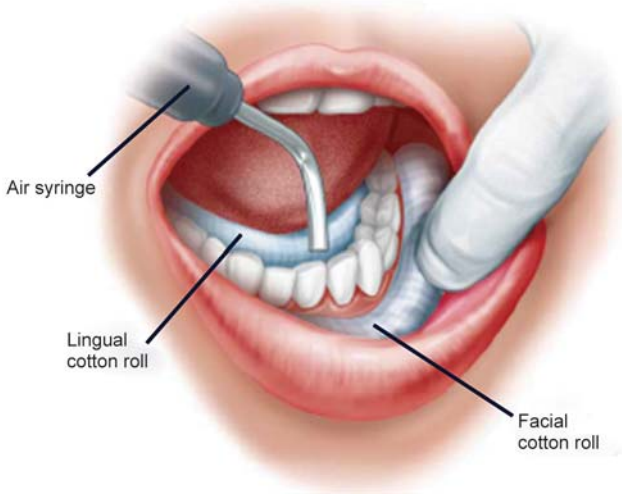


Fig. 30.29: Drying of teeth with air syringe

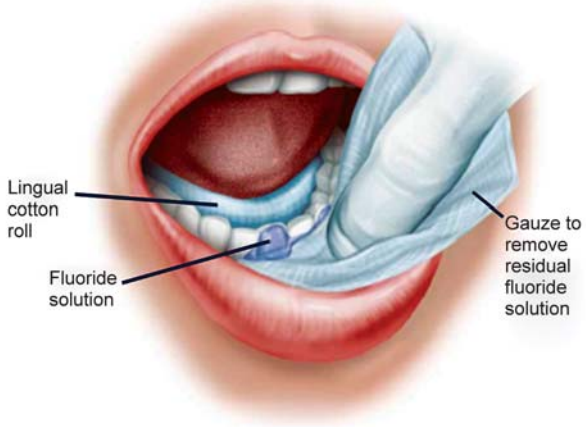


Fig. 30.31: Cleaning with gauze to remove residual product

- Insert saliva ejector lingually on one side of mouth opposite to where application is taking place.
- Dry teeth thoroughly with air syringe-maxillary first, then mandibular (Fig. 30.29).
- Quickly apply fluoride with a cotton tipped applicator to moisten all teeth (Fig. 30.30).
- Time the procedure for 1 to 4 minutes, based on manufractures recommendations.
- Ensure tooth surfaces remain wet with product by applying continuously through the recommended time period.
- When application is complete, remove saliva ejector, cotton rolls, and all other application materials.
- Gently wipe teeth with gauge to remove residual product (Fig. 30.31).
- Instruct patient to expectorate any excess fluoride.
- Follow the same technique for opposite side of mouth.
- Instruct patient to not eat, drink, rinse, or brush teeth for at least 30 minutes.

Efficacy of Topical Fluorides

The efficacy of topical fluoride depends on:

a. The concentration of fluoride used.
b. The frequency with which it is applied and the duration of application.
c. The specific fluoride compound used.

Regarding the concentration of fluoride used, most fluoride dentifrice studies have shown a dose/response effect. Studies conducted by Horowitz, van Rijkom and Helfenstein have shown that the trends in clinical effectiveness of professionally applied topical fluoride agents are similar (Table 30.6).

Table 30.6: Comparative effectiveness of professionally applied topical fluoride agents

Agent	*Fluoride* concentration (ppm F)	*Average* effectiveness % caries reduction
2% NaF	9,200	29
APF (1.2% F)	12,300	22
8% SnF_2	19,500	32
Fluoride varnish (5% NaF)	22,600	38

SELF APPLIED FLUORIDES

Self application of fluoride is usually carried out with groups of persons, usually children at one time, under only general supervision, in contrast to professionally applied fluoride treatments which are expensive because they depend upon one professionally trained person treating one person at a time, with expensive equipment or supplies.

Requisites for self applied fluoride agents: [community and individuals]:

1. Should be completely safe.
2. Should be effective for preventing caries.
3. Method should be suitable for use by large groups and at a reasonably low cost.
4. Should be acceptable to participants.
5. Should be easy to use to ensure compliance.
6. Should require few professional personnel.
7. Should be able to be supervised by non-dental personnel after short periods of in-service training.

The concentration of fluoride in dentifrices, mouth rinses, and gels for home use in USA is regulated by the Food and Drug Administration. For dentifrices, the agency has proposed a range of concentrations from 850 to 1150 ppm total fluoride (USFDA, 1988). Since, the availability of fluoride ion in concentrations that are safe and effective is the most important consideration, the agency has further specified minimal fluoride ion concentrations that must be available in dentifrices, depending on the active ingredient (Table 30.7).

FLUORIDE DENTIFRICES

Investigation into effectiveness of adding fluoride to tooth-paste has been carried out since 1945 and covers a wide range of active ingredients in various abrasive formulations. Fluoride compounds that have been tested for caries-inhibitory properties include sodium fluoride, acidulated phosphate fluoride, stannous fluoride, sodium monofluorophosphate and amine fluoride. Most toothpaste nowadays contain sodium fluoride or sodium monofluorophosphate as active ingredient, usually in concentration of 1000–1100 mg F/g.

Fluoride Concentration in Toothpaste

Studies have been undertaken to investigate the dose response relationship for different fluoride levels in tooth-paste up to 2500 ppm. The results suggest that increased fluoride levels give a greater reduction in the incidence of dental caries. Increased benefit is of the order of 6 percent for each 500 ppm over 1000 ppm fluoride. In Europe an upper limit of 1500 is suggested for toothpaste sold over the counter without prescription. In India most toothpaste contains 1000 ppm of fluoride.

Table 30.7: Active ingredients in fluoride dentifrices

Food and drug administration proposed rules for active ingredients in fluoride dentifrices	
NaF	0.188 to 0.254% with an available fluoride ion concentration o ≥ 650 ppm
MFP	0.564 to 0.884% with an available fluoride ion concentration (consisting of PO_3F and F combined) of ≥ 800 ppm
SnF_2	0.351 to 0.474% with an available fluoride ion concentration of ≥700 ppm for products containing abrasives other than $Ca_2P_20_7$
SnF_2	0.351 to 0.474% with an available fluoride ion concentration of ≥290 ppm for products containing the abrasive $Ca_2P_20_7$

Fluoridated Toothpaste for Children

Concern about the fluorosis risk from children swallowing toothpaste has led to trial of lower-strength dentifrices. Findings from studies of 500–550 mgF/g products suggest efficacy equivalent to 1000 mgF/g toothpaste. Since children can swallow between 0.12 and 0.38 mg of toothpaste per brushing, lower fluoride toothpaste may reduce the risk of fluorosis while substantially retaining the caries preventive benefits. However, the production of candy like flavors and toothpaste containing fluoride at 1500 ppm or more should not be encouraged for use by children, as it may lead to an excessive ingestion of fluoride.

WHO Expert Committee in 1994 Suggested That

- Everyone should be encouraged to brush daily with fluoride toothpaste.
- Every effort must be made to develop affordable fluoridated toothpastes for general use in developing countries.
- Fluoridated toothpaste tubes should carry advice that for children under the age of 6 years brushing should be supervised and only a very small amount (less than 5 mm) should be placed on the brush or the chewing-stick.

Toothpaste Formulations

- Most 1000 ppm fluoride containing toothpaste achieve this concentration, i.e. [0.1%F= 1 mgF/g paste] by adding one of the following four fluoride salts.
- Sodium fluoride [0.2% NaF]

- Sodium monofluorophosphate [0.76% Na_2PO_3F]
- Stannous fluoride [0.4% SnF_2]
- Stannous Fluoride toothpaste have one major disadvantage that they lead to unsightly black/ brown extrinsic staining of tooth surface, specially around margins of tooth colored restorations. The discoloration is probably due to precipitation on the acquired pellicle of oxides and sulphides of tin.
- Both sodium fluoride and sodium monofluorophosphate dentifrices can be recommended freely as available evidence fails to support the superiority of one fluoride over the other. A unique characteristic of sodium monofluorophosphate is its compatibility with a wide variety of dentifrice abrasive system.

In contrast to other fluoride compounds such as stannous fluoride, which are almost completely dissociated in aqueous solution to yield fluoride ions that readily react with available cations, the fluoride in sodium monofluorophosphate remains largely complexed as PO_3F^- in solution. This fluoride complex is compatible with a wide variety of abrasive system. By far the greatest number of dentifrices on sale in the world today has sodium monofluorophosphate as their active ingredient.

Mechanism of Action

Two possible mechanisms have been suggested. One suggests that MFP ions is incorporated into the hydroxyapatite crystal lattice with a subsequent slower release of fluoride ion which then replaces hydroxyl groups to form fluorapatite. On the other hand it is suggested that it is MFP ions itself which is incorporated into the apatite crystals by means of a substitution reaction with one or more of the phosphate groups.

Fluoride in toothpaste is taken up directly by demineralized enamel and it also increases the fluoride concentration in dental plaque, thus leaving a store of fluoride available for remineralization when pH drops.

Effects of Fluoridated Toothpaste on Root Surface Caries

Majority of trials of fluoridated toothpaste has been conducted on coronal caries in children and adolescents and little information is available on the effects of fluorides on the root surface caries in adults. Preliminary results of studies have shown a statistically significant reduction in both coronal and root surface caries.

Manner of Use of Fluoridated Toothpaste

- Fluoridated toothpaste should be used daily for tooth cleaning by person of all ages to control development and progression of dental caries.
- In children under the age of 6 years, brushing should be supervised in order to prevent excessive ingestion.

Table 30.8: Recommended schedule for use of fluoride dentifrice

Age group	*Recommendation*
Below 4 yr	Fluoride toothpaste not recommended
4-6 yr	Brushing once daily with fluoride toothpaste and two times without paste
6-10 yr	Brushing twice daily with fluoride toothpaste and once without paste
Above 10 yr	Brushing three times daily with fluoride toothpaste

- In children only a very small amount (less than 5 mm) which approximates the "pea size" should be placed on the brush (Table 30.8).

Effects of Combining More than One Fluoride Agent

Studies involving use of a mixed fluoride system, i.e. MFP and NaF showed that mixed fluoride system showed significant reductions in mean caries increment over the positive control. But it was not clear from this study whether the improvement was due to the mixture of fluoride agents or merely to the extra fluoride available from the test pastes.

Safety of Fluoride Dentifrices

Fluoride toothpaste generally contains around 800-1000 ppm of F^- and the free available fluoride approximately 500–600 ppm, i.e. about 30 mg F in a tube of 50 gm. The certainly lethal dose [CLD] of fluoride for a 70 kg adult is 5–10 gm of NaF or 32–64 mgF/kg body weight. and safely tolerated dose [STD] is approximately ¼ of the CLD, i.e. 1.25–2.5 gm.

Usually the largest size toothpaste manufactured is about 200 gms and it can best contain 200 mgF whereas the available F^- will be only about 140 mg. This amount of fluoride is within the range of Safely Tolerated Dose [STD] for a 6-year-old child, i.e. even if a 6-year-old child eats a whole of the economy size toothpaste of 200 gms at one time, the child is still within the Safely Tolerated Dose.

Most toothpaste marketed in India contains 1000 ppm of fluoride. A 1 inch ribbon [1 gm] of dentifrice of an adult toothbrush contains approximately 1 mg fluoride.

Effect of Fluoridated Toothpaste on Root Surface Caries

The vast majority of trial of fluoridated toothpastes has been conducted on coronal caries in children and adolescents and little information is available on the effect of such toothpastes on root surface caries in adults. Preliminary results of studies are promising but more studies are required.

FLUORIDE MOUTHRINSES

Frequent use of low concentration of fluoride is more cariostatic than less frequent use of higher concentration of fluoride for topical application. In areas where water fluoridation is not possible or has not been implemented, the fluoride mouthrinses have been found to be an effective tool in prevention of dental caries. Over the past few decades fluoride mouthrinsing has become one of the most widely used caries-preventive public health measure.

Sodium fluoride mouth rinse is now widely used in school based programs as well as by individuals at home. Other less extensively tested fluoride mouth rinses include those containing APF, stannous fluoride, ammonium fluoride and amine fluoride. For reasons of lowest expense, convenience in handling as well avoidance of unpleasant taste, NaF became the most widely used of these tested products in public health programs.

METHODS OF PREPARATION

For Home Use

It can be prepared by dissolving 200 mg NaF tablet [10 mg NaF and the rest lactose as fillers] in 5 teaspoons of fresh clean water [approx. 25 ml]. Lactose is used as fillers as it is non-reactive with fluoride. This much is sufficient for a daily mouth rinse for a family of about 4 members, providing approximately 0.04 percent NaF.

For Use in School

For a school set up a packet of 2 gm NaF powder can be dissolved in 1000 ml of water to make 0.2 percent solution. A weekly or fortnightly schedule is most convenient in schools using 0.2 percent neutral NaF.

Studies have shown that regular use of NaF mouth rinses reduced caries increments in children by about 20 to 35 percent over periods of 2–3 years.

Over the Counter

Mouth rinse products contain fluoride ion at a concentration of 200–900 mg/L for daily and weekly use respectively.

RECOMMENDATIONS

Mouth rinses designed to be rinsed and spit out, either prescribed by your dentist or an over-the-counter variety.

***0.2* percent of NaF solutions are recommended [900 ppm F^-] for *weekly*/ *fortnightly* use, while *0.05* percent [225 ppm F^-] for *daily* use**. In communities with fluoridated water supplies or with natural occurring optimum fluoride level in drinking water, mouth rinsing programs would give a super added benefit. Mouth rinses designed to be rinsed and spit out, either prescribed by your dentist or an over-the-counter variety. The ADA recommends the use of fluoride mouthrinses, but not for children under six years of age because they may swallow the rinse.

Over-the-counter daily fluoride mouthrinses generally contain 0.05 percent NaF (200–220 ppm F). A 10 mL volume should be swished around the mouth vigorously once each day for one minute (ideally just before bedtime) and then expectorated. Patients should not rinse afterwards for 30 minutes. Pharmacy-only "weekly" fluoride mouthrinses typically contain 0.2 percent NaF (900 ppm F). They are designed to be used under adult supervision, once each week for one minute.

Fluoride mouthrinse should be used at a time of day when toothpaste is not used, and it should not be a substitute for brushing with fluoridated toothpaste. After rinsing, mouthrinse should be spat out, not swallowed.

ADVANTAGES

1. Caries reduction by 30 percent.
2. Seemingly low cost resulting from supervision by teachers, volunteer mothers or inexpensive hourly workers.
3. A reasonable procedure to use in high risk population.

FLUORIDE EXPOSURE FROM MULTIPLE SOURCES

Fluorides are found naturally throughout the world. They are present to some extent in all foods and waters so that all humans ingest some fluoride. Fluoride has become more available via food and drink as shown by different studies (Tables 30.9 and 30.10), fluoridated water, dentifrices, mouthwashes, etc. This can be extremely beneficial in terms of the prevention of dental decay. It can also increase the risk of the milder forms of dental opacities/fluorosis. Because of this there should be a co-ordinated approach to fluoride delivery. It is imperative that fluoride availability from all sources is taken into account before embarking on a specific course of fluoride treatment.

Table 30.9: Fluoride concentrations of foods

Food	*Fluoride concentration (mg/liter or kg)*	
	Average	*Range*
Fruits	0.06	0.02–0.08
Meat, fish, poultry	0.22	0.04–0.51
Oils and fats	0.25	0.02–0.44
Dairy products	0.25	0.02–0.82
Leafy vegetables	0.27	0.08–0.70
Sugar and adjunct substances	0.28	0.02–0.78
Root vegetables	0.38	0.27–0.48
Grain and cereal products	0.42	0.08–2.01
Potatoes	0.49	0.21–0.84
Legume vegetables	0.53	0.49–0.57
Nonclassifiable	0.59	0.29–0.87
Beverages	0.76	0.02–2.74

Table 30.10: Fluoride content in various food items

Food item	*Fluoride (mg/kg)*	*Food item*	*Fluoride (mg/kg)*
Cereals		***Fruits***	
Wheat	4.6	Banana	2.9
Rice	5.9	Mango	3.2
Maize	5.6	Apple	5.7
		Guava	5.1
Pulses		***Beverages***	
Gram	2.5	Tea	60-112
Soybean	4.0	Coconut water	0.32-0.6
Vegetables		***Spices***	
Cabbage	3.3	Coriander	2.3
Tomato	3.4	Garlic	5.0
Cucumber	4.1	Ginger	2.0
Ladyfinger	4.0	Turmeric	3.3
Spinach	2.0	***Food from Animal Sources***	
Mint	4.8	Mutton	3.0-3.5
Brinjal (egg plant)	1.2	Beef	4.0-5.0
Potato	2.8	Pork	3.0-.5
Carrot	4.1	Fish	1.0-6.5

(Modified from SR Sengupta, B Pal, Iodine and fluoride content of foodstuffs, Indian J Nutr Dicter (1971)

Table 30.11: Various methods of fluoride application and caries reduction

Method	*Dose/concentration*	*%Reduction in caries*
Water fluoridation	0.5–1.2 ppm	50–65
Mouthrinses	0.05% NaF daily 0.2% NaF (wkly)	20–30
Dentifrices	0.4% SnF_2 0.76% MFP 0.22% NaF	20–30
Professionally Applied	2.0% NaF 8.0 or 10% SnF_2 1.23% APF	30–40

EVIDENCE IN CARIES REDUCTION

Fluoride therapy can lead to marked reduction in caries depending upon the method used. It varies from 20–65 percent as shown in Table 30.11.

The Evidence-based Clinical Recommendations for the Use of Professionally Applied Topical Fluorides [PATF]

The American Dental Association defines the term "evidence-based dentistry" as follows Evidence-based dentistry (EBD) is an approach to oral health care that requires the judicious integration of systematic assessments of clinically relevant scientific evidence relating to the patient's oral and medical condition and history, with the dentist's clinical expertize and the patient's treatment needs and preferences.

Younger than 6 Years

	High risk	*Moderate risk*	*Low risk*
PATF Fluoride varnish	Fluoride varnish every 3-6 months interval	Fluoride varnish at 6 months interval	Not required
Fluoride gels	Avoid to reduce the risk of ingestion as quantity more than varnish	Avoid to reduce the risk of ingestion as quantity more than varnish	
Fluoridated water	Being used	Being used	Being used
Fluoride toothpaste	Being used	Being used	Being used

- Patients whose caries risk is lower, may not receive additional benefit from professional topical fluoride application. (Fluoridated water and fluoride toothpastes may provide adequate caries prevention in this risk category. Whether or not to apply topical fluoride in such cases is a decision that should balance this consideration with the practitioner's professional judgment and the individual patient's preferences.)
- Moderate-risk patients should receive fluoride varnish applications at six-month intervals. Fluoride varnish contains a smaller quantity of fluoride compared to fluoride gels; and, therefore, its use reduces the risk of inadvertent ingestion in children younger than 6 years.
- Higher-risk patients should receive fluoride varnish applications at 3-6 month intervals.

6 to 18 Years of Age

	High risk	*Moderate risk*	*Low risk*	
PATF	Fluoride varnish/Gel every 6 months interval	Fluoride varnish/ Gel at 6 months interval	Not required	PATF applied every 3 months may provide additional benefit *in high risk*

Contd…

Contd…

	High risk	*Moderate risk*	*Low risk*
Fluoridated water	Being used	Being used	Being used
Fluoride toothpaste	Being used	Being used	Being used

- Patients whose caries risk is lower, may not receive additional benefit from professional topical fluoride application. Fluoridated water and fluoride toothpastes may provide adequate caries prevention in this risk category. (Whether or not to apply topical fluoride in such cases is a decision is based on practitioner's professional judgment.)
- Moderate-risk patients should receive fluoride varnish or gel applications at six-month intervals.
- Higher-risk patients should receive fluoride varnish or gel application at six-month intervals. Fluoride varnish applications at three-month intervals or fluoride gels at three-month intervals may provide additional caries prevention benefit.

Older than 18 Years

	High risk	*Moderate risk*	*Low risk*
PATF	Fluoride varnish/Gel every 3-6 months interval	Fluoride varnish/Gel at 6 months interval	Not required
Fluoridated water	Being used	Being used	Being used
Fluoride toothpaste	Being used	Being used	Being used

- Patients whose caries risk is lower, may not receive additional benefit from professional topical fluoride application. (Fluoridated water and fluoride toothpastes may provide adequate caries prevention in this risk category. Whether or not to apply topical fluoride in such cases is a decision that should balance this consideration with the practitioner's professional judgment and the individual patient's preferences.)
- Moderate-risk patients should receive fluoride varnish or gel applications at six-month intervals.
- Higher-risk patients should receive fluoride varnish or gel applications at three- to six-month intervals.

All ages Application time for fluoride gel and foam should be four minutes. A one minute fluoride application is not endorsed.

FLUORIDE MECHANISM OF ACTION

- Any pre-eruptive benefit due to ingestion of fluoride during tooth development is now believed to be relatively unimportant.
- Primary mode of action of F is *topical*
- Post-eruptive benefit is *cumulative*

Fluoride mechanism of action inhibits of demineralization

- F *surrounding the carbonated apatite crystals* is much more effective at inhibiting demineralization than F *incorporated into the crystals* at the levels found in enamel
- F incorporated developmentally into the normal tooth mineral is *insufficient* to have a measurable effect on acid solubility.
- If F is present in the plaque fluid at the time that the bacteria generate acid it will travel with the acid down into the sub-surface of the tooth, adsorb to the crystal surface and protect it against being dissolved.

Enhances remineralization

- The saliva is "supersaturated" with calcium and phosphate providing a *driving force* for mineral to go back into the tooth.
- The partially dissolved crystals act as "*nucleators*" for remineralization
- Fluoride acts to *speed up* this remineralization process by adsorbing to the surface and acting to bring calcium and phosphate ions together, and is preferentially included in the chemical reaction that takes place, producing a lower solubility end-product

Inhibits plaque bacteria

- F from topical sources is taken up by the bacteria when they produce acid, thereby inhibiting essential enzyme (enolase) activity.

31 Dental Fluorosis and its Prevention

CM Marya

Ingestion of excess fluoride, most commonly in drinking-water, can cause fluorosis which affects the teeth and bones. Moderate amounts lead to dental effects, but long-term ingestion of large amounts can lead to potentially severe skeletal problems. Paradoxically, low levels of fluoride intake help to prevent dental caries. The control of drinking-water quality is therefore critical in preventing fluorosis.

Fluorosis is caused by excessive intake of fluoride. The dental effects of fluorosis develop much earlier than the skeletal effects in people exposed to large amounts of fluoride. Clinically dental fluorosis is characterized by staining and pitting of the teeth. In more severe cases all the enamel may be damaged. However, fluoride may not be the only cause of dental enamel defects. Enamel opacities similar to dental fluorosis are associated with other conditions, such as malnutrition with deficiency of vitamins D and A or a low protein-energy diet. Ingestion of fluoride after six years of age will not cause dental fluorosis.

Chronic high-level exposure to fluoride can lead to skeletal fluorosis. In skeletal fluorosis, fluoride accumulates in the bone progressively over many years. The early symptoms of skeletal fluorosis include stiffness and pain in the joints. In severe cases, the bone structure may change and ligaments may calcify, with resulting impairment of muscles and pain.

Acute high-level exposure to fluoride causes immediate effects of abdominal pain, excessive saliva, nausea and vomiting. Seizures and muscle spasms may also occur.

Acute high-level exposure to fluoride is rare and usually due to accidental contamination of drinking-water or due to fires or explosions. Moderate-level chronic exposure (above 1.5 mg/liter of water—the WHO guideline value for fluoride in water) is more common. People affected by fluorosis are often exposed to multiple sources of fluoride, such as in food, water, air (due to gaseous industrial waste), and excessive use of toothpaste. However, drinking water is typically the most significant source. A person's diet, general state of health as well as the body's ability to dispose of fluoride all affect how the exposure to fluoride manifests itself.

SOURCES OF FLUORIDE

Various sources of fluoride entering the body are drinking water, food, industrial exposure, drugs and cosmetics, etc. However, drinking water is considered as the major contribution to fluoride entering the human body.

Drinking Water

The major source of fluoride in the groundwater is fluoride bearing rocks from which it gets weathered and/or leached out and contaminates the water. Fluorides occur in three forms, namely, fluorospar or calcium fluoride (CaF_2), apatite or rock phosphate [$Ca_3F\ (PO_4)_3$] and cryolite (Na_3AlF_6).

Food Items

Besides water, food items especially agricultural crops are heavily contaminated with fluoride as they are grown in the areas where the earth's crust is loaded with fluoride bearing rocks. The fluoride content in food material mainly depends upon:

1. Fluoride level in soil.
2. Fluoride level in atmosphere.
3. Use of fertilizers and pesticides and other sources of contamination.

Industrial Exposure

Various industries involving the manufacture of phosphate fertilizers, aluminium extraction, fluorinated hydrocarbons (refrigerants, aerosol propellants etc.), fluorinated plastics (polytetrafluoroethylene etc.), petroleum refining and hydrogen fluoride manufacturing units are mainly responsible for airborne fluoride. Fluoride dust and fumes pollute the environment; inhaling dust and fumes is as dangerous as consuming fluoride containing food, water or drugs. Not only the industrial workers are affected but the people living in the vicinity of such industries may also get afflicted.

Drug and Cosmetics

The sodium fluoride containing drugs for osteoporosis, osteosclerosis and dental caries are in use for many years. The prolonged use of these drugs may cause fluorosis. Additionally, the toothpastes and mouthrinses also contain higher fluoride concentration.

FLUORIDE INTAKE

Uppermost limit of fluoride intake (threshold for dental fluorosis) today is still 0.05–0.07 mg/kg body wt/day, as suggested by Burt. However, today this figure must be clearly stated and recognized to include fluoride intake not only from food and beverages (which is probably less than 0.05–0.07 mg F/kg body weight as found in duplicate-diet studies), but also nondietary sources of intake such as dentifrices, dietary fluoride supplements, mouthrinses, and gels. It is important to bear in mind that this threshold level of fluoride intake above which dental fluorosis could occur is still only an estimate and that the threshold level of intake could be even lower than 0.05–0.07 mg/kg bw.

Clearly, in a biological sense, it is the total ingested and bio-available fluoride that is important in consideration of dental caries prevention and the occurrence of objectionable dental fluorosis. An important issue in the consideration of what constitutes the threshold level of fluoride intake is the differentiation between intake from foods (Table 31.1) and beverages (including water) only versus total fluoride intake from food and beverages (including water), plus dentifrices, dietary fluoride supplements, rinses, and gels. In addition, more accurate information on background levels of children's fluoride intake from food and beverages (including water) alone is desirable if appropriate dosages for fluoride supplements are to be recommended in the future.

Fluoride Intake from Milk and Formula

The fluoride content of breast milk is very low and consistently is found to be less than 0.01 ppm. Cow's milk also contains very low levels of fluoride, generally below 0.05 ppm. It has been recommended that infant concentrated formulas should not contain more than 0.4 ppm fluoride.

Some infants react to cow's milk and are fed soy-based formulas. These consistently have been found to contain higher levels of fluoride than milk based formulas.

Therefore, if dietary fluoride supplements are to be recommended for very young infants in low fluoride areas, the type of feeding as well as the fluoride content of the water used in reconstituting formulas need to be considered carefully because some infants on infant formulas may require a reduced dosage or no supplementation compared to their counterparts on breast milk or cow's milk.

Fluoride Intake from Water

The estimated fluoride intake from only water mixed with concentrated formula ranged from 0 to 1.12 mg/day (mean=0.28 mg/day). Estimated total fluoride intake from water from all sources (water by itself, and mixed with concentrated formula, beverages, baby foods/cereals, and other foods) ranged from 0 to 1.29 mg/day (mean=0.36 mg/day).

In determining fluoride intake from tap water, it is important to consider the effect of water filtration systems being used in the home. The majority of home filtration systems are carbon or charcoal filter systems that generally do not remove fluoride. However, the more expensive home distillation and reverse osmosis systems remove the majority of the fluoride.

Bottled waters are promoted as a safe source of clean drinking water and sometimes are used instead of tap water for the reconstitution of infant formulas and other beverages. Bottled waters can show considerable variation in fluoride content. Although most bottled waters contain less than 0.3 ppm fluoride, several, especially artesian waters and certain imported mineral waters, contain approximately 1.0 ppm fluoride or more.

Fluoride Intake from Beverages

Studies among children in some countries such as the United States, Canada, and Hong Kong report a substantial increase in the consumption of beverages and a reduction in average tap water consumption.

Because the main component of most beverages is water, the fluoride content of these products closely parallels the fluoride content of water used in their processing.

Fruit juices processed in plants supplied with fluoridated water have been found to contain more fluoride than those processed in plants supplied with nonfluoridated water.

In a study in North Carolina, the fluoride content of 280 available beverage products was found to be highly variable, ranging from <0.l to as much as 6.7 ppm. Many carbonated beverages had fluoride levels close to 1 ppm, juices ranged up to 1.70 ppm (mean=0.36 pprn), and punches up to 1.44 ppm (mean=.33 ppm).

Another important source of fluoride ingestion is tea. Raw tea leaves contain as much as 400 pprn fluoride. When infused with deionized water, the fluoride content of tea has been found to range from 0.1 to 4.2 ppm fluoride, with an average of about 3 ppm. A cup of tea (200 mL) daily, therefore, could yield on an average about 0.6 mg F/day. Where tea drinking is common, it can be an important source of fluoride intake. For example, average daily fluoride intake from tea among 'high tea consumers' was reported by Hargreaves to be about 1 mg.

Fluoride Intake from Food Products and Infant Formula

Infant cereals, infant chicken products, fish products such as salmon, sardines, and some sea foods contain high levels of fluoride. Infant chicken products have been found to contain

Table 31.1: Fluoride intake (means and ranges) from diet alone, reported from different countries

Study	Age	Fluoridated Areas		Nonfluoridated Areas	
		mg/Day	mg/kgbw	mg/day	mg/kgbw
Dietary survey studies					
McClure (USA, 1943)	1-3 years	0.42-0.83	0.03-0.10		
	4-6 years	0.56-1.11	0.02-0.09		
	7-9 years	0.70-1.38	0.02-0.07		
Burt (USA, 1992)	3-6 months	0.33*	0.04-0.07		
	6-12 months	0.43*	0.04-0.06		
	1-3 years	0.65*	0.04-0.07		
	3-6 years	0.90*	0.03-0.05		
	6-8 years	1.00*	0.03-0.05		
Ham and Smith (USA, 1974)	2 years	0.61			
Singer and Ophaug (USA, 1979)	2 months	0.63	0.13	0.05	0.01
	4 months	0.68	0.10	0.10	0.02
	6 months	0.76	0.09	0.15	0.02
Ophaug et al. (USA, 1985)	6 months	0.42	0.05	0.35	0.04
	2 years	0.62	0.05	0.21	0.03
Featherstone and Shields (USA, 1988)	6 months	0.40	0.05	0.20	0.03
Dabeka et al. (Canada, 1982)	3-6 months	0.42	0.06	0.25	0.04
	6-9 months	0.48	0.06	0.27	0.04
	9-12 months	0.56	0.05	0.28	0.03
Hattab and Wei (Hong Kong, 1988)	6-11 months	0.23	0.03		
Schamschula et al. (Hungary, 1988)	4 years	0.72		0.22	

*Uppermost limit of intake
(Modified from Steven M. Levy, Nupur Guha-Chowdhury. Total Fluoride Intake and Implications for Dietary Fluoride I Supplementation. J Public Health Dent 1999;59(4):211-23)

about 0.6 to 10.6 pprn fluoride and tinned fish up to 40 ppm fluoride. Dried sea foods, which constitute a significant part of the diet in some cultures, also contain high levels of fluoride (about 3–290 ppm). The high levels of fluoride in these products are a result of the inclusion of bone and shell, which accumulate fluoride.

Fluoride Intake from Dentifrices

Nearly 90 percent or more of all dentifrices sold through out the world specially in the United States, Canada, and other western countries contain fluoride, commonly in the form of either sodium monofluorophosphate or sodium fluoride. Fluoride dentifrices are used almost universally and are an important source of fluoride intake because fluoride ingestion from toothpaste is common in children.

The fluoride concentration in dentifrices in the United States ranges from 1,000 to 1,500 ppm. Most dentifrices in India contain 1000 ppm of fluoride.

Many studies report that the amount ingested, which can ranges from essentially none to 100 percent, is inversely related to age and directly related to the amount applied to the toothbrush.

In a study in UK by E M Bentle (1999) the mean amount of toothpaste applied on the brush was 0.36 g of which 0.27 g (72%) was retained in the mouth. The mean amount of fluoride ingested per brushing was 0.42 mg when using the 1,450 ppm F toothpaste and 0.10 mg when using the 400 ppm F toothpaste.

Therefore, ingestion of toothpaste can contribute substantial amounts of fluoride and it has been concluded that some young children may be ingesting enough fluoride from dentifrice to cause dental fluorosis. Age is indirectly proportional to ingestion of fluoride.

To reduce the risk of fluorosis, it has been suggested that use of higher concentration fluoride dentifrices by preschool children be avoided, that only small quantities of paste be used under parental direction and supervision, that further development and testing of lower concentration fluoride dentifrices be encouraged, and that dentifrice tubes dispense smaller quantities “so that inappropriate eating of fluoride dentifrice is avoided”.

Fluoride Intake from Mouthrinses

The use and ingestion of fluoride mouthrinses is a potential source of fluoride intake in children. Fluoride mouthrinses

available for weekly use (daily if at high risk for caries) contain 0.20 percent NaF (about 910 ppm fluorides) and the ones for daily use contain 0.05 percent NaF (about 230 ppm fluoride).

The amount of rinse ingested following the use of mouthrinses is variable and has been reported to be inversely related to age and experience with rinsing, and directly related to rinsing time and volume of rinse used. Study have shown that the mean quantity of fluoride ingested by preschool children aged 3 to 5 years was 0.40 mg F for a 0.05 percent NaF rinse and 1.60 mg for a 0.2 percent NaF rinse.

In one study, following rinsing with 7 mL of 0.05 percent NaF mouthrinse, 3-year-old children swallowed an average of 26 percent of the mouthrinse (0.44 mg F), 4-year-old children 24 percent (0.42 mg F), and 5- and 6-year-old children 22 percent (0.35 mg F). A large number of children are probably ingesting a substantial dose of fluoride (1.0 to 1.5 mg) on at least 20 to 30 occasions throughout the year.

Fluoride Intake from Professional and Self-applied Fluoride Gels

The amount of fluoride ingested following professional topical application of a fluoride gel (typically containing 12,300 ppm fluoride for APF) is variable, but generally ranges from 10 to 35 mg of fluoride when not using suction and from 2 to 7 mg fluoride when using suction with subsequent expectoration.

Distribution

Fluorosis is endemic in 22 countries around the world. Drinking water containing fluoride is the major source of fluorosis due to geological crust contamination. The guidelines followed for fluoride content in drinking water in most of the countries are based on the WHO norms. According to the WHO, the desirable upper limit for fluoride in drinking water is 1.5 mg/L. Senegal is the first country to reduce the upper permissible limit of fluoride in drinking water from 1.5 mg/L to 0.6 mg/L. The reason for such drastic change is due to the high prevalence of dental fluorosis in children with 1.5 mg/L fluoride in drinking water. India has reduced the upper limit of fluoride in drinking water from 1.5 mg/L to 1.0 mg/L.

World

Fluoride in water is mostly of geological origin. Waters with high levels of fluoride content are mostly found at the foot of high mountains and in areas where the sea has made geological deposits. Known fluoride belts on land include: one that stretches from Syria through Jordan, Egypt, Libya, Algeria, Sudan and Kenya, and another that stretches from Turkey through Iraq, Iran, Afghanistan, Pakistan, India, northern Thailand, New Zealand and China. There are similar belts in the Americas and Japan. In these areas fluorosis has been reported.

India

The problem has reached alarming proportions affecting at least 17 states of India:

i. 50-100% districts are affected - Andhra Pradesh, Tamil Nadu, Uttar Pradesh, Gujarat, Rajasthan.
ii. 30-50% districts are affected - Bihar, Haryana, Karnataka, Maharashtra, Madhya Pradesh, Punjab, Orissa, West Bengal.
iii. < 30 % districts are affected - J & K, Delhi, Kerala.

Table 31.2 shows the districts most affected and their endemic fluoride concentration in various states of India.

Optimum Concentration of Fluoride in Drinking Water

According to WHO standards, the fluoride in drinking water should be within a range that slightly varies above and below 1 mg/L. In temperate regions, where water intake is low, fluoride level up to 1.5 mg/L is acceptable. The Ministry of Health, Government of India, has prescribed 1.0 and 2.0 mg/L as permissive and excessive limits for fluoride in drinking water, respectively. Table 31.3 shows different health impacts at varying fluoride concentrations in drinking water.

FLUORIDE TOXICITY

The fluoride compounds differ widely with respect to fluoride bioavailability and hence in their acute toxic potential. The differences in toxic potential of different fluoride compounds are related to various factors such as solubility of the compound, cation content of the compound, e.g. stannous fluoride is slightly more toxic than sodium fluoride because high doses of tin ion adversely affect the kidney and other organs.

Other factors influencing the toxicity include route of administration, age, rate of absorption, and acid-base status.

It can be *chronic* or *acute* toxicity.

Chronic refers to long term ingestion of fluoride in amounts that exceed the approved therapeutic level.

Acute toxicity: Acute means rapid intake of an excess dose over a short period time.

Acute fluoride poisoning is rarely seen.

Symptoms of acute fluoride poisoning.

1. Salivation
2. Nausea
3. Vomiting
4. Abdominal pain
5. Diarrhea
6. Cramps
7. Cardiac arrhythmia
8. Coma

Table 31.2: Endemic fluoride districts in various states of India and fluoride concentration

States	*Districts*	*Range of fluoride concentration (mg/L)*
Assam	Karbianglong, Nagaon	0.2–18.1
Andhra Pradesh	All districts except Adilabad, Nizamabad, West Godhavari, Visakhapattnam, Vijzianagaram, Srikakulam	0.11–20.0
Bihar	Palamu, Daltonganj, Gridh, Gaya, Rohtas, Gopalganj, Paschim, Champaran	0.6–8.0
Gujarat	All districts except Dang	1.58–31.0
Haryana	Rewari, Faridabad, Karnal, Sonipat, Jind, Gurgaon, Mohindergarh, Rohtak, Kurukshetra, Kaithal, Bhiwani, Sirsa, Hisar	0.17–24.7
Karnataka	Dharwad, Gadag, Bellary, Belgam, Raichur, Bijapur, Gulbarga, Chitradurga, Tumkur, Chikmagalur, Manya, Banglore, Mysore	0.2–18.0
Kerala	Palghat, Allepy, Vamanapuram, Alappuzha	0.2–2.5
Maharashtra	Chandrapur, Bhandara, Nagpur, Jalgaon, Bulduna, Amravati, Akola, Yavatmal, Nanded, Sholapur	0.11–10.2
Madhya Pradesh	Shivpuri, Jabua, Mandla, Dindori, Chhindwara, Dhar, Vidhisha, Seoni, Sehore, Raisen and Bhopal	0.08–4.2
Punjab	Mansa, Faridcot, Bhatinda, Muktsar, Moga, Sangrur, Ferozpur, Ludhiana, Amritsar, Patila, Ropar, Jallandhar, Fatehgarh sahib	0.44–6.0
Rajasthan	All the 32 districts	0.2–37.0
Tamil Nadu	Salem, Periyar, Dharampuri, Coimbatore, Tiruchirapalli, Vellore, Madurai, Virudunagar	1.5–5.0
Uttar Pradesh	Unnao, Agra, Meerut, Mathura, Aligarh, Raibareli, Allahabad	0.12–8.9
West Bengal	Birbhum, Bhardaman, Bankura	1.5–13.0

Table 31.3: Concentration of fluoride in drinking water and its effects on human health

Fluoride concentration (mg/L)	*Effect*
<0.5	Dental caries
0.5 – 1.5	Promotes dental health, prevents tooth decay
1.5 – 4.0	Dental fluorosis (mottling and pitting of teeth)
4.0 – 10.0	Dental fluorosis, skeletal fluorosis (pain in neck bones and back)
>10.00	Crippling fluorosis

Source: International Drinking Water Standards (1971), WHO, Geneva.

MANAGEMENT OF ACUTE FLUORIDE TOXICITY

Initial Emergency Response in the Oral Care Setting

- Induce vomiting by administering an emetic, such as ipecac (this should occur only if the client has a gag reflex, is conscious, and is not convulsing)
- This is followed by the oral administration of 1% calcium chloride or calcium gluconate; if these are not available milk should be ingested.
- While the client is receiving attention, medical assistance is requested and transport to the medical assistance room should occur as soon as possible.

Response by Medical Personnel

Emergency response is dependent on the severity of symptoms and may include the following options:

- Inserting an endotracheal tube, followed by gastric lavage with a calcium-containing solution or activated charcoal.
- Establishing an airway
- Establishing an intravenous line
- Maintaining cardiovascular circulation
- Hourly blood analysis for plasma fluoride levels and monitoring for hyperkalemia and hypocalcemia
- Fluid replacement to reverse effects of vomiting and diarrhea to maintain urine flow
- Intravenous calcium replacement, glucose administration, oxygen, artificial respiration, or other supportive therapies
- If the client responds favorably, continue supportive therapies until the following are in normal range: mental alertness, vital signs, and serum chemistry profile.

(Ekstrand J, Fejerskov O, Silverstone LM: Fluoride in Dentistry, Copenhagen, 1988, Munksgaard).

LETHAL AND SAFE DOSES OF FLUORIDE

A. Certainly Lethal Dose (CLD)

A lethal dose is the amount of drug likely to cause death if timely interception by antidote is not initiated.

In Adult: CLD is 5–10 gm of sodium fluoride taken at 1 time. The fluoride ion equivalent is 32–64 mg Fluoride (F) per kg body weight.

In Children: CLD is approximately 0.5–1.0 gm. It varies with size and weight of the child.

B. Safely Tolerated Dose (STD)

It is usually one fourth of the CLD.

Adult STD: 1.25 – 2.5 gm of sodium fluoride (8–16 mg F/kg).

Children: less than 1gm (1000 mg) is fatal for children 12 years and younger and ½ gm (500 mg) exceeds the STD for all ages. For children under 6 years of age, however 500 mg is lethal.

The STD, the amount of fluoride that can be ingested without causing symptoms of serious acute toxicity is approximately one fourth the CLD. Table 31.4 gives information regarding the safely tolerated dose (STD) and certainly lethal dose (CLD) of fluoride based on body weight and age.

Table 31.4: Certainly lethal and safe doses of fluoride

Age in years	*Body weight*	*CLD (mg)*	*STD (mg)*
2	22	320	80
4	29	422	106
6	37	538	135
8	45	655	164
10	53	771	193
12	64	931	233
14	83	1206	301
16	92	1338	334
18	95	1382	346

From Heifetz SB, Horowitz HS: The amount of fluoride in current fluoride therapies: Safety considerations for children, J Dent Child 51(4):257, 1984

DENTAL FLUOROSIS AND ENAMEL OPACITIES

It is important to diagnose the condition. It is difficult to differentiate between dental fluorosis and other enamel disturbances. Dental fluorosis is generalized within the dentition and over the entire tooth surface which makes it easy to distinguish fluoride-induced enamel changes from other enamel defects (non-fluoride origin) which may be symmetrically distributed in the oral cavity. Russell (1961) suggested differential diagnosis between fluorosis and mild non-fluoride enamel opacities (Table 31.5).

VARIOUS FORMS OF FLUOROSIS

The various forms of fluorosis arising due to excessive intake of fluoride are briefly discussed below.

Dental Fluorosis

Due to excessive fluoride intake, enamel loses its lustre. In its mild form, dental fluorosis is characterized by white, opaque areas on the tooth surface and in severe form, it is manifestated as yellowish brown to black stains and severe pitting of the teeth. This discoloration may be in the form of spots or horizontal streaks. Normally, the degree of dental fluorosis depends on the amount of fluoride exposure up to the age of 8–10, as fluoride stains only the developing teeth while they are being formed in the jawbones and are still under the gums.

Table 31.5: Differential diagnosis between milder forms of dental fluorosis and non-fluoride enamel opacities by Russell (1961)

Characteristic enamel opacities	*Milder forms of fluorosis*	*Non-fluoride enamel opacities*
Area affected	Usually seen on or near tips of cusps or incisal edges	Usually centered in smooth surface; may affect entire crown
Shape of lesion	Resembles line shading in pencil sketch; lines follow incremental lines in enamel, form irregular caps on cusps	Often round or oval
Demarcation	Shades off imperceptibly into surrounding normal enamel	Clearly differentiated from adjacent normal enamel
Color	Slightly more opaque than normal enamel; "paper white". Incisal edges, tips of cusps may have frosted appearance. Does not show stain at time of eruptions (in these milder degrees, rarely at anytime)	Usually pigmented at time of eruption; often creamy-yellow to dark reddish-orange

Contd...

Contd...

Characteristic enamel opacities	*Milder forms of fluorosis*	*Non-fluoride enamel opacities*
Teeth affected	Most frequent on teeth that calcify slowly (cuspids, bicuspids, second and third molars). Rare on lower incisors. Usually seen on six or eight homologous teeth. Extremely rare in deciduous teeth	Any tooth may be affected. Frequent on labial surfaces of lower incisors. May occur singly. Usually 1-3 teeth affected. Common in deciduous
Gross hypoplasia	None. Pitting of teeth does not occur in the milder forms. Enamel surface has glazed appearance, is smooth to point of explorer	Smooth to point of explorer. Absent to severe. Enamel surfacemay seem etched, be rough to explorer
Detection	Often invisible under strong light; most easily detected by line of sight tangential to tooth crown	Seen most easily under strong light on line of sight perpendicular to tooth surface

The effects of dental fluorosis may not be apparent if the teeth are already fully grown prior to the fluoride over exposure. Therefore, the fact that an adult shows no signs of dental fluorosis does not necessarily mean that his or her fluoride intake is within the safety limit.

Incipient Caries and Fluorosis Diagnosis

It is important to differentiate visually between incipient caries and developmental white spot hypocalcifications (fluorosis) of enamel. Careful visual inspection of a completely dry tooth surface may help in detecting early carious lesions, but only to the trained eye. The tooth will be opaque; exhibiting no translucency due to the extensive subsurface porosity caused by demineralization and may have a grayish-blue aspect of dentine beneath the enamel. The latter is common to observe and is unaffected by drying and wetting. So, a white spot that is an incipient lesion will disappear upon wetting and a hypocalcification will remain whether dry or moist.

White spot carious lesions usually occur around margins of gingival (the favorable site for plaque deposition)

Skeletal Fluorosis

Skeletal fluorosis affects the bones/skeleton of the body. Skeletal fluorosis affects children as well as adults. It does not easily manifest until the disease attains an advanced stage. Fluoride mainly gets deposited in the joints of neck, knee, pelvic and shoulder bones and makes it difficult to move or walk. The symptoms of skeletal fluorosis are similar to spondylitis or arthritis.

Early symptoms include sporadic pain, back stiffness, burning like sensation, pricking and tingling in the limbs, muscle weakness, chronic fatigue, abnormal calcium deposits in bones and ligaments. The advanced stage is osteoporosis in long bones and bony outgrowths may occur. Vertebrae may fuse together and eventually the victim may be crippled. It may even lead to a rare bone cancer, osteosarcoma and finally spine, major joints, muscles and nervous system get damaged.

Non-skeletal Manifestations

The soft tissues of the body also may be affected by excessive consumption of fluoride. The symptoms include gastro-intestinal complaints, loss of appetite, pain in stomach, constipation followed by intermittent diarrhoea. Cardiac problems may arise due to cholesterol production. Repeated abortions or still birth, male infertility due to sperm abnormalities are also some of the complications. Excessive consumption of fluoride may lead to muscle fibre degeneration, low hemoglobin levels, deformities in RBCs, excessive thirst, headache, skin rashes, nervousness, neurological manifestations (it affects brain tissue similar to the pathological changes found in humans with Alzheimer's disease), depression, gastrointestinal problems, urinary tract malfunctioning, nausea, abdominal pain, tingling sensation in fingers and toes, reduced immunity.

PREVENTION OF FLUOROSIS

Excessive fluoride ingestion by human beings can be prevented by using the following approaches:

Using alternate water sources: Alternate water sources include surface water, rainwater and low-fluoride groundwater.

Improving the nutritional status of population at risk: Adequate calcium intake is directly associated with a reduced risk of dental fluorosis. Vitamin C ingestion also safeguards against the risk of fluorosis.

Defluoridation: Removing excess fluoride from drinking water using different techniques such as Nalgonda method. This defluoridation method is based on the combined use of alum and lime in a two-step process.

DEFLUORIDATION OF WATER

Many states in India have ground water between 1–5 mgF/l, and in some areas fluoride concentration exceeds 21 mgF/l.

Dean's classification of fluorosis (Dean's Fluorosis Index):

Score	*Criteria*
Normal (0) 	The enamel represents the usually translucent semivitriform type of structure. The surface is smooth, glossy, and usually a pale creamy white color.
Questionable (0.5) 	The enamel discloses slight aberrations from the translucency of normal enamel, ranging from a few white flecks to occasional white spots. This classification is utilized when a definite diagnosis of the mildest form of fluorosis is not warranted and a classification of "normal" is not justified.
Very mild (1) 	Small, opaque, paper white area scattered irregularly over the tooth but not involving as much as approximately 25% of the tooth surface. Frequently included in this classification are teeth showing no more than 1 to 2 mm of white opacity at the tip of the summit of the cusps of the bicuspids or second molars.
Mild (2) 	The white opaque areas in the enamel of the teeth are more extensive but do not involve as much as 50% of the tooth.
Moderate (3) 	All enamel surfaces of the teeth are affected, and surfaces subject to attrition show marked wear. Brown stain is frequently a disfiguring feature.
Severe (4) 	All enamel surfaces are affected and hypoplasia is so marked that the general form of the tooth may be altered. The major diagnostic sign of this classification is the discrete or confluent pitting. Brown stains are widespread and teeth often present a corroded appearance.

Source: Dean 1942. American Association for the Advancement of Science.

Ministry of health, Government of India have prescribed 1.0 mgF/l as permissive and 2 mgF/ l as excessive limits. Population exposed to high fluoride levels requires defluoridation of water.

Desirable Characteristics of Defluoridation Process

- Cost-effective
- Easy to handle/operate by rural population-the major sufferer
- Independent of input Fluoride concentration, alkalinity, pH, temperature
- Not affect taste of water
- Not add other undesirable substances (e.g. Aluminum) to treated water.

Defluoridation is carried out by one of the two general methods.

Additive Method

In this chemicals are added to precipitate the fluoride or to absorb fluoride on other precipitated compounds. Chemicals usually used are lime (calcium oxide), magnesium compounds and aluminum sulfate (alum). Precipitation step is followed by mixing, flocculation, settling and filtration. The filtering beds need to be cleaned constantly of the accumulating sludges, e.g. Nalgonda technique.

Adsorption Method

This is carried out by running fluoride over contact beds where the fluoride is removed by ion exchange or chemical reactions with the agents comprising the bed matrix. Bed regeneration is essential.

Cation Exchange Resins

a. Defluoron-1: Sulfonated saw dust impregnated with 2% alum solution.
b. Carbion.
c. Magnesia: Raises pH of treated water beyond 10, hence acidification or recarbonation is necessary for correction.
d. Defluoron- 2: Developed in 1968. It is a sulfonated coal using aluminum solution as regenerant.

VARIOUS METHODS OF DEFLUORIDATION OF WATER

Defluoridation of drinking water is the only practicable option to overcome the problem of excessive fluoride in drinking water, where alternate source is not available. These methods are based on the principle of adsorption, ion-exchange, precipitation–coagulation, membrane separation process, electrolytic defluoridation, electrodialysis, etc.

Adsorption

Several adsorbent materials have been tried in the past to find out an efficient and economical defluoridating agent. Activated alumina, activated carbon, activated alumina coated silica gel, calcite, activated saw dust, activated coconut shell carbon and activated fly ash, groundnut shell, coffee husk, rice husk, magnesia, serpentine, tricalcium phosphate, bone charcoal, activated soil sorbent, carbion, defluoron-1, defluoron-2, etc., are different adsorbent materials reported in the literature. The most commonly used adsorbents are activated alumina and activated carbon. The fluoride removing efficiency of activated alumina gets affected by hardness and surface loading (the ratio of total fluoride concentration to activated alumina dosage). Chloride does not affect the defluoridation capacity of activated alumina. The process is pH specific, so pH of the solution should be between 5.0 and 6.0 because at pH > 7, silicate and hydroxide become stronger competitor of the fluoride ions for exchange sites on activated alumina and at pH less than 5, activated alumina gets dissolved in acidic environment leading to loss of adsorbing media. The process is highly selective but it has low adsorption capacity, poor physical integrity, requires acidification and pretreatment and its effectiveness for fluoride removal reduces after each regeneration. Mckee and Johnston 1934, investigated the use of powdered activated carbon for fluoride removal and achieved good results. The process is pH dependent with good results only at Ph 3.0 or less. Therefore, the use of this material is expensive due to need of pH adjustment.

Advantages

- The process can remove fluoride up to 90 percent.
- Treatment is cost-effective.

Limitations

- The process is highly dependent on pH and works best only in a narrow pH range (5–6)
- High concentration of total dissolved salts (TDS) can result in fouling of the alumina bed
- Presence of sulfate, phosphate or carbonate results in ionic competition
- The process has low adsorption capacity, poor integrity and needs pretreatment
- The regeneration is required after every 4–5 months and effectiveness of adsorbent for fluoride removal reduces after each regeneration
- Disposal of fluoride laden sludge and concentrated regenerant is also a problem.

Ion-exchange

Fluoride can be removed from water supplies with a strongly basic anion-exchange resin containing quarternary ammonium

functional groups. The removal takes place according to the following reaction:

$$\text{Matrix-NR3}+Cl^- + F^- \rightarrow \text{Matrix-NR3}+F^- + Cl^-$$

The fluoride ions replace the chloride ions of the resin. This process continues until all the sites on the resin are occupied. The resin is then backwashed with water that is supersaturated with dissolved sodium chloride salt. New chloride ions then replace the fluoride ions leading to recharge of the resin and starting the process again. The driving force for the replacement of chloride ions from the resin is the stronger electronegativity of the fluoride ions.

Advantages

- Removes fluoride up to 90–95 percent.
- Retains the taste and color of water intact.

Limitations

- Efficiency is reduced in presence of other ions like sulfate, carbonate, phosphate and alkalinity
- Regeneration of resin is a problem because it leads to fluoride rich waste, which has to be treated separately before final disposal
- The technique is expensive because of the cost of resin, pretreatment required to maintain the pH, regeneration and waste disposal
- Treated water has a very low pH and high levels of chloride.

OTHER METHODS

Coagulation–precipitation

Lime and alum are the most commonly used coagulants. Addition of lime leads to precipitation of fluoride as insoluble calcium fluoride and raises the pH value of water upto 11–12. $Ca(OH)_2 + 2F^- \rightarrow CaF_2 + 2OH^-$

As lime leaves a residue of 8.0 mg F^-/L, it is used only in conjunction with alum treatment to ensure the proper fluoride removal.

As a first step, precipitation occurs by lime dosing which is followed by a second step in which alum is added to cause coagulation. When alum is added to water, essentially two reactions occur. In the first reaction, alum reacts with some of the alkalinity to produce insoluble aluminium hydroxide [$Al(OH)_3$]. In the second reaction, alum reacts with fluoride ions present in the water. The best fluoride removal is accomplished at pH range of 5.5–7.5.

Limitations

- The process removes only a small portion of fluoride (18–33%) in the form of precipitates and converts a greater portion of ionic fluoride (67–82%) into soluble aluminum fluoride complex ion, and therefore this technology is erroneous. Also, the soluble aluminum fluoride complex is itself toxic
- Due to use of aluminium sulfate as coagulant, the sulfate ion concentration increases tremendously and in few cases, it crosses the maximum permissible limit of 400 mg/L, which causes cathartic effect in human beings
- The residual aluminum in excess of 0.2 mg/L in treated water causes dangerous dementia disease as well as pathophysiological, neurobehavioral, structural and biochemical changes. It also affects musculoskeletal, respiratory, cardiovascular, endocrine and reproductive systems
- Regular analysis of feed and treated water is required to calculate the correct dose of chemicals to be added, because water matrix keeps on changing with time and season
- Maintenance cost of plant is very high
- The process is not automatic. It requires a regular attendant for addition of chemicals and looking after treatment process
- Large space is required for drying of sludge.

Membrane Process

Although various conventional techniques of water purification described earlier are being used at present to solve the problem of groundwater pollution, none of them is user-friendly and cost-effective technique due to some or the other limitation and has either no or very long pay back period. In the recent years, RO membrane process has emerged as a preferred alternative to provide safe drinking water without posing the problems associated with other conventional methods. Reverse Osmosis (RO) is a physical process in which the contaminants are removed by applying pressure on the feed water to direct it through a semipermeable membrane. The process is the reverse of natural osmosis as a result of the applied pressure to the concentrated side of the membrane, which overcomes the natural osmotic pressure. RO membrane rejects ions based on size and electrical charge. The factors influencing the membrane selection are cost, recovery, rejection, raw water characteristics and pretreatment. Efficiency of the process is governed by different factors such as raw water characteristics, pressure, temperature and regular monitoring and maintenance, etc.

There are two types of membranes that can remove fluoride from water: Nano filters (NF) and RO. NF is a relatively low pressure process that removes primarily the larger dissolved solids as compared to RO. Conversely, RO operates at higher pressures with greater rejection of all dissolved solids. Fluoride removal efficiencies upto 98 percent by membrane processes have been documented by many researchers.

Advantages

- The process is highly effective for fluoride removal. Membranes also provide an effective barrier to suspended solids, all inorganic pollutants, organic micropollutants, pesticides and microorganisms, etc.
- The process permits the treatment and disinfection of water in one step
- It ensures constant water quality
- No chemicals are required and very little maintenance is needed
- Life of membrane is sufficiently long, so problem of regeneration or replacement is encountered less frequently
- It works under wide pH range
- No interference by other ions is observed.

Limitations

- It removes all the ions present in water, though some minerals are essential for proper growth, remineralization is required after treatment
- The process is expensive in comparison to other options
- The water becomes acidic and needs pH correction
- Lot of water gets wasted as brine
- Disposal of brine is a problem.

DEFLUORIDATION OF WATER USING NALGONDA TECHNIQUE

After extensive testing of many materials and processes including activated alumina since 1961, National Environment Engineering Research Institute (NEERI), Nagpur evolved an economical and simple method for removal of fluoride which is referred to as Nalgonda Technique.

Nalgonda Technique involves addition of aluminum salts, lime and bleaching powder followed by rapid mixing, flocculation, sedimentation, filtration and disinfection. Aluminium salt may be added as aluminum sulfate or aluminum chloride or combination of these two. Aluminum salt is only responsible for removal of fluoride from water. The dose of aluminum salt increases with increase in the fluoride and alkalinity levels of the raw water. The selection of either aluminum sulfate or aluminum chloride also depends on sulfate and chloride contents of the raw water to avoid them exceeding their permissible limits. The dose of lime is empirically 1/20th that of the dose of aluminum salt. Lime facilitates forming dense floc for rapid settling. Bleaching powder is added to the raw water at the rate of 3 mg/l for disinfection.

Mechanism of Defluoridation by Nalgonda Technique

Nalgonda Technique is a combination of several unit operations and processes incorporating rapid mixing, chemical interaction, flocculation, filtration, disinfection and sludge concentration to recover water and aluminium salts.

Rapid Mix

Provide thorough mixing of alkali, aluminum salts and bleaching powder with the water. The chemicals are added just when the water enters the system.

Flocculation

Flocculators subsequently provide gentle agitation before entry to the sedimentation tank. The flocculation period permits close contact between the fluoride in water and polyalumenic species formed in the system. The interaction between fluoride and aluminum species attains equilibrium.

- The chemical reaction involving fluorides and aluminum species is complex. It is a combination of polyhydroxy aluminum species complexation with fluorides and their adsorption on polymeric aluminum hydroxides (floc). Besides, turbidity, color, odor, pesticides and organics are also removed. The bacterial load is also reduced significantly. All these are achieved by adsorption on the floc.
- Lime or sodium carbonate ensure adequate alkalinity for effective hydrolysis of aluminium salts, so that residual aluminium does not remain in the treated water.
- Simultaneous disinfection is achieved with bleaching powder which also keeps the system free from undesirable biological growths.

Sedimentation

Permits settleable floc loaded with fluorides, turbidity, bacteria, and other impurities to be deposited and thus reduces concentration of suspended solids that must be removed by filters.

Filtration

Rapid gravity sand filters are suggested to receive coagulated and settled water. In these filters unsettled gelatinous floc is retained. Residual fluorides and bacteria are absorbed on the gelatinous floc retained on the filter bed.

Disinfection and Distribution

The filtered water collected in the storage water tank is re-chlorinated with bleaching powder before distribution.

Salient Features of Nalgonda Technique

- No regeneration of media
- No handling of caustic acids and alkalies
- Readily available chemicals, used in conventional municipal water treatment are only required

- Adaptable to domestic use
- Flexible upto several thousand m^3/d
- Applicable in batch as well as in continuous operation to suit needs
- Simplicity of design, construction, operation and maintenance
- Local skills could be readily employed
- Highly efficient removal of fluorides from high levels of 1.5 to 20 mg/l to desirable levels
- Simultaneous removal of color, odor, turbidity, bacteria and organic contaminants
- Normally, associated alkalinity ensures fluoride removal efficiency
- Sludge generated is convertible to alum for use elsewhere
- Little wastage of water and least disposal problems
- Needs minimum of mechanical and electrical equipment
- No energy except muscle power for domestic equipment
- Annual cost of defluoridation (1991 basis) of water at 40 liters per capita per day (lpcd) works out to Rs. 20/- for domestic treatment and Rs. 85/- for community treatment using fill and draw system based for 5,000 population, for water with fluoride levels of 5 mg/l and 400 mg/l and alkalinity which requires 600 mg/l alum dose
- Provides de-fluoridated water of uniform acceptable quality.

When to Adopt Nalgonda Technique

The Nalgonda technique is normally adopted when the area under consideration has following characteristic features:

- Absence of acceptable, alternate low fluoride source within transportable distance.
- Total dissolved solids below 1500 mg/l; desalination may be necessary when the total dissolved solids exceed 1500 mg/l.
- Total hardness is below 600 mg/l.
- Hardness >200 mg/l and <600 mg/l require precipitation softening, and >600 mg/l becomes a cause for rejection or adoption of desalination.
- Alkalinity of the water to be treated must be sufficient to ensure complete hydrolysis of alum added to it and to retain a minimum residual alkalinity of 1 to 2 meq/l in the treated water to achieve pH between 6.5 to 8.5. in treated water.
- Raw water fluorides ranging from 1.5 to 20 mgF/l.

Domestic Defluoridation

Defluoridation at domestic level can be carried out in a container (bucket) of 60 liter capacity with a tap 3-5 cm above the bottom of the container for the withdrawal of water after precipitation and settling. The raw water taken in the container is mixed with adequate amount of aluminum sulfate solution (alum), lime or sodium carbonate and bleaching powder depending upon its alkalinity and fluoride content. Alum solution is added first and mixed well with water. Lime or sodium carbonate solution is then added and the water stirred slowly for 20 minutes and allowed to settle for nearly one hour. The supernatant which contains permissible amount of fluoride is withdrawn through the tap for consumption. The settled sludge is discarded.

METHODS TO CONTROL FLUOROSIS

Water fluoridation	Use appropriate concentration of fluoride. Monitor fluoride Levels on a regular basis
Supplements	Use recommended dosage schedule. Advise patients of risk if schedule not followed. Use in high risk children.
Toothpaste	Supervise brushing and amount of paste in children younger than 6 years of age. Consider pediatric paste (500 ppm F) in children younger than 3 years of age.
Rinses	Use in high risk patients over 6 years of age.
Infant formulas	Prepare with non-fluoridated water.
Overall	Monitor fluorosis and total fluoride exposure in community.

It is advised by the WHO that, at a minimum, the fluoride level in local water supplies should be monitored and the population should be examined for signs of excessive fluoride exposure(e.g. moderate and/or severe dental fluorosis and crippling skeletal fluorosis).

Four criteria are essential and may contribute to the success of fluorosis prevention through treatment of drinking-water at a decentralized level:

1. The right method has to be selected to deal with given water quality and social acceptability.
2. Proper design and process understanding are required at least among the responsible officials.
3. Media and unit spare parts have to be made available though an appropriate infrastructure, such as village communities and social and health workers.
4. Motivation and training of users has to be continued through the same, or a similar, infrastructure.

Where treatment to remove fluoride is practised, chemicals used should be of a grade suitable for use in drinking-water supply as outlined in the WHO Guidelines for Drinking-water Quality.

In India, fluorosis was first detected in Nellore district of Andhra Pradesh in 1937. Since then considerable work has been done in different parts of India to explore the fluoride laden water sources and their impacts on human as well as on animals. At present, it has been estimated that fluorosis is prevalent in 17 states of India and the fluoride level ranges from 0.11 to 37 mg/L (see Table 31.2).

32 Dental Caries Vaccine

Avinash J, CM Marya

Dental caries remains one of the most widespread diseases of mankind. Advances in prophylactic measures to deal with this disease have significantly reduced the overall caries rate. However, in developing countries, dental caries is often at epidemic proportions, especially among the poor. Thus, more effective public health measures are needed to address this worldwide problem.

The World Oral Health Report 2003, published by the WHO, indicates that dental caries is a major health problem in most industrialized countries, affecting 60 to 90% of school children and most adults. The average number of decayed, missing and filled permanent teeth for individuals of 12 years of age is 3.5 in the Americans, 2.4 in the western Pacific, 2.0 in Europe, 2.0 in the eastern Mediterranean, and 1.5 in Southeast Asia and Africa.

It is expected that the prevalence of dental caries will increase in Africa as a result of growing consumption of sugar and inadequate exposure to fluoride. In the United States, 98% of individuals of 40 to 44 years of age have experienced carious infection (with an average of 44 carious surfaces per individual).

The concept of vaccination against dental caries has existed almost the time that this disease was recognized to result from the colonization of teeth by acidogenic bacteria. Considerable progress has been made in elucidating the factors involved in their pathogenic activity, culminating recently in the sequence of entire S. mutans genome.

HISTORY OF VACCINATION

The principle of immunization against dental caries was first shown by Bowen in 1969. Although he did not measure immunological parameters, Bowen showed that monkeys that were immunized intravenously with S. mutans developed little carious disease.

The principle of vaccination against dental caries was then extended to include the involvement of mucosal immunity. This stemmed from a study in which rats were immunized subcutaneously in the vicinity of the salivary glands with mutans streptococci(Taubman, M. A. 1973).

This immunization induced salivary secretory IgA responses, the levels of which directly correlated with a reduction in the number of bacteria recovered after experimental mutans streptococcal infection, as well as a reduction in the development of subsequent disease.

Michalek and co-workers (1976) were the first to show that induction of immunity by a different mucosal route (the feeding of bacteria) was sufficient to elicit a protective salivary secretory IgA response in rats without the induction of detectable specific serum IgG.

PROPERTIES OF AN IDEAL DENTAL CARIES VACCINES

- Broad coverage for all common cariogenic S.mutans strains (a multi-component vaccine might be needed for broades coverage).
- Should work for both high- and low-risk populations(but high-risk population might need both active and passive mechanisms for protection)
- Could be given as a part of another immunization (WHO effort is to reduce number of vaccinations)
- Could be given by various routes and still be effective
- Inexpensive
- Delivered by individuals with little trainning
- Could provide “herd immunity”.

But because of different variations more than one vaccine approach may ultimately be optimal to use.

MOLECULAR PATHOGENESIS OF DENTAL CARIES

The molecular pathogenesis of mutans streptococcal-associated dental caries can be thought of as occurring in three phases as described by Martin A et al 2006.

The *first phase* involves the initial attachment of the microorganism to the dental pellicle. This is mediated by an adhesin from mutans streptococci that is known as antigen I/II (Fig. 32.1A).

The *second phase,* which is known as *accumulation*, depends on the presence of sucrose, as well as glucosyltransferases (GTFs) and glucan-binding proteins (GBPs) from mutans streptococci (Fig. 32.1B). After cleaving sucrose into its component saccharides (glucose and fructose), mutans streptococci GTFs synthesize glucans that have various α-1, 3- and α-1, 6-linkages and different solubilities in water.

In the third phase, the multivalent glucans that have been produced interact with GBPs and with the glucan-binding domain of GTFs, both of which are present at the surface of mutans streptococci. The aggregation and the multiplication of these bacteria result in the accumulation of biofilms that are known as dental plaques, which are composed of masses of mutans streptococci.

When these accumulations are of sufficient magnitude and when sugars (including sucrose and glucose) that are substrates for these bacteria are available, large amounts of lactic acid are produced, causing enamel dissolution and carious lesions (Fig. 32.1C).

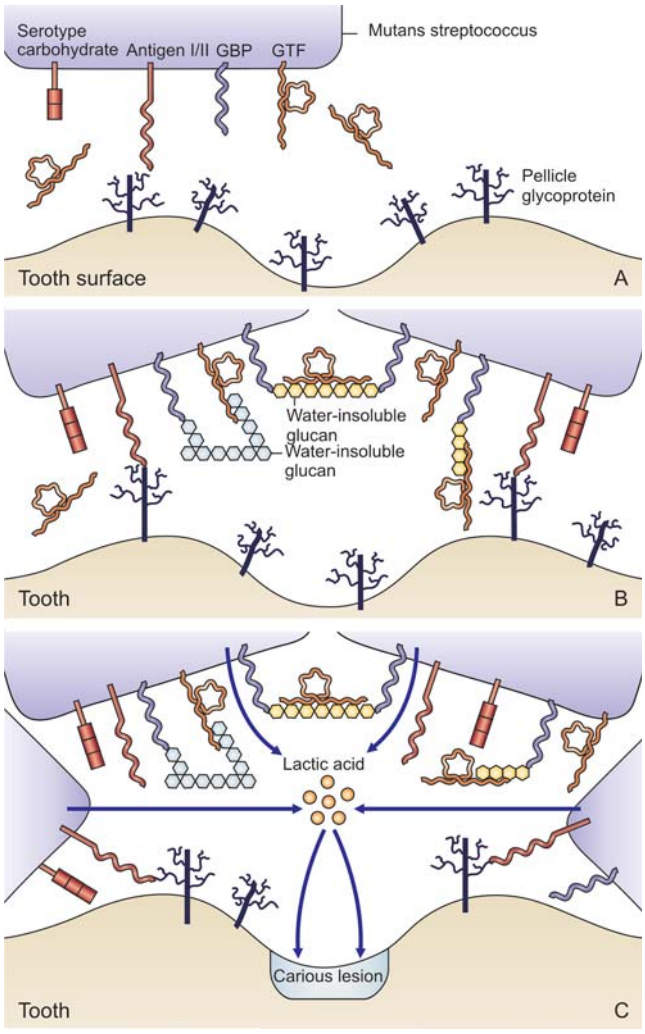


Fig. 32.1: The molecular pathogenesis of dental caries associated with mutans streptococci (Modified from Martin A et al. Nature Reviews Immunology 2006)

BASIC CONCEPTS

Immunity is resistance exhibited by a host towards injury caused by microorganism and their products.

DIFFERENT TYPES OF IMMUNITY

1. Innate immunity/inborn immunity-genetic or constitutional make-up.
2. *Artificial immunity:*
   a. Active immunity- develops as a result of antigenic stimulus.
      - Natural active immunity – previous clinical/sub clinical infection
      - Artificial active immunity – immunization
   b. Passive immunity—readymade antibodies
      - Natural passive immunity – mother to child transmission
      - Artificial immunity – Normal human Ig, Specific human Ig or antisera.

VACCINES

Vaccines are immuno-biologiccal substance designed to produce specific protection against a given disease. It stimulates the production of a protective antibody and other immune mechanisms. Vaccines are prepared from live modified organisms, inactivated or killed organisms, extracted cellular fractions, toxiods, or a combination of thereof.

Mechanism of Action of Vaccine

Saliva contains approximately 1to 3% of immunoglobulin concentration, a majority of which is secretary IgA. However, saliva also contains the humoral immunoglobulin IgG and IgM from the gingival sulcular fluid. In addition, cellular components of the immune system such as lymphocytes, macrophages, and neutrophils are also present in gingival sulcus.

Mucosal immunization with mutans streptococcal antigens at inductive sites, including gut-associated lymphoid tissue (GALT) and nasopharynx associated lymphoid tissue (NALT), results in the migration of antigen-specific IgA producing B cells to effector organs, such as the salivary glands. This is followed by the differentiation and maturation of these B cells and the secretion of IgA in the lamina propria, where it crosses the effector tissue ducts into the saliva. The three main types of mutans streptococcal antigen that are involved in dental-caries pathogenesis and for which specific secretory IgAs have been found, are antigen I/II, GTFs and GBPs.

Some of the possible ways antibodies might control bacterial growth are listed below:

The salivary immunoglobulin may act as a specific agglutinin interacting with the bacterial surface receptors and inhibiting colonization and subsequent caries formation. They might also inactivate surface glucosyltransferase, which would then reduce the synthesis of extra cellular glucans resulting in reducing plaque formation.

The salivary glands produce secretory IgA antibodies by direct immunization of the Gut Associated Lymphoid Tissue (GALT), from where sensitized B-cells may be home to the salivary glands. The salivary IgA antibodies have, of course, direct access to the tooth surface. They may prevent S. mutans from adhering to the enamel surface or they may prevent formation of dextran by inhibiting the activity of glucosyltransferase (GTF).

Thus, several stages in the molecular pathogenesis of dental caries are susceptible to immune intervention such as:

- Microorganisms can be cleared from the oral cavity while still in the salivary phase by antibody-mediated aggregation.
- Antibody could also block the receptors necessary for colonization (e.g. adhesins) or accumulation (e.g. glucan-binding domains of GBPs and GTF) within the dental biofilm.
- Immune inactivation of GTF enzymes would prevent formation of the glucan matrix.
- Modification of metabolically important functions may also be targeted.

In addition, the antimicrobial activity of salivary antibody may be enhanced or redirected by synergism with innate components of immunity, such as mucins or lactoferrin.

Cariogenicity of Mutans Streptococci (Virulence)

Streptococcus mutans is found to be the leading cause of dental caries (tooth decay) worldwide and is considered to be the most cariogenic of all of the oral streptococci. S. mutans is a facultative anaerobic, non-hemolytic, acidogenic organism, producing extracellular and intracellular polysaccharides.

The organism fulfils Koch's postulates as a cause of dental caries:

1. S. mutans is found in the plaque of carious teeth and cannot usually be isolated in the absence of caries.
2. The organism can be grown in pure culture.
3. Infection of germ-free rats or normal hamsters with S. mutans induces caries.
4. The organism can then be recovered from the carious lesion and grown in pure culture.
5. Antibodies to this organism are increased in patients with caries.

There are some characteristics of mutans streptococci that contribute to their cariogenicity, such as their ability to:

- *Transport sugar*: It has both high and low affinity transport systems which can operate over a wide range of conditions to ensure substrate uptake, even under extreme conditions, e.g. low pH.
- *Produce acid*: An efficient glycolytic pathway rapidly produces low terminal pH values in plaque.
- *Tolerate acids* (aciduricity): Cells are able to survive, metabolize and grow at low pH values.
- *Produce extracellular polysaccharides* (EPS): EPS contributes to the plaque matrix, consolidates attachment of cells, and may localize acidic fermentation products.
- *Produce intracellular polysaccharides* (IPS): IPS utilization allows acid production to continue in the absence of dietary sugars.

Adherence to the solid surfaces by S. mutans is necessary both before and after colonization. S. mutans is able to attach to the surface by either of two mechanisms:

1. Sucrose-independent adsorption, in which the bacteria attach to acquired pellicle through specific extracellular proteins (adhesions) of these organisms.
2. Sucrose-dependent mechanisms, in which bacteria require the presence of sucrose to produce extracellular polysaccharides, or by glucans, which allow attachment and accumulation.

Natural History of Mutans Streptococcal Colonization

- S. mutans does not colonize the mouths of infants prior to the eruption of teeth.
- Infants most likely become infected from their parents or from other individuals with whom they have frequent contact since the organism is not found free-living in nature and it has only been isolated from humans and certain animals. Studies which have utilized bacteriocin typing and serotyping to 'fingerprint' individual strains have shown that strains isolated from the newly erupted teeth of infants are often identical to those present in the saliva of the mother.
  >Initial acquisition of MS occurred at the median age of *26 months* during a discrete period which was designated as the "window of infectivity"
- Another window of infectivity for MS will be present when permanent teeth begin emerging between six and twelve years of age
- It is seen that despite, the influence of maternal dose, children who do not become infected by approximately three years of age appear to remain uninfected, or minimally colonized for several years, possibly until new opportunities for colonization occur upon eruption of the secondary dentition. This suggests that a longer-term benefit could ensue if mutans streptococcal colonization could be impeded in early childhood by measures such as immunization.

- Furthermore, infants whose mothers harbor higher levels of S. mutans in saliva become colonized more readily than infants of mothers with low salivary S. mutans levels.
- One therapeutic approach to reduce S. mutans infection in infants could be to lower the salivary numbers in mothers by either dietary sucrose restriction, chemotherapy or a combinalion of both [Köhler et al., 1983].
- S. mutans does not colonize teeth uniformly. The organism may be more frequently isolated from fissures and interproximal surfaces, those areas most frequently involved in caries, than from buccal or lingual smooth surfaces.

SPECIFIC VACCINE TARGETS

There are several types of vaccine against dental caries in development, and these differ in terms of their target antigen(s).

S. mutans posess various cell surface substances; Adhesins, GTFs, and glucan binding proteins (GBP). These substances are used for vaccine preparation. Most of the recent experimental efforts have been directed toward these compounds.

Adhesins

Adhesins form the two principal human pathogens of S. mutans (variously identified as antigens I/II, Pac, or P1 and Streptococcus sobrinus, Spa-A or Pag) and has been purified. Antigens I/II (Ag I/II) are found in the culture supernatant as well as in the S. mutans cell surface. This 185-kDa protein composed of a single polypeptide chain of approximately 1600 residues. Ag I/II contains an alanine-rich tandem-repeating region in the N-terminal third and a proline rich repeat region in the center of the molecule. These regions have been associated with the adhesin activity of Ag I/II. The proline-rich central portion contains an adhesin epitope basing their conclusions on adhesin inhibition assays involving the recombinant fragment of Ag I/II. The antibody directed to the intact Ag I/II molecule or to its salivary binding domain blocked adherence of S. mutans of saliva-coated hydroxyapatite. Immunization of mice with synthetic peptide (residue 301to 319) from the alanine rich region of Ag I/II suppressed tooth colonization with S. mutans.

Abundant *in vitro* and *in vivo* evidence, using a variety of active and passive immunization approaches, indicates that antibody with specificity for mutans streptococcal adhesins can interfere with bacterial adherence and subsequent dental caries caused by *S. mutans*.

Glucosyltransferase

S. mutans has three forms of glucosyltransferases (GTFs):

1. Water insoluble glucan synthesizing enzyme: GTF-I
2. Water insoluble and water-soluble glucan synthesizing enzymes: GTF-S-I
3. Water-soluble glucan synthesizing enzymes: GTF-S

The genes encoding GTF-I, GTF-SI, and GTF-S are called the GTF-B, GTF-C, and GTF-D genes, respectively. All three GTF genes are important for smooth surface caries formation in the pathogen-free rat model system. Streptococcus sobrinus produces a water insoluble glucan-synthesizing enzyme GTF-S

Thus, the presence of antibody to GTF in the oral cavity, prior to infection, can significantly influence the disease outcome, presumably by interference with one or more of the functional activities of the enzyme.

Glucan Binding Protein (GBP)

S. mutans secretes at least three distinct proteins with glucan binding activity: GBP-A, GBP-B, and GBP-C. Of the three S. mutans GBPs, only GBP-B has been shown to induce a protective immune response to experimental dental caries. GBP-A has a sequence of 563 amino acids. The molecular weight is 59.0 kDa. The carboxy-terminal 2/3 rd of GBP-A sequence has significant homology with a putative glucan binding region of S. mutans GTFs. The C-terminal region contains 16 repeating units, which represent the full glucan-binding domain of this protein. GBP-A has a greater affinity for water soluble glucan than for water insoluble glucan.

Dextranases

Dextran is an important constituent of early dental plaque. Dextranase is an enzyme produced by mutans Streptococcus. They destroy dextran and thus the bacteria can invade dextran-rich early dental plaque. Dextranase, when used as an antigen, can prevent the colonization of the organism in early dental plaque.

ROUTES OF IMMUNIZATION

In general, four routes of immunization have been used with S. mutans [KM SHIVAKUMAR et. al 2009]:

1. Oral (Common mucosal)
2. Systemic (subcutaneous)
3. Active gingivo-salivary
4. Passive immunization

Mucosal applications of dental caries vaccines are generally preferred for the induction of secretory IgA antibodies in the salivary compartment, since this immunoglobulin constitutes the major immune component of major and minor salivary gland secretions. Many investigators have shown that exposure of an antigen to a mucosally associated lymphoid tissue in the gut, nasal, bronchial, or rectal site can give rise to immune responses not only in the region of induction but also in remote locations. This has given rise to the notion of a "common mucosal immune system". Consequently, several mucosal routes have been used to induce protective immune responses to dental caries vaccine antigens.

COMMON MUCOSAL IMMUNE SYSTEM

Oral Route

Many of the earlier studies relied on oral induction of immunity in the GALT (Gut-associated lymphoid tissue, which consists of the Peyer's patches, the appendix, and solitary lymph nodes in the gastrointestinal tract, is considered to be one of the principle inductive sites of mucosal immune responses, especially sIgA responses) to elicit protective salivary IgA antibody responses. In these studies, an antigen was applied by oral feeding, gastric intubation, or in vaccine containing capsules or liposome Killed *S. mutans* was administered to germ-free rats in drinking water for 45 days before implantation of live *S. mutans* and then throughout the experimental period. A significant reduction in caries was related to an increased level of salivary IgA antibodies to *S. mutans*, as the serum antibody titer was minimal. Oral immunization with *S. mutans* did not induce significant secretory IgA in monkeys. Daily administration of 10 cells of *S. mutans* in capsules produced a small increase in secretory IgA. The oral route failed to reduce caries significantly, as compared with subcutaneous immunization. The rise in secretory antibodies produced was small and of short duration, even after secondary immunization. Experiments in humans of the ingestion of *S. mutans* in gelatins capsules resulted in an increase in secretory IgA antibodies in saliva, although for a limited time only. Immunological memory in secretory IgA responses is rather limited and this may curtail the value of oral immunization. Although the oral route was not ideal for reasons including the detrimental effects of stomach acidity on antigen, or because inductive sites were relatively distant, experiments with this route established that induction of mucosal immunity alone was sufficient to change the course of infection with *S. Mutans* and disease in animal models and in humans.

Intranasal Route

More recently, attempts have been made to induce protective immunity in mucosal inductive sites that are in closer anatomical relationship to the oral cavity. Intranasal installation of the antigen, the nasal associated lymphoid tissue (NALT), has been used to induce immunity to many bacterial antigens including those associated with mutans Streptococcal colonization and accumulation.

Tonsillar Route

The ability of tonsillar application of antigens to induce immune responses in the oral cavity is of great interest. The tonsillar tissue contains the required elements of immune induction of secretory IgA responses although IgG, rather than IgA, response characteristics are dominant in this tissue. Nonetheless, the palatine tonsils, and especially the nasopharyngeal tonsils, have been suggested to contribute precursor cells to mucosal effector sites, such as the salivary glands. Interestingly, repeated tonsillar application of a particulate antigen can induce the appearance of IgA antibodies producing cells in both the major and minor salivary glands experimented in rabbit.

Minor Salivary Gland

The minor salivary glands populate the lips, cheeks, and soft palate. These glands have been suggested as potential routes for mucosal induction of salivary immune responses, given their short, broad secretory ducts that facilitate retrograde access of bacteria and their products and give the lymphatic tissue aggregates that are often found to be associated with these ducts. Experiments in which Streptococcus sobrinus GTF was topically administered onto the lower lips of young adults have suggested that this route may have potential for dental caries vaccine delivery. In these experiments, those who received labial application of GTF had a significantly lower proportion of indigenous *S. mutans*/total Streptococcal flora in their whole saliva during a 6-week period following a dental prophylaxis, compared with a placebo group.

Rectal

More remote mucosal sites have also been investigated for their inductive potential. For example, rectal immunization with nonoral bacterial antigens such as *Helicobacter pylori* or *Streptococcus pneumoniae,* presented in the context of toxin-based adjuvant, can result in the appearance of secretory IgA antibodies in distant salivary sites. The colo-rectal region as an inductive location for mucosal immune responses in humans is suggested from the fact that this site has the highest concentration of lymphoid follicles in the lower intestinal tract. Preliminary studies have indicated that this route could also be used to induce salivary IgA responses to mutans streptococcal antigens such as GTF. One could, therefore, foresee the use of vaccine suppositories as one alternative for children in whom respiratory ailments preclude the intranasal application of the vaccine.

Systemic Route of Immunization

Subcutaneous administration of *S. mutans* was used successfully in monkeys and elicited predominantly serum IgG, IgM, and IgA antibodies. The antibodies find their way into the oral cavity via gingival crevicular fluid and are protective against dental caries. Whole cells, cell walls and the 185-kD Streptococcal antigen have been administered on 2 to 4 occasions. A subcutaneous injection of killed cells of S. mutans in Freund's incomplete adjuvant or aluminium hydroxide elicits IgG, IgM, and IgA classes of antibodies protection against caries was associated predominantly with increased serum IgG antibodies.

Active Gingivo-salivary Route

There has been some concern expressed regarding the side effects of using these vaccines with the other routes. In order to limit these potential side effects, and to localize the immune response, gingival crevicular fluid has been used as the route of administration. Apart from the IgG, it is also associated with increased IgA levels.

PASSIVE IMMUNIZATION

An alternative approach is the development of antibodies suitable for passive oral application against dental caries. This has considerable potential advantage that it completely avoids any risks that might arise from active immunization. Conversely, in the absence of any active response on the part of the patient, there is no induction of immunological memory, and the administered antibodies can persist in the mouth for only a few hours or 2 to 3 days in the mouth.

Apparent Failure of Natural Immunity in Protection against Dental Caries

- *S mutans* is a poor immunogen, particularly as it preferentially colonizes enamel surfaces.
- Sensitization to the organism might depend on the entry of a sufficient dose of antigenic material
- Natural immunization induces a low antibody titre which is relative higher in IgM than lgG antibodies
- The T-cell response to S. mutans also appears to be of a low order of magnitude and may need boosting for effective function.

ACTIVE IMMUNIZATION IN HUMANS

Few clinical trials have been performed to examine the protective effect of active immunization with dental caries vaccines containing defined antigens. However, several studies have shown that mucosal exposure of humans to immunization with glucosyltransferases from *S. mutans* or *S. sobrinus* can lead to the formation of salivary IgA antibody, albeit at modest levels.

Active immunization has the advantage of inducing the endogenous production of salivary antibodies and the establishment of immune memory but requires a commitment to performing the human trials necessary to establish safety and efficacy.

PASSIVE IMMUNE APPROACHES

Local passive immunization has recently received much attention as a safe procedure for controlling *S. mutans* and preventing dental caries.

Passive-immunization techniques, using transfer of milk antibody specific for whole mutans streptococci from mother to suckling infant, have been investigated in animal models and shown to be protective against dental caries.

Lehner et al. showed that local passive immunization by repeated application of anti-AgI/II monoclonal antibodies to the deciduous teeth of Rhesus monkeys prevented significant colonization of the fissures and smooth-surfaces of the teeth by *S. mutans* and the subsequent development of dental caries over a period of 1 year.

As reported by van Raamsdonk et al, that local application of a monoclonal antibody reactive with antigen B (Spa A) of *S. sobrinus* reduced the colonization of implanted *S. sobrinus*, compared with controls. Moreover, Ma et al. reported that applying a monoclonal antibody raised against AgI/II on the teeth of human volunteers prevented colonization by *S. mutans*.

Dietary antibody supplements (including chickenegg- yolk antibody specific for *S. mutans* GTF) and topical application of monoclonal antibody have also been shown to interfere with the formation of dental caries.

Various strategies include:

Maternal immunization: Passive immunization can occur by oral immunization (secretory IgA is stimulated) of pregnant rats. The milk from immunized rat mothers confers protection to the weanlings. It is possible that any mammal can be protected in this fashion.

Xenogeneic immunization: It has been shown that cows can be immunized against cariogenic bacteria and that antibodies against those bacteria appear in the cow's milk. The cow's milk (or whey) can then confer protection immunity in a passive manner. The antibodies were of the IgG1 subclass, indicative of the parenteral immunization used. In cow's milk and colostrum, IgG1 is the major secreted immunoglobulin isotype. Both *S. mutans* and caries scores were reduced in gnotobiotic rats. Of course, gnotobiotic rats are easy to protect compared to conventional animals and humans; however, whey from immunized cows, used as a mouthrinse, appeared to decrease *S. mutans* in volunteers.

Genetically modified Yoghurt: Lennacet Hammarstarm of Karolimsha institute, Stockholm, Sweden and his colleagues *engineered lactobacillus Zeae* to carry an antibody against Streptococcus mutans on their surface. The antibody sticks to the molecule on *S. mutans* that normally sticks to teeth. The two species clump together and slide harmlessly down the throat.

One other source of edible xenogeneic antibodies is also underinvestigation—chicken eggs. A Japanese group working with Susan Michalek has begun to explore the potential therapeutic capacity of chicken egg IgY in a mouthrinse.

Monoclonal Antibodies

Monoclonal antibodies to *S. mutans* cell surface antigen I/II have been investigated. The topical application in human

Possible mechanisms of antibody-mediated intervention against mutans streptococci

Isotype	*Step in caries pathogenesis*	*Mode of action*	*Antibody specificity*
S-IgA	Adherence to salivary pellicle	Blocking of adhesion-receptor interaction	AgI/II
		Reduction of hydrophobicity	Surface antigens
		Agglutination and clearance	Surface antigens
	Binding to early colonizers	Blocking of adhesion-receptor interaction	AgI/II
	Sucrose- dependent accumulation	Inhibition of glucan production	GTF
		• Inhibition of substrate binding	• Catalytic region
		• Inhibition of polymer synthesis	• Glucan binding region
		Blocking of adhesion	GTF (glucan binding region) GBP
	Acid production and other metabolic activities	Blocking of glucose uptake	Not known
		Synergism with:	
		• Peroxidase(inhibition of acid production)	Not known
		• Lactoferrin (inhibition of iron acquisition)	Iron-uptake molecules
IgG	Colonization of cervical tooth sites	Opsonization and phagocytosis	AgI/II; other surface antigens
	Invasion of dentinal tubules	Inhibition of collagen binding	AgI/II

subjects brought a marked reduction in the implanted *S. mutans*. Thus, by bypassing the system, less concern exists about the potential side effects.

Other Potential Xenogenic Passive Immunization Strategies

- Monoclonal antibodies
- Chimeric MAb
- CDR-grafted MAb

ADJUVANTS AND DELIVERY SYSTEMS FOR DENTAL CARIES VACCINES

Various new approaches have been tried out to potentiate aspects of the immune response to induce sufficient antibodies to achieve a protective effect to overcome the existing disadvantages.

Synthetic Peptides

Any antigen derived from animals or humans has the potential for hypersensitivity reaction. The chemically synthesized peptides hold an advantage in that this reaction can be avoided. This has been found to enhance the immune response. In humans, synthetic peptides elicited both IgG and T-cell proliferative responses, and the antibodies were both anti-peptide and anti-native. The synthetic peptides give antibodies not only in the GCF but also in the saliva. The synthetic peptide used is derived from the Glucosyltransferase enzyme.

Coupling with Cholera Toxin Subunits

Cholera toxin (CT) is a powerful mucosal immunoadjuvant, which is frequently used to enhance the induction of mucosal immunity to a variety of bacterial and viral pathogens in animals systems. Mucosal application of a soluble protein or peptide antigen alone rarely results in elevated or sustained IgA responses. However, the addition of small amounts of CT or the closely related *E. coli* heat-labile enterotoxins (LT) can greatly enhance mucosal immune responses to intragastrically or intranasally applied mutans Streptococcal antigens or to peptides derived from these antigens. The coupling of the protein with the nontoxic unit of the cholera toxin was effective in suppressing the colonization of *S. mutans*.

Fusing with Salmonella More Details

The avirulent strains of salmonella are an effective vaccine vector; fusion using recombinant techniques have been used.

Microcapsules and Microparticles

Combinations of antigens or various types of particles have been used in an attempt to enhance mucosal immune responses. The microcapsules and microparticles made of poly lactide-co-glycolide (PLGA) have been used as local delivery systems because of their ability to control the rate of release, evade preexistent antibody clearance mechanisms, and degrade slowly without eliciting an inflammatory response to the polymer.

Liposomes

Liposomes, which are bilayered phospholipids membrane vesicles manufactured to contain and deliver drugs and antigens, have been used to enhance mucosal responses to mutans Streptococcal carbohydrate and GTF. Liposomes are thought to improve mucosal immune responses by facilitating M cell uptake and delivery of antigen to lymphoid elements of inductive tissue.

TIMING AND TARGET POPULATION FOR CARIES VACCINATION

The timing of immunization should precede the "window of infectivity", i.e. The period during which children usually become infected with mutans streptococci which extend from 19 to 31 months of age (median age of 26 months). Alternatively, immunization of mothers to reduce the indigenous mutans streptococci could prevent the transmission of these bacteria to infants during the critical window of infectivity.

Available evidence indicates that mothers are the principal source when the children acquire mutans streptococci and that the mother's salivary levels of mutans streptococci are related to the extent of infection and occasionally with the caries experience of the child.

Although clinical trials have mostly been carried out in young adults (age 18 to 23) this is not the target population of choice, mainly because young adults are already infected with mutans streptococci (mainly *S. mutans*) and because the effects of antibody are transient. On the basis of analysis of the natural history of oral colonization of young children with streptococci and of the ontogeny of the salivary immune response, the appropriate target population for a vaccine against dental caries is infants aged upto 12 months.

The saliva of newborns is devoid of secretory IgA. However, the concentration of secretory IgA rapidly increases and is close to that of adults by 1 or 2 years of age and certainly by 4 to 7 years of age. Therefore, colonization with oral bacteria occurs in a mucosal environment that is immunologically responsive to infectious challenge. By 12 months of age, both secretory IgA1 and secretory IgA2 specific for antigens of early colonizing streptococci are present.

Serum IgG specific for *S. mutans* and *S. mutans* GTF is present in very small amounts between 1 and 3 years of age, which is when colonization with *S. mutans* is taking place, and salivary IgA specific for *S. mutans* GTF can be found in less than 10% of children aged 1 to 3 years. So, although children between the ages of 1 and 3 years are immunologically competent with respect to mucosal immunity, they are often not infected with mutans streptococci at this time, and they do not produce antibody to mutans streptococcal GTF. The main components of the early microbiota of an infant are *Streptococcus salivarius* and *Streptococcus mitis*, both of which colonize an individual shortly after birth. These soon constitute most of the streptococci in the oral cavity, but the eruption of dentition at upto 6 months of age signals a considerable change in the characteristics and distribution of the colonizing microbiota. Teeth provide colonization sites for *Streptococcus sanguis* (also known as *Streptococcus sanguinis*) and mutans streptococci, as well as other tooth-inhabiting microorganisms. *S. sanguis* can be detected in most children by the end of the first year of life. Initial colonization of the mouth of a child with mutans streptococci usually occurs during a 'window of infectivity' between 18 and 36 months of age. However, children can remain uninfected until the permanent dentition erupts).

Therefore, it might be possible to actively immunize children of this age with a mutans streptococcal antigen that is crucial in the molecular pathogenesis of dental caries (such as GTF).

An ideal vaccine to alleviate dental caries would have the following features: the vaccine should consist of an antigen(s) that is involved in the molecular pathogenesis of dental caries; the vaccine should contain functionally important epitopes; and the vaccine should be administered by a route that will reproducibly elicit mucosal antibody (intranasal and tonsillar routes being promising). Also, vaccination should occur when infants are immunocompetent with respect to salivary IgA production and before infection with mutans streptococci occurs. This is best accomplished when children are up to 12 months of age. One or more booster immunizations might be required (Fig. 32.2).

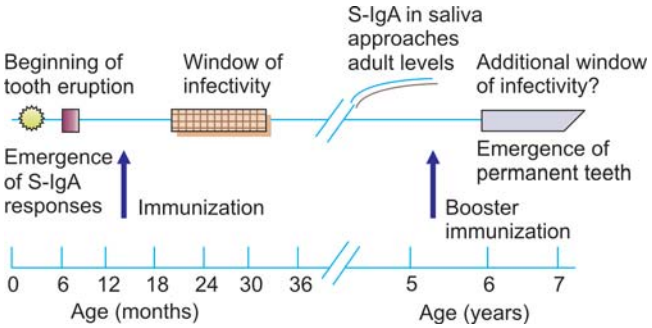


Fig. 32.2: Appropriate timing of mucosal vaccine against dental caries

RECENT ADVANCES

Recently a vaccine is being discovered, a protein called *p1025*. This protein tricks *Streptococcus mutans*, the main cause of tooth decay, into believing that that there are no vacant sites on the tooth for it to attack. The bacterium has a surface protein that hooks on to enamel. Researchers have found that p1025 mimics the protein of the bacterium, occupying all docking points.

RISKS OF USING CARIES VACCINE

All vaccines, even if properly manufactured and administered, seem to have risks:

1. The most serious is that sera of some patients with rheumatic fever who show serological cross-reactivity between heart tissue antigens and certain antigens from hemolytic Streptococci.
2. Experiments from antisera from rabbits immunized with whole cells of *S. mutans* and with a high molecular weight protein antigen of *S. mutans* were reported to cross react with human heart tissues.

3. Glucosyltransferase was also tested for cross-reactivity with human heart tissue and the results were negative. Further research showed that the C-terminal part of Ag I/II contains an epitope, which is cross-reactive with human IgG and, although the clinical significance of this observation is unknown, it appears that this potentially harmful epitope should be excluded from a caries vaccine. The human IgG cross-reactive region is also present in other mutans streptococci such as Streptococcus sobrinus as well as in non mutans streptococci.

PROSPECTS AND CONCERNS

With all these apparently effective pre-clinical approaches, one may ask, "What is the *ideal* dental caries vaccine approach?"

Ideally, one would favor a vaccine that has:

- Broadest coverage to intercept infection by all common cariogenic mutans streptococcal strains, one that would work for both low and high-risk populations
- One whose immunity would last through the critical primary and secondary infection periods, one that could be given with, or as part of, other immunizations
- One that could be given by various routes and still be effective
- One that would be inexpensive, one that could be delivered by individuals with little training, one that might provide secondary immunity to others in the population who were not themselves immunized.

PUBLIC HEALTH ASPECTS

Safety and Cost Effectiveness

Developed Countries

Caries already has declined. Useful in some special risk groups:

- Head and neck radiotherapy with severe xerostomia
- Chronologically sick children on continous medication
- Mentally or physically handicapped
- Congenital or acquired heart disease
- Blood disorders
- Long-term steroid therapy

Developing Countries

- May be beneficial owing to high prevalence of dental caries, low dentist to population ratios, lack of organized health care facilities.

33 Pit and Fissure Sealants

CM Marya

Over the last few decades, several advancements have been made in caries prevention. Along with systemic and topical fluoride, the increased acceptance and use of pit and fissure sealants have without question had an impact on the prevention of caries.

Fluorides have been found extremely effective in preventing caries on smooth surfaces of the teeth, but less effective on occlusal surfaces. Sealants protect the occlusal surfaces, inhibiting bacterial growth and providing a smooth surface that increases the probability that the surface will stay clean.

It has been documented for decades that sealants are safe, effective, and underused. The latest data available indicate that in the United States only 15 percent of children aged 6–17 years have dental sealants (Cherry-Peppers G, Gift HC, Brunelle JA, Snowden CB. 1995). Gonzalez CD, 1996 report indicates just 10 percent of the sample had sealants on their permanent molars. Why there is underusage of a proven preventive material is hard to explain. Dentists continue to identify lack of insurance coverage for sealant application as a major barrier to patients receiving the service.

CLASSIFICATION OF PITS AND FISSURES (FIG. 33.1)

Nagano classified occlusal fissure into five types on the basis of fissure morphology: V, U, Y, I, IK types.

A pit and fissure sealant is an organic polymer (resin) that flows into the pit and fissures and bonds to the enamel surface mainly by mechanical retention.

Majority of sealants are made of Bis-GMA (Bisphenol A-glycidyl methylacrylate).

PURPOSE OF SEALANT

1. To provide physical barrier to seal off the pit or fissure.
2. To prevent the bacteria and their nutrients from collecting within the pits or fissures to create the acid environment necessary for the initiation of dental caries.

CRITERIA FOR THE IDEAL SEALANT

1. A viscosity allowing penetration into deep and narrow fissures even in maxillary teeth.
2. Adequate working time.
3. Rapid cure.
4. Good and prolonged adhesion/bonding to enamel.
5. Low sorption and solubility.
6. Resistance to wear.
7. Be compatible with the oral tissues (minimum irritation to tissues).
8. Cariostatic action.

Types of Sealants

A. Based on generation (Figs 33.2 to 33.5)

1. Generation 1 Sealant (photocured via UV light).
2. Generation 2 Sealant (auto or chemically-cured).
3. Generation 3 Sealant (photocured via visible light).
4. Fluoride containing sealants.

B. Based on fillers

1. Unfilled.
2. Filled sealant (fillers increase abrasion resistance, bond strength).

   Fillers: glass and quartz particles.
3. Fluoride –Releasing.

C. Based on Color

Helps in quick identification for evaluation during maintenance assessment:

1. Clear: Esthetic but difficult to detect in follow-up (Fig. 33.6).
2. Tinted/opaque sealant: easy to detect.

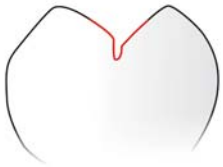
D. BIS-GMA *versus* non BIS-GMA sealant



U Type : Almost the same width from top



V Type: Wide at top and gradually narrowing at base



I Type: Extremely narrow slit



IK Type: Extremely narrow slit with a larger space at bottom



Inverted Y

Fig. 33.1: Types of fissure



Fig. 33.2: UV-light cured (1st generation) pit and fissure sealant



Fig. 33.3: Self/autocure (2nd generation) sealants

Types of pit and fissure sealants

Based on	*Types*	*Characteristics*
Generations	1. First generation sealants	1. Photo-cured via UV light
	2. Second generation sealants	2. Auto- or chemically cured.
	3. Third generation sealants	3. Photo-cured via visible light.
	4. Fluoride containing sealants	4. Double protection.
Fillers	Unfilled	1. Flow is better.
	Filled	2. More resistant to wear.
Color of the sealants	1. Clear	1. Esthetic, but difficult to detect on recall visits.
	2. Tinted	2. Can be easily identified.
	3. Opaque	3. Can be easily identified.



Fig. 33.4: Visible light-cured (3rd generation) sealants



Fig. 33.5: Fluoride containing (4th generation) sealants



Fig. 33.6: Clear pit and fissure sealants

Advantages and disadvantages of the chemically-cured and light-cured sealant systems

	Advantages	*Disadvantages*
Self-cure:	1. Simple to use 2. Less expensive—does not require additional equipment	1. Once mixing has started, the operator must continue mixing and immediately place the sealant, or stop and make a new mix if a problem should occur. 2. The catalyst and base must be mixed prior to placement, increasing the chance of incorporating air bubbles into final product.
Light-cure:	1. Operator has control over the initiation of polymerization 2. Supplied as single liquid so no mixing is required.	1. Requires extra-piece of equipment that can break down. 2. High cost of curing light and shorter shelf-life of material.

RATIONALE FOR USING PIT AND FISSURE SEALANTS

1. **A very high proportion of dental decay occurs in pits and fissures**
   The change in the pattern of caries in recent years is such that it now principally involves the pits and fissures of molar teeth in children and adolescents. Recent data shows that the relative proportion of pit and fissure lesions has increased to 84 percent of the total new caries experience.
2. **Pits and fissures remain at risk of caries for long periods of time, not just within the first few years after eruption.**
   The period of caries susceptibility has extended due to a slowing of the rate of progression of dental caries. Hence, the theory that teeth should be sealed within two years after eruption needs to be reconsidered.
3. **Fluoride has limited effect in preventing pit and fissure caries.**
   The effect of systemic or topical fluorides in preventing dental caries is noted principally on the smooth surfaces of teeth; the effect on pit and fissure caries is relatively small. Even with optional fluoride therapy, pit and fissure caries may be delayed, but not prevented, on the same scale as smooth-surface lesions. Approximately 1 mm of enamel is present on smooth surfaces, whereas the base of a fissure may be close to, or even lie within dentine.
   Thus in the event of fissure caries, the underlying dentine becomes rapidly involved, while on a smooth surface it may take 3–4 years for a lesion to penetrate into dentine. Hence, the inclusion of pit and fissure sealants forms an important part of any caries control program because it is intended for those caries-susceptible areas least benefited by fluoride.
4. **Fissure sealants are effective at preventing pit and fissure caries and are best used as part of an overall preventive program.**
   The British Society of Pediatric Dentistry (2000) has stated that "Sealants are highly effective in preventing dental caries in pits and fissures of teeth when applied by trained operators in clinical trials and community health programs. When used appropriately, sealants result in improvements in oral health but their use on all occlusal tooth surfaces for preventive reasons will result in wastage of scarce resources". Sealing of pits and fissures in all patients may be considered to be ideal treatment and is justified for all patients classified as "high risk". However, financial and other constraints demand that guidelines for patient and tooth selection should be established.

PROCEDURE OF PIT AND FISSURE SEALANT APPLICATION

Sealant Placement Guidelines

Step 1: Prepare the Teeth

Plaque and debris might interfere with the etching process or sealant penetration:

- Clean the pit and fissure surfaces
- Utilize a dry toothbrush, prophy cup with pumice or prophy paste, or air abrasion
- Use an explorer to remove any debris in the pit or fissure
- Rinse for 20–30 seconds
- Re-evaluate surface for residual or loose debris.

A widening of the fissures with rotary instrumentation is yet another type of fissure conditioning that has been recommended before etchant and sealant application. This is known as the invasive pit and fissure technique.

Step 2: Isolate the Teeth

Adequate isolation is the most critical aspect of the sealant application process. Salivary contamination of a tooth surface during or after acid etching will have a deleterious effect on the ultimate bond between enamel and resin.

- Use cotton rolls, dry angles, and/or rubber dam.

Some of the disadvantages of Rubber dam include: discomfort during clamp placement, need for local anesthetic in some instances, difficulty in securely placing a clamp onto a partially erupted tooth, an increase in the cost and need for sterilization of the armamentarium.

Another alternative to the rubber dam is the Vac-Ejector moisture control system, which consists of a bite block and rubber tongue shield that connect to the high-speed evacuation line, providing a clear, dry field for sealant procedures. Clinical studies have found that sealant retention with the Vac-Ejector, either with or without a chairside assistant, is comparable to that with sealants placed under rubber dam or cotton roll isolation.

Step 3: Dry the Surfaces

- Dry teeth with air for 20–30 seconds
- Check to make sure there is no moisture coming out of air syringe tip.

Step 4: Etch the Surfaces (Fig. 33.7)

There are various etchant materials available, but the most frequently used etchant is 37 percent orthophos-phoric acid. This is available as both a liquid solution and a gel. One should always apply the etchant onto all the susceptible pits and fissures of the tooth and extend it up the cuspal inclines well beyond (at least 2 millimeters) the anticipated margin of the sealant:

- Apply etchant as directed by manufacturer
- Usually between 30 and 60 seconds
- If using a gel or semi-gel: Apply gel and let stand for the allotted amount of time
- If using a liquid: Continue to apply etchant throughout the etchant time.

Step 5: Rinsing and Drying the Teeth (Fig. 33.8)

- Rinse surfaces for 60 seconds
- Check for effectiveness of etchant by drying with air; surface should appear "chalky white"

- If not, repeat etching procedure
- Placement of new cotton rolls and/or dry angles
- Dry teeth with air for 20–30 seconds.

Step 6: Application of Sealant Material (Fig. 33.9)

During sealant application, all the susceptible pits and fissures should be sealed for maximum caries protection. The sealant material can be applied to the tooth in a variety of methods. Many sealant kits have their own dispensers, some pre-loaded that directly apply the sealant to the tooth surface:

- Self-curing: Mix equal parts of the two components
- Will polymerize in 60–90 seconds
- Light-curing: Apply with syringe provided by manufacturer
- Apply curing light to material
- Will polymerize in 20–30 seconds.

Step 7: Evaluate the Sealant

The sealant should be visually and tactually inspected for complete coverage and absence of voids or bubbles. Small voids in the sealant can be repaired simply by adding new material to the void and polymerizing.

Step 8: Occlusal Evaluation

- Check occlusion with articulating paper
- Adjustments must be made with filled resins

Step 9: Re-evaluation

- Recall patient for having the sealants evaluated on a six-month basis.

INDICATIONS FOR USE

A sealant is indicated for children and adults:

1. Who may be at moderate or high risk of developing dental caries, for a variety of reasons.
2. With incipient caries (limited to enamel of pits and fissures).
3. Who have sufficiently erupted permanent teeth with susceptible pits and fissures.
4. Who have existing pits and fissures that are anatomically susceptible pits and fissures.
5. A deep or irregular fissure, fossa, or pit is present, especially if it catches the tip of the explorer (for example, occlusal pits and fissures, buccal pits of mandibular molar, lingual pits of maxillary incisors).
6. The fossa selected for sealant placement is well isolated from another fossa with a restoration present.
7. An intact occlusal surface is present where the contralateral tooth surface is carious or restored.

CONTRAINDICATIONS

A sealant is contraindicated if:

1. Patient behavior does not permit use of adequate dry field (isolation) techniques throughout the procedure.
2. There is an open occlusal carious lesion.

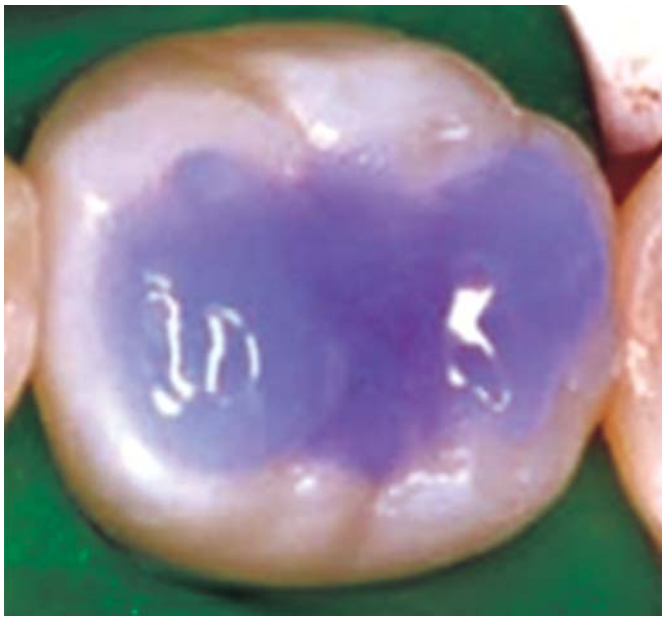


Fig. 33.7: Etching of surface

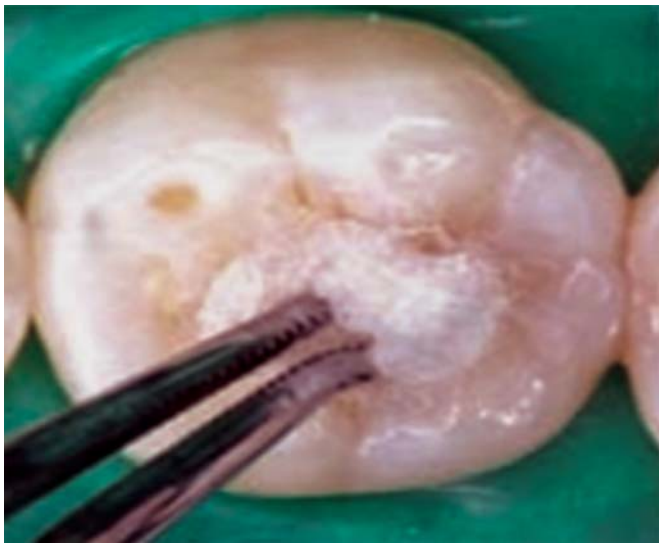


Fig. 33.8: Drying the teeth

3. Caries, particularly proximal lesions, exist on other surfaces of the same tooth (radiographs must be current).
4. A large occlusal restoration is already present.
5. If pits and fissures are well coalesced and self-cleansing.
6. Life-expectancy of primary tooth is limited.
7. When patients is allergic to methacrylate.

SEALANT RETENTION

Sealants are both cost-effective and underutilized in prevention of occlusal caries. The long-term efficacy of sealants is well documented. Sealants are lost most frequently from the lingual

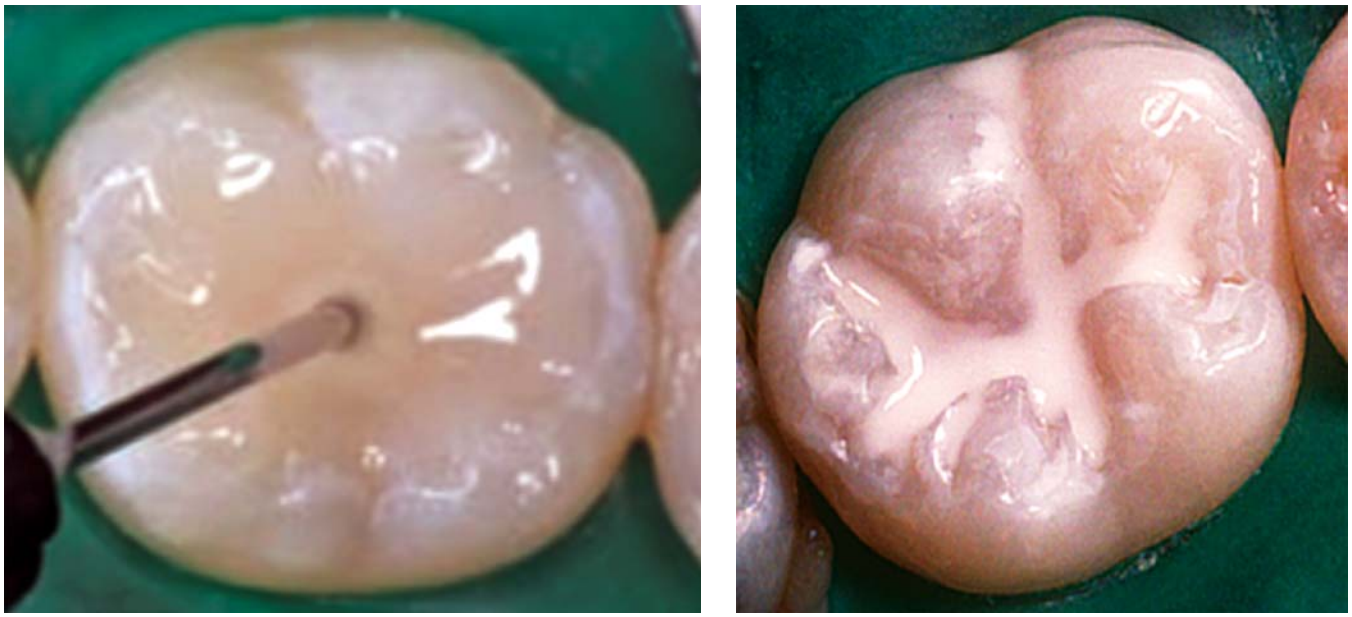


Fig. 33.9: Occlusal surface with pit and fissure sealant

surfaces of maxillary molars and the buccal surfaces of mandibular molars. This can be attributed to the shallower pits, which increase the difficulty of complete etching and retention. Most clinicians find that retention rates are less for primary teeth; up to 50 percent less according to Lein. The theory behind this reduction in retention is the direction of the enamel rods in primary teeth. The ends of enamel rods in permanent teeth form an angle perpendicular to the outer enamel surface, whereas the enamel rods in primary teeth often form an angle that does not allow for optimum retention. Initial retention failure of sealants is historically attributed to technique errors, the most common of which is moisture contamination.

Other technique errors that can affect retention are inadequate etching, incorporation of air bubbles into the sealant material (which weakens the material), and incomplete removal of debris from the pits and fissures prior to etching. Sealant retention depends not only on proper application, but also on the eruption status of the tooth. When a tooth is not completely erupted, the retention rate is lower—possibly due to difficulties maintaining a dry tooth surface during application. Without a doubt, the retention rate is lowered when an operculum is present over the distal marginal ridge of a molar. One study found a replacement rate of 54 percent on molars when an operculum was present, although no replacement was necessary on molars sealed later in the eruption process.

Undoubtedly, sealants are susceptible to occlusal wear. This is a problem only if the seal at the margins of the sealant is not maintained.

Again, this emphasizes the importance of continued evaluation of the sealant. In the past, fluoride treatment prior to the sealant placement was contraindicated, because it was felt that the fluoride interfered with the bond between the sealant and the tooth surface. Recent research suggests that fluoride use prior to sealant placement may not adversely affect the bonding strength of enamel and sealants.

INCIPIENT FISSURE CARIES AND SEALANTS

Advantages of the invasive technique, where the fissures are widened with a small bur before the placement of sealants, are the following:

1. The ability to diagnose the extent of the carious lesion if present.
2. Higher retention rates for sealants were obtained following mechanical preparation of the fissure area.
3. The risk of microleakage was also reduced when the fissure was enlarged.

Considering these points, in cases of deep and narrow fissures that are discolored and suspected of being carious, the invasive pit and fissure sealing should be chosen.

PREVENTIVE RESIN RESTORATIONS

A logical extension of preventive sealant strategy involves the use of resin restorative materials plus in discrete areas of caries attack on a fissured surface. First reported by Simonsen and Stallard (1978), this 20-year-old concept has gained wide approval. The procedure involves removal of those areas of teeth involving caries, followed by bonding resin restorative

material into them, and finally covering all restorative material and any remaining fissured anatomy with sealant. The obvious saving of tooth structure is significant. By avoiding the old philosophy "extension for prevention" tooth preparation and replacing it with the idea of discrete removal of caries, there is a major reduction in intracoronal preparation and tooth structure loss.

The longevity of the PRR is dependent to a great extent upon the retention and repair of the overlying sealant.

This method is indicated where caries within a fissure has just reached the dentine. Under ideal circumstances the fissure sealants can successfully prevent pogression of caries, therefore sealing of the very superficial lesion is a viable option compared to the more destructive conventional restorative approach, which involves the removal of healthy tooth structure to gain good access.

FLUORIDE CONTAINING SEALANTS

The addition of fluoride to sealants was considered since 1976 and efforts to combine the two continue today. Basically, two methods of incorporating fluoride are used. In one, a soluble salt of fluoride is added to unpolymerized resin. After sealant is applied to the tooth, the salt dissolves and fluoride ions are released. The other method involves an organic fluoride compound, which is chemically bound to resin. However, it is questionable whether this fluoride releasing sealant will have any clinical effect on caries, since sealants usually do not penetrate to the depths of the pit and fissures, where caries usually initiates.

PUBLIC HEALTH SEALANT PROGRAMS

These programs are school based, school linked or the combination of the two. The American Association of Community Dental Programs has developed a manual "Seal America: The Prevention Invention", which provides information to the public health program administrators.

In 1990, the United States Public Health Service published a national health objective for the year 2000, stating that 50 percent of children should have sealants on one or more permanent molar teeth.

Instructions to the Patient or Parent

It is necessary to receive consent from the parent or guardian of a minor or a mentally impaired patient prior to placing a sealant. The patient and/or parent must understand that sealants can only help prevent caries on the tooth surfaces where the sealants are applied; and that plaque control, fluoride therapy, and sugar discipline are still necessary to prevent decay on the rest of the tooth surfaces. Discuss the life-expectancy (the retention rate, which varies from patient-to-patient) of sealants with the patient/guardian. Use a mouth mirror whenever possible to show the patient and/or parent which tooth has been sealed. Explain that it may feel "high" immediately after placement, but that it should feel normal in two to three days through normal chewing action. If it does not, the patient should return to the dental office to have the excess height reduced.

The patient or parent should be advised to check the sealant during routine oral hygiene procedures and to contact the dental office if there is any sign of sealant loss or breakage. Inform the patient or parent of the need for six-month recall appointments to monitor sealant retention. At the recall appointment, the sealed tooth should be categorized and treated according to one of the three following categories:

Recall status of tooth	*Treatment*
All pits and fissures covered	No treatment required
Sealant missing from some of all of the pits and fissures; exposed surface sound	Reseal the exposed pits and fissures (i.e. sealant replaced)
Sealant missing from some of all of the pits and fissures; caries present	Restore carious pits and fissures (i.e. restorative procedures)

COST-EFFECTIVENESS

Sealant effectiveness and cost-effectiveness are dependent upon disease levels and the selection of patients and tooth surfaces to be sealed. Thus, another critical way in which sealant usefulness can be increased is by developing and applying evidence-based caries risk assessments to individual patients.

To achieve maximum benefit, sealants should:

- Be used for targeted prevention in high risk children and young adults.
- Be applied to teeth such as mandibular molars that are likely to develop caries.
- Be used in conjunction with other preventive measures.
- Employ contemporary resin materials (second or third generation resins), or glass ionomers with appropriate viscosity and surface wetting properties.
- Be placed by dental auxiliaries (dental therapists or dental hygienists) to reduce their overall cost.
- Be monitored overtime and re-applied as needed.

Clinical Considerations

- When there is an indication for placement, then sealant should be placed as soon as possible. However, susceptible sites of teeth can be sealed at any age depending on assessment of risk factors:
  - Where there is a real doubt about the caries status of a susceptible site on clinical examination, e.g. a stained fissure, then a bitewing radiograph should be obtained. If there is clear evidence that the lesion is confined to enamel then the surface can be sealed and monitored clinically and radiographically.

- When the evidence is unclear, then removal of the stained areas in the fissures (enamel biopsy) should be performed.
- If the lesion extends into dentine after removal of staining, then a sealant restoration ("preventive resin/GIC restoration") may be placed. A more extensive cavity will require a conventional restoration.
- For more extensive lesions showing involvement of the DEJ, a preventive resin restoration (PRR) is undertaken.
- The choice between resin/composite and glass ionomer sealant should be based on adequacy of moisture control. As the resins are most durable they should generally be preferred, while GIC should be used in cases where moisture control is difficult, e.g. in erupting or newly erupted teeth. GIC sealants in these cases are regarded more as a temporary sealant or a Fluoride release vehicle, rather than a true sealant.

Fluoride-containing sealants have not shown superiority to regular sealant. Glass ionomer sealants have failed miserably in comparison to resin-based sealants, showing very poor retention. The major benefit of resin sealants, that of excellent retention and thus physical blocking of the fissure system, appears much more important for caries prevention than the transient benefit of fluoride release over the short-time glass ionomer sealants are retained.

Unfilled sealants perform better than filled sealants. Colored or clear resin sealant is a matter of personal preference; however, it has been shown that the ability to assess retention properly in colored sealants is much less error prone than with clear sealants. Use of an opaque color may interfere with the potential for laser fluorescent diagnosis of caries under a sealant.

Autocured sealant appears to have equivalent documentation of performance compared to visible-light-cured sealant.

The use of an intermediate bonding layer, or the incorporation of the benefits of the advances of the past decade in dentine bonding agents into newly formulated pit and fissure sealants, is perhaps the most exciting new potential development for the future of pit and fissure sealant materials.

The advantages of invasive sealants and PRR are:

1. There is minimal removal of tooth structure, hence greater tooth strength.
2. There is no marginal leakage, with a reduced risk of recurrent caries.
3. Local anesthetic is not normally required.
4. The restoration can be completed in one visit and polishing is not required.
5. Caries in adjacent pits and fissures is prevented without fissure removal.
6. Pleasing aesthetics are obtained.
7. The restorations are cost-effective and can be easily repaired.

The fissure morphology and the occlusion (e.g. load bearing area) largely dictate the choice between filled and unfilled products.

Strict adherence to moisture control must be observed. Saliva control can normally be achieved by the correct placement of a sufficient number of cotton rolls. Gaining adequate control of the oral environment at the time of placement is critical for long-term success of resins, when used for PRR or as plain sealants.

SEALANT FAILURE

The success of sealants is dependent upon a strong sealant-to-enamel bond, with sufficient mechanical retention being the primary determinant of clinical success. Improper technique is the major cause of failure or early loss of sealants; therefore, it is imperative that the operator strictly adhere to proper sealant placement. The following list describes common technique errors:

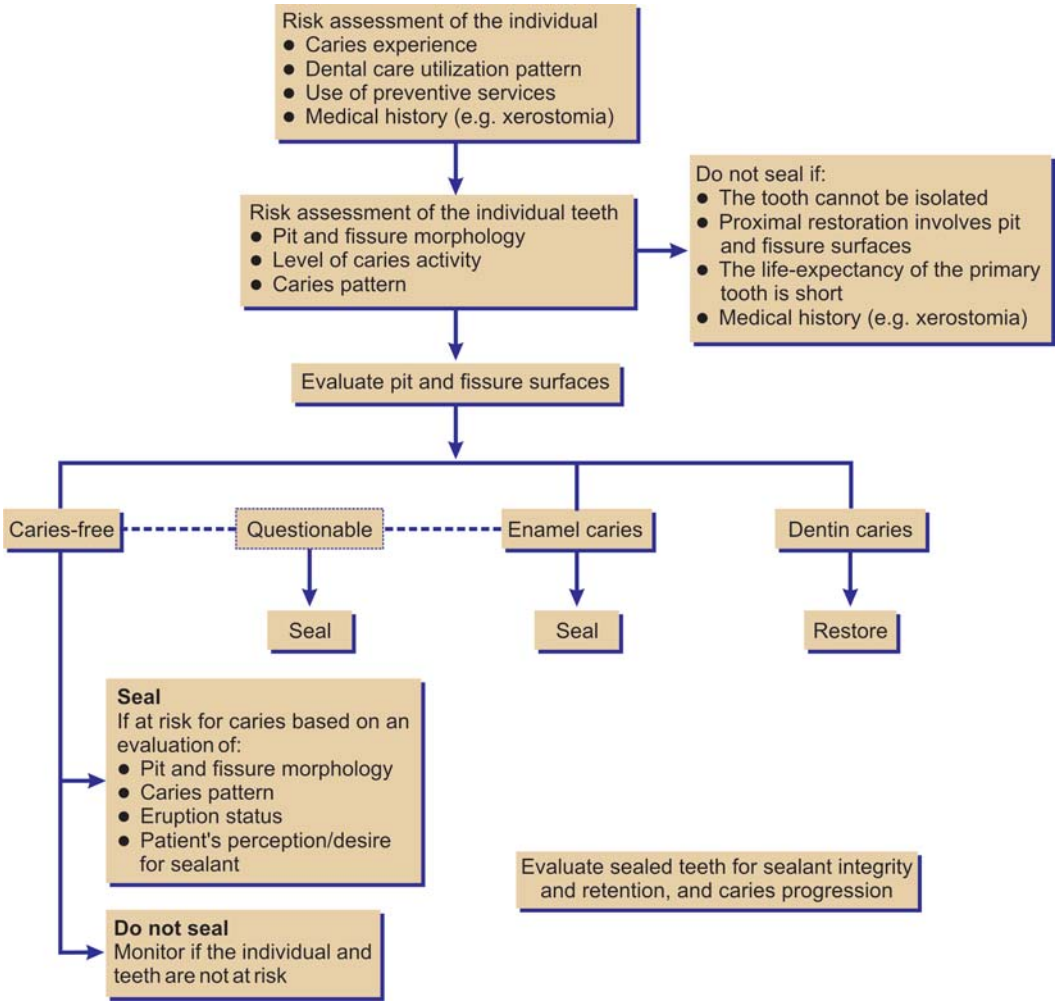
1. *Contamination* may be caused by either saliva or calcium phosphate products as described earlier. The enamel surface must be re-etched if contaminated.
2. *Inadequate surface preparation* may be caused by improper cleansing prior to applying the etchant and/or the etching process itself.
3. *Incomplete or slow mixing* of self-cure sealants affects polymerization of the Bis-GMA material. If polymerization is negatively affected (e.g. starts to set-up before placement), a new mix should be made.
4. *Too slow application of the material* results in a less viscous (thicker) mix that cannot flow easily into the pits and fissures, causing an incomplete seal. Place material within the time frame recommended by the manufacturer.
5. *Air entrapment due to whipping or vigorous mixing* can occur during the mixing of self-cured sealants. It is important to replace the caps on the resin bottles since moisture can be lost through evaporation. The result is a less viscous material which does not flow properly.
6. *Overextension of the material beyond the conditioned tooth surface* results in a weakened sealant in the areas that are overextended. If the sealant margins extend beyond etched tooth structure, those areas will cause increased micro-leakage beneath the sealant and/or fracture of the sealant. The sealant should be replaced, confining the area of placement to etched tooth structure.
7. *Outdated materials* may not serve as an effective sealant.

NEWER SEALANTS

1. WetBond Pit and Fissure Sealant

The difference between Embrace WetBond pit and fissure sealant and traditional sealants is that it bonds chemically and micromechanically to moist tooth surfaces. It integrates with the tooth structure to create a strong, margin-free bond that virtually eliminates microleakage. This is the first pit and fissure sealant resin that can be applied in a moist field. It forms a unique Resin Acid-Integrating Network (RAIN) that improves penetration into pits and fissures and provides superior sealing of the margins. No bonding agents are required (Fig. 33.10).

Guideline for Sealant Use in Individual Care Programs



Guidance on Sealant Use in Community Programs

1. **Define the community**
(check all that apply)
— School system(s)
— Municipality(ies)
— Neighborhood(s)
— State
— Homebound
— Managed care system
— Institution(s)
— Other, _____

2. **Assess Community Need for Dental Sealants**
(check all that apply)

Needs

— High pit and fissure caries level and low proximal caries level
— Low sealant prevalence
— Poor access to dental care
— Low income

3. **Weigh Supports Constraints for Sealant Program Development**
(check all that apply)

Supports	vs.	*Constraints*
— Adequate human resources		— Lack of human resources
— Adequate fiscal resources		— Lack of fiscal resources
— Community values oral health		— Community does not value oral health

Contd...

Contd...

— Support for public health programs
— Practical

— Lack of acceptance of public health program
— Impractical to implement a program
— Legal issues (i.e. supervision)
— Concerns about liability

— Dental community support

— Dental community does not support

4. Select Approaches for Increasing Sealant Prevalence
(check all that apply)
— Direct service

— Sealant promotion (public professional, third party)
— Policy development (e.g. Medicaid rules, state practice acts)
— Other, _____
— No program

5. Define Specific Population
(check all that apply)
Population Groups
— Schoolchildren
— Special populations
– Head start
– Residential care
– Military
– Managed care organization
– Other _____
— Other, _____

Modifiers
— High % of low income people
— age or grade _____
— high caries risk status
— Increase in caries risk
— Geography _____
— People with disabilities
— Other, _____

6. Identify Individuals to be Evaluated for Sealants
(check either "all people" or "some people")
— All people (assumes consent)

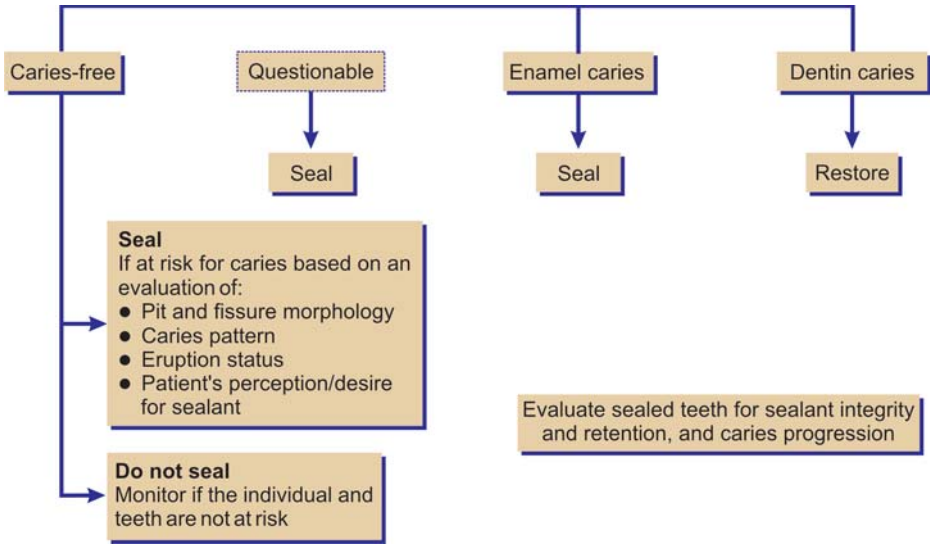
— Some people (assumes consent)

Selection factors
(check all that apply)
— Low SES
— Lack of dental care
— Other, _____

7. Identify Teeth/Tooth Surfaces Risk Assessment of the Individual
(caries experience, dental care utilization pattern, medical history, preventive behaviors)

Evaluate Tooth Status
(do not seal if the tooth cannot be isolated, restoration of proximal caries will involve the pit/fissure, or life-expectancy of the primary tooth is short)

Evaluate Pit and Fissure Surface for Sealant Application



Risk Factors for Sealants

Children	*Risk factors*
Low risk	No new or incipient caries in the past year Good oral hygiene Regular dental visits
Moderate risk	One new, incipient or recurrent caries in the past year Deep pits and fissure High familial caries experience History of pits and fissure caries Early childhood caries Frequent sugar exposure Decreased salivary flow Compromised oral hygiene Irregular dental visits Inadequate fluoride exposure Treatment for braces
High risk	Two or more new or recurrent carious lesions in past year Deep pits and fissure Sibling or parents with high caries rate History of pit and fissure caries Early childhood caries Frequent sugar exposures Decreased salivary flow Compromised oral hygiene

2. Illuminating Pit and Fissure Sealant

Through the use of a UV pen light, Seal-N-Glo fluoresces a blue/white color. The fluorescent glow provides clinicians with a visual verification of the sealant margins at the time of placement and offers the easiest way to verify retention and inspect margins during patient recall appointments.

3. Pit and Fissure Sealant With ACP (Amorphous Calcium Phosphate)

It is resilient and flexible, creating a strong, long-lasting sealant. This light-cure has a controlled flowability that keeps the sealant on the tooth structure while completely filling occlusal surfaces. It forms a chemical and thermal barrier that protects the tooth enamel on the occlusal surface from caries. Pit and fissure sealant is a light-cured sealant that contains the "smart material" amorphous calcium phosphate (ACP) that slowly releases calcium and phosphate ions, the basic building blocks of teeth (Fig. 33.11).



Fig. 33.10: WetBond pit and fissure sealant



Fig. 33.11: Pit and fissure sealant with ACP

ACP is referred to as a "smart material" because it only releases calcium and phosphate ions when the surrounding pH drops to a level where it could start to dissolve the tooth. Once the calcium phosphate is released, it acts to neutralize the acid and buffer the pH. It forms a chemical and thermal barrier that can help keep patients free from carious lesions on the occlusal surfaces.

34 Atraumatic Restorative Treatment

CM Marya

Atraumatic restorative treatment (ART), also known as Alternative restorative treatment, is defined as *"a dental caries treatment procedure involving the removal of soft, demineralized tooth tissue using hand instrument alone, followed by restoration of the tooth with an adhesive restorative material, routinely glass ionomer"*.

It has been endorsed by the World Health Organization and the International Association for Dental Research as a means of restoring and preventing caries with the goals of preserving tooth structure, reducing infection and avoiding discomfort.

ART may be used to restore and prevent caries in young patients, uncooperative patients, or patients with special health care needs or when traditional cavity preparation and/or placement of traditional dental restorations are not feasible. Success rates for ART restorations depend on the material used, training of the operator, and extent of caries. Glass ionomer cement is the material of choice for ART because of its bonding to enamel and dentine, fluoride release, and ease of use.

Unlike the conventional methods ART is non-threatening; this characteristic has the great advantage of making oral care more popular among the population—in particular, the young. It is not painful, therefore, does not need anesthesia, does not use expensive electrically driven equipment and can be provided at low cost.

This technique is simple enough to train nondental personnel or primary health care workers. All one needs are a flat surface for the patient to lie, a stool for the operator and the necessary instruments and materials for ART which can easily be carried in a small bag. ART, therefore, is suited for people residing in remote areas and for field practise and can be carried out in schools, village halls or in health centers with minimum equipment and resources.

PRINCIPLES

- Removing carious tooth tissues using hand instruments only.
- Restoring the cavity with a restorative material that sticks to the tooth.

REASONS OF USING HAND INSTRUMENTS FOR ART

1. It makes restorative care accessible for all population groups.
2. The use of a biological approach, which requires minimal cavity preparation that conserves sound tooth tissues and causes less trauma to the teeth.
3. The low cost of hand instruments compared to electrically driven dental equipment.
4. The limitation of pain that reduces the need for local anesthesia to a minimum and reduces psychological trauma to patients.
5. Simplified infection control. Hand instruments can easily be cleaned and sterilized after every patient.

MATERIAL USED

Glass ionomer cement is used as the restorative material in ART.

CONTRAINDICATIONS FOR ART

1. There is presence of swelling (abscess) or fistula (opening from abscess to the oral cavity) near the carious tooth.
2. The pulp of the tooth is exposed.
3. Teeth have been painful for a long time and there may be chronic inflammation of the pulp.
4. There is an obvious carious cavity, but the opening is inaccessible to hand instruments.
5. There are clear signs of a cavity, for example in a proximal surface, but the cavity cannot be entered from the proximal or the occlusal directions.

INSTRUMENTS

- Mouth mirror
- Explorer
- Pair of tweezers
- Dental hatchet
- Spoon excavator, small

- Spoon excavator, medium
- Spoon excavator, large
- Applier/carver
- Glass slab or paper mixing pad
- Plastic spatula

MATERIALS

- Cotton wool roll
- Cotton wool pellet
- Clean water
- Glass ionomer restorative material
- Liquid, powder and measuring spoon
- Dentine conditioner
- Petroleum jelly
- Wedge
- Plastic strip
- Articulation paper

RESTORING ONE-SURFACE CAVITIES USING ART

The procedure for caries removal for one-surface cavities:

1. Place cotton wool rolls alongside the tooth to be treated.
2. Remove plaque from tooth surface with wet cotton wool pellets.
3. Dry the tooth surface with dry cotton wool pellets.
4. If necessary, make the entrance of the cavity wider with a dental hatchet.
5. Remove the carious dentine (Fig. 34.1) with excavators starting at the enamel-dentine junction.
6. Fracture of unsupported thin enamel with the hatchet. Make sure the enamel does not contain any carious spots.
7. Clean the cavity with wet and then dry cotton wool pellets.
8. Remove the caries near the pulp carefully.
9. Clean the cavity again with wet cotton wool pellets.
10. Check the relation of the tooth to be restored with the opposing teeth by asking the patient to bite.
11. Complete the procedure by drying the cavity with dry cotton wool pellets.

Cleaning the Prepared Cavity

In order to improve the chemical bonding of glass ionomer to the tooth structures, the cavity walls must be very clean (Fig. 34.2). It is not effective to do this with wet cotton wool pellets and therefore, a chemical solvent is used. There are two possibilities:

- A dentine conditioner or tooth cleaner, especially developed for this purpose or,
- The liquid supplied with the glass ionomer itself.

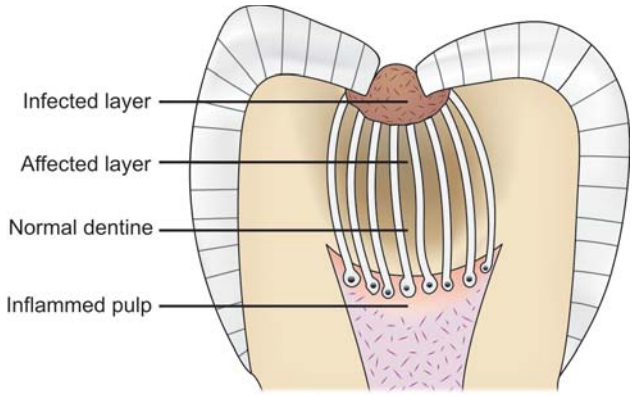


Fig. 34.1: Carious tooth

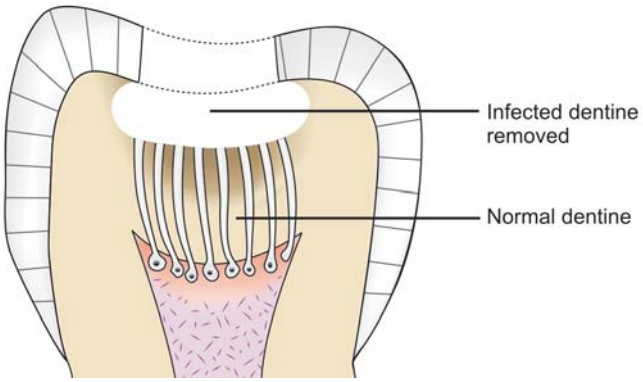


Fig. 34.2: Tooth after removal of infected dentine

Procedure for Conditioning One-surface Cavities Step-by-Step

If manufactured dentine conditioner/tooth cleaner is used.

1. Apply one drop of conditioner on a slab or pad.
2. Dip a cotton wool pellet in the conditioner.
3. Clean the cavity and adjacent fissures with the conditioner for 10 to 15 seconds.
4. Wash the cavity and fissures immediately at least twice with cotton wool pellets, dipped in clean water.
5. Dry the cavity with dry cotton wool pellets.
6. Repeat procedures 3 to 5 times if the conditioned cavity becomes contaminated with saliva and/or blood.

Restoring the Cavity

Make sure that the tooth is kept dry during the restorative phase. If necessary place new cotton wool rolls. An assistant is very useful at this stage, especially for mixing the glass ionomer material.

Ensure that all necessary materials and instruments are available and ready for use. After, the cavity is conditioned, washed and dried, you can start mixing the glass ionomer. Insert the mixture into the cavity in small amounts using the blunt end of the applier/carver instrument. This will avoid inclusion of air bubbles. Push the mixture into place with the round surface of a medium excavator. Make sure the mixture goes into small cavities and under any enamel overhanging. Also, place a little extra material on the adjacent pits and fissures. Rub a small amount of petroleum jelly on the gloved index finger and press the soft restorative material firmly into the cavity and fissures. This is called 'the press-finger technique'. Remove the finger sideways after a few seconds. The time from the start of mixing until removal of finger should be no more than one minute.

Excess glass ionomer material will be displaced by the press-finger technique towards the slopes of the cusps and between the cusps in the direction of buccal/lingual and proximal surfaces. Quickly and carefully remove any excess material with a carver (Fig. 34.3).

Then do not disturb the restoration during the hardening period and keep the tooth moisture free.

After about 1 to 2 minutes (depending on climatological conditions) check the bite. Place a piece of blue/red articulation paper on the restored tooth. Ask the patient to close the mouth and bite from side to side. Make sure that the patient does not bite on the cotton wool rolls. If the ART restoration is too high, blue/red spots appear. The height of the restoration can then be adjusted by scraping away some of the colored stained restorative material with the carver blade of the applier/carver.

Finally, cover the ART restoration with a new layer of petroleum jelly. Then remove the cotton wool rolls. The restorative procedure is finished. Ask the patient not to eat for at least one hour.

Procedure for Restoring One-surface Cavities

Step-by-Step

1. Check that all instruments and materials are available and ready for use.
2. Ensure that the tooth is kept dry during the restoration phase.
3. Mix restorative material according to earlier description (20-30 seconds).
4. Insert the mixture in small amounts into the cavity and into the adjacent fissures, using the blunt blade of the applier/carver. Use round surface of a medium excavator to push the mixture into deeper parts of the cavity and under any overhanging.
5. Rub some petroleum jelly on the gloved index finger.
6. Place the index finger on the restorative material, press and remove finger sideways after a few seconds.
7. Remove visible excess of glass ionomer with a medium or large excavator.
8. Wait 1 to 2 minutes till the material feels hard, whilst keeping the tooth dry.
9. Check the bite using articulation paper and adjust the height of the restoration with the applier/carver if needed.
10. Apply a new layer of petroleum jelly.
11. Remove cotton wool rolls.
12. Ask the patient not to eat for at least one hour.

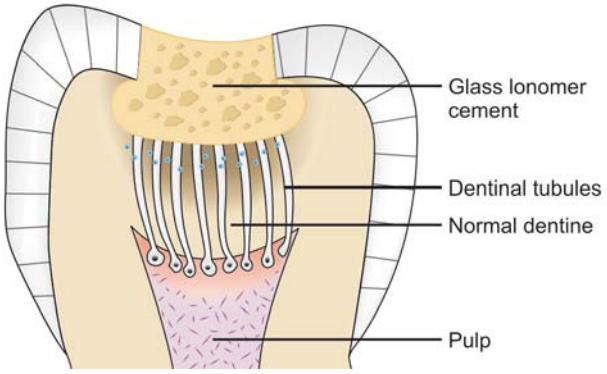


Fig. 34.3: Tooth sealed with glass ionomer cement

Hygiene and Control of Cross Infection

- Try and wear gloves always.
- Cleaning and disinfection of the working place and sterilization of instruments is essential to prevent infection passing from operator to patients and vice versa or between patients via the operator.
- Cleaning and disinfection of surfaces in the working place can be done by using cotton gauzes impregnated with methyl spirit (alcohol).
- In a clinic, instruments can be sterilized in an autoclave or a pressure cooker. If not in the clinic, a pressure cooker or a pan with a lid to boil the instruments can be used.

To avoid the risk of infection with diseases such as the human immunodeficiency virus (HIV) and hepatitis B virus (HBV), all instruments must be sterilized before being used for each patient.

TREATMENT MATERIAL (Glass Ionomer as a Restorative Material)

The material used for restoring cavities and sealing pits and fissures is glass ionomer.

Composition

The material is supplied as a powder and liquid that must be mixed together. The powder is in a glass containing silicon oxide, aluminum oxide and calcium fluoride. The liquid is either polyacrylic acid or demineralized water.

Clinical Characteristics

The reasons for using glass ionomer:

- Glass ionomer bonds chemically to enamel and dentine and provides a good cavity seal.

- One of the most significant characteristics of glass ionomer is the continued slow release of fluoride from the material after it has set. This helps prevent dental caries developing around the restoration.
- Glass ionomer is not harmful to the pulp and gingiva. During setting, the material may cause the pulp to feel tender. After 24 hours, when completely set, adverse reactions do not occur anymore.
- Compared to established dental restorative materials, glass ionomers have higher surface wear and lower strength.

Mixing

It is essential to closely follow the handling instructions of the manufacturer particularly with respect to powder and liquid ratios.

Restoring the Cavity

The mixture should be inserted into the prepared cavity and over the remaining fissures as soon as it is ready. Use the applier/carver to place small amounts of the mixture into the cavity. This technique will avoid air being trapped between the floor of the cavity and the glass ionomer (voids). The entire application procedure must be completed within 30 to 40 seconds.

Precautions to Remember

- Both powder and liquid should only be dispensed onto the mixing pad only after the cavity is properly dried and protected from saliva.
- The lid of powder and liquid bottle should be replaced back carefully into position immediately after use. This prevents uptake of moisture from the air or evaporation of the water component from the liquid.
- If more than 30 seconds are used for mixing and the mixture looks dry, do not use it. As there will be poor adhesion of the cement to the tooth structure. A fresh mixture should be made.
- All glass ionomer should be removed from the dental instruments immediately after use before the material has hardened, or put the instruments in water for easy cleaning later.
- Instructions of the manufacturer should be followed carefully as each type of glass ionomer may have its own specific needs.

RESTORING MULTIPLE-SURFACE CAVITIES USING ART

Preparing the Cavity

Basically, two types of multiple-surface cavities exist, those in front teeth and those in premolar/molar teeth. Those in front teeth are usually not very large, but multiple-surface cavities in premolars/molars vary and can be large.

It is usually not necessary to open the cavity. Start excavation at the enamel/dentine junction, and then remove caries towards the pulp. Ensure that the cavity outline is smooth and free of caries, particularly the outline in the proximal surface. Do this by placing the dental hatchet on the enamel close to the end of the cavity. Then push gently down. Small pieces of enamel will chip off. Smoothen the outline further by scraping the dental hatchet over the enamel. Make sure that the dental hatchet is well supported by your fingers.

Procedure for Restoring Multiple-surface Cavities in Anterior Teeth Step-by-Step

1. Work in a dry environment using cotton wool rolls. Replace these as required.
2. Clean the cavity and ensure that the outline is smooth and free of caries. Place a plastic strip between the teeth and use this to make the correct tooth contour of the proximal surface.
4. Insert a softwood wedge between the teeth just at the gum margin to keep the plastic strip firmly in position.
5. Condition the cavity as described for the one-surface cavity.
6. Mix the glass ionomer as described before and insert it into the cavity until it is slightly overfilled.
7. Hold the strip tightly with the index finger on the palatal side of the tooth. Wrap the strip firmly around to the buccal side to adapt the restorative material well into the cavity. Hold the strip with the thumb on the buccal side for 1 to 2 minutes until the material has set firmly.
8. Remove the strip and wedge, and cover the restoration with petroleum jelly.
9. Remove any excess material with the carver, check the bite with articulation paper and apply another coat of petroleum jelly.
10. Remove cotton wool rolls.
11. Ask the patient not to eat for one hour.

Procedure for Restoring Multiple-surface Cavities in Posterior Teeth Step-by-Step

1. Work in a dry environment using cotton wool rolls. Replace these as required.
2. Clean the cavity and ensure that the outline is smooth and free of caries.
3. Place the strip between the teeth. Insert a wedge to support the strip under the contact point at the gum margin.
4. Condition the cleaned cavity and adjacent fissures as described for the one-surface cavity.
5. Fill the cavity completely with glass ionomer. Insert material into corners and under unsupported enamel first. Make sure that there is enough restoration material to fill the entire cavity and the adjacent fissures. If material mixed is not enough to fill the cavity, mix a

new lot and insert a second filling on top of the first material (avoid contamination with saliva or blood).
6. Handle the plastic strip as explained for cavities in anterior teeth.
7. Try to place a petroleum jelly coated, gloved index finger on top of restoration and press slightly for a few seconds. Remove finger sideways.
8. Remove excess glass ionomer with a medium or large excavator. Leave the restoration to harden for 1 to 2 minutes, and then remove wedge and strip.
9. Check bite with articulation paper.
10. If necessary, remove excess restorative material with the carver.
11. Check that the cusps of the opposite tooth should not destroy the restoration.
12. It is better to have no occluding contacts than a contact that is too high.
13. Trim the proximal margins with the carver and apply new petroleum jelly.
14. Check the height of the restoration again with articulation paper and apply petroleum jelly if necessary and remove cotton wool rolls.
15. Advise the patient not to eat for at least one hour.

MONITORING ART RESTORATIONS

Careful Monitoring of Restorations is Important

ART can be used both in the dental clinic and in communities where no clinic exists. For example, ART restorations can be performed in schools and health centers in urban and remote areas.

No restoration, irrespective of the material used, lasts forever. Some restorations will last for many years, others may fail earlier. Faulty restorations and sealants need to be identified and repaired. Monitoring is more easily undertaken in schools than in clinics, since students/pupils will normally be available when the school is visited.

The first clinical evaluation could take place after six months. Further evaluations can be planned on an annual or biannual basis depending on factors such as expected caries development, length of time students stay at school and the possibility of seeing the individuals again (remote areas).

PROTOCOL FOR FAILED OR DEFECTIVE RESTORATION

A restoration may not be acceptable or unsatisfactory anymore for several reasons:
1. It is completely missing.
2. A large part of it has broken away.
3. The restoration is fractured.
4. Much of the restorative material has worn away.
5. Caries has developed at the restoration margin or elsewhere on the tooth surface.

Restoration is Completely Missing

Some of the reasons for failure could be:
1. Contamination with saliva or blood during the restorative procedure.
2. Mix of material was too wet or too dry.
3. Not all the soft caries had been removed.
4. Thin undermined enamel had been left behind, and this later broke off.

Whatever the reason, clean the cavity completely. Apply dentine conditioner and refill the cavity.

Part of the Restoration has Broken away

It is probable that the restoration was too high or air bubbles were trapped in the material during placement of the restoration. Whatever the reason, clean the tooth surface and/or remaining restorative material with an explorer or small excavator and wet cotton wool pellets first, before conditioning the entire surface and material. Fill the gap with a new mixture of glass ionomer and ensure that the restoration is not too high.

Restoration has Fractured

This most commonly happens in a multiple-surface restoration which was too high. The way to repair it very much depends on the location of the fracture line and the mobility of the fractured part. If the fractured part is loose and can be removed, repair the gap. However, if the fractured part cannot be removed, repair through ART is not possible then traditional treatment using a drill is needed.

Restoration has Worn away

Possible reasons for this are the patient eats very hard food frequently, the patient clenches his/her teeth frequently or the mixture had been too wet that so much material has been lost that the restoration should be rebuilt. Ensure that all the surfaces of the tooth and the remaining restoration are clean and free from soft tooth tissues. Apply dentine conditioner over the glass ionomer and the cavity walls. Place a new layer of glass ionomer on top of the old one and finish the restoration.

Caries has Developed in the Adjacent Fissures or Surface

Remove the soft tooth tissues. After all decay has been removed, clean and fill the new cavity adjacent to the restoration according to the standard procedures.

ADVANTAGES AND LIMITATION OF ART

The advantages of ART include the following:
1. The use of easily available and relatively inexpensive hand instruments rather than expensive electrically driven dental equipment.

2. A biologically friendly approach involving the removal of only decalcified tooth tissues, which results in relatively small cavities and conserves sound tooth tissue.
3. The limitation of pain, thereby minimizing the need for local anesthesia.
4. A straightforward and simple infection control practice without the need to use sequentially autoclaved handpieces.
5. The chemical adhesion of glass ionomers that reduces the need to cut sound tooth tissue for retention of the restorative material.
6. The leaching of fluoride from glass ionomers, which prevents secondary caries development and probably remineralizes carious dentine.
7. The combination of a preventive and curative treatment in one procedure.
8. The ease of repairing defects in the restoration; and
9. Low cost.

Obviously, one of the greatest advantages of ART is that it makes it possible to reach people who otherwise never would have received any oral care.

The limitations of ART include the following:

1. Long-term survival rates for glass ionomer ART restorations and sealants are not yet available; the longest study reported so far is of three years duration.
2. The technique's acceptance by oral health care personnel is not yet assured.
3. The possibility exists for hand fatigue from the use of hand instruments over long periods.
4. Hand mixing might produce a relatively unstandardized mix of glass ionomer, varying among operators and different geographical/climatic situations.
5. The misapprehension that ART can be performed easily, this is not the case and each step must be carried out to perfection.
6. The apparent lack of sophistication of the technique, which might make it difficult for ART to be easily accepted by the dental profession.
7. A misconception by the public that the new glass ionomer "white fillings" are only temporary dressings.

FAILURE PREVENTION AND MANAGEMENT

The management of ART failures follows principles of restoration repair instead of replacement.

ART Failure Management

Partial Material Loss

- Cleaning fracture surface.
- Application of dentine conditioner
- Placement of new GIC layer.

Complete Material Loss

- Cleaning cavity surface.
- Application of dentine conditioner.
- Placement of new GIC layer.

Caries-Related to Restoration Margin

- Caries removal using hand excavator.
- Cleaning GIC surface.
- Application of dentine conditioner.
- Placement of new GIC layer.

THE PRINCIPAL STEPS OF ART

- *Isolate the tooth* with cotton wool rolls.
- *Clean the tooth surface* to be treated with a wet cotton wool pellet.
- *Widen the entrance of the lesion*: This step is necessary only if the entrance is small.
- *Remove caries*: Depending on the size of the cavity, use either the smaller or medium-sized excavator.
- *Provide pulpal protection* if necessary: This step is used only for very deep cavities and is achieved by applying a setting calcium hydroxide paste to the deeper parts of the floor of the cavity.
- *Clean the occlusal surface*: All pits and fissures should be clear of plaque and debris as much as possible.
- *Condition the cavity* and occlusal surface (Optional): Use a drop of dentine conditioner on a cotton wool pellet and rub both the cavity and the occlusal surfaces for 10 to 15 seconds. The conditioned surfaces should then be washed several times with wet cotton wool pellets. The surfaces are then dried with dry pellets. *Conditioning increases the bond strength of glass ionomers.*
- *Mix glass ionomer* according to manufacturers instructions. Do not alter the powder-liquid ratio.
- *Insert mixed glass ionomer* into the cavity and overfill slightly.
- *Press* petroleum jelly coated gloved finger on top of the entire occlusal surface and apply slight pressure.
- *Check the bite.*
- *Remove excess material* with the carver.
- *Recheck the bite* and adjust the height of the restoration until comfortable.
- *Cover filling* with petroleum jelly.
- *Avoid eating or drinking* for at least one hour.

35 Prevention of Dental Caries

CM Marya

Dental caries is a bacterial disease that progresses when acid produced by bacterial action on dietary fermentable carbohydrates diffuses into the tooth and dissolves the mineral, that is, demineralization. Pathological factors including acidogenic bacteria (mutans streptococci and lactobacilli), salivary dysfunction, and dietary carbohydrates are related to caries progression.

The teeth are covered by dental plaque with the bacteria. Certain bacteria in dental plaque, such as the mutans streptococci (which includes *Streptococcus mutans and S. sobrinus*) and lactobacilli are acidogenic; they produce acids when they metabolize fermentable carbohydrates. These acids, such as lactic, acetic, propionic and formic acid, can dissolve the calcium phosphate mineral of the tooth enamel or dentine.

If this process of dissolution is not halted or reversed, the carious lesion progresses, and eventually leading to a cavity. Any fermentable carbohydrate such as glucose, sucrose, fructose, or starch (cooked) can be metabolized by these bacteria with the evolution of organic acids (e.g. acetic, lactic, propionic) as by-products. The acids diffuse through the plaque and into the porous enamel or dentine of tooth, dissociating to produce hydrogen ions as they travel. The hydrogen ions readily dissolve the mineral, freeing calcium and phosphate into solution, which can diffuse out of the tooth. This is demineralization, or loss of mineral as illustrated in Figure. 35.1.

CARIES FORMATION

Caries formation is a dynamic process governed by demineralization and remineralization. Demineralization is the

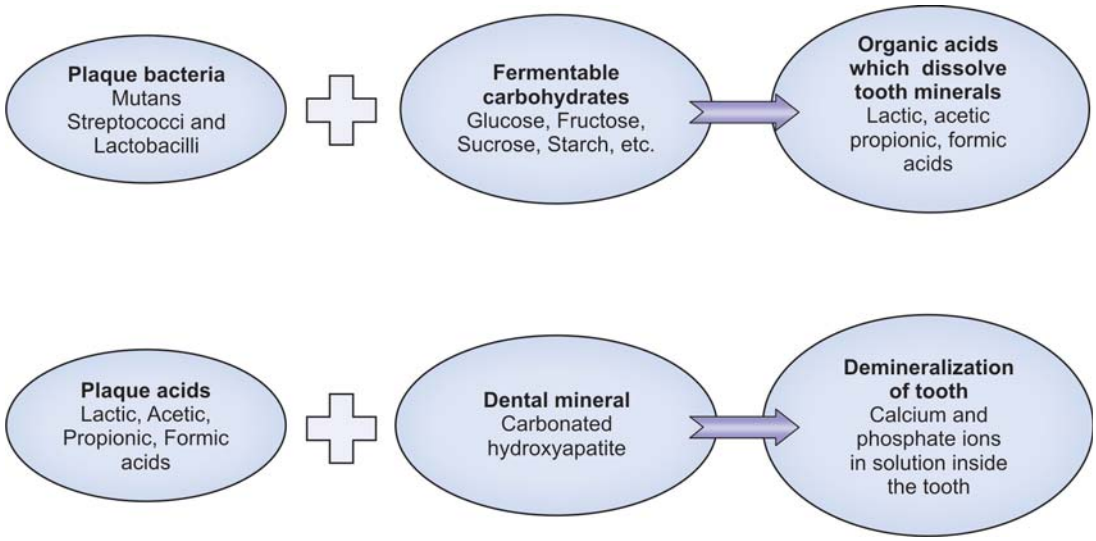


Fig. 35.1: Schematic representation of acid production by plaque bacteria, followed by demineralization of tooth mineral. (Modified from Featherstone JDB: Prevention and Reversal of Dental Caries: Role of Low Level Fluoride. Community Dent Oral Epidemiol 1999;27:3-40)

process of removing mineral ions from dental enamel when the pH of plaque drops below the critical pH value of 5.5; the critical value for enamel dissolution is 5 to 6, and an average pH of 5.5. Acids produced by bacteria cause demineralization by dissolution and removal of ions such as calcium (Ca^{++}) and phosphate (PO_4^{-}). A substantial amount of demineralization of hydroxyapatite can take place without destroying its structural integrity, but cavities will eventually occur if there is no remineralization. Remineralization restores the integrity of hydroxyapatite by replacing the missing ions. Calcium ions are necessary for remineralization. Redeposition of mineral (remineralization) occurs when the pH of plaque rises. Protective factors which include salivary calcium, phosphate and proteins, salivary flow, and fluoride in saliva can balance, prevent or reverse dental caries as shown in Figure. 35.2.

Plaque Bacteria Causing Dental Caries

1. *Specific plaque hypothesis:* According to this, only a few organisms out of the various microorganisms in plaque flora are responsible for dental caries.
2. *Non-specific plaque hypothesis:* This theory proposed that the carious process was result of the overall activity of the total plaque microflora. Hence, daily removal of plaque by mechanical plaque control (toothbrushes) is of great importance.
3. *Ecological plaque hypothesis:* According to this theory microorganisms associated with dental caries may be present at various sites. Demineralization results due to a shift in the balance of these resident microfloras due to change in local environment. Frequent intake of sugars encourages the growth of acidogenic and aciduric species, thus predisposing a site to dental caries. Hence, mechanical plaque control and restriction of sugar intake are both important in prevention of dental caries.

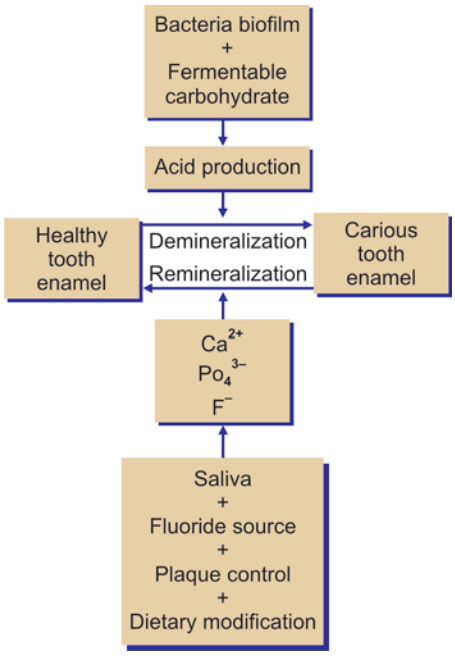


Fig. 35.2: Diagram of the caries process as regular flux of demineralization (destruction) and remineralization (repair)

The caries process starts with the loss of the first ions from the apatite crystals and ends with cavitation. In between these two events, many dynamic reactions take place as part of fluctuating process of demineralization and remineralization of teeth. The diagram of caries process shows that there are two landmarks that are of great clinical significance.

These two events are:

i. *The initiation of the subsurface lesion ''white spot lesion'':* This is a small area of subsurface demineralization, beneath the dental plaque. The lesion appears white because the loss of mineral changes the refractive index compared with that of the surrounding translucent enamel. The body of the sub-surface lesion may have lost as much as 50 percent of its original mineral and often has an ''apparently intact surface layer'' over it. The surface layer forms by remineralization (redeposition of mineral) as the calcium and phosphate ions diffuse or travel out of the tooth into the overlying plaque fluid (the fluid between the bacteria in the plaque). The process of demineralization continues each time carbohydrate is taken into the mouth and metabolized by the bacteria.

ii. *The terminal stage of subsurface lesion when it becomes irreversible (cavity):* The diagram also emphasizes the need for a reliable means of determining the extent of caries activity occurring in the environment of the teeth. It is between these two events that primary preventive dentistry practices should be vigorously applied to arrest and to reverse the progression of caries (Fig. 35.3).

REASONS FOR PREVENTION OF DENTAL CARIES

- Symptomatic treatment is intensive
- The cost of treatment is high
- It compromises nutrition
- Results in dysfunctional speech
- Causes severe pain and suffering

GOALS OF PREVENTION OF DENTAL CARIES

- Early detection of incipient lesion
- Reduce the number of cariogenic bacteria
- Limitation of caries activity
- Identification of high risk patients
- Evaluation of caries risk assessment

METHODS OF PREVENTION OF DENTAL CARIES

The caries process is now well understood; much of it has been described extensively in the dental literature. Some details of the caries process remain to be unraveled, but, in general,

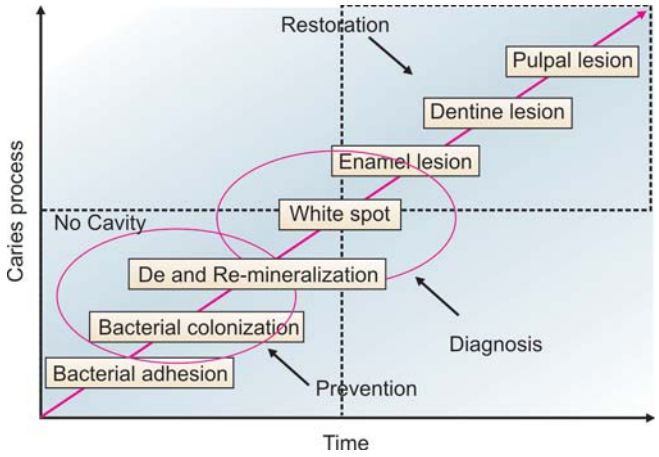


Fig. 35.3: Stages in caries process
(Modified from Joel H Berg, The Marketplace for New Caries Management Products: Dental Caries Detection and Caries Management by Risk Assessment BMC Oral Health 2006; 6(Suppl 1):S6)

we understand the process well enough to initiate better targeted methods of caries prevention and intervention. Prevention, intervention, and reversal of dental caries can be enhanced by either reducing the pathological factors or enhancing the protective factors (Fig. 35.4).

1. INCREASE THE RESISTANCE OF THE TEETH

A. Fluorides

Widespread use of multiple forms of fluoride is mainly responsible for the marked decrease in caries throughout the world.

Systemic Use of Fluoride

1. Community water fluoridation
2. Milk and salt fluoridation

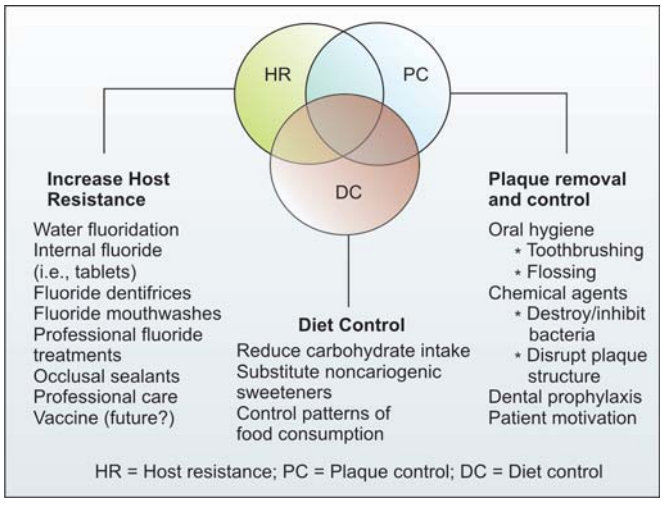


Fig. 35.4: Methods of caries prevention

3. Fluoride supplementation in the form of tablets and lozenges
4. Consuming a fluoride-rich diet such as tea, fish, etc.

Topical

1. Use of fluoridated toothpaste
2. Use of fluoride mouthwash
3. Use of fluoride varnishes (in-office application, longer duration of action, high fluoride content)
4. Professionally applied solution
5. Fluoride gels
6. Use of casein phosphopeptide–amorphous calcium phosphate (CPP–ACP).

B. Sealants

C. Saliva Substitutes Containing Fluoride

2. COMBAT CARIES-INDUCING MICROORGANISMS

This includes combating the microbial plaque by physical and chemical methods.

A. Physical Methods (Removal of Plaque)

a. Toothbrushing
b. Use of dentifrices
c. Prophylaxis by dentist
d. Mouth rinsing
e. Use of dental floss/tooth pik

B. Chemical Methods

a. These include the use of fluoride-containing toothpaste.
b. Mouthrinses — chlorhexidine 0.2 percent (0.12% in USA).
c. Use of povidone–iodine mouthwash.

C. Caries Vaccine

3. MODIFY THE DIET

This means modifying caries-promoting ingredients in the diet.

Diet refers to the customary allowance of food and drink taken by any person from day to day. Thus, the diet may exert an effect on caries locally in the mouth by reacting with the enamel surface and by serving as a substrate for cariogenic microorganisms.

Initially dietary modification meant restriction of intake of sugars. Much more pragmatic approach was the encouragement of sugar substitution-the use of hypoacidogenic and nonacidogenic sweeteners that did not promote dental caries. Many such sweeteners are available and are being used. Their use should be encouraged.

1. INCREASE THE RESISTANCE OF THE HOST/ TEETH

A. Fluorides

Widespread use of multiple forms of fluoride is mainly responsible for the marked decrease in caries throughout the world.

Mechanism of Action

The mechanism of action of fluoride that results in the reduction of dental caries is not completely understood. There is evidence that fluoride inhibits the demineralization of enamel, enhances remineralization and inhibits bacterial enzymes. The bacteria that cause caries produce acid through the fermentation of carbohydrates, which can dissolve the carbonated hydroxyapatite mineral of teeth, a process called "demineralization".

Incorporation of fluoride into apatite crystals reduces the dissolution of apatite during acid attacks. Fluoride concentrated in plaque and saliva interrupts the caries process by inhibiting the demineralization and enhancing the remineralization of enamel. When fluoride is present in sufficient concentrations, it adsorbs to the crystal surface, attracting calcium and phosphate ions to form a remineralized acid-resistant fluorapatite structure (Figs 35.5 and 35.6). The fluoride incorporated into teeth during development is not thought to be a major factor in preventing caries; rather, it is the daily presence of fluoride in plaque and saliva that plays a significant role. Therefore, regular exposure to fluoride in drinking water, toothpastes and topical preparations is important for caries prevention.

Understanding the interplay of hydrogen ions (H^+), OH^-, F^-, Ca^{++} and PO_4^- is paramount in formulating an approach to prevention. The simple strategy would be to maintain a low concentration of F^- in the oral fluid while decreasing the concentration of H^+ and increasing the concentration of Ca^{++} and PO_4^- to prevent demineralization and enhance remineralization.

SYSTEMIC USE OF FLUORIDE

Community Water Fluoridation

Many studies have demonstrated substantial reductions in caries prevalence as a result of water fluoridation. Where caries prevalence was high, the modal percentage reduction in caries over a period of years was 40 to 49 percent in primary teeth and 50 to 59 percent in permanent teeth. The optimum fluoride concentration will normally be within the range 0.5 to 1.0 mg/l.

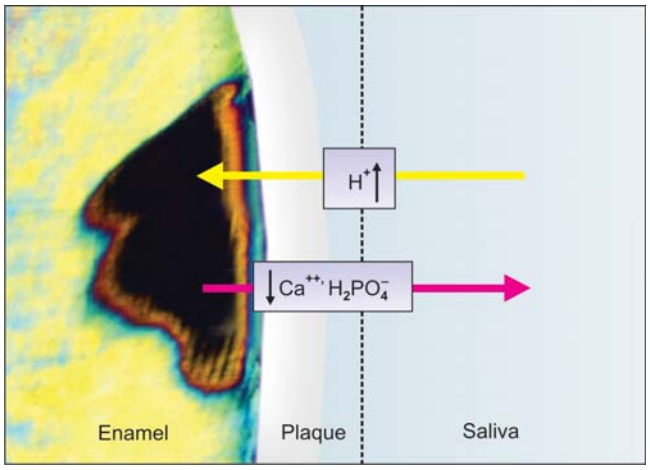


Fig. 35.5: Diagrammatic representation of the interplay of hydrogen (H^+), calcium (Ca^{++}) and phosphate (PO_4^-) ions in the process of demineralization

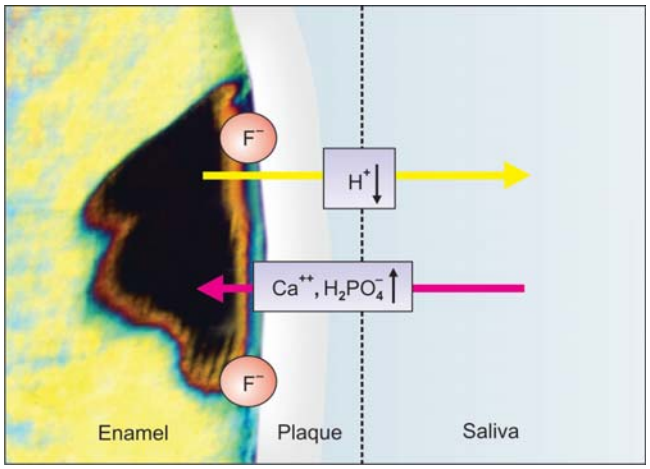


Fig. 35.6: Diagrammatic representation of the interplay of fluoride (F^-), hydrogen (H^+), calcium (Ca^{++}) and phosphate (PO_4^-) ions in the process of remineralization

Salt Fluoridation

The main advantages of salt as a vehicle for fluoride are that it does not require a community water supply and it permits individuals to accept or reject it; nonfluoridated salt, like noniodized salt, can be made available to the population. Even where fluoridated salt is used in multiple products, as in parts of Costa Rica, Jamaica and Switzerland, salt fluoridation has been well accepted. So far, five countries have used salt as a vehicle for fluorides: Switzerland (since 1955), France (since 1986), Costa Rica (since 1987), Jamaica (since 1987), and Germany (since1991), and the introductory stages have been reached in Mexico and Spain. In Switzerland concentrations of 90 mg F/kg and 250 mg F/kg were tried,

and after evaluation a concentration of 250 mg/kg is now recommended.

Fluoride Supplementation in the Form of Tablets and Lozenges

Fluoride supplements have limited application as a public health measure.

In areas with medium to low caries prevalence, a conservative prescribing policy should be adopted, and a dose of 0.5 mg F/ day prescribed for individuals at risk from the age of 3 years.

In areas where there is particular concern about caries in the primary and permanent dentitions, a dosage regimen should be used, starting at 6 months of age that takes into account the fluoride content of the drinking water.

Consuming a Fluoride-rich Diet such as Tea, Fish, etc.

Milk Fluoridation

Encouraging results have been reported with milk fluoridation. WHO is currently preparing a report on the use of fluoridated milk.

Advantage: During infancy when the sole source of diet is milk, it gives exposure to fluoride leading to fluorapatite formation.

TOPICAL FLUORIDES

These may be or self applied or professionally applied.

The use of professionally applied topical fluoride (PATF) is one means of preventing caries that is frequently used in private practice and public health settings. In terms of the relative reduction in decayed and filled surfaces, PATF is more effective against smooth surface caries than occlusal caries.

Topical fluoride applications are indicated for patients with active smooth surface caries and for patients in high caries risk groups (Table 35.1). This includes special patient groups, such as those undergoing orthodontic treatment.

Table 35.1: Indications for use of professionally applied topical fluorides

Indications
• Patients who are at high risk for caries on smooth tooth surfaces
• Patients who are at high risk for caries on root surfaces
• Special patient groups, such as:
– Orthodontic patients
– Patients undergoing head and neck irradiation
– Patients with decreased salivary flow
• Children whose permanent molars should, but cannot, be sealed
• Not recommended for patients with low caries risk who reside in communities with optimal fluoridation

1. *Use of fluoridated toothpaste:* Fluoride dentifrices remain the most widely used method of delivering topical fluoride. Fluoride dentifrices have been shown in numerous clinical trials to be effective anticaries agents and have been recognized as a major cause of the remarkable decline in caries prevalence in many developed countries. Dentifrices have been widely adopted around the world as the principle means of delivering topical fluoride and obtaining caries preventive benefits. Over 95 percent of all dentifrices sold in the US contain fluoride. A recent systematic quantitative evaluation by Marinho et al 2003 (Cochrane Database of Systematic Reviews) provides the best evidence for the effectiveness of fluoride dentifrice. Based on a meta-analysis of 70 trials on the effectiveness of fluoride dentifrice compared to placebo for the prevention of dental caries in children, they found clear evidence that the use of fluoride dentifrices has a caries inhibiting effect (average reduction in DMFS of 24%) on permanent dentition. Furthermore, the effectiveness of fluoride dentifrice may be relatively greater in individuals with higher caries experience, with increased fluoride concentration, increased frequency of use, and with supervised brushing.

   In addition to the inherent properties of a fluoride dentifrice product, biological and behavioral factors can modify its anticaries effectiveness. All of these factors interplay in what can be described as the "application" phase (the initial interaction of relatively high concentrations of fluoride with the tooth surface and plaque), and the "retention" phase (the fluoride remaining in the mouth after brushing that is retained in saliva, plaque and plaque fluid, the tooth surface, and oral soft tissue reservoirs).

   Studies have shown that fluoride in toothpaste at a concentration of 1000 to 1500 ppm F results in approximately 30 percent reduction in caries.

   Factors affecting dentifrice effectiveness: Behavioral factors include the frequency of dentifrice use, length of brushing, rinsing practices after brushing, the time of day that dentifrice is applied, and amount of dentifrice applied to the brush. It is well established that the frequency of use has a major influence on effectiveness.

   - Brushing twice per day or more has a greater preventive effect than once per day.
   - Length of the brushing time (application phase) determines how long the relatively high fluoride concentration in the dentifrice slurry stays in contact with the teeth and plaque, allowing fluoride uptake to take place.
   - The higher the fluoride concentration, the greater the driving force for fluoride diffusion through plaque toward the tooth surface.

- Rinsing behaviors after toothbrushing affect the amount of fluoride retained in the mouth and have been reported to affect caries experience.
- Physiologic (biological) factors, mainly salivary flow rate during and after fluoride application influence the rate of fluoride clearance.
- Bedtime use of fluoride dentifrice results in longer fluoride retention than daytime application due to greatly decrease salivary flow during sleep.
- The amount of fluoride applied to the toothbrush (dose) is not as important as the concentration of available fluoride in a dentifrice. Reduced fluoride concentration dentifrices are not as effective as regular concentration products
- The fluoride dose is, however, important in regard to enamel fluorosis in children under six years of age because of dentifrice ingestion. For this reason, reducing the amount of fluoride applied is a better strategy than lowering the dose of products intended for use by children.

2. *Fluoride mouthrinses:* A meta-analysis of 34 studies by Marinho *et al*, 2003 (Cochrane Database of Systematic Reviews) reported that the supervised use of fluoride mouthrinse by children is associated with a clear reduction (preventive fraction of 26%) in caries increment. Both daily rinsing with 0.05 percent NaF (226 ppm F) and once a week/once every two weeks rinsing programs with 0.2 percent NaF (900 ppm F) were found to be effective. From a mechanistic perspective, fluoride mouthrinses can lead to higher levels of oral fluoride retention than fluoride dentifrice, depending on behavioral practices after tooth-brushing. Studies have reported that salivary fluoride retention, after fluoride mouthrinse (226 ppm F) use was significantly greater than after brushing with fluoride dentifrice (1100 ppm F), based on integrated F values over the first two hours after application. The common practice of rinsing with tap water after toothbrushing greatly reduced the oral fluoride retention. This finding suggested that the combination of brushing with fluoride dentifrice followed by fluoride mouthrinse use may be beneficial.
3. *Use of fluoride varnishes:* It is one of the best options for the application of topical fluoride to teeth in the absence of water fluoridation. Evidence of the caries-preventive effectiveness of fluoride varnish in both permanent and primary dentitions is available. The most common types of NaF varnish are duraphat (2.2% F) and Fluor protector (0.1% F). The advantage of varnish is its ability to adhere to tooth surfaces, which prolongs contact time between fluoride and enamel and improves fluoride uptake into the surface layers of enamel. Various types of fluoride varnishes available is shown in Table 35.2.
4. *Professionally applied solution:* Since 1940, painting of the teeth with a fluoride solution as caries preventive measure was used. The most common fluoride solution was initially 2 percent sodium fluoride which was applied to the teeth for 3 to 4 minutes after a thorough oral prophylaxis. Commonly used fluoride solutions are 2 percent NaF, 8 percent SnF2 and 1.23 percent APF (acidulated phosphate fluoride). The painting proved not to be cost effective for general use but had to be reserved for individuals with high caries activity or at caries risk.
5. *Fluoride gel and foam:* Professionally applied gels are indicated for individuals at-risk of dental decay. Concentrations are usually high. In view of this they must be handled with care.

   Fluoride gel applications are more commonly used in the US and Canada. Gels are applied in styrofoam mouth trays, and the most widely used gel is 1.23 percent acidulated phosphate fluoride (APF). Fluoride foams are relatively recent products that are similar to gels, but have not been assessed in clinical trials. Topical fluoride gels are best applied in foam-lined mouth trays and left in contact with the teeth for 4 minutes.
6. *Use of casein phosphopeptide*–Amorphous calcium phosphate (CPP–ACP), which is available as tooth mousse, helps to remineralize the soft initial carious, demineralized areas of the teeth.

Table 35.2: Various types of fluoride varnishes with concentration

Types of fluoride varnish	*Concentration of fluoride*	
Fluorprotector	8,000 ppm	0.8% F^-
Lawefluor	22,600 ppm	2.2% F^-
Duraphat	22,600 ppm	2.2% F^-
Bifluorid	56,300 ppm	5.6% F^-

B. Sealants

Fluorides are successful in increasing the resistance of interproximal, facial and lingual tooth surfaces but fall short on occlusal pits and fissures. These areas are also resistant to effective oral hygiene. Pit and fissure sealants are adhesive resins which help to seal these pits and fissure and prevents dental caries.

C. Saliva Substitutes Containing Fluoride

A saliva substitute may be helpful and sometimes necessary in patients with practically no saliva production due to, e.g. radiation towards the head and neck region, medication, diseases in saliva glands or other reasons that may result in long-lasting oral dryness. Some of these products are fluoridated and prescribed when caries risk is high.

2. COMBAT CARIES-INDUCING MICRO-ORGANISMS/PLAQUE REMOVAL AND CONTROL

This includes combating the microbial plaque by physical and chemical methods.

A. Physical Methods *(Removal of Plaque)*

a. Toothbrushing
b. Use of dentifrices (fluoride containing)
c. Prophylaxis by dentist
d. Mouthrinsing
e. Use of dental floss/tooth pik.

The correct method and frequency of brushing should be followed in the morning and before going to bed and preferably after every major meal. Tongue cleaning and the use of indigenous agents such as the bark of neem or mango (where toothbrush and paste are unaffordable) should be encouraged.

The use of various interdental cleaning aids such as dental floss, interdental brush, water pik, etc. supplements the cleansing effect of a toothbrush. Use of an electronic toothbrush in children and persons with decreased manual dexterity is recommended.

B. Chemical Methods

a. These include the use of fluoride containing toothpaste.
b. Mouthrinses —chlorhexidine 0.2 percent (0.12% in USA).
c. Use of Povidone–iodine mouthwash.

C. Caries Vaccine

The development of a vaccine against dental caries involves identification of appropriate antigens of mutans streptococci against which protective immune responses can be mounted, and the selection of a method of immunization that will generate sustained levels of salivary antibodies. Antigens receiving most attention include streptococcal surface proteins that are involved in attachment to tooth surfaces and glucosyltransferases that synthesize adhesive glucans from sucrose. Recent advances in mucosal immunology and the introduction of novel strategies for inducing mucosal immune responses now raise the possibility of constructing an effective and safe vaccine. Passive immunization by the oral application of preformed antibodies against selected antigens of mutans streptococci has also shown promise and may facilitate understanding of the mechanisms of protective immunity against caries.

3. MODIFY THE DIET/DIET CONTROL

This means modifying caries-promoting ingredients in the diet.

The form of the fermentable carbohydrate directly influences the duration of exposure and retention of the food on the teeth. Prolonged oral retention of cariogenic components of food may lead to extended periods of acid production and demineralization and to shortened periods of remineralization. Duration may also be influenced by the frequency and amount of fermentable carbohydrate consumed. Liquid sugars, such as those found in beverages and milk drinks, pass through the oral cavity fairly quickly with limited contact time or adherence to tooth surfaces.

According to WHO, carbohydrates should deliver 55 to 75 percent of the daily energy intake. A maximum of 10 percent should come from free sugars (diet, nutrition and the prevention of chronic diseases; WHO expert committee, WHO Technical Report Series, 1990). The "sugar-clock" is a good way of visualizing the patient's acid attacks. For those suffering from caries disease, or for those at high-risk for developing cavities, the number of intakes resulting in acid-formation should be restricted to 5 to 6 per day, if possible.

Initially dietary modification meant restriction of intake of sugars. Much more pragmatic approach was the encouragement of sugar substitution-the use of hypoacidogenic and nonacidogenic sweeteners that did not promote dental caries. Many such sweeteners are available and are being used. Their use should be encouraged. The most promising dietary approach is the use of the nonacidogenic sweeteners—xylitol (a sugar substitute). It is used primarily in chewing gum. Xylitol chewing gum has been shown to reduce levels of mutans streptococci by altering their metabolic pathways. It also enhances remineralization and arrests dental caries. It acts as cariostatic agent.

Protective Elements in Diet

Several food components have been tested on their ability to reduce the caries-inducing effects of carbohydrates. Some positive results have been found in animal experiments but evidence for a significant effect on human caries is lacking, except for *fluorides*.

Phosphates are found naturally in different cereals. In tests, sodium phosphates or calcium sucrose phosphates have been added to different food products resulting in an increased caries reduction. The cariostatic actions of phosphates are primarily, if not entirely, a local topical one. "The presence of phosphates in the oral environment prevents the loss of phosphorus from the tooth enamel because of the common ion effect. Phosphates, along with calcium and fluoride ions, contribute to the remineralization of incipient demineralized areas of enamel. The phosphates seem to improve the structural nature of the enamel surface by making it harder and smoother. Because of their detergent properties, phosphates can probably interfere with the adherence of pellicle and plaque bacteria to the enamel surface. Phosphates can also inhibit bacterial growth.

Fats seem to reduce the cariogenicity of different foods but it is not clear to what extent and how. Possible explanations may be that the fat would form a protective barrier on the tooth surface or maybe just surround the carbohydrates, making them less available and making the removal from the oral cavity a little faster. Some fatty acids have an antimicrobial effect which could have an impact on plaque formation.

Cheese according to some studies it may reduce the levels of cariogenic bacteria. The high calcium and phosphorus content also seems to be a factor in the cariostatic mechanisms of cheese as well as the casein and cheese proteins.

BASIC DIETARY RECOMMENDATIONS (DIET COUNSELING)

- Reduce the intake and frequency of refined carbohydrates.
- Avoid sticky foods and replace refined with unrefined natural food
- Increase the intake of fibrous food to stimulate salivary flow, which is protective against caries
- Consume caries-protective foods such as cheese, nuts, raw vegetables, fruits, etc
- Stimulate salivary flow with sugar-free chewing gum
- Avoid putting an infant or child to bed with a bottle of milk, juice, or other sugar containing beverage

To facilitate for the patient to reduce the number of snacks, it may be necessary to improve the main meals. If the main meals are made up properly, the desire of eating between meals is reduced. The goal is not to exclude sugar from the diet but rather to make the patient eat sugar in a "sensible way" which means reasonable amounts and mainly at meal times — "sugar discipline".

A low amount of sugar intake is desirable from a cariological point of view. According to WHO , very little caries occurs in children when the national consumption level of sugar is below 10 kg per caput per annum, i.e. about 30 g/day, but a steep increase may occur from 15 kg upwards.

STRATEGIES FOR PREVENTION OF DENTAL CARIES

Two strategies:

The Population Strategy

The population strategy, which is aimed at a general reduction of the risk factors for all the individuals in the population, (whether diseased or not). A population strategy, providing preventive treatment for all subjects, is thought to be useful in populations with high caries occurrence, because its goal is to change the distribution of the disease by controlling the determinants of caries in the whole population. The purpose is to move the risk level to the more favorable level of the distribution of the disease in the population.

The High Risk Strategy

The high risk strategy, which aims at targeting the program at those individuals with the highest risk. As caries progression or reversal is determined by the balance between protective and pathological factors, caries prevention should be given high priority not only by physicians (general, pediatric, pediatric dentist) but also by schools and even the governmental authorities. According to the high risk strategy, individuals with a high risk of caries are identified and preventive measures are taken to diminish their risk. There are three basic prerequisites for the successful application of such a strategy. First, the occurrence of caries in the target population must be low enough justifying the effort and expense of identifying individuals who are believed to develop a high number of caries lesions. Secondly, accurate, acceptable and feasible measures for identifying the subjects with the highest risk of developing new caries lesions must be available. Thirdly, interventions that aim at bringing down the increased risk of caries in a high risk group should be based on methods that are effective and feasible.

Interventions for Individual Patients

Several chemotherapeutic approaches have been studied, primarily in Europe, with encouraging results. Chlorhexidine mouthwashes, varnishes, and gels have been used against caries causing bacteria with some effectiveness. Sugar substitutes such as sorbitol and xylitol have been promoted to modify high sucrose diets and thereby, lower bacterial production of damaging acids. Regular exposure to xylitol appears to modify the transmission of *mutans streptococci* from mother to child leading to significant reductions in the rates of decay in the child. Fluoride exposure reverses demineralization thereby preventing or reversing the caries process. Fluoride can be added to drinking water, toothpaste, topical gels, varnishes, and mouthwashes or can be in supplements including fluoride lozenges. Sealants, when applied to newly erupted permanent molars, provide an effective barrier to the bacteria and by products that decay the chewing surfaces of teeth.

Current research suggests that prenatal interventions with the mother, such as use of xylitol gum and chlorhexidine to control growth of oral pathogens, as well as oral health instruction and dental care produce beneficial prevention effects for the child. Early efforts at preventing expression of the disease in the primary teeth are also important for maintaining the health of the permanent teeth.

Public Health Interventions

Over the past 55 years, numerous studies have demonstrated that optimal fluoridation of water systems reduces caries rates in both children and adults. Depending on the size of the community, fluoridation costs an average of 20 to 50 percent per person per year. For communities with populations greater than 20,000, every $1 invested in community water fluoridation yields an annual savings of $38 in dental treatment. The National Institute of Dental and Craniofacial Research estimated that nearly $40 billion was saved nationally on dental treatment costs in the 1980s because of improvements in oral health attributable to the widespread use of fluorides and increased of use preventive services by practitioners.

Although, public education and promotion of preventive oral health activities are widespread, successful outcomes are more likely to occur with specific preventive interventions targeted to those at highest risk for developing caries. These include:

- Incorporating oral health into well baby care;
- Screening one-year-old children to identify those at high-risk and ensure they are followed up with preventive regimens;
- Providing fluoridated toothpaste for infants and children;
- Providing topical fluorides for infants, young children, and older adults;
- Applying sealants for second and sixth grade children in targeted schools;
- Incorporating oral health into prenatal care;
- Screening high-risk pregnant women and referring them for dental treatment to control levels of *mutans streptococci* that might be transmitted to their infants;
- Providing chlorhexidine rinses and xylitol products to pregnant women to control levels of *mutans streptococci* that might be transmitted to their infants;
- Providing dental care to low income families. Washington state is unique in the US in developing what are called ABCD (Access to Baby and Child Dentistry) programs to increase access to preventive dental care for infants from low-income families. These programs should include pregnant women; and
- Screening institutionalized adults to identify high-risk patients for follow-up with preventive regimens.

Increasing access to preventive and restorative dental services for children and adults increases use of preventive services and results in a decrease in the incidence of caries.

THE CARIES BALANCE

Fluoride's three extensively studied and documented principal mechanisms of action rely on the presence of fluoride in saliva, in the plaque at the tooth surface and in the fluid among the crystals in the subsurface of the enamel or dentine. The clinical effects of fluoride, therefore, can be optimized by using delivery methods that bring fluoride to the surface of the tooth and into the plaque rather than incorporating fluoride into the tooth mineral crystals during tooth development. These topical delivery methods are equally applicable to adults and children and include fluoride in beverages and foods, dental products and drinking water. The benefits of continually providing low levels of fluoride in the saliva and plaque from the aforementioned topical sources are well known.

Pathological and Protective Factors in the Caries Balance

Caries progression, as opposed to reversal, consists of a delicate balance between the factors—namely, a bacterially generated acid challenge and a combination of demineralization inhibition and reversal by remineralization. The balance between pathological factors (such as bacteria and carbohydrates) and protective factors (such as saliva, calcium, phosphate and fluoride) is a delicate one that swings either way several times daily (Fig. 35.7).

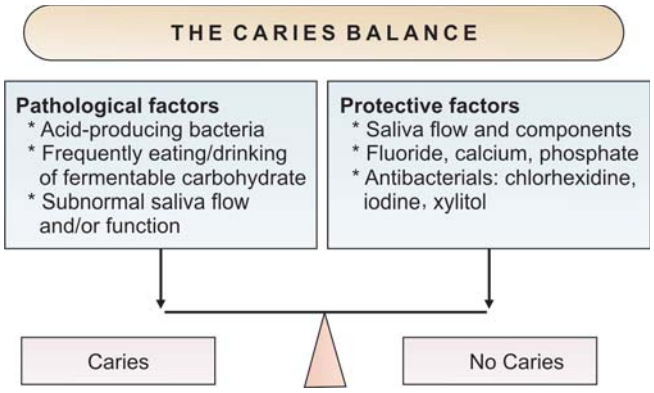


Fig. 35.7: The caries balance: A schematic diagram of the balance between pathological and protective factors in the caries process

Protective Factors

Saliva is essential for the protection of the tooth against dental caries and provides many natural protective factors including calcium, phosphate, antibacterial components and other proteins with various functions. Extrinsic antibacterial agents such as chlorhexidine also can be considered as protective factors in this balance, as can fluoride from external sources. The mechanisms of action of fluoride described apply primarily to fluoride from topical sources; systemically incorporated fluoride has only a minor role in protecting against dental caries.

This conclusion is supported not only by laboratory data, but also by epidemiologic studies. Studies clearly show the beneficial and more important posteruptive (topical) effects of fluoride in the drinking water than the weak pre-eruptive effects of fluoride. The cariostatic effects of fluoride are, in part, related to the sustained presence of low concentrations of ionic fluoride in the oral environment, derived from foods and beverages, drinking water and fluoride containing dental products such as toothpaste. Prolonged and slightly elevated low concentrations of fluoride in the saliva and plaque fluid decrease the rate of enamel demineralization and enhance the rate of remineralization. For example, fluoride at 0.04 ppm in saliva can enhance remineralization. Remineralization of early lesions also requires calcium and phosphate, which are derived primarily from saliva and plaque fluid.

Pathological Factors

Pathological factors obviously include cariogenic bacteria and the frequency of ingestion of fermentable carbohydrates that sustain these bacteria. The importance of mutans streptococci (which includes *S. mutans* and *S. sobrinus*) in the development of dental caries has been reviewed extensively. Numerous cross-sectional studies in humans have shown that greater numbers of mutans streptococci and lactobacilli in saliva or plaque are associated with high caries rates. Longitudinal

studies have shown that an increase overtime in numbers of both of these bacterial groups is associated with caries onset and progression.

MODIFYING THE CARIOUS PROCESS

As it is clear now that caries is a multifactorial disease. The cause is pH fluctuations in the bacterial plaque, but these in turn may be influenced by such factors oral hygiene, diet, fluoride and salivary flow. In addition a number of other variables are important such as social class, income, education, knowledge, attitudes and behavior. Figure 35.8 shows the progress of dental caries. The diagrammatic representation shows that when the destructive forces outweigh the reparative powers of saliva, the process will progress. Conversely, if the reparative forces outweigh the destructive forces, the process will arrest. Early diagnosis is important because, once carious lesions have cavitated; only operative intervention can replace the tissue. Fillings do not prevent caries, because new lesions can develop adjacent to restorations. If fillings are to last, preventive nonoperative treatments must go hand-in-hand with operative treatment.

The basis of preventive, nonoperative treatment is modification of one or more of the factors involved in the carious process. The caries process can be modified, if timely modification in diet and hygiene are done, since the process usually takes months or years to destroy the tooth.

RISK GROUPS FOR DENTAL CARIES

The caries risk potential of an infant can be determined by the use of the caries risk assessment tool. However, even the most judiciously designed and implemented caries risk assessment tool can fail to identify all infants at risk of early childhood dental caries. If an infant is assessed to be within one of the following risk groups, the care requirements would be significant and surgically invasive; therefore, these infants should be seen by a dentist as early as six months of age and no later than six months after the first tooth erupts or 12 months of age (whichever comes first) for establishment of a dental home: Establishing a "Dental home" means that child's oral health care is delivered in a comprehensive, continuously accessible, coordinated and family-centered way by a licensed dentist [(The American Academy of Pediatric Dentistry, (AAPD)].

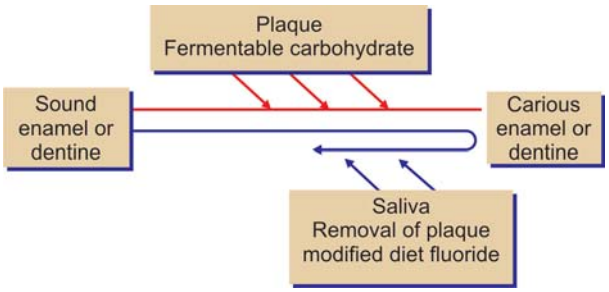


Fig. 35.8: Modifying the caries process: An alternating process of demineralization and remineralization

Risk Groups include

- Children with special health care needs
- Children of mothers with a high caries rate
- Children with demonstrable caries, plaque, demineralization, and/or staining
- Children who sleep with a bottle or breastfeed throughout the night
- Later-order offspring
- Children in families of low socioeconomic status

Despite all efforts to predict children at high risk of caries, patients can and do fall outside statistical expectations. In these cases, the mother may not be the colonization source of the child's dental flora, the dietary intake of simple carbohydrates may be extremely high, or other uncontrollable factors may combine to place the patient at risk of caries. Therefore, screening for risk of caries in the parent and patient coupled with oral health counseling, although a feasible and equitable approach to early childhood caries control is not a substitute for early establishment of the dental home. Whenever possible, the ideal approach to early childhood caries prevention and management is the early establishment of a dental home.

ANTICIPATORY GUIDANCE: PARENT AND PATIENT EDUCATION

General anticipatory guidance for the mother (or other intimate caregiver) before and during the colonization process should include the following:

- *Oral hygiene*—the parent should be instructed to brush thoroughly twice daily (morning and evening) and to floss at least once every day.
- *Diet*—the parent should be instructed to consume fruit juices only at meals and to avoid all carbonated beverages during the first 30 months of the infant's life.
- *Fluoride*—the parent should be instructed to use fluoride toothpaste and rinse every night with an alcohol-free over-the-counter mouthrinse with 0.05 percent sodium fluoride.
- *Caries removal*—parents should be referred to a dentist for an examination and restoration of all active decay as soon as feasible.
- *Delay of colonization*—mothers should be educated to prevent early colonization of dental flora in their infants by avoiding sharing of utensils (i.e. shared spoons, cleaning a dropped pacifier with their saliva, etc.).
- *Xylitol chewing gums*—recent evidence suggests that the use of xylitol chewing gum (4 pieces per day by mother) had a significant impact on decreasing the child's caries rates.

General anticipatory guidance for the young patient (0 to 3 years of age) should include the following:

- *Oral hygiene*—the parent should begin to brush the child's teeth as soon as they erupt (twice daily, morning and evening) and floss between the child's teeth once everyday as soon as teeth contact one another.
- *Diet*—after the eruption of the first teeth, the parent should provide fruit juices (not to exceed 1 cup per day) during meals only. Carbonated beverages should be excluded from the child's diet. Infants should not be placed in bed with a bottle containing anything other than water. Ideally, infants should have their mouths cleansed with a damp cloth after feedings.
- *Fluoride*—all children should have optimal exposure to topical and systemic fluoride. Caution should be exercised in the administration of all fluoride-containing products. The specific considerations of the judicious administration of fluoride should be reviewed and tailored to the unique needs of each patient. Review articles with applicable fluoride recommendations and supplementation algorithms are available.

LEVELS OF PREVENTION OF DENTAL CARIES

PRIMARY PREVENTION OF DENTAL CARIES IN CHILDREN (BEFORE DISEASE OCCURS)

An explicit caries risk assessment should be made for each child presenting for dental care.

The following factors should be considered when assessing caries risk:

- Clinical evidence of previous disease
- Dietary habits, especially frequency of sugary food and drink consumption

Several ***dietary factors*** are associated with caries incidence:

- Amount of fermentable carbohydrate consumed
- Sugar concentration of food
- Physical form of carbohydrate
- Oral retentiveness (length of time teeth are exposed to decrease plaque pH)
- Frequency of eating meals and snacks
- Length of interval between eating
- Sequence of food consumption

Other factors:

- Use of fluoride
- Plaque control
- Saliva
- Medical history

Secondary and Tertiary Prevention of Dental Caries

- Limiting the impact of caries at an early age
- Rehabilitation of decayed teeth with further preventive care

Procedure for Caries Identification

1. Dry each tooth surface with compressed air to improve visualization.

DIAGNOSIS AND MANAGEMENT OF CARIES

Diagnosis of Dental Caries

- *Bitewing radiographs* are recommended as an essential adjunct to patient's first clinical examination
- The frequency of further radiographic examination should be determined by an assessment of the patient's caries risk

Management of Carious Lesions

Occlusal caries:

- If only a part of the fissure system is involved in small to moderate dentine lesions with limited extension the treatment of choice is a composite sealant restoration
- If caries extends clinically into dentine, then carious dentine should be removed and the tooth restored
- *Dental amalgam* is an effective filling material which remains the treatment of choice in many clinical situations. There is no evidence that amalgam restorations are hazardous to the general health

Approximal caries:

- *Preventive care,* e.g. topical fluoride varnish, rather than operative care is recommended when approximal caries is confined (radiographically or visually) to enamel
- In an approximal lesion requiring restoration, a conventional class II restoration should be placed in preference to a tunnel preparation

Re-restoration:

- The diagnosis of secondary caries is extremely difficult and clear evidence of involvement of active disease should be ascertained before replacing a restoration

2. Clinically/visually inspect each tooth surface (buccal, lingual, occlusal, and proximal):
   - Visually first, then gently with explorer, only if indicated to remove plaque and debris to assist with visualization. Do not use heavy downward pressure with the point of the Shepherd's hook explorer; use the side of the point. Research has shown that the use of an explorer may cause iatrogenic damage to an early noncavitated lesion by breaking through the intact surface enamel and thus eliminate any chance for remineralization.
   - Use transillumination in the anteriors
   - During the clinical/visual inspection look for changes in color and translucency and/or breaks in the enamel surface.
     - Chalky-white areas of decalcification (white spot lesions)
     - Grayish-white, gray discolorations around marginal ridges and margins of restorations
     - Yellowish brown, brown discolorations in occlusal pits and fissures
     - Shadowing on proximal surfaces
     - Black discoloration (arrested caries).
3. Use radiographs to assess presence of carious lesions:
   - Bitewings are useful for detecting interproximal lesions
   - Current standard—

  - If an enamel lesion detected on the radiograph is not past the dentinoenamel junction, then it can be arrested or revered by remineralization.
  - A radiolucency through the thickness of the enamel or into the dentine requires surgical (restorative) intervention followed by non-surgical interventions (i.e. infection control (CHX), fluoride, etc.).
4. New technology in caries detection:
   - Laser fluorescence, (e.g. diagnodent)
   - Light fluorescence, (e.g. QLF)
   - Digital imaging fiber optic transillumination (e.g. DIFOTI).

BEHAVIOR MODIFICATION IN HIGH CARIES RISK CHILDREN (TABLE 35.3)

- *Dental health education advice* should be provided to individual patients at the chair side as this intervention has been shown to be beneficial.
- Children should *brush their teeth twice a day* using toothpaste containing at least 1000 ppm fluoride. They should spit the toothpaste out and should not rinse out with water.
- The need to *restrict sugary food and drink consumption* to meal times only should be emphasized.
- Dietary advice to patients should encourage the *use of nonsugar sweeteners*, in particular xylitol, in food and drinks.
- Patients should be encouraged to use *sugarfree chewing gum*, particularly containing xylitol, when this is acceptable.
- Clinicians should prescribe *sugarfree medicines* when ever possible and should recommend the use of sugarfree forms of nonprescription medicines.

Tooth Protection in Children at High Caries Risk

- *Sealants* should be applied and maintained in the tooth pits/fissures of high caries risk children, and the condition of sealants should be reviewed at each check-up.
- Glass ionomer sealants should only be used when resin sealants are unsuitable.
- *Fluoride tablets* (1mg F daily) for daily sucking should be considered for children at high risk of decay.
- A *fluoride varnish* (e.g. duraphat) may be applied every four to six months to the teeth of high caries risk children.
- *Chlorhexidine varnish* should be considered as an option for preventing caries.

PREVENTIVE THERAPY BASED ON RISK FACTORS

The preventive therapy varies from person to person and is dependant on the risk factor of an individual as shown in Table 35.4.

BEHAVIOR MODIFICATION IN GERIATRICS

Prevention of Root Caries

Root caries prevention requires proper assessment and observation of the caries risk level for the patient. Proper preventive measures of plaque removal, diet modification, and the use of topical fluoride has demonstrated significant results in arresting active carious lesions.

Preventive measures include educating patients and people assisting them to avoid high sugar containing meals,

Table 35.3: Primary prevention in children at high caries risk

Behavior modification	*Tooth protection*
• **Dental health education** advice should be provided to individual patients at the chair side as this intervention has been shown to be beneficial • Children should **brush their teeth** twice a day using toothpaste containing at least 1000 ppm fluoride • They should spit the toothpaste out and should not rinse with water • The need to **restrict sugary food and drink** consumption to meal times only should be emphasized • Dietary advice to patients should encourage the use of **nonsugar sweeteners**, in particular xylitol, in food and drink. • Patients should be encouraged to **use sugarfree chewing gum**, particularly containing xylitol, when this is acceptable. • Clinicians should prescribe **sugarfree medicines** whenever possible and should recommend the use of sugar free forms of nonprescription medicines	• **Sealants** should be applied and maintained in the tooth pits/fissures of high caries risk children • The condition of sealants should be reviewed at each check-up • Glass ionomer sealants should only be used when resin sealants are unsuitable – **Fluoride tablets** (1 mg F daily) for daily sucking should be considered for children at high risk of decay – A **fluoride varnish** (e.g. duraphat) may be applied every four to six months to the teeth of high caries risk children. – **Chlorhexidine varnish** should be considered as an option for preventing caries • Consistent preventive message should be reinforced by the practice team and other health care professionals.

Table 35.4: Preventive therapy based on risk factors

Low-risk	*Moderate-risk*	*High-risk*
Dental health education	Dental health education	Dental health education
Fluoridated dentifrices	Fluoridated dentifrices	Fluoridated dentifrices
	Systemic fluoride supplements	Systemic fluoride supplements
	Professionally applied topical fluorides	Professionally applied topical fluorides
	Sealants	Sealants
	Antimicrobials	Home fluoride
		Dietary counseling

maintaining a proper toothbrushing technique and oral hygiene measures, and having regular dental check-ups.

Elderly patients (especially, those with limited manual dexterity) need to be educated about plaque control with the use of an interproximal brush or electrical oral hygiene devices.

Fluoride is an appropriate agent for prevention of root caries because it promotes the remineralization process and reduces the rate of demineralization.

Many elderly patients are on medications with anticholinergic side effects.

Such patients need to be advised about the side effects of such medications, so that the necessary preventive measures can be followed. The clinician should direct special attention to root caries-prone patients who are wearing dental prosthesis. This is achieved by proper management of soft tissues during fixed prosthesis procedures (e.g. design, contours, and polish) and avoiding placing the margins of a restoration coronal to the surrounding tissue to eliminate plaque accumulation. For removable prosthesis, retainers and guide planes should be placed in cleansing areas that allow salivary flow.

As stated previously, fluoride is an appropriate agent for prevention of root caries because it promotes the remineralization process and reduces the rate of demineralization.

There are numerous methods by which fluoride can be supplied. Exposure to fluoride in drinking water results in increasing resistance to root caries, and people living in areas with fluoridated water are less prone to caries in general than those who live in areas lacking fluoridated water.

Topical fluoride products are available as 0.05 percent sodium fluoride rinse, 0.12 percent chlorhexidine rinse, and as 1.1 percent neutral sodium fluoride gel in a 5-minute tray technique, with four applications over 2 to 4 weeks.

Other products are dentrifices containing 1100 ppm sodium fluoride.

Fluoride chewing gum which is effective especially in patients with low salivary flow and xylitol containing chewing gum which stimulates salivary flow and decreases plaque formation, although studies have not shown its effectiveness in preventing adult caries.

Fluoride containing varnishes have also been effective against root caries.

Application of dentine adhesives can have the adverse effect of demineralizing the root surface.

A caries risk assessment should be completed for all elderly patients, and those patients found to be at moderate to high risk for root caries should receive an aggressive preventive protocol.

This protocol is based upon four primary strategies for prevention of future root caries. The first strategy is to try to improve salivary flow rates and increase buffering capacity. The second strategy is to try to reduce the numbers of cariogenic bacteria (*Streptococcus mutans*) in the oral cavity.

The third strategy is to reduce the numbers of exposures and quantity of ingested refined carbohydrates.

The fourth is to attempt to remineralize incipient lesions and prevent new lesions from developing (tilt the demineralization–remineralization equation in favor of remineralization).

Many of the specific procedures that will be recommended could have an impact in multiple areas.

Prevention (Primary and Secondary)

- Identify risk factors for root caries at the individual level
- Ensure an accurate diagnosis of root caries
- Provide dietary, oral hygiene and correct brushing advice
- Prescribe appropriate fluoride regimens such as high fluoride (e.g. 5000 ppm) dentifrice, gel, varnish
- Prescribe if appropriate chlorhexidine (as a mouthwash, spray, gel or varnish), other similar antiseptics, and/or remineralizing products with calcium phosphopeptide-amorphous calcium phosphate (CPP-ACP)
- If necessary, prescribe regimens to stimulate salivary flow, such as chewing gum with or without the inclusion of active ingredients (e.g. chlorhexidine, xylitol, CPP-ACP), sucking sugarless candies, sucking buffered citric/fruit acid tablets, using systemic cholinergic medications (e.g. pilocarpine/cimeviline, with monitoring of adverse effects)
- Consider prescribing saliva substitutes, such as gels, sprays and liquids, with placement around dentures as well as on teeth and oral soft tissues
- Review patients on a schedule appropriate to their level of risk.

Management

Depending on the depth and extension of the lesion, management may include remineralization, removal of softened tissue, restoration or extraction.

The primary aim should be remineralization.

Caries removal using hand instruments, supplemented by chemomechanical caries removal systems, may be appropriate for specific groups of patients

There is some evidence that glass ionomer cement (conventional or resin-modified) may be the material of choice for the restoration of root caries lesions, especially if subgingival.

36 Prevention of Periodontal Disease

CM Marya

The only known approach to prevention of periodontitis is to prevent gingivitis, which from several points of view has been seen as a worthwhile endeavor.

The rationale of controlling periodontal disease by regular plaque removal is based on premise that supragingival plaque, if undisturbed will become subgingival plaque, which has a potential to be colonized by pathogenic bacteria. Only a few gingivitis sites progress to periodontitis, but which one will do so is difficult to identify. The principles to prevention include the regular and consistent removal of plaque, supragingival and subgingival, soft and mineralized, i.e. calculus from the teeth and gingival crevices.

This approach is not aimed at specific pathogens but seek to control the build up of all plaque.

Until methods of controlling periodontal infections by enhancing host response and identifying susceptible individuals are produced by personal, professional or chemical means is the best method for achieving plaque control to prevent periodontal diseases.

ORAL HYGIENE ASSESSMENT

To modify the oral health behavior, it is necessary to assess oral hygiene status which involves determining the:

- Amount of hard deposits
- Awareness of his or her oral hygiene status
- Home care regimen being followed.

Of the various tooth deposits (Table 36.1), bacterial plaque is a risk factor for the dental caries and periodontal disease. Stains and calculus assist in the retention of bacterial plaque on the teeth and supporting structures. By understanding the level of bacterial load present in the oral cavity, prevention and intervention can be aimed at reducing plaque biofilm and achieving optimal oral habits.

Table 36.1: Various tooth deposits

• Bacterial plaque biofilm
• Tooth stains (intrinsic/extrinsic)
• Dental calculus
• Material alba and food debris.

STAGES OF PERIODONTAL DISEASE

Progression of periodontal disease from initial gingival inflammation to deeper structures is the result of a complex array of micropathological sequences. The multifactorial nature of periodontal disease is often, the difficulty in explaining the various pathogenic events. Delicate balance between host and bacteria in health, once breached, results in breakdown of periodontal health.

Difference in extent of involvement of various sites in an individual, and period of exacerbation and quiescence as pointed out earlier, makes a difficult task in determining the current status of periodontium in different stages. To understand the process, it is divided into the following:

- Gingivitis
- Mild periodontitis
- Moderate periodontitis
- Advanced periodontitis.

Stages of Periodontal Disease Progression and their Associated Signs and Symptoms

Healthy Gums (Fig. 36.1)

- Coral pink color
- Gums hug teeth tightly
- No bleeding.

Gingivitis (Fig. 36.2)

- Plaque and tartar build up is present at the gum line
- Inflammation of the gums
- Bleeding while brushing or during probing
- Inflamed, sensitive gums
- Bad breath/taste.

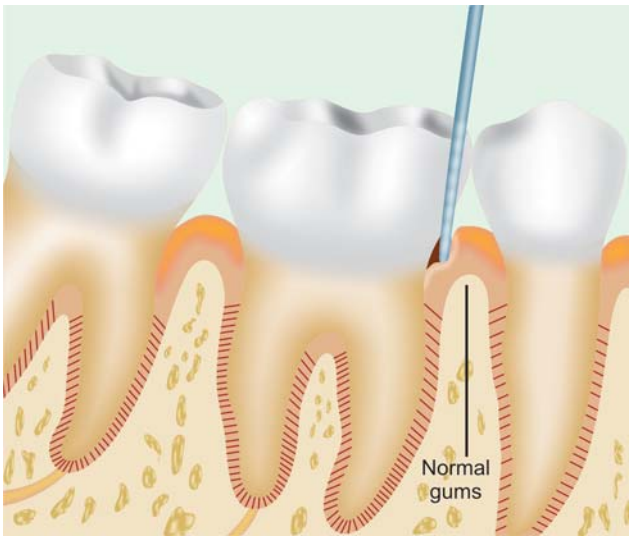


Fig. 36.1: Healthy gums

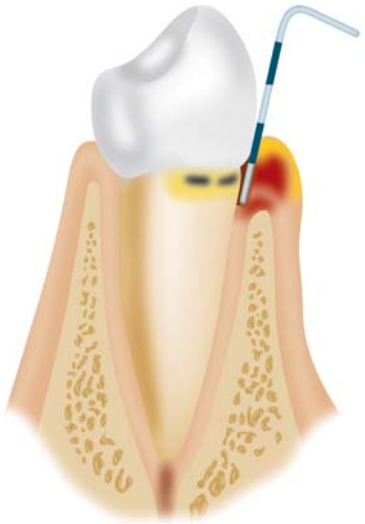


Fig. 36.3: Mild periodontitis

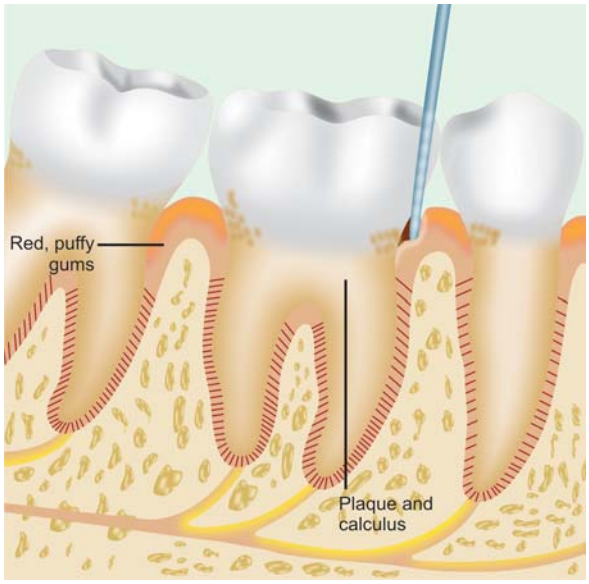


Fig. 36.2: Gingivitis

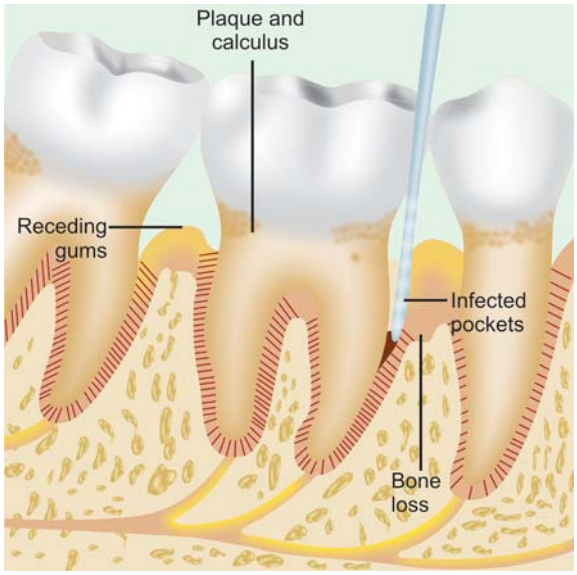


Fig. 36.4: Moderate periodontitis

Mild Periodontitis (Fig. 36.3)

- More pronounced gingival bleeding, swelling
- Gums may begin to pull away from teeth
- Pockets 3 to 4 mm deep.

Moderate Periodontitis (Fig. 36.4)

- Gum recession
- Gum abscesses may develop
- Bad breath, bad taste
- Teeth may begin to drift and show spaces
- Pockets 4 to 6 mm deep.

Advanced Periodontitis (Fig. 36.5)

- Teeth may become mobile or loose
- Constant bad breath and bad taste
- Teeth sensitive due to exposed roots
- Pockets>6 mm deep
- Some teeth may have been extracted.

PREVENTION OF PERIODONTAL DISEASE

Prevention of gingivitis and periodontitis is based primarily on plaque and calculus control around the teeth. It is generally understood that periodontitis is preceded by gingivitis, though

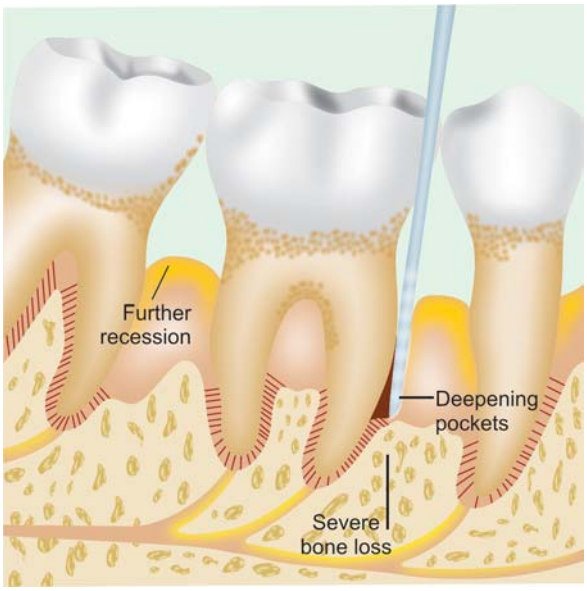


Fig. 36.5: Advanced periodontitis

signs of gingivitis may not always be apparent during bursts of disease activity leading to further attachment loss. The maintenance of good oral hygiene becomes important not only in preventing or reducing gingivitis per se and controlling the associated plaque bacteria, both of which are significant oral health objectives, but also as a measure to prevent the subsequent development of periodontitis in susceptible people. The effectiveness of rigorous levels of plaque control in helping to manage the onset or progression of periodontal diseases has been demonstrated in several clinical trials.

Approach to Plaque Control

Primary prevention of gingivitis requires consistent thorough removal of plaque as a life time basis. The rationale is to remove plaque before it mature to the point at which gingivitis begins. Plaque formation begins supragingivally. It can be controlled at this point by simple mechanical means. Once plaque becomes established subgingivally, it cannot be removed by individual by self-care and professional intervention is necessary.

Disease severity ranges along a continuum of slight to severe, and localized to generalized, depending upon the amount, location and rate of attachment loss. Chronic periodontitis often affects different areas of the mouth to different degrees. It is usually progressive, characterized by bursts of disease progression followed by periods where the disease is more quiescent. If left untreated, tooth loss may result due to the progressive nature of the disease. Clearly the goal is to attain and/or preserve oral tissue health with appropriate therapies. Success can be measured directly by preserving the dentition and periodontium, which includes the gingiva, periodontal ligament, root cementum and alveolar bone.

Surrogate markers of success in measuring periodontal health include maintaining clinical attachment levels and reducing or eliminating pocket depths, inflammation, infection and bleeding on probing. Probing pocket depth (PPD) is a measurement of the distance between the gingival margin and the base of the probable crevice. Clinical attachment loss (CAL) is a measurement of the distance between the cementoenamel junction (CEJ) and the base of the probable crevice or pocket. Furcation involvement may range from 1st degree, where horizontal loss of support is less than 1/3rd of the width of the tooth, to 3rd degree, where there is a horizontal loss of support from one side of the furcation through to the other side. Mobility can range from degree 1 (0.2-1 mm horizontal crown motion), to degree 2 (greater than 1 mm horizontal crown motion), to degree 3 (horizontal and vertical crown motion).

METHODS OF PREVENTION OF PERIODONTAL DISEASE

i. Prevention of build up of plaque
ii. Removal of other etiological risk factors

I. The essential three approaches to prevent the build up of plaque are:

1. Mechanical plaque removal by individual.
2. Mechanical plaque removal by dental professional.
3. Chemotherapeutic method of plaque control.

1. Mechanical Plaque Removal by Individual

It involves daily removal of the plaque biofilm from the teeth and adjacent oral tissues. Mechanical removal of plaque, through the use of toothbrush and other oral physiotherapy aids is most widely accepted mechanism for plaque removal.

Home Care

Home care includes mechanical and chemical plaque control by individuals.

It includes use of mechanical methods like toothbrush and interdental cleaning aids like:

Mechanical Plaque Control

1. Toothbrush
   A. Manual
   B. Electrical
   C. Ionic toothbrushes
   D. Sonic and ultrasonic
2. Interdental oral hygiene aids
   A. Dental floss
   B. Dental floss holder
   C. Toothpicks and Toothpick Holder
   D. Interproximal brushes
   E. Single tuft brushes
   F. Knitting yarm
   G. Gauze strip

H. Pipe cleaner
I. Wedge stimulators

3. Adjunctive aids
   A. Irrigation devices (Water-Pik)
   B. Tongue cleaner
   C. Dentifrices
   D. Mouthrinses [mouthwash]
   E. Rubber tip stimulator
   F. Denture brush

Toothbrushing

Toothbrushes are either manual or electrically powered devices. A manual toothbrush is made up of bristles, a head, and a handle. Bristles are the most important part of the toothbrush and are either artificial or natural in origin. A brush that is soft, round ended, or polished with artificial nylon bristles is recommended. The homogeneity of the material, uniformity of size, elasticity, resistance to fracture, and the ability to repel water and food debris give the artificial bristles many advantages over the natural bristles. However, natural bristles are seldom used in toothbrushes nowadays.

A soft bristled brush is more effective in removing plaque with less harm to soft and hard tissues than a brush with hard bristles because soft bristles are more flexible and thus can reach subgingival and proximal areas. A hard-bristled brush may cause 3 to 6 times more abrasion than soft brushes. Round ended bristles are recommended because they have been shown to cause 30 to 50 percent less soft tissue trauma than course-cut bristles. The size and shape of a toothbrush head is one of the most important parts of a toothbrush. A small head is recommended because it allows the patient to reach into places in the mouth that would be inaccessible to a large head toothbrush.

The head of the electric toothbrush is usually smaller than the manual and is removable.

The toothbrush handle should be firm, resilient, and resistant to fracture. It is very common that small brushes are recommended for children. It should be considered that neuromuscular coordination in young children is not yet fully developed. Therefore, brushes with large handles are more suitable for them. Special patients with limited arm or finger movement require modification of the handles such as enlarging or extending them.

Frequency of Tooth Cleaning

The objective of plaque control in prevention of periodontal disease is therefore, the periodic removal of the accumulated plaque at interval which is sufficiently frequent to prevent pathologic events arising from recurrent plaque formation. The frequency of brushing depends on the effectiveness of the patient in removing plaque.

Generally, the patients need two thorough brushings a day. However, the thoroughness of tooth cleaning is more important than the specific method of tooth brushing and the frequency.

Individual with healthy gingival and no history of periodontal disease can prevent gingivitis by complete plaque removal in every 48 hours.

But if the inflammation is already present, colonization of cleaned tooth surface occur much sooner and plaque grows and matures more rapidly. To control gingivitis rather than prevent its onset, more frequent plaque removal may be necessary.

Studies have shown that to achieve gingival health, the interval between tooth cleaning sessions should be not less than 12 hours and not greater than 48 hours, depending upon prevailing gingival conditions and individual susceptibility to periodontal disease.

Duration and Technique of Tooth Cleaning

Thoroughness of technique is an important factor in prevention of gingivitis. The various brushing technique are:

1. Bass method
2. Modified Bass technique
3. Stillman and Modified Stillman's technique
4. Charter's Method
5. Roll technique
6. Physiologic Method
7. Fones Method
8. Leonards method
9. Scrub Brush method.

The duration of brushing was found to have a greater influence on plaque removal than either its frequency or pattern.

The ideal tooth brushing technique is the one that removes plaque, food debris and stain, and stimulates the gingival tissues with the least time and effort, and does not damage oral tissues.

Since these criteria cannot be met with any specific tooth brushing technique, it is necessary to evaluate each individual condition in order to select the proper brushing method. It appears that a short stroke of vibrating scrub technique is the recommended method for the general public. With this method, the toothbrush can clean only one or two teeth at a time, and it will probably take about three minutes of brushing to clean all the teeth adequately.

Dental Floss

Dental floss is available in various styles and sizes. Generally, they consist of very small continuous multifilament threads or tapes of either unwaxed or waxed synthetic fibers, usually nylon.

Patients with tight teeth contact areas need thin unwaxed floss that can be slipped easily between the contact areas, whereas in patients with crowded teeth, heavy calculus deposits, or defective and overhanging restorations, a bonded

unwaxed floss or waxed floss is the dental floss of choice because they do not fray as easily as unwaxed floss. Dental tape is recommended when there is considerable interdental space resulting from gingival recession and bone loss.

In interproximal areas, routine brushing is not adequate, but interdental brushes (manual or electric) with soft bristles that bend and conform to surface irregularities may be useful (Fig. 36.6).

Flossing or use of toothpicks can disrupt interproximal plaque formation and, if performed daily, may control interproximal gingival inflammation and prevent the onset of progressive periodontal disease. However, dental flossing may not be effective in patients exhibiting exposed root surface concavities, grooves or furcations. Also, most patients are unable or unwilling to comply with the need for daily flossing. Various surveys indicate that less than 10 percent of patients use dental floss on a daily basis and more than 50 percent never use it.

Numerous devices are available to facilitate manipulation of dental floss, which may improve compliance in some patients. For all antiplaque measures, it is important to remember that overzealous and improper use of the toothbrush or dental floss can damage the teeth and the periodontium.

Brushing, rinsing, flossing and interdental brushing do not reach periodontal pathogens at the bottom of deep periodontal pockets.

Toothbrushes penetrate only 0.9 mm and oral rinses only 0.2 mm into subgingival areas.

On the other hand, oral irrigation devices designed for home use may reach as much as 50 percent of the pocket depth.

Mechanical Plaque Control and Chemical Plaque Control

Rest of the Interdental aids like toothpick, interproximal brushes, irrigation devices, toothpaste and different antiplaque mouthwashes have been discussed in detail in the chapter 'Plaque control and oral hygiene aids'.

2. Mechanical Plaque Removal by Dental Professional

Professional care has been shown to successfully control plaque deposits and gingivitis and seen as to control the progress of periodontitis.

Professional Care

Dental health education: The objectives is to produce a change in behavior which will result in a reduction of plaque accumulation sufficient enough to prevent the initiation and progression of dental caries and periodontal disease and to make the patient as much as possible, independent of professional support. Therefore, an educative approach aimed at changing the patient's attitude to periodontal disease must be used.

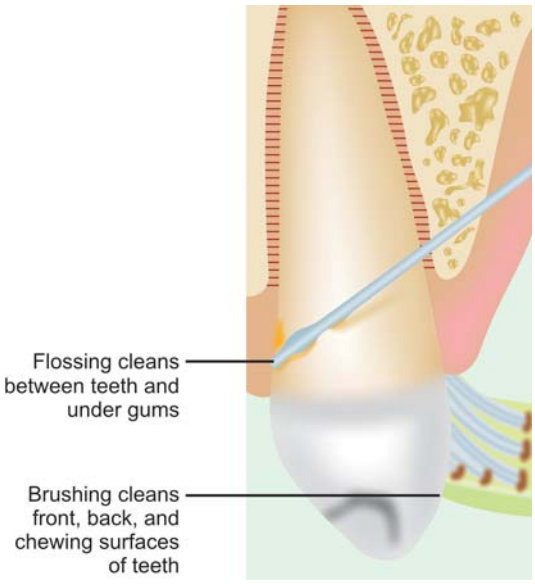


Fig. 36.6: Action of brushing and flossing

The traditional approach to dental health education and instruction in oral hygiene was carried out by dental professional at chair side which was labor intensive. Repetition could affect the mood of instruction and effect the instructions. Studies have shown that the self educational program, comprising self examination and instruction manual was as effective as chair side instruction by dental professional in changing the hygiene habits.

Oral hygiene instruction needs to be periodically reinforced to have a long term effect. The biggest challenge in the prevention of periodontal disease is how to motivate the individual to follow prescribed effective and health care programs throughout the life.

The responsibility thus would be thus:

- To provide information about the dental health
- To provide information and guidance about methods and techniques of plaque control
- Motivate the patient to bring about a change in his behavior; which promotes dental health.

The periodontal health education would include advice on:

- Dental hygiene
- Diet influencing the plaque formation, e.g. dietary sugars, natural cleansers such as fruits and vegetables, etc.
- Smoking cessation.

Scaling and Root Planning

Scaling is sufficient to remove plaque and calculus from enamel completely. Root surface, however, may have deposits

of calculus embedded in cemental irregularities. A portion of cementum must therefore be removed to eliminate these deposits. Plaque accumulation results in contamination of cementum by toxic substances notably endotoxins. Evidence suggests that this cementum may be biologically unacceptable to adjacent gingival tissues and should be removed by root planning.

Polishing

Early experimental studies have shown that polishing to a high gloss inhibits formation of pellicle and calculus but there is no documented evidence of periodontal health benefits from this practice. Removal of extrinsic tooth stains for cosmetic reasons and psychological effect of having clean teeth may be the principal effects of polishing. Removal of fluoride during polishing from superficial layers of enamel could be a significant drawback. Hence polishing cannot be supported as a routine procedure but may be indicated in when plaque removal is inhibited by surface roughness.

3. Chemotherapeutic Method of Plaque Control

Mechanical methods of plaque removal require a lot of motivation, manual dexterity and time. These problems have led to the development of chemical methods which supplement mechanical cleaning. These include chemicals and antimicrobials mouthwashes discussed in detail in chapter-Plaque control and oral hygiene aids.

Chemical Plaque Control

1. Antibiotics
2. Enzymes
3. Phenolic compounds and essential oils
4. Quaternary ammounium compounds
5. Bisguanides
6. Natural products
7. Metal salts
8. Amine alcohols
9. Oxygenating agents
10. Fluorides

II. Removal of other etiological risk factors such as

- Ill-fitting dentures
- Faulty restorations
- Plunger cusp
- Stress
- Smoking, etc.

Levels of Prevention of Periodontal Disease

Preventive periodontal therapy can be categorized as primary, secondary or tertiary.

Primary prevention aims to reduce risk factors (e.g. dental plaque removal, immunization against possible periodontal pathogens) before clinical presentation of disease and can be accomplished by intervention strategies aimed at both the general public and special, high risk populations. The latter group includes people with a family history of severe periodontal disease, pregnant women, diabetic patients, patients infected with the human immunodeficiency virus, patients with neutrophil defects, and people with various behavioral risk factors, such as smoking and excessive consumption of refined carbohydrates (in dental caries prone subjects). Patients at high risk of developing periodontitis should be monitored more closely and treated more aggressively.

The aim of *secondary prevention* is to intervene at early disease or precursor states (e.g. treating gingivitis to prevent the development of periodontitis).

Tertiary prevention seeks to limit the impact of established disease (e.g. resection of deep periodontal pockets to reduce nidi for plaque accumulation).

PATIENTS' ROLE IN PREVENTIVE PERIODONTAL THERAPY

The least expensive way to manage periodontal disease is through self-care. However, the effectiveness of patient; preventive efforts is questionable. Self-care can involve various mechanical and antimicrobial approaches and should be customized for each patient, depending on periodontal conditions and the patient's ability and willingness to comply. To improve the effectiveness of self care measures, dental professionals must communicate effectively with patients and reinforce the need for preventive periodontal therapy.

SUPPORTIVE PERIODONTAL THERAPY (SPT)

It is an extension of periodontal therapy, which is planned following the active phase of periodontal care at approximately timed intervals to review the general health history, reassess the status of periodontal health, and provide preventive oral hygiene care.

It is also called as periodontal maintenance or preventive maintenance.

Examples include:

1. Smoking cessation assistance.
2. At home, rinsing, irrigation, use of dentifrices and other antimicrobials.
3. Desensitization of teeth.
4. Correction of biofilm retaining irregularities.
5. Counseling for patients with systemic diseases for which periodontal infection is a risk factor, e.g. diabetes, cardiovascular disease, etc.

Goals of SPT

The goals of SPT are to:

1. Prevent or minimize recurrence and progression of periodontal disease in patients who have been treated for gingivitis or periodontitis.
2. Prevent or reduce incidence of tooth loss.

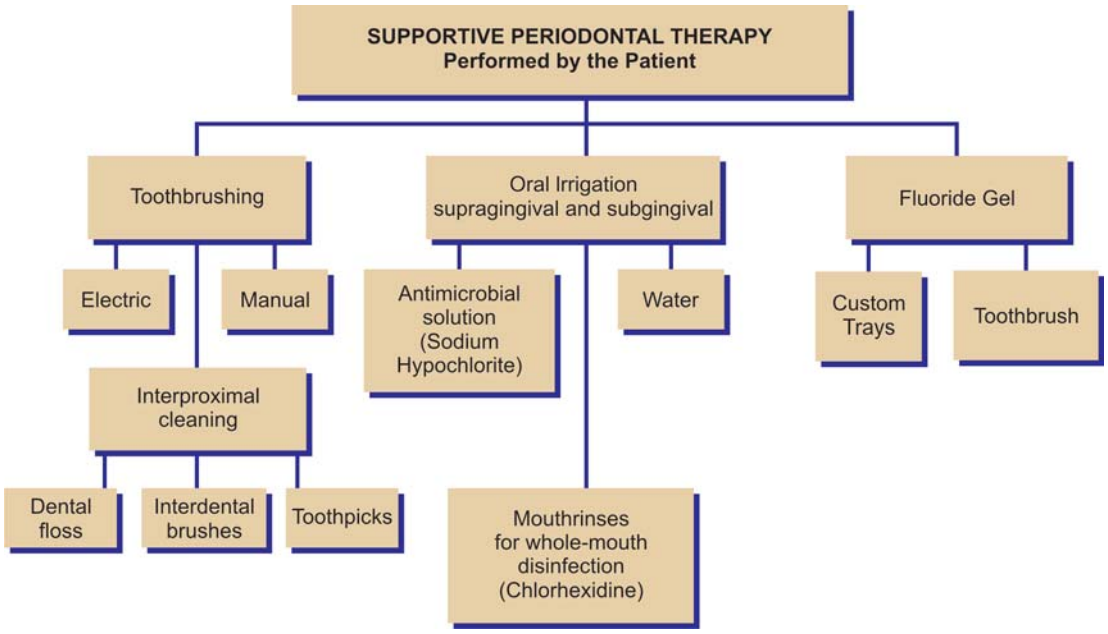


Fig. 36.7: Supportive periodontal therapy performed by the patient

Components of SPT

1. *Health history* (smoking, systemic diseases, pregnancy, stress).
2. *Pharmacological history* (medication).
3. *Dental history.*
4. *Restorative examination* (prosthesis, caries activity and restoration, implants, overhangs or ill fitting restorations).
5. *Periodontal examination* (gingival inflammation, probing depth, attachment loss, bleeding on probing, bone loss, furcation involvement, mobility).
6. *Deposits* (supra- and subgingival plaque and calculus).
7. *Radiographs* (to assess the advancing disease).
8. *Assessment* of the patient's self-reported oral hygiene regimen.
9. *Microbiological monitoring*.
10. *Removal of supragingival deposits.*
11. *Removal of subgingival accretions.*
12. *Behavior modification* (including oral hygiene instruction and control of risk factors such as smoking cessation).
13. *Planning* future appointments.

Frequency of SPT

The frequency of maintenance and care depends on patients susceptibility to periodontal disease, but at least four appointments per year are recommended for most patients with a history of periodontitis. This is due to the reason that after periodontal pathogens are suppressed, they return to pretreatment levels in 9 to 11 weeks but this interval may vary significantly among persons.

Most studies show that patients who receive frequent professional preventive therapy are more likely to maintain their periodontal attachment levels than are patients who have more infrequent maintenance care appointments.

To improve the effectiveness of self care measures, dental professionals must communicate effectively with patients and reinforce the need for preventive periodontal therapy. Self-care can involve various mechanical and antimicrobial approaches and should be customized for each patient, depending on periodontal conditions and the patient's ability and willingness to comply (Fig. 36.7).

37 Prevention of Malocclusion

CM Marya, Gurkeerat Singh

INTRODUCTION

Preventive orthodontics generally shows results over a period of time. The right time to initiate preventive orthodontics would be ideally during prenatal counseling.

Begg in 1977 stated that "the proper time to begin treatment is as near the beginning of the variation from the normal, in the process of development of the dental apparatus, as possible". Such observations are extremely apt in clinical situations as the magnitude of the problem remains small and so does the duration of treatment and at times the cooperation levels.

In our society, the deciduous dentition is given the least importance, with the promise that the deciduous teeth have to exfoliate eventually. However, maintaining the integrity of deciduous teeth and occlusion leads to their preservation up to exfoliation, which in turn forms one of the most important steps in preventive orthodontics. Therefore, this is largely the responsibility of the pedodontist and where such specialists are unavailable, of the general dentist. The general dentist's view of initiating treatment should be as early as possible instead of the now impregnated view that it should be initiated after all the permanent teeth have erupted. There is a fundamental need for a shift in this thought process among the general dentists.

Some of the procedures and concepts of preventive and interceptive orthodontics are common but the time of application pertaining to the stage of dental development are different. These procedures not only prevent or intercept a developing malocclusion, but also allow proper mastication to develop along with speech, which in turn leads to the development of an individual with good esthetics and has a positive psychological effect apart from guiding dental growth and development positively.

Definition

Graber (1966) has defined preventive orthodontics as the action taken to preserve the integrity of what appears to be a normal occlusion at a specific time.

Profitt and Ackermann (1980) has defined it as prevention of potential interference with occlusal development.

PREVENTIVE MEASURES UNDERTAKEN (PREVENTIVE ORTHODONTICS)

1. Parent counseling
2. Caries control
3. Space maintenance
4. Exfoliation of deciduous teeth
5. Abnormal frenal attachments
6. Treatment of locked permanent first molars
7. Abnormal oral musculature and related habits.

PARENT COUNSELING

Parent counseling though the most neglected, is the most effective way to practice preventive orthodontics.

Parent counseling may be divided into:

a. Prenatal counseling
b. Postnatal counseling which in turn can be associated with the clinical examination of the child at:
   i. Six months to one year of age
   ii. Two years of age
   iii. Three years of age
   iv. Five to six years of age.

Prenatal Counseling

This is the most effective time to get across to the expecting parents. They are open to ideas and receive the suggestions regarding better welfare of the child's well being. The gynecologists would benefit immensely on having their patients counseled on dental health.

Prenatal counseling may involve the following:

- The importance of oral hygiene maintenance by the mother.
- How irregular eating and hunger pangs by the mother can result in her developing decayed teeth, which can

be quite painful on pulpal involvement, especially during the third trimester of pregnancy.
- Recent studies have indicated a possible co-relationship between the mother's poor oral hygiene and premature births.
- A mother suffering from pregnancy induced diabetes mellitus, would be more difficult to manage during the pregnancy period especially if her oral hygiene is poor.
- To have natural foods containing calcium and phosphorus, e.g. milk, milk products, egg, etc. especially during the third trimester, as they would allow adequate formation of deciduous teeth crowns.

Postnatal Counseling

Postnatal counseling should be advocated along with the clinical examination of the child. The same can be divided into:

Six Months to One Year of Age

This is the most important period of counseling. The parents are made aware of:
- Teething and the associated irritation, slight loose motions are possible in mildly elevated febrile condition
- Most of the parents are appalled on seeing the deciduous teeth erupting in rotated positions. Awareness to be brought about as to how they are in that position and that they would eventually straighten out on erupting fully
- No sugar addition to bottle milk, however mother's milk is preferred and the best for the TMJ development as well as for non development of tongue thrusting habits
- Brushing with the help of a finger brush (Fig. 37.1) during bathing should be introduced. Cleaning of the deciduous dentition with a clean, soft cotton cloth dipped in warm saline is also recommended, to prevent the initiation of nursing or rampant caries
- Child should be initiated to drinking from a glass by one year of age.



Fig. 37.1: Finger brush

Two Years of Age

- Bottle feeding if previously initiated should never be given during the passage to sleep. Bottle feeding should be withdrawn completely by 18 to 24 months of age. This would decrease the chances of initiation of decay and the potential for nursing caries
- Brushing to be initiated post-breakfast and post dinner
- Clinical examination to assess any incipient decay and eruption status of teeth.

Three Years of Age

- *Clinical examination*—Generally the full comple-ment of deciduous dentition should have erupted by now. To assess the occlusion, molar and canine relationships and if there is the presence of any discrepancies away from the normal, e.g. unilateral cross bite, supernumerary teeth, missing teeth, fused teeth, etc
- The child should be on 3 square meals a day.
- Oral habits such as thumb sucking, lip sucking, oral breathing, etc and their effects on the development of occlusion should be considered. Parents should be informed accordingly. The use of muscle training appliances should be considered
- To assess clinically for incomplete eruption of deciduous second molars/pericoronal flaps may lead to decay on the same
- Child to be encouraged to begin brushing on his own at least once a day, preferably post breakfast.

Five to Six Years of Age

- Parents to be informed about the initiation of exfoliation of deciduous teeth and that it would go up to 12 to 13 years of age
- Clinical examination
- The need for constant review and recall on a regular basis
- In case of extraction of deciduous teeth due to decay, etc. the needs, advantages and importance of space maintainers should be explained.

CARIES CONTROL

Caries involving the deciduous teeth (Fig. 37.2), especially the proximal caries is the main cause of development of a malocclusion. There has been a sudden spurt in nursing and rampant caries (Fig. 37.3), involving the deciduous



Fig. 37.2: Caries involving deciduous teeth



Fig. 37.4: Placement of stainless steel crown in deciduous dentition



Fig. 37.3: Rampant caries

and the mixed dentition generally, which has resulted in a sudden demand for preventive and interceptive orthodontics. The importance of maintaining and preserving the deciduous dentition should be counseled to the parents and pediatricians.

Most of the parents first seek the opinion of their pediatrician regarding their child's decayed teeth. In case of proximal decay, the adjacent tooth tends to tilt into the proximally decayed area resulting in the loss of arch length, thereby resulting in lesser space for the succedaneous tooth to erupt in their rightful place and position. Therefore, the proximal decay should be restored accurately at the earliest and much problems may not arise provided arch length loss is equal to or less than the Leeway Space of Nance. In case of pulpal involvement due to caries, partial pulpectomy or pulpotomy is done followed by the placement of stainless steel crown (Fig. 37.4).

Caries initiation can be prevented by diet counseling, topical fluoride application, pit and fissure sealants and educating parents (prenatal counseling and postnatal counseling).

SPACE MAINTENANCE

Space maintainers in different forms may be required to maintain spaces in case of premature loss of teeth (to be discussed later in this chapter) (Fig. 37.5).

EXFOLIATION OF DECIDUOUS TEETH

Generally the deciduous teeth should exfoliate in about three months of exfoliation of the one in the contralateral arch. Any delay more than that should be considered with suspicion and the following should be ruled out:

- Overretained deciduous/root stumps
- Fibrous gingivae
- Ankylosed/submerged deciduous teeth to be assessed radiographically
- Restoration overhangs of the adjacent tooth
- Presence of any supernumerary tooth.

ABNORMAL FRENAL ATTACHMENTS

It may cause the development of diastemas/excess spacing between the teeth, which in turn may not allow the eruption of succedaneous teeth. Surgical correction of the high frenal attachments is therefore advised (Figs 37.6A and B). The tongue should also be assessed for ankyloglossia/tongue-tie (Fig. 37.7).

LOCKED PERMANENT FIRST MOLARS

The permanent first molars may get locked distal to the deciduous second molars, at times. Slight distal (proximal) stripping of the deciduous second molar allows the permanent first molar to erupt in their proper place.



Fig. 37.5: Space maintainers



Fig. 37.6A: A "high" labial frenum attachment

ABNORMAL ORAL MUSCULATURE

Abnormal oral musculature can be prevented:

- *Tongue thrusting habits* or retained infantile swallow patterns are related to prolonged breastfeeding or bottle feeding by the mother. The same should be withdrawn by 18 to 24 months of age.
- *Hyperactive mentalis* action results in the lingual inclination of mandibular incisors resulting in decreased arch length and an increased chance for the developing anterior crowding.
- Oral habits such as:
  i. *Thumb/digit/lip sucking*-The child can be distracted from indulging in the same.
  ii. *Mouth breathing*-The child can be given adequate medical attention, regarding recurrent upper respiratory tract infection. Oral screens (Fig. 37.8) and the recently introduced myofunctional appliances such as the pre-orthodontic trainers, (Fig.37.9) train the child to breathe through the nose, thus allowing the proper development of nasal passage, regression of adenoid mass and the development of a shallow, broad palate.



Fig. 37.6B: The muscle attachment was surgically removed to allow permanent maxillary central incisors to move together



Fig. 37.7: Tongue-tie

SPACE MAINTENANCE (IN THE DECIDUOUS AND THE MIXED DENTITION)

Space maintenance is defined as the measures or procedures that are brought into use due to premature loss of deciduous tooth/teeth, to prevent loss of arch development.

Space maintainers are defined as the appliances that prevent loss of arch length and which in turn guide the permanent tooth into a correct position, in the dental arch (Fig. 37.10).

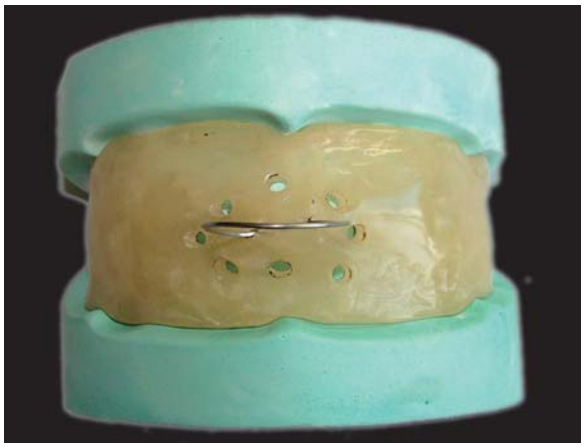


Fig. 37.8: Oral screen

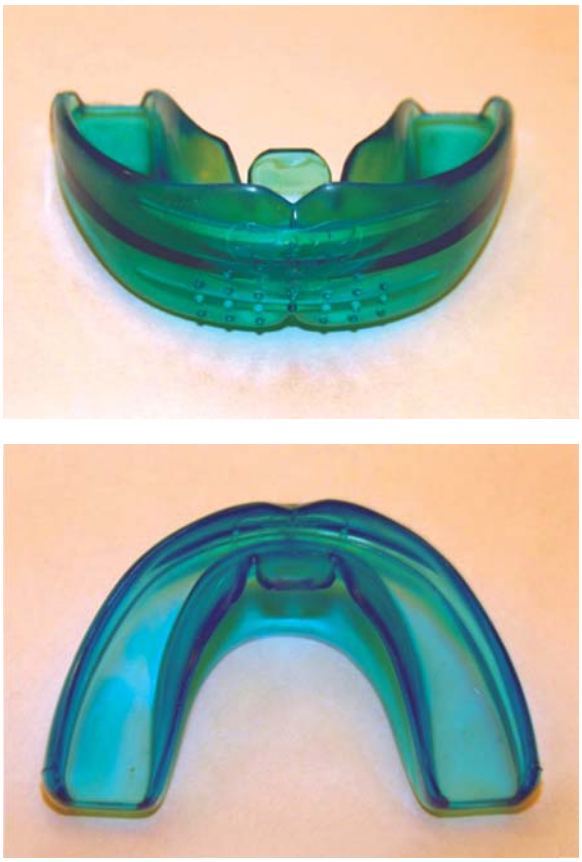


Fig. 37.9: Pre-orthodontic trainer

Premature loss of deciduous tooth/teeth in the anterior or posterior quadrant results in the adjacent tooth to tip or migrate into the edentulous space. This in turn results in a decrease in the arch length, which if greater than the Leeway space of Nance, would lead to lesser space for the premolars to erupt. The premolars would then be impacted or erupt buccally or lingually, resulting in a malocclusion.



Fig. 37.10: Fixed type space maintainer to prevent mesial migration of permanent 1st molar

The likelihood of a child requiring corrective orthodontic treatment tends to increase on premature loss of deciduous teeth, irrespective of it being deciduous first or second molars.

FACTORS TO BE CONSIDERED FOR SPACE MAINTENANCE

1. *Time elapsed since loss of tooth:* Maximum loss of space occurs within 2 weeks to 6 months of the premature loss of deciduous tooth. In the majority of cases, patients do not come back for space maintainers post-extraction despite being informed of the same.
   Therefore, it is recommended to fabricate the space maintainer before the extraction and to be inserted at the time of extraction.
2. *Dental age of the patient:* The dental age is more important than the chronological age of the patient.
   Several studies have indicated that the premature loss of a deciduous molar less than 7 years of chronological age generally leads to a delayed eruption by more than a year but the loss after 7 years of chronological age may lead to premature eruption. However, this is not true for many cases and the dental age is a more reliable parameter.
3. *Amount of bone covering the developing succedaneous tooth bud:* The developing premolars usually require 3 to 5 months to move through 1 mm of covering alveolar bone, as observed on a bitewing radiograph. However, the eruption could be earlier provided the alveolar bone covering the developing tooth bud has been destroyed by the periapical/furcation involvement of the deciduous tooth.
4. *Stage of root formation:* The developing tooth bud begins to erupt actively if the root is three-fourth formed.
5. *Sequence of teeth eruption:* The status of the developing and erupting tooth buds adjacent to the space created by the premature loss of the deciduous tooth is important. Two clinical conditions are of importance:

- The first one being is premature loss of deciduous second molar. If the level of eruption of the second permanent molar is at a level higher than that of the second premolar, then there is a likelihood of permanent first molar to tip mesially and impact the eruption of the second premolar.
- The second scenario is that of premature loss of deciduous first molar and an erupting permanent lateral incisor, which tends to distally ditch the deciduous canine thus effecting the eruption of permanent first premolar. This also results in the lingual inclination of the anteriors especially in the mandible thus resulting in the collapse of the anterior segment.

6. *Congenitally missing teeth:* If detected before the tooth distal to them erupts, it is advisable to extract their precursor deciduous tooth. This would permit the tooth present distal to the congenitally missing tooth to move bodily and erupt in its place. And, if the space has been created as the congenitally missing tooth was detected later on, the edentulous area can be rehabilitated prosthetically.
7. *Eruption of the permanent tooth in the opposite arch:* If the permanent tooth in the opposing arch to the prematurely lost tooth has erupted, then an occlusal stop should be placed on the planned space maintainer so as to prevent the supra eruption of the opposing permanent tooth, which in turn would maintain an acceptable curve of Spee.

IDEAL REQUIREMENTS OF SPACE MAINTAINERS

1. Should maintain the desired mesiodistal dimensions of the space.
2. Should not interfere with the eruption of the permanent teeth.
3. Maintenance of functional movement (physiological) of the teeth.
4. Should allow for space regainence mesiodistally, when required.

Fixed space maintainers require lesser maintenance and cooperation as compared to removable space maintainers. All types of appliances tend to break.

Lingual arch on the mandible appears to fracture/disfigure the most.

CLASSIFICATION OF SPACE MAINTAINERS

Majority of the authors classify them into:

A. Fixed
B. Removable

INTERCEPTIVE ORTHODONTICS

A malocclusion, if detected as soon as possible, can be eliminated or made less severe, by initiation of interceptive orthodontic procedures. Preventive orthodontic procedures are also interceptive in nature if undertaken soon after the development of the malocclusion.

An interceptive procedure undertaken at the right time can, therefore, either eliminate a developing malocclusion or make it less severe, so as to allow corrective orthodontics to deliver a stable and conservative result, in the shortest treatment time possible with least discomfort to the patient. An interceptive orthodontic procedure will ensure that an oral habit does not become fixed and its deleterious effects do not affect the normal growth and development of the patient. It will also ensure that there is no loss of arch length due to the premature loss of deciduous tooth/teeth or due to rotated teeth or on crowding of teeth and guide the growth of mandible by using myofunctional appliances so as to deliver greater benefits to the patient.

Council of Orthodontic Education of the American Association of Orthodontists: Orthodontics Principles and Policies has defined Interceptive Orthodontics as that phase of the science and art of orthodontics employed to recognize and eliminate potential irregularities and malpositions in the developing dentofacial complex. It implies that corrective measures may be necessary to prevent a potential irregularity from progressing into a more severe malocclusion.

The basic interceptive procedures undertaken are

1. Space regaining
2. Correction of anterior and posterior cross bites
3. Elimination of oral habits
4. Muscle exercises
5. Removal of soft or hard tissue impediments in the pathway of eruption
6. Resolution of crowding
7. Interception of developing skeletal malocclusions.

Space Regaining

If space maintenance is not carried out on the premature loss of a deciduous second molar, the permanent first molar may tip or move mesially, resulting in the loss of the arch length. The loss of the arch length may impede the second premolar to erupt (Fig. 37.11).

Causes of the mesial tipping/drifting of molars are:

1. Extensive carious lesions.
2. Ectopic eruption.
3. Premature extraction of primary molars—without any space maintenance.

Correction of Anterior and Posterior Cross Bites

Cross bites, ianterior or posterior should be corrected as soon as they are detected. Some authors believe that the same should be treated during the deciduous dentition. However, it may be better to treat them as the permanent teeth begin to erupt into the oral cavity.



Fig. 37.11: Space regainers

The child may be too young and uncooperative at the deciduous dentition stage. Moreover, it is easier to bring about changes in the mixed dentition stage.

Cross bites can be unilateral or bilateral. These can also be true or functional in nature or a combination of the two.

If the cross bite is not treated in time it could lead to a skeletal malocclusion, which would require corrective orthodontic treatment later on.

Some of the common appliances used in the correction of cross bites are tongue blade therapy, inclined planes, composite inclines, Hawley's appliance with Z-spring , quad helix appliance.

Elimination of Oral Habits Leading to Interception

Habits Related to Oral Cavity

Habit can be defined as the tendency towards an act that has become a repeated performance, relatively fixed, consistent and easy to perform by an individual. It is necessary to record such habits which are related to the oral cavity or which affect the oral cavity.

Oral habits such as thumb/digit sucking, mouth breathing, tongue thrusting, lip sucking, etc. tend to cause malocclusions. Clinical studies have linked the development of Class II malocclusions to these oral habits. All the oral habits lead to an imbalance in the forces acting on the teeth, causing the development of dental malocclusions and if left untreated over a longer period of time, these definitely cause skeletal malocclusions. Oral habits also lead towards abnormal positioning of the tongue, aberrant lip and perioral musculature, development of unfavorable V shaped and high palatal arches as well.



Fig. 37.12: Thumb sucking

Thumb or Digit Sucking

The habit of thumb or digit sucking is considered normal till the age of 3½ to 4 years (Fig. 37.12). Prolonged habit may lead to malocclusion.

The diagnosis of this habit can be done by relating clinical findings. The clinical findings for thumb or digit sucking are:

- Increased overjet - Labial tipping of upper anterior and/or lingual tipping of lower anterior
- Open bite (Fig. 37.13)
- Posterior cross bite
- Callus on fingers/thumb and clean nails



Fig. 37.13: Open bite due to thumb sucking

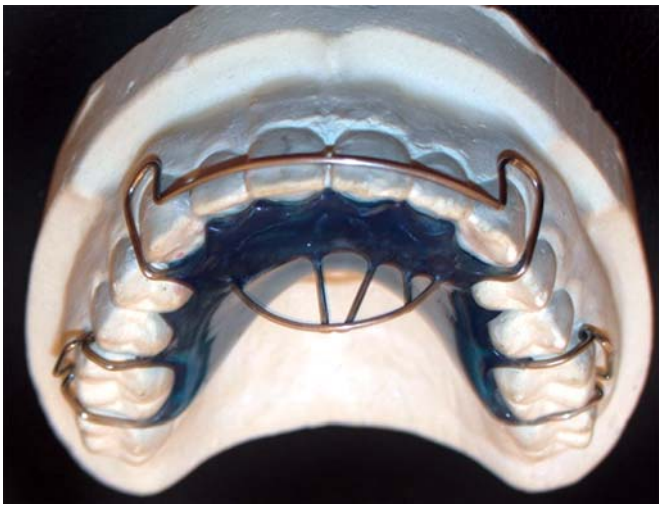


Fig. 37.15: Habit breaking appliance for thumb sucking

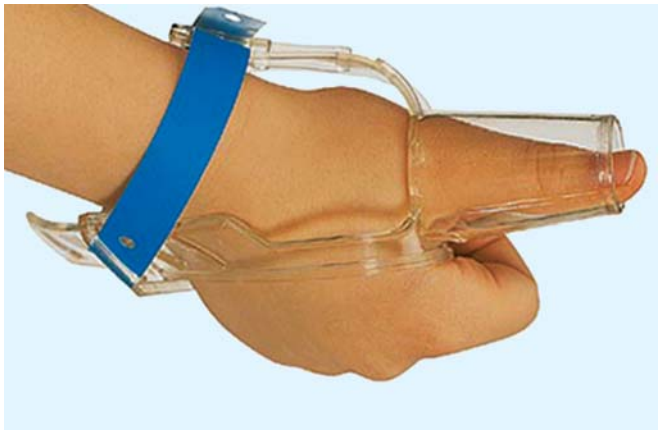


Fig. 37.14: Thumb guard

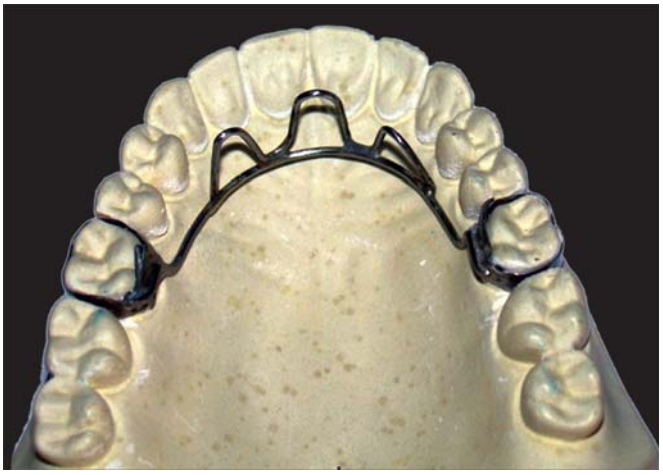




Fig. 37.16: Habit breaking appliance (fixed type) for tongue thrusting

- Apart from the clinical signs enquiry with the parents (for children) or directly asking the patient may provide information.

Habit breaking appliances are given to the child to prevent thumb sucking such as thumb guard and crib (Figs 37.14 and 37.15).

Tongue Thrusting

Tongue thrusting can be identified by the following clinical signs:

- Proclination of upper and lower anteriors
- Anterior open bite
- Bimaxillary protrusion
- Indentition on tongue
- An enquiry with patient may be necessary for confirmation.

Habit breaking appliances are given to the child to prevent tongue thrusting (Fig. 37.16).



Fig. 37.17: Nail biting

Mouth Breathing

Mouth breathing can be identified using one of the following methods

Mirror test – A double sided mirror is placed between nose and mouth. Fogging will occur on the side of respiration.

Water test – Patient is asked to fill his mouth with water. After sometime the mouth breathers will start to feel uncomfortable.

The clinical features of mouth breathing are:

- Long narrow face
- Gingivitis of upper anteriors
- Increased caries pattern.

Biting Lip/Nail/Pen/Pencil (Fig. 37.17)

Patient will generally accept the presence of the habit. The clinical features range from:

- Wear of incisors
- Cracking of lips
- Notching of teeth.

Muscle Exercises

The normal development of the occlusion depends on the nature of the muscles of the face. If the oromaxillofacial musculature were in a state of balance, a good occlusion would develop and if any of the muscle groups were aberrant it would result in a malocclusion in some form or the other. Muscle exercises allow a clinician to bring such aberrant muscular functions into normal functioning, to create normal health and function, as they are important elements in aiding growth and development of normal occlusion.

Uses

1. To guide the development of occlusion.
2. To allow optimal growth patterns.
3. To provide retention and stability in post corrective (mechanical) orthodontic cases.

Exercises

Exercises of orbicularis and circumoral group of muscles:

- Upper lip is stretched in the posteroinferior direction by overlapping the lower lip. Such muscular exercises allow the hypotonic lips to form an oral seal labially.
- Hypotonic lips can also be exercised by holding a piece of paper between the lips.
- Parents can stretch the lips of the child in the posteroinferior direction at regular intervals.
- Swishing of water between the lips until they get tired.
- Massaging of the lips.
- Playing a reed musical instrument produces fine lip tonicity.
- Placement of scotch tape over the lips helps to train them to remain sealed.
- Use of an oral screen with a holder to exercise the lips.
- Button pull exercise: A 1½ inch diameter button is taken through which a thread is passed. The patient is asked to place the button behind the lips and pull the thread while the lips try to resist the same.
- Tug of war exercise: Is similar to the button pull exercise, where the difference is that two buttons are used and another individual pulls the thread gently while the same movement is resisted, by the patient.

Exercises of the Tongue

Exercises of the tongue are done to correct any aberrant tongue swallow patterns:

- *One elastic swallow:* Orthodontic elastic, usually 5/16th inch, is placed on the tip of the tongue and the patient is asked to raise the same to rugae area and swallow.
- *Two elastic swallow:* 25/16th inch elastics are used and one is placed on the tip of the tongue whereas the other is placed on the dorsum of the tongue in the midline and asked to swallow.
- *Tongue hold exercise:* A 5/16th inch elastic is used and the patient is asked to place the same on a designated spot over a definite period of time with the lips closed. The patient is asked to swallow with the elastic in the designated position and lips apart.
- *Hold pull exercise:* The tip of the tongue is made to contact the palate in the midline and the mandible is gradually opened. This allows the stretching of the frenum to relieve a mild tongue-tie.

Exercises of Masseter Muscles

At times, it is advised to strengthen the masseter muscles. The patient is asked to clench his teeth, count up to 10 in his mind and then relax them. This has to be repeated over a period of time, until the masseter muscles feel tired.

Exercises of Pterygoid Muscles

In case of disto occlusion cases, the patient is asked to protrude the mandible as much as possible and then retracted. Repeat the exercises until the muscles feel tired. The ability to keep the mandible in correct position gradually improves.

Limitations of Muscle Exercises

1. Exercises are not known to drastically alter any bone growth pattern.
2. They are not a substitute for corrective orthodontic treatment.
3. Patient compliance is extremely important.
4. If not done correctly, can be counterproductive.

Removal of Soft or Hard Tissue Impediments in the Pathway of Eruption

The clinical conditions in which the hard and soft tissue acts as an impediment in the natural pathway of tooth eruption are:

Retained Deciduous Tooth/teeth

A clinical manifestation, which has become more common today due to the shift from hard, detergent diet to a soft diet.

Generally, retained deciduous teeth are observed in the mandibular anterior region, with the permanent teeth erupting lingually or in the maxillary anterior and buccal regions, with the permanent teeth erupting labially/buccally. The unilateral presence of such retained teeth also results in a midline shift thus compounding an arch space deficiency in a quadrant (Fig. 37.18). Interception by extraction of the retained deciduous teeth would resolve the malocclusion completely or decrease its severity, thus allowing easier management of the same.

Supernumerary Teeth

Presence of supernumerary teeth and mesiodens would impede the eruption of the permanent teeth in their rightful place (Fig. 37.18). Therefore, timely extraction of the same would go a long way in interception of a developing malocclusion.

Fibrous/Bony Obstruction of the Erupting Toothbud

If the contralateral tooth fails to erupt even after three months, there should be a cause for concern and a radiographic assessment, therefore, becomes mandatory. Surgical intervention may be required.



Fig. 37.18: Supernumerary teeth

RESOLUTION OF CROWDING

Crowding of teeth is one of the primary reasons that a parent tends to bring a child for a pediatric dental consultation. Crowding is present at different stages and of variable severity during the mixed dentition stage. Normally, in the anterior segment, the incisal liability plays an active role whereas in the posteriors, the Leeway space of Nance helps in the resolution of any crowding.

Incisal liability in the anteriors occurs due to the greater mesiodistal dimensions required by the permanent incisors as compared to their deciduous predecessors. Due to the same, the crowding may further accentuate, especially in a non-spaced dentition and where primate spaces are absent. In such clinical conditions, the mandibular lateral incisors may erupt more lingually and the maxillary lateral incisors may erupt more palatally or labially. The deciduous permanent tooth size differential averages 6 to 7 mm even when there is no crowding.

Management of Crowding

The stepwise management of crowding involves the following steps:

1. Observation
2. Disking of primary teeth
3. Extractions and serial extraction
4. Corrective orthodontic referral.

1. *Observation:* Clinical observation of the spaces in the deciduous dentition reveals 50 percent chances of resolution of crowding in permanent dentition, if the physiological spaces are between 2 to 3 mm, and no crowding occurs, if these spaces are > 6 mm.
   If the crowded permanent incisors require 2 mm spaces for resolution, then there is a greater chance that no interception would be required. Therefore, a regular recall and review regimen is a must.
2. *Disking of primary teeth:* It is again an effective mechanism to resolve anterior crowding. This procedure is generally done if the space required for the resolution of anterior crowding is not > 4 mm. Disking is done of the mesial surfaces of the deciduous canines, followed by that of the distal surfaces of deciduous canines, if more space is required. If still more space is required after recall and review, then mesial surfaces of the deciduous first molars can be disked. Topical fluoride

application after disking is a must to ensure that child does not suffer from any sensitivity.

The combination of observation and disking allows the interceptive pedodontist to treat a larger proportion of anterior crowding cases, provided the cases are referred on time and that they seek review as and when advised.

3. *Extractions and serial extraction:* Retained deciduous teeth should be extracted if their successors have erupted and submerged deciduous teeth should be extracted on radiographic and clinical evaluation.
4. *Corrective orthodontic referral:* Cases treated by serial extraction as well as severe crowding cases and those having severe dentoskeletal malocclusions should be referred to the corrective orthodontists for the needful.

Fixed orthodontics might be required in some cases even in the mixed dentition case.

Intervention should be of a short duration and only undertaken in selective cases. A retention appliance is a must following removal of the appliance.

Serial Extraction and Guidance of Eruption

It is logical to intercept a malocclusion as early as possible and to reduce or, in rare instances, avoid banded or bonded corrective therapy at the sensitive teenage period.

Serial extraction, if done properly in carefully selected patients reduces time, the cost of the treatment, discomfort to the patient and time lost by the patient and the parents. These days more stress is being put on lingual correction system as well as ceramic and invisible corrective orthodontic treatment systems, serial extraction becomes more important, as the best way to hide the appliances is not to use them at all or use them for a limited period of time.

One of the most crucial decisions that the clinicians are required to make, is whether to extract teeth for the correction of the malocclusion. To do this, they need all the intelligence, training and experience they can muster. Adding the dimension of time, complicating the clinical situation as growth and development proceeds, the treatment by serial extraction procedures make it even more demanding. Serial extraction therefore should never be initiated without a comprehensive diagnosis, which is established by a thorough evaluation of the diagnostic records.

Definition

Tweed has defined it as the planned and sequential removal of the primary and permanent teeth to intercept and reduce dental crowding problems. Dental crowding exists where there is an excess of tooth material in relation to the amount of basal and alveolar bone that supports the teeth.

Indications

1. Class I malocclusion with an arch size, tooth size deficiency of 5 mm or more per quadrant, normal eruption sequence as assessed radiographically and a skeletal growth pattern within normal limits.
2. Arch length deficiency, which could be unilateral or bilateral, is indicated by:
   a. Non-pathologic
      i. Midline shift of mandibular incisors due to displaced lateral incisors.
      ii. Premature loss of deciduous canine.
      iii. Abnormal canine root resorption.
      iv. Canine being blocked out labially.
      v. Mandibular and maxillary anterior teeth that are proclined (bimaxillary protrusion), could be associated with crowding.
      vi. Gingival recession on the labial aspect of mandibular anterior.
      vii. Ectopic eruption.
   b. Pathologic
      i. Extensive proximal caries and subsequent mesial migration of the teeth distal to the carious lesion.
      ii. Premature loss of deciduous tooth and lack of subsequent space maintenance.
      iii. Deleterious oral habits.
      iv. Improper proximal restorations.
      v. Tooth ankylosis.

Contraindications

1. Mild to moderate crowding with tooth size arch length deficiency < 5 mm per quadrant.
2. Class II division 2 and Class III malocclusions.
3. Spaced dentition.
4. Congenital absence as in anodontia/oligodontia.
5. Extensive caries involving permanent first molars, which cannot be conserved.
6. Open bite and deep bite, which should be corrected first.

Procedure

Different authors have given different sequences for following guidance of occlusion. Some of the most common and accepted sequences are:

a. Tweed's method
b. Dewel's method
c. Nance's method

It is important that before each step of extraction, the sequence should be reevaluated.

Tweed's Method (1966)

Proposed the extraction sequence DC4. The deciduous first molars are extracted at eight years of age. The deciduous canines are maintained to slow down the eruption of permanent canines. As soon as the first premolars are in the advanced eruptive stage wherein their crowns are above the

alveolar bone radiographi-cally, the deciduous canines along with the first premolars are extracted.

Dewel's Method (1978)

Proposed the extraction sequence CD4. At about eight and half years of age the deciduous canines are extracted so as to create space for the self alignment of crowded anteriors. At about nine and half years of age, as the incisor crowding would have got resolved and the first premolar would have had their roots developed up to their half level or more radiographically, the deciduous first molars are extracted so as to allow the first premolar to erupt prematurely into the oral cavity. The first premolars are then extracted to allow the permanent canines to erupt in their place and in alignment.

Nance's Method

Proposed the extraction sequence of D4C. It is basically a modified Tweed's method. It involves the extraction of deciduous first molars at about eight years of age, which is followed by the extraction of the first premolars and deciduous canines.

Interception of Developing Skeletal Malocclusions

A developing skeletal malocclusion if detected at an earlier stage can be intercepted so as to decrease its severity and at times even resulting in a normal occlusion.

These changes are brought about by myofunctional therapy, which more appropriately is known as Functional Jaw Orthopedics today.

Mills (1991) has defined a functional appliance as a removable or fixed appliance, which changes the position of the mandible so as to transmit forces generated by the stretching of the muscles, fascia and/or periosteum, through the acrylic and wirework to the dentition and the underlying skeletal structures.

38 Wasting Diseases of Teeth

CM Marya

INTRODUCTION

Non-carious destruction of teeth has been observed in archaeological material from various parts of the world and clearly pre-dates the first appearance of dental caries.

The causes of tooth wear may be intrinsic or extrinsic and are usually chemical (acidic) or mechanical (frictional) in nature. Several factors may combine to cause tooth wear in any individual patient. Tooth wear, especially tooth erosion is an increasingly recognized clinical problem. Non-carious cervical lesions (cervical wear) are defined as the loss of tooth substance at the cementoenamel junction (Mair, 1992). Terms also used to describe these are 'cervical erosion/abrasion' lesions and 'abfractions'. The term 'abfraction' evolved from the work by McCoy (1982), Lee and Eakle (1984), and Grippo (1991) and describes a theoretical process whereby occlusal forces create stresses in enamel and dentine along the cervical area and predispose it to erosion and abrasion.

TOOTH WEAR

Tooth wear can be separated into Attrition, Abrasion, Erosion and Abfraction (Table 38.1).

Attrition: Attrition is defined as the loss of enamel, dentine, or restoration by tooth-to-tooth contact (Pindborg, 1970). Occlusal and incisal attrition can occur during deglutition and clenching; however, wear becomes most severe during bruxism, as evidenced by the advanced and often rapid wear of the teeth seen in that condition. Proximal attrition (which occurs at contact areas) can cause a reduction of the dental arch.

Abrasion: Friction between a tooth and an exogenous agent causes wear called "abrasion". *Abrasion is the loss of tooth substance from factors other than tooth contact (Pindborg, 1970).* If teeth are worn on their occlusal surfaces, incisal surfaces or both by friction from the food bolus, this wear is termed "masticatory abrasion".

Erosion: Erosion is defined as the loss of dental hard tissues by chemical action not involving bacteria (Eccles, 1982). Erosion may present on the anterior and posterior teeth and may be limited to the enamel only or also affect dentine to a greater or lesser extent.

Abfraction: Abfraction is the microstructural loss of tooth substance in areas of stress concentration. This occurs most commonly in the cervical region of teeth, where flexure may lead to a breaking away of the extremely thin layer of enamel rods, as well as microfracture of cementum and dentine. These lesions, which appear to result from occlusal loading forces, frequently have a crescent form along the cervical line, where this brittle and fragile enamel layer exists.

ATTRITION

Attrition occurs from tooth-to-tooth contact without the presence of food (i.e. tooth grinding) and typically is characterized by the facet that is matched by a corresponding facet on a tooth in the opposing arch.

When dentine is exposed, it remains flat with no 'cupping' or 'scooping', and the microwear detail observed under magnification is that of parallel striations typically occurring within the facet border. In general, well-defined, shiny facets are a good measure for active attrition. Occlusal and incisal attrition can occur during deglutition and clenching; however, wear becomes most severe during bruxism, as evidenced by the advanced and often rapid wear of the teeth seen in that condition (Fig. 38.1). Proximal attrition (which occurs at contact areas) can cause a reduction of the dental arch.

ABRASION

The role of abrasion has been investigated in the laboratory and clinically. Most of the early laboratory studies were based on the hypothesis that brushing with toothpastes containing abrasives will wear teeth. Early clinical work suggested that

Table 38.1: Various types of tooth wear and their clinical appearance

Term	*Definition*	*Clinical Appearance*
Erosion	Progressive loss of hard dental tissue by chemical processes not involving bacterial action	• Broad concavities within smooth surface enamel • Cupping of occlusal surfaces, (incisal grooving) with dentine exposure • Increased incisal translucency • Wear on non-occluding surfaces • "Raised" amalgam restorations • Clean, non-tarnished appearance of amalgam restorations • Loss of surface characteristics of enamel in young children • Preservation of enamel "cuff" in gingival crevice is common • Hypersensitivity • Pulp exposure in deciduous teeth
Attrition	Loss by wear of surface of tooth or restoration caused by tooth to tooth contact during mastication or parafunction	• Matching wear on occluding surfaces • Shiny facets on amalgam contacts • Enamel and dentine wear at the same rate • Possible fracture of cusps or restorations
Abrasion	Loss by wear of dental tissue caused by abrasion by foreign substance (e.g. toothbrush, dentifrice)	• Usually located at cervical areas of teeth • Lesions are more wide than deep • Premolars and cuspids are commonly affected
Abfraction	Loss of tooth surface at the cervical areas of teeth caused by tensile and compressive forces during tooth flexure (Studies needed to prove this hypothetical phenomenon)	• Affects buccal/labial cervical areas of teeth • Deep, narrow V-shaped notch • Commonly affects single teeth with excursive interferences or eccentric occlusal loads

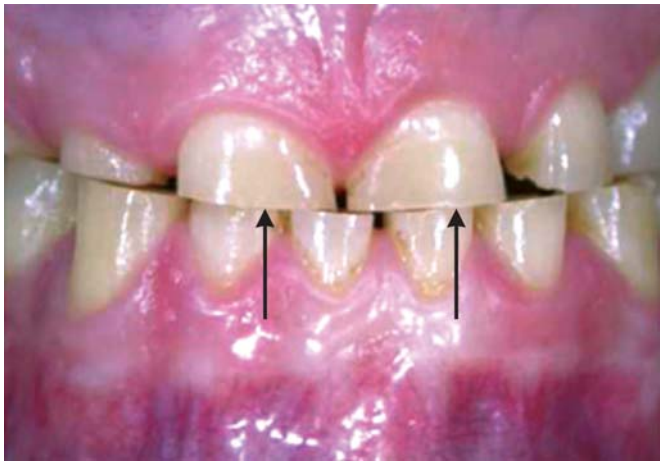


Fig. 38.1: Attrition or bruxism causing the loss of incisal edges of teeth

the orientation of the toothbrush influenced the wear of the teeth. From these studies, horizontal brushing was suggested as causing two to three times as much wear compared with vertical brushing. Some studies suggest that toothpaste has more relevance to abrasion than does the toothbrush (Litonjua et al, 2004). Very small and insignificant changes on the tooth surface are caused by the toothbrush itself. Abrasion can occur as a result of overzealous toothbrushing, improper use of dental floss and toothpicks, or detrimental oral habits such as chewing tobacco; biting on hard objects such as pens, pencils or pipe stems; opening hair pins with teeth; and biting fingernails. Abrasion also can be produced by the clasps of partial dentures. Toothbrush abrasion lesions have more well-defined margins and often are wedge-shaped when they appear in cervical regions (Fig. 38.2).

Occupational abrasion may occur among tailors or seamstresses who sever thread with their teeth, shoemakers and upholsters who hold nails between their teeth, glassblowers, and musicians who play wind instruments.

EROSION

Dental erosion may be defined as tooth wear produced by chemical dissolution of teeth by acids other than those produced by bacteria.

Dissolution of mineralized tooth structure occurs upon contact with acids that are introduced into the oral cavity from intrinsic (e.g. gastroesophageal reflux, vomiting) or extrinsic sources (e.g. acidic beverages, citrus fruits).

According to the source of the acid, it is either intrinsic or extrinsic. *Intrinsic* sources of acids originate in the stomach and are associated with eating disorders, such as anorexia and bulimia nervosa (Scheutzel, 1996), or with acid reflux and regurgitation (Bartlett et al, 1996). *Extrinsic* sources are acids contained in dietary components, such as carbonated

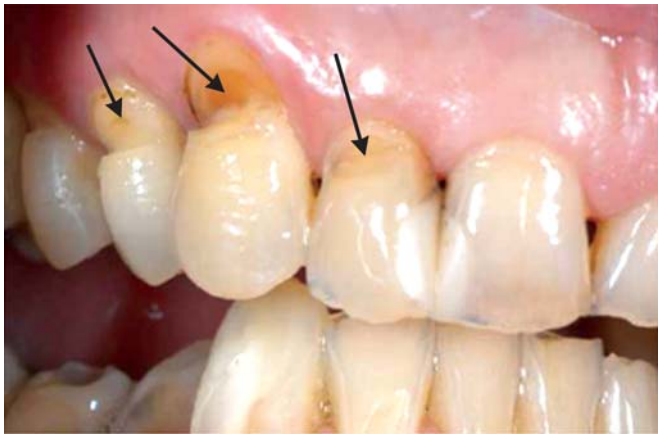


Fig. 38.2: The affect of abrasion on the cervical surfaces of upper teeth

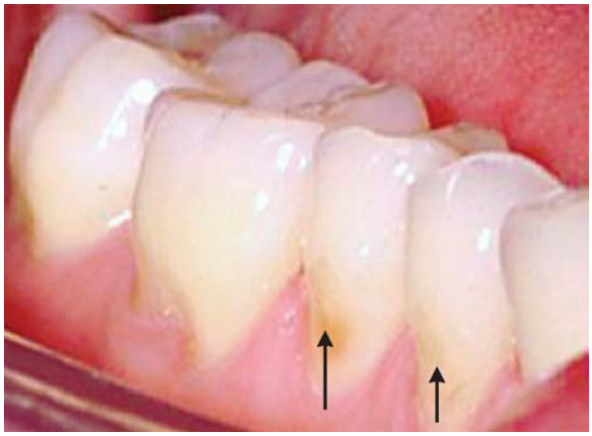


Fig. 38.3: Erosion of the cervical areas of the posterior teeth caused by citrus drinks

soft drinks and fruit, and fruit juices (Zero, 1996; Lussi et al, 2004).

Eroded tooth surfaces that have lost detailed surface microanatomy appear rounded and glazed. Cupping becomes a predominant feature in those areas where the softer and less-mineralized dentine is exposed (Fig. 38.3).

JOHN O GRIPPO in 2004 suggested that the term *erosion* be replaced with *corrosion.*

Erosion, as defined by the American Society for Testing and Materials Committee on Standards, is "the progressive loss of a material from a solid surface due to mechanical interaction between that surface and a fluid, a multicomponent fluid, impinging liquid or solid particles". This can be observed as a shoreline is eroded by the pounding surf, or bridge supports are eroded by the rush of river waters around them. No such powerful flow of fluids occurs in the human mouth to affect teeth.

Therefore, erosion, as defined here, has no significant effect on teeth. The term "erosion" should be deleted from the dental lexicon and supplanted by the term "corrosion" to denote chemical dissolution of teeth.

Corrosion: Tooth surface loss caused by chemical or electrochemical action is termed "corrosion".

There are both endogenous and exogenous sources of corrosion.

Endogenous Sources of Corrosion

Bulimia produces a unique pattern of enamel loss. The corrosion, called "perimolysis," is most marked on the palatal surfaces of maxillary anterior teeth and, in more severe cases, on the buccal surfaces of posterior teeth.

A special pattern of surface loss also is observed in patients with gastroesophageal reflux disease, or GERD.

Exogenous Sources of Corrosion

It has been reported that any food substance with a critical pH value of less than 5.5 can become a corrodent and demineralize teeth.

This may occur as a result of consuming and/or mulling highly acidic foods and beverages such as mangoes and other citrus fruits, drinking carbonated soft drinks and sucking sour candies. Acidic mouthwashes also may be implicated.

Alcohol abuse has been reported to cause a high incidence of corrosion, owing to the chronic regurgitation and vomiting that stems from the gastritis associated with alcohol abuse.

Occupational tooth corrosion can occur during exposure to industrial gases that contain hydrochloric or sulfuric acid, as well as acids used in plating and galvanizing and in the manufacture of batteries, ammunitions and soft drinks.

Diagnosis of Erosion

Tooth erosion is one of the various manifestations of non-carious tooth destruction that have been termed tooth wear. Many patients present with tooth wear that is the result of several etiological factors that do not fall conveniently into one or other of the categories, attrition, abrasion or erosion. Therefore, clinical appearance is the most important feature for dental professionals to diagnose dental erosion. This is of particular importance in the early stage of erosive tooth wear.

The appearance of smooth silky-glazed appearance with the absence of perikymata and intact enamel along the gingival margin, with cupping and grooving on occlusal surfaces are some typical signs of enamel erosion. Tooth erosion may be present in patients with gastroesophageal reflux disease, bulimia and anorexia (Table 38.2).

Several indices are available for this, ranging from the relatively simple index of Eccles and Jenkins that was designed

Table 38.2: Risk factors for erosion

Risk factors	
Citrus fruits intake	More than twice daily
Sports drinks intake	Weekly or more often
Soft drinks consumed	4-6 or more per week
Bruxism habit	
Whole saliva unstimulated flow rate (0.1 mL/min)	
Excessive attrition	
Apple vinegar intake	Weekly or more often
Eating disorder	
Vomiting	weekly or more often
Symptoms or history of gastroesophageal reflux disease	

for recording the severity of erosion, through the more detailed modification of the same index proposed by Lussi and the detailed *Tooth Wear Index* of Smith and Knight. The location of tooth erosion and its severity should be recorded.

For an individual practitioner, study casts are a useful record of the status at any particular time and can be used to monitor progression of erosion. Computer-aided image analysis of impressions or study models is being developed and may become useful clinical tools for recording progression of erosion.

Preventive Treatment for Erosion (Table 38.3)

Advice on toothbrushing can be contentious, particularly when dentine is exposed. Gentle brushing only before bedtime, using a soft multitufted brush and a fluoride dentifrice, may be advisable. Patients should be monitored intensively during the first few weeks for treatment compliance, then again after two and three months. Any softened dentine present should have hardened after three months. Continued dentine hypersensitivity indicates continued erosive activity. Follow-up visits at appropriate intervals, possibly over a long period of time, are required. For patients taking acidic medicaments and those who take drugs and suffer from systemic diseases that cause xerostomia, early contact with physicians may result in alternative drugs and general help.

Eliminating acids, reducing the effects of xerostomia and other cofactors, and improving the resistance of the teeth to acidic attacks are essential.

Table 38.3: Suggested preventive measures for progression of erosion

Preventive measures
• Diminish the frequency and severity of the acid challenge.
• Enhance the defense mechanisms of the body (increase salivary flow and pellicle formation).
• Enhance acid resistance, remineralization and rehardening of the tooth surfaces (use of Topical fluorides).
• Improve chemical protection (use of antacids and cheese).
• Decrease abrasive forces (Use of soft tooth brushes and avoid brush immediately after acid challenge).
• Provide mechanical protection (use of bonding agents on exposed dentine and Occlusal guards).
• Monitor stability

Using Neutral or Alkaline Mouthwashes

Using sugarfree chewing gum and finishing a meal with milk or a small piece of cheese also are beneficial for increasing salivary flow.

Fluoride Dentifrices and Topical Fluoride Mousse or Gels

Fluoride varnishes, and filled resin bonding agents can be applied to reduce any tooth hypersensitivity and allow for remineralization

APF gel is particularly effective among professional wine tasters for preventing demineralization and treating dentine hypersensitivity and erosion problems.

ABFRACTION

Abfraction means 'to break away' (Braem et al, 1992). There remains many lesions that cannot be explained by toothbrush abrasion or erosion alone— for example, single-tooth lesions with unaffected teeth on either side. It is suggested that abfraction is the cause of such lesions. Abfraction lesions present primarily at the cervical region of the dentition and are typically wedge-shaped, with sharp internal and external line angles.

Such lesions are hypothesized to be the result of eccentrically applied occlusal forces leading to tooth flexure rather than the result of abrasion alone (Figs 38.4 and 38.5). According to the flexure theory, masticatory or parafunctional forces in areas of hyper or malocclusion may expose one or several teeth to strong, tensile compressive or sheering stress. When focused on the CEJ, these stresses provide microfractures in enamel and dentine. The resulting wedge-shaped defects have sharp edges. This phenomenon is not well understood.

EPIDEMIOLOGY OF TOOTH WEAR

Collectively the various manifestations of non-carious tooth destruction have been termed tooth wear which conveniently allows for discussion of the problem without the obligation to meet all the precise definitions of each manifestation of the condition. Indeed many patients present with tooth wear that is the result of several etiological factors that do not fall conveniently into one or other of the categories, attrition, abrasion or erosion. Careful observation by the dentist or hygienist at a routine visit is still probably the most usual way for tooth wear to be seen.

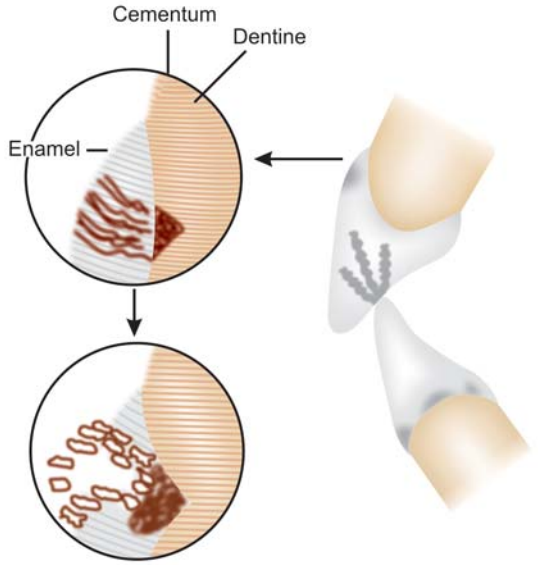


Fig. 38.4: The mechanism of wear under stress under large occlusal forces or off axis loading of tooth cusps leading to concentration of stress and microcrack formation



Fig. 38.5: Abfractions, in the form of wedge-shaped lesions, starting in the cervical enamel of the two premolars caused by eccentric loading

There is some suggestion that the shape of the lesion is related to its etiology (Sognnaes et al, 1972; Brady and Woody, 1977; Lee and Eakle, 1984). One group of authors suggested, in a literature review, that those lesions with sharply defined margins could be caused by abrasive factors, whereas erosion produces broader, dishshaped but shallower lesions (Levitch et al, 1994).

Prevalence

Over the past 20 years there have been a number of studies evaluating the prevalence of tooth wear in different populations. By far the majority of prevalence studies have been reported on children and adolescents as these groups are easier to investigate and recruit. Studies on adults on the other hand tend to be less common because of the difficulty of recruitment.

Prevalence of Tooth Wear and Erosion in the Deciduous Dentition

Most of the studies on tooth wear in children have been reported from Europe (Jones et al 1995, Al-Malik et al 2002, Wiegand et al. 2006). Millward et al (1994) investigated 178, 4-year-old children from Birmingham, UK and reported that as high as 17percent showed involvement of dentine exposure.

Another study on 987 pre-school children conducted in Saudi Arabia reported 31percent showed some evidence of tooth wear with 13 percent having dentine exposure. However, in this study the measurements were restricted to the primary maxillary incisors. A larger study in China on 1,949 children aged 3-5 year-old reported that only 5.7 percent showed signs of wear (Luo et al 2005).

Prevalence of Tooth Wear and Erosion in Adolescents

Ganss et al 2001 measured erosive wear on study models casts of 1000 11-year-old and reported up to 70 percent of tooth surfaces and 26.4 percent with advanced lesions high incidence of erosive wear. Milosevic et al (1994) reported 30% exposed dentine in 1035 14-year-old in Liverpool, England. Their study included all tooth surfaces and observed the most commonly affected surface was the incisal edges of upper and lower incisors. Bartlett et al. (1998) reported the results from 210, 11-14-year-old and observed less destruction with less than 2 percent with dentine exposure.

Dental erosion was included in the examination for the first time in the 1993 National Survey of Child Dental Health conducted in the United Kingdom. In this study, 17,061 children were examined. Over half of the 5 and 6-year-old had erosion, 25 percent with dentinal involvement of the primary dentition. In the 11+ year age group, almost 25 percent had erosion, 2 percent with dentinal involvement in the mixed dentition. In a study of 1035, 14-year-old children randomly selected from a Liverpool population, 30 percent had exposed incisal dentine. Another 8 percent had exposed dentine on occlusal or lingual surfaces.

Truin et al. (2005) reported the prevalence of erosion in a group of 12-year-old children in the Hague, the Netherlands. Their examination was limited to the palatal surfaces of the incisors and canines and the occlusal surfaces of first molars.

Wear was observed on 59.7 percent of the subjects with 2.7 percent having dentine involvement.

Prevalence of Tooth Wear and Erosion in Adults

Johansson et al reported the occlusal and incisal wear amongst Swedish military personnel and reported that 28 percent had erosion of the maxillary teeth.

A Swiss study by Lussi A, Schaffner M, Hotz P, et al (1991) has reported that in subjects aged between 26 and 30 years, 7.7 percent had facial erosive lesions into dentine and 29.9 percent had occlusal tooth wear into dentine. In the 46-50-year-old group, 13.2 percent exhibited facial erosive lesions into dentine and 42.6 percent had occlusal erosion involving dentine.

Smith BG, Robb ND (1996) in a study of 1007 patients in England, used the Tooth Wear Index (TWI). The results indicated that 5.7 percent of tooth surfaces were worn to an unacceptable degree in the 15-26-year-old group. In the 56-65-year-old group, 8.2 percent of the tooth surfaces were unacceptably worn.

Xhonga and Valdmanis (1986) examined 527 subjects selected randomly aged between 14 and 88 years (or: and aged from 14 to 88 years). The authors suggested that the prevalence in the USA was around 25 percent but dentine involvement was comparatively rare at 4 percent.

The difference between genders has been reported in a number of studies. Most studies have reported the incidence to be more common in males (van Rijkom et al 2002). A recent review concluded that there was an increasing trend towards increasing wear with age (Jaeggi et al 2006). In addition, dietary habits, presence of gastroesophageal reflux and socioeconomic status all affected the prevalence of erosive tooth wear.

PREVENTION OF TOOTH WEAR

Strategies for preventing tooth wear are largely based on the individual. Abrasion and attrition are disorders that are individual-based. Erosion has certain features, including its prevalence and relationship to diet, that make the disease problem somewhat similar to that of caries.

Fluoride

Fluoride is the mainstay of caries prevention and it was, therefore, natural for fluoride to be considered as a possible vehicle for preventing tooth erosion. In fact the literature contains conflicting reports about the benefits of fluoride in this respect. A number of animal and *in vitro* studies suggest that adding fluoride to potentially erosive drinks will reduce the erosive potential of these drinks. Addition of fluoride to sports drinks has also been shown to reduce the erosive potential of these, otherwise highly erosive, drinks. Amaechi et al. have shown that xylitol and fluoride have an additive effect in reducing the erosive potential of orange juice in *in vitro* studies. Some studies however, showed that the protective effect against erosion of fluoride added to soft drinks was minimal. Clearly some more research is required in this area to resolve these differences, perhaps through the development of agreed test systems to evaluate erosive potential. It is known that tooth brushing shortly after drinking an erosive beverage causes an increase in tooth wear. Topical fluoride appears to protect against this subsequent tooth wear following acid challenge. This is specially helpful in reducing dentine wear in previously eroded teeth.

Drink Modification

Considering the increasing prevalence of tooth erosion, specially in young children and teenagers and the strong association between consumption of acidic drinks and tooth erosion, it still seems logical to develop drinks with low erosive potential

Drink modification has been developing in recent years with varying success. Addition of calcium lactate to soft drinks has been shown to reduce the erosive potential of the most of erosive beverages. A successful attempt to reduce the erosive potential of soft drinks by the addition of calcium citrate-malate was reviewed by Grenby but a later *in vivo* investigation by Rugg-Gunn et al found no difference in the amount of erosion seen in enamel slabs treated with plain or modified orange drinks. One of the potentially most important steps in soft drink modification has been the development and subsequent marketing of a low pH drink. This low pH blackcurrant drink has been modified with the addition of calcium and has been shown in *in situ* and *in vitro* studies to be less erosive than black-current drinks without added calcium and also less erosive than orange juice.

Diet Modification

Diet modification is a difficult area to achieve succesful disease prevention as shown by past experience with dental caries. Studies have shown a strong links between dietary factors and tooth wear. The dentist should advise the patients with tooth wear to modify their diet.

Patients with tooth wear thought to be linked to dietary acids should be closely questioned about their dietary habits and modifications as per the patient should be suggested.

Diet modification methods include:

- Reducing the frequency of consumption of these foods
- Limiting consumption of fruit and fruit juices to mealtimes
- Consuming of hard cheese or milk products after drinking an erosive beverage as it may promote re-hardening of the enamel.
- Chewing-gum containing carbamide (urea) has been shown to raise salivary pH rapidly. This may, therefore, reduce the erosive effect of acid in the mouth.

The method of drinking erosive beverages is thought to contribute to tooth erosion especially when cola-type drinks are swished around the mouth before swallowing. Drinking

through a straw has been shown to reduce the potential for tooth erosion from acidic drinks, specially on the palatal surfaces of the maxillary incisors that are most commonly affected in patients with erosion.

Abrasion caused by diet or tooth brushing is greater if the teeth have been recently exposed to dietary or gastric acid. Attin et al have shown that resistance to this abrasion develops in the mouth if brushing is done 60 minutes after acid challenge. This is probably of particular significance for patients who have frequent episodes of vomiting.

Dentists should advise the patients not to brush shortly after consuming carbonated drinks. Similarly, mouthrinses with a low pH should not be recommended for prolonged use or as pre-brushing rinses.

Remineralizing toothpaste has been shown to increase the hardness of acid-treated teeth significantly more than conventional fluoride toothpastes in *in vitro* studies.

Saliva

Saliva and pellicle are important factors in protection of tooth substance against acid attack. Amaechi et al and Johansson et al have shown that erosion is usually found in areas of the dental arches that are lacking in pellicle. Increasing salivary flow and hence accumulation of pellicle will, therefore, probably offer protection against erosion. Increasing salivary flow and, consequently, buffer capacity should increase protection against erosion and promote remineralization. Sugar-free chewing-gum and even fluoride-containing or carbamide-containing gum should be advised, particularly for adolescents who may be least willing to limit their consumption of acidic beverages. A number of preparations intended to promote salivation are available for patients including those with dry mouth symptoms who may not be willing to chewing-gum. Lozenges are examples of such topical preparations and Xerodent™ has the added advantage of containing fluoride.

Gastric Reflux

Reflux disease and vomiting are important causes of tooth erosion. Recognition of the erosion and presumptive diagnosis by the dentist should lead to appropriate referral for further investigation. Diagnosis and treatment of the underlying condition is obviously a prerequisite to stopping the progression of the tooth wear. In many cases of tooth wear associated with gastric disturbance, both attrition and erosion are seen. Because many individuals with erosion are young males, who usually consume a lot of acidic drink but this is also the age group that is active in sport and training and may, for example experience gastric reflux as a consequence.

Patient suspected of bulimia should be referred to a psychiatrist. This is often difficult and depends to a great extent on the rapport and trust that the dentist has built up with the patient.

Lifestyle Changes

Lifestyle changes are particularly difficult to achieve, especially in the age groups that are frequently found to have tooth wear. Drinking carbonated beverages with a straw; eating a piece of cheese shortly afterwards; and taking antacids, xylitol gum or xylitol-fluoride-containing lozenges after exercise are not activities that fit in particularly well with the lifestyle of young people. Nevertheless the dental profession has the responsibility to inform patients of the problem and its consequences. Indeed the rise in awareness of tooth erosion, in Europe at least, has occurred as caries levels have rapidly declined.

Restorative Procedures

Restorative treatment of teeth affected by tooth wear is very expensive and not always covered by health services, even in Europe. Various non-or minimally-invasive procedures have been tried in order to prevent further tooth wear but clearly extensive crown and bridge work is sometimes required. Conservative approaches that may also offer a degree of protection/prevention against further wear are therefore urgently sought as are restorative techniques that do not involve further destruction of remaining tooth substance. Dentine-bonding agents have been shown to be effective in reducing sensitivity and offering protection against further dissolution of erosive lesions. These should be applied and the patient monitored before any final decision is taken on restorative measures.

Prevention of attrition and abrasion is not usually considered until the patient actually has signs of the problem. Diagnosis is usually more straightforward than with erosion except in cases where attrition or abrasions are superimposed on erosion when diagnosis can become problematic. Patients with bruxism may well need occlusal splints, at least to use at night, and restorative treatment is frequently necessary.

Careful monitoring of the progress of the tooth wear over time, for example with study casts, is helpful both for the dentist and as an aid to increase patient cooperation. The use of fluoride and antacid medications as well as the protective effect of cheese should be emphasized. Correction of tooth brushing technique and the use of less abrasive toothpaste should help reduce abrasion and habits that may lead to abrasion should be controlled.

39 Prevention of Dental Trauma

CM Marya

In virtually all sporting and recreational activities, accidents happen and traumatic oral injuries are possible. Although dental and soft tissue injuries typically are associated with collision and contact sports such as football or ice hockey, oral trauma is just as common, if not more so, in basketball, soccer, baseball, bicycling, in-line skating, gymnastics and other sports. Through the years, the use of orofacial protectors (face shields, helmets and mouthguards) in football has reduced the prevalence of oral trauma from 50 percent of all injuries to approximately 1 percent. Yet, in limited-contact sports such as basketball that do not mandate mouthguards or other orofacial protectors, 14 to 34 percent of reported injuries are to the orofacial area. Another survey of practicing dentists found the highest incidence of oral injury in baseball and biking, two popular noncontact sports.

Facial trauma that results in fractured, displaced, or lost teeth can have significant negative functional, esthetic, and psychological effects on children. Dentists and physicians should collaborate to educate the public about prevention and treatment of oral traumatic injuries.

The greatest incidence of trauma to the primary dentition occurs at 2 to 3 years of age, when motor coordination is developing. The most common injuries to permanent teeth occur secondary to falls, followed by traffic accidents, violence, and sports. All sporting activities have an associated risk of orofacial injuries due to falls, collisions, and contact with hard surfaces.

Baldava P, Anup N (2007) reported prevalence of 14.9% of traumatic injuries to anterior teeth in the study on Indian population with sports activities being the most common cause. Permanent maxillary central incisors were most commonly injured with injuries involving enamel and dentine being the most frequently observed. Increased overjet and inadequate lip coverage were significantly associated with the occurrence of trauma.

CAUSES

While most dental injuries are accidental, there are things that make these accidents more likely to happen. Some of the most common are:

1. Playing contact sports, such as rugby or boxing, (any sport that involves physical contact) speed or moving objects (such as bats and balls) are major risk for damaging the teeth
2. Malaligned teeth (Proclination) has shown to increase the risk of trauma.
3. Being unsteady on the feet—this includes young children who can trip over easily, or if you have a condition such as epilepsy is present which may damage the teeth if the person falls during a fit.

Sports Injury

Participation in sports makes a positive and powerful contribution to social, personal, and physical development. It helps to promote the adoption of a healthy lifestyle and prevention of diseases and illness. Despite these benefits, there are some risks involved with sport participation, including a risk of orofacial injury.

This risk exists in contact sports such as rugby, and hockey, but also in sports with less contact, such as basketball, soccer and baseball. Estimates of the number of dental injuries attributable to sports related accidents range from 13 to 39 percent of all dental injuries. Every individual involved in contact sport has at least a 10 percent chance each season of sustaining an orofacial injury.

The majority of sport-related dental and orofacial injuries affect the upper lip, maxilla, and maxillary incisors, with 50 to 80 percent of dental injuries involving the maxillary incisors. Use of mouthguard may protect the upper incisors. However, studies have shown that even with a mouthguard in place, up to 25% of dentoalveolar injuries still can occur.

These injuries can occur during organized competitive sports as well as unorganized recreational activities.

The main instances of orofacial injury in non-contact sport results from projectiles such as baseballs, tennis balls, or bats hitting the face. Injuries to the teeth include crown fractures which occur due to high-velocity trauma from an object such as a baseball; root fractures; and displacements (luxations),which occur due to low-velocity trauma from an elbow or entanglement in a basketball net.

The majority of orofacial injuries affect the upper jaw, with maxillary incisor injuries accounting for 80 percent of all cases. Early trauma to the mouth may result in damaged teeth that may exfoliate abnormally; permanent teeth that fail to erupt; color changes in teeth; infections in which painful abscesses develop; injury to underlying permanent teeth, such as localized enamel hypoplasia on the surface of the crown; and tooth loss that leaves unwanted open spaces.

Most orofacial injuries occurring from sports activities can be painlessly avoided by using a mouthguard. Studies have long emphasized the protective value of mouthguards in reducing sports-related injuries to the teeth and soft tissues.

Mouthguards are removable appliances that protect intraoral soft tissue—such as lips, cheeks, and gums—from lacerations and bruising. They prevent chipping, luxations, avulsions; fractured teeth, roots, and bones; mandibular/maxillary fractures; and temporomandibular dysfunction.

Some have suggested that properly fitted mouthguards can reduce the incidence and severity of concussions.

In 1892, the first mouthguard was made by Wool Krause. There was no mention of mouthguards again until 1915 when a professional boxer named Ted "Kid" Lewis used a mouthguard during a championship bout. This mouthguard, or "gum shield" as it was referred to at that time, was fabricated by Jacob "Jack" Marks of London, England and consisted of a custom-fitted rubber strip that fit under the lips and over the outer surfaces of the teeth and gingiva.

For more than 50 years, The American Dental Association (ADA) has promoted the use of properly fitted mouthguards as the primary means of protecting against oral injury during sporting activities that pose a risk of oral injury, including acrobatics, baseball, basketball, bicycling, boxing, equestrian events, field events, field hockey, football, gymnastics, handball, ice hockey, in-line skating, lacrosse, martial arts, racquetball, rugby, shot-putting, skateboarding, skiing, skydiving, soccer, softball, squash, surfing, volleyball, water polo, weightlifting and wrestling.

Definition of Mouthguard

The ASTM (American Society for Testing and Materials) defined athletic mouthguard as a resilient device or appliance placed inside the mouth (or inside and outside) to reduce mouth injuries particularly to the teeth and surrounding structures.

The IASD (International Academy for Sports Dentistry) adopted the ASTM operational definition for a mouthguard. The IASD statement goes further to state that the single word "mouthguard" must be replaced by the terminology "properly fitted mouthguard".

MECHANISM FOR THE ACTION OF THE MOUTHGUARDS

Researchers proposed have the following mechanisms for the action of the mouthguard in reducing the incidence or severity of concussion and trauma.

1. Opening the Condylar Space

The mandibular condyle of the jaw fits into the skull at a structure called the trough of the mandibular fossa. The mouthguard opens up the space between the condylar head and the mandibular fossa, of the temporal bone. This space decreases the force delivered to the temporal area of the head by preventing the condyle of the mandible from being driven into the fossa.

2. Dissipation of Forces

Mouthguards absorb the energy from a blow to the head, chin, and face and dissipate the upward force and remaining energy to the jaw across the entire mouthguard, thereby reducing trauma to the brain and skull. Mouthguards cushion the shock from a blow to the jaw and prevent the transmission of the shock through the temporomandibular joint to the skull.

3. Reduction of Rotational Forces

A blow to the inferior aspect of the mandible is transmitted through the midfacial skeleton, forcing the skull to rotate backwards. The mouthguard allows the user to exert a clenching force with the head and neck muscles, which stabilizes the skull and reduces the jarring of the brain.

4. Protection to Patients Undergoing Orthodontic Treatment

Mouthguards also can provide substantial protection to patients receiving orthodontic treatment. By moving soft tissue away from teeth and preventing intraoral laceration and bruising, properly fitted mouthguards can assist athletes wearing fixed orthodontic appliances.

5. Protection from Traumatic Blows

Mouthguards offer protection by absorbing high impact energy from potentially traumatic blows and dissipating that energy, which otherwise would be transferred directly to the underlying dentition specially the anterior teeth.

6. Cushioning between the Maxilla and Mandible

By providing cushioning between the maxilla and mandible, mouthguards also may lessen the incidence or severity of condylar-displacement injuries and thereby reduce the potential for concussion.

SELECTION OF A MOUTHGUARD

Choose a mouthguard that:

- Is resilient and tear-resistant
- Fits properly and is comfortable
- Is easy to clean
- Does not restrict speech or breathing

IDEAL MOUTHGUARD PROPERTIES

To provide adequate protection, the literature suggests that a mouthguard should:

- be properly fitted to the wearer's mouth and accurately adapted to his or her oral structures
- be made of resilient material approved by the U.S. Food and Drug Administration and cover all remaining teeth on one arch, customarily the maxillary
- stay in place comfortably and securely
- be physiologically compatible with the wearer
- be relatively easy to clean
- have high-impact energy absorption and reduce transmitted forces upon impact

For the athlete's safety, the mouth protector should have adequate retention, comfort and fit, without interfering with speech or breathing during play.

Fabricating a custom mouthguard with the above characteristics can be professionally accomplished under the direction or supervision of a dentist. By promoting the use, safety and affordability of properly fitted mouthguards, dentists can increase patient satisfaction and compliance by providing mouthguards of appropriate thickness that do not slip in the wearer's mouth.

TYPES OF MOUTHGUARD

The American Society for Testing and Materials [ASTM] designated three categories for athletic mouthguards:

- The ready-made, or stock mouthguard
- The mouth-formed, "boil-and-bite" protector
- The custom-made model

Stock Mouthguard

The stock mouthguard is a preformed thermoplastic tray that fits loosely over the teeth (Fig. 39.1). This mouthguard type is fabricated in an inexpensive, ready-for-wear model and is sold in limited sizes (ranging from small to large), with little-to-no retention or adaptability to hard and soft tissues. To be held in place, the stock mouthguard requires the wearer's mouth to be closed to provide any protective benefit, which can interfere with breathing and speaking. For these reasons, the stock mouthguard is considered by many to be less protective.

Mouth-formed Mouthguard

Mouth-formed protectors are sold in two varieties: the shell-liner mouthguard and the thermoplastic, boil-and-bite model. The shell-liner mouthguard consists of a polyvinyl chloride outer shell that fits loosely over the dentition and includes an inner lining of plasticized acrylic gel or silicone rubber. This appliance is less commonly available and usually bulkier than a boil-and-bite mouthguard.



Fig. 39.1: Stock mouthguard

The self-adapted, boil-and-bite mouthguard is the most commonly used oral protective device and is widely distributed at department and sporting goods stores (Fig. 39.2). The boil-and-bite mouthguard typically is manufactured as a standard tray of thermoplastic material (such as EVA). A dentist or the sports participant can form a boil-and-bite mouthguard by softening it in hot water, briefly cooling it in cold water, placing it in the mouth and shaping the material with fingers, tongue and some biting pressure to form a stable impression.

Although the boil-and-bite mouthguard is a low-cost appliance that can be reshaped and refitted after initial formation, some comparative studies have noted limitations in this type of mouthguard. One study found that boil-and-bite mouthguards can become dangerously thin in critical areas during formation, losing between 70 and 99 percent of their occlusal thickness. Furthermore, laboratory impact tests of boil-and-bite mouth protectors have reported less adequate cushioning, retention and absorption than offered by custom-made mouthguards. A 1994 study noted that more than 40 percent of athletes wearing self-adapted mouthguards reported a loose fit, and two of three said they were too bulky.



Fig. 39.2: Mouth-formed mouthguard

Appropriate care should be taken when forming a boil-and-bite mouthguard. A dentist can help ensure proper fit and consistent thickness in the labial and occlusal portions and other critical areas. When properly formed according to the manufacturer's instructions, a boil-and-bite mouthguard usually can be worn over braces or other orthodontic appliances.

Another variation of the boil-and-bite mouth-guard is called the "jaw-joint protector", a bimaxillary device that positions the mandible forward in an effort to protect the associated basal skull surface from concussion. Further study is required to determine the safety and effectiveness of jaw-joint protectors and their ability to reduce brain injury.

Custom-made Mouthguard

A custom made mouthguard is individually designed and form-fitted in a dental office or made in a professional laboratory, based on the dentist's instructions (Fig. 39.3). Because of the technique, material and detail that goes into making a custom mouthguard, it is considered by many to be the professionally preferred protective device Although custom mouthguards can be the most expensive option, the literature suggests that they generally provide better retention and comfort, less interference with speech and breathing, and more adaptability to orthodontic appliances.

These can be either vacuum-formed or pressure-laminated by a dentist or a dental laboratory (based on the dentist's instructions).

STEPS IN MOUTHGUARD FORMATION

Formation of a professionally fitted custom mouthguard typically consists of five standard steps:

1. Making an impression of the patient's arch for which the mouthguard will be made (an impression of the opposing arch and a bite registration are taken only if occlusal adjustments are to be made with an articulated cast).
2. Pouring a high-strength stone model of the patient's upper teeth.
3. Forming one or more sheets of thermoplastic material (such as ethylene vinyl acetate, polyvinyl chloride, polyvinyl acetate, natural rubber, soft acrylic resin or other material) on the stone model.
4. Seating the mouthguard with proper occlusal balance and equilibration.
5. Final trimming of excess material from the mouthguard.

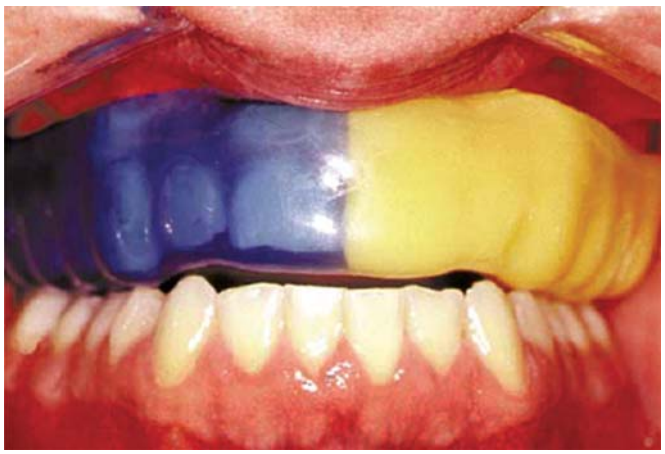


Fig. 39.3: A custom-made mouthguard

The role of the athletic mouthguard is to offer effective protection against oral injury, with variation in materials, comfort, cost and adaptation to the teeth. The properties of these common mouthguard types are presented below.

The ADA continues to promote mouthguard use and collaborate with international and national sports conferences, sanctioning bodies, school federations and other agencies to mandate the use of orofacial protectors.

Given the prevalence of oral injury in sports and recreational activities, other dental organizations and health care agencies also have advocated the use of properly fitted mouthguards to reduce oral trauma in the general public. The American Academy of Pediatric Dentistry (AAPD) recommends the use of properly fitted mouthguards in "organized sporting activities with risk of orofacial injury," and the American Academy of Pediatrics encourages youth soccer players to use protective eyewear and mouthguards.

To efficiently determine the extent of injury and correctly diagnose injuries to the teeth, periodontium, and associated structures, a systematic approach to the traumatized child is

CARE OF THE MOUTHGUARD

Care of the mouthguards can be done by doing the following:

- Rinse before and after each use or brush with a toothbrush and toothpaste.
- Occasionally clean the mouthguard in cool, soapy water and rinse thoroughly.
- Transport the mouthguard in a sturdy container that has vents.
- Make sure not to leave the mouthguard in the sun or in hot water.
- Check for wear and replace the mouthguard when necessary.

CARE TO BE TAKEN WHEN USING A MOUTHGUARD

To get the best service from a mouthguard, one should:

- Not wear removable appliances, such as retainers, with a mouthguard.
- Wear a custom-fitted mouthguard if wearing braces or have a protruding jaw, receding chin or cleft palate.
- Not chew on or cut pieces off the mouthguard.
- Wear the mouthguard during practice sessions as well as during games.
- Schedule regular dental checkups and visit the dentist before each playing season.
- Bring the mouthguard on each dental visit.

essential. Assessment includes a thorough history, visual and radiographic examination, and additional tests such as palpation, percussion, and mobility evaluation. Intraoral radiography is useful for the evaluation of dentoalveolar trauma. If the area of concern extends beyond the dentoalveolar complex, extraoral imaging may be indicated. Treatment planning takes into consideration the patient's health status and developmental status as well as extent of injuries. Advanced behavior guidance techniques or an appropriate referral may be necessary to ensure that proper diagnosis and care are given.

PREVENTING DENTAL INJURY IN CHILDCARE

Dental injuries are a common source of trauma in young children. Injury to the primary teeth is most likely to occur between the ages of 1 to 3. Given young children's natural propensity for exploration, as well as their inherent lack of coordination, it is no surprising that dental injuries are so common at this age.

Older children often suffer tooth injury due to sports activities or falls from skateboards, roller blades, or bicycles.

Potential Injuries

The most common dental injuries are teeth that have been knocked out due to trauma or a chipped tooth as a result of a fall. Dental injuries in young children tend to be to the upper maxillary region and central incisors, or the upper front teeth.

In addition to the teeth, however, injuries may also occur to the jaw, soft tissue or gums, and the alveolar bone.

The potential injuries include:

1. Crown fracture
2. Root fracture
3. Concussion
4. Subluxation
5. Lateral luxation
6. Intrusion
7. Extrusion
8. Avulsion

Childcare providers often witness common events in childcare settings that can cause dental or oral injury such as falling from playground equipment; tripping and hitting the mouth on the floor or a piece of furniture; or getting hit in the mouth with a ball or other play object while participating in a group activity.

Such incidents may result in inflammation of the gums, a chipped or broken tooth, or even a knocked out tooth. If the impact is hard enough, the jaw could be damaged or knocked out of alignment.

The best way to prevent dental injury in young children is to take the necessary precautions to remove hazards.

American Academy of Pediatrics (AAP) and Caring for Our Children: National Health and Safety Performance Standards have suggested few guide lines discussed below:

GUIDELINES FOR OUT-OF-HOME CHILD CARE

- Prevent children from climbing on non-approved surfaces such as furniture or railings.
- Prohibit the use of equipment such as walkers or trampolines that may be associated with dental injuries.
- Keep all walkways and doorways free of toys, debris, and electrical cords.
- Attach corner protectors to furniture and counter tops.
- Be sure playgrounds have approved resilient surfaces under and around all play equipment.
- Make sure children wear helmets when riding tricycles or other wheeled toys. Teach them the appropriate way to wear helmets (secured on the head and covering the forehead).
- Trips and falls are common causes of dental injuries. Injuries also can occur when children jam their mouths into the spout of a water fountain as they drink
- A safe environment and appropriate supervision while children are at play, will help prevent injury.

PREVENTION OF DENTAL TRAUMA

The prevention of dental trauma and its complications is based on two utmost important aspects: primary prevention (the regular usage of mouthguards and faceguards during sport activities, avoidance of lip or tongue piercing and the removal of intra oral ornaments and alignment of Angle Class II malocclusion), and secondary prevention (prompt and proper first aid management in case of dental injury, for enhancing the tooth prognosis and reducing the complication).

PRIMARY PREVENTION

For children, playgrounds and play areas are a recipe for fun—or perhaps an accident waiting to happen. Playing without fear or tears provides many benefits to a child's development. Yet every year, hundreds of thousands of children suffer serious playground-related injuries that require emergency medical treatment.

Four Components of the Thoroughly Tested, Easy-to-Implement S.A.F.E. Model

National Program for Playground Safety (NPPS) recommends:

Supervision—adults must be trained in appropriate active supervision techniques.

Age—appropriate design—children of varying age groups need equipment designed for their specific developmental characteristics.

WORLD HEALTH ORGANIZATION TOOTH INJURY DEFINITIONS

Avulsion: A complete displacement of a tooth from its socket.

Chipped: A complete fracture and displacement of a portion of the tooth.

Concussion: Tooth is sensitive to percussion but not displaced or abnormally mobile.

Fracture crown: Fracture of enamel and dentine; may or may not involve exposure of pulp.

Fracture enamel: Fracture of enamel only and includes chipping, cracking, and incomplete fractures.

Fracture root: Fracture of root only.

Luxation extensive: Tooth is very mobile because of partial displacement out of its socket.

Luxation intrusive: Tooth has been forced down and embedded into bone.

Luxation lateral: Tooth has been displaced and may be very firm.

Subluxation: Tooth has increased mobility but has not been displaced.

CATEGORIES OF OROFACIAL INJURIES

Soft tissue injuries
- These include contusions or lacerations to the lips, tongue or gingiva, as well as dislocations or trauma to the temporomandibular joint, bruising to the facial muscles, nerves, fascia, and blood vessels.

Dental injuries
- These include chips or minor, moderate or severe fractures, tooth luxation, avulsions.
- There may also be trauma to the ligaments or trauma/concussion to the tooth where the tooth is not moved out of position.

Bony injuries
- These include minor fractures to the alveolar bone and facial bones.

Other injuries
- These include aspiration of teeth or other dental prostheses, and cerebral concussions.

Fall surfacing—the type and depth of ground materials must be adequate for cushioning falls.
Equipment—plastic, wooden, and metal equipment must be maintained, repaired, and replaced.

PLAYGROUND SURFACES

Most government rules for play equipment recommends that an impact absorbing surface be provided around the items from which children are most likely to fall.

The ability of a surface to absorb an impact is measured by its Critical Fall Height (CFH).

Rubber Mulch is a unique product that consists of granular rubber particles, also referred to as rubber chunks, nuggets and shredded rubber. Rubber Mulch is made from 100%. Recycled Rubber provides a safe, resilient, non-abrasive surface. It is perfect for playgrounds, sport surfaces or any area that requires the protection, durability and flexibility of Shredded rubber. Playground Mulch tyre chips conform to all U.S. Consumer Product Safety Commission (CPSC) safety guidelines and has earned ADA approval, making playgrounds safe for children while preserving the environment (Fig. 39.4).

U.S. Consumer Product Safety Commission (CPSC) has given the most important safety information about planning, constructing, and maintaining an outdoor home playground to help in the prevention of injuries and other hazards to children playing on playgrounds (public and home). Given At: http://www.cpsc.gov/cpscpub/pubs/324.pdf.

OUTDOOR HOME PLAYGROUND SAFETY CHECKLIST (CPSC)

Supervision

- Be sure to always supervise children on play equipment.

Surfacing

- Install a protective surface under and around play equipment to reduce the likelihood of serious head injuries.
- For most play equipment, install protective surfacing 6 feet in all directions beyond the equipment.
- For swings, extend protective surfacing in front and back of the swing to a distance that is twice the height of the bar from which the swing is suspended.
- For tire swings, install protective surfacing outward from the swing equal to the suspension chain plus 6 feet.

Types of Surfacing

- Carpeting and thin mats are not adequate as protective surfacing. Maintain at least 9 inches of loose-fill material (such as wood mulch/chips, engineered wood fiber (EWF), or shredded/recycled rubber mulch for equipment up to 8 feet high; and 9 inches of sand or pea gravel for equipment up to 5 feet high) or use an ASTM F1292 rated material at the depth required for the equipment height.
- Use wood mulch/chips, shredded rubber mulch, or engineered wood fiber for equipment up to 8 feet high;
- Use sand, pea gravel, or mulch products listed above for play equipment up to 5 feet high; or
- Use surface mats tested to provide impact protection equal to or greater than the height of the play equipment.



Fig. 39.4: Safe playground surface with soft rubber mulch

Equipment Maintenance

- Periodically check nuts, bolts, caps, swing seats, suspension ropes, chains, and cables and replace as necessary. Maintain loose-fill surfacing and surface mats.

Opening

- Eliminate openings that can trap a child's head or neck, such as openings in guardrails or ladders. Openings should be smaller than 3½ inches to prevent entry of a small child's body, or larger than 9 inches to allow a child's head and body to slide completely through.

Ropes

- Never attach jump ropes, clotheslines, pet leashes, or cords of any kind to play equipment. Anchor any climbing ropes at both ends. Remove drawstrings from children's clothes. Children can strangle on these.

Anchors

- Bury or cover anchors with adequate surfacing material to prevent tripping. Play equipment should not tip over.

Guardrails or Barriers

- Make sure that platforms and ramps over 30 inches high have guardrails or barriers to prevent falls.

Repair

- Repair sharp points or edges on equipment that can cause injuries.

Upkeep of Hardware

- Replace missing hardware, eliminate protruding bolts, and close "S" hooks that can cause injuries.

EARLY TREATMENT OF LARGE OVERJETS (MIXED DENTITION)

Studies have shown that the incidence of accidental trauma to permanent incisors significantly increases with overjets greater that 9 mm.

SECONDARY PREVENTION

Prompt intervention following dental trauma can reduce complications of injury and also improves the prognosis.

Clinical Evaluation of Dental Trauma [Nowak AJ 2002]

Medical History

Take a complete medical history. Assess the need for subacute bacterial endocarditis (SBE) prophylaxis. Determine if the child has a bleeding disorder, or is immunocompromised. Record any current medications. Question the parent about allergies to medications. Obtain a history of any prior surgeries. Determine if the child's tetanus immunization is up-to-date. Determine if the child lost consciousness due to the injury.

Dental History

The clinician should determine how, when, and where the injury occurred. "How" is important because it provides information on the severity of the injury. "When" is important, because the prognosis for the injured tooth worsens with every minute of delay in treatment. "Where" is important, because it may determine whether or not tetanus prophylaxis is warranted.

Physical Examination

A thorough examination is necessary to assess the full extent of all injuries. Important information to be gathered for each patient includes: vital signs, review of all systems, head and

neck exam, and accident information. It is important to rule out head injury, ocular damage, and cervical spine injury. An evaluation of pupil size and reaction to light may establish the presence of head injury.

Extraoral Examination

The location and size of all extraoral and intraoral injuries must be recorded. Palpate the mandible, zygoma, TMJ, and mastoid region. Ensure that no mandibular or maxillary fractures are present. Find any mandibular fractures by palpating the lower border of the mandible for a "step-down" fracture. Record any extraoral lacerations, bruises, or swelling. If a laceration is present in the upper or lower lip, the area must be inspected for foreign bodies such as gravel or tooth fragments. Any foreign bodies must be debrided from the soft tissue.

The mandibular condyles and maxilla should be carefully palpated. Check jaw movements for normal range of movements. Chin lacerations require careful evaluation of the cervical spine and mandibular condyles. Indications of condylar fractures include: an anterior open bite, a malocclusion, or limited mandibular opening. Confirmation of condylar fractures requires a panoramic radiograph with closed–and open–mouth views.

Intraoral Examination

All extraoral and intraoral clots and debris must be removed prior to examining the oral soft and hard tissue. Palpate the alveolus to detect any fractures. Have the patient clench the teeth so that the dental occlusion can be evaluated. Each tooth should be examined for damage or mobility.

The labial mucosa, maxillary frenum, gingival tissues, and tongue should be examined for bruising or lacerations. All intraoral lacerations must be cleaned and explored, looking for any foreign bodies. The oral frenum, when torn, will heal without long-term consequences. A tongue laceration should be sutured if the tissue edges are not self-approximating. Most intraoral impalement injuries will heal on their own – except for soft tissue avulsion injuries.

Radiographic Examination

For evaluating injuries to the maxillary or mandibular teeth, an occlusal radiograph is the film of choice. If a root fracture is suspected, radiographs at two different angles are required for a definite diagnosis. For intruded teeth, a lateral anterior radiograph provides additional useful information. A panoramic radiograph helps to evaluate suspected mandibular or condylar fractures.

Photographic Documentation

The use of preoperative and postoperative photography is very useful for documentation purposes.

FIRST AID FOR AN AVULSED TOOTH

I. Primary Tooth

A primary tooth that has been avulsed is usually not reimplanted. Avulsed primary teeth should not be replanted because of the potential for subsequent damage to developing permanent tooth germs.

II. Permanent Tooth

Replant as soon as possible and then stabilize the replanted tooth in its anatomically correct location, to optimize healing of the periodontal ligament and neurovascular supply while maintaining esthetic and functional integrity except when replanting is contraindicated by:

1. The child's stage of dental development (risk for ankylosis where considerable alveolar growth has to take place);
2. Compromising medical condition;
3. Compromised integrity of the avulsed tooth or supporting tissues.

Steps

1. Do not touch the root of the tooth. Handle the tooth by the crown only.
2. Rinse the tooth off only if there is dirt covering it. Do not scrub or scrape the tooth.
3. Attempt to reimplant the tooth into the socket with gentle pressure, and hold it in position.
4. If unable to reimplant the tooth, place it in a protective transport solution, such as Hank's solution, cold milk, saline and saliva (Buccal vestibule). This will hydrate and nourish the periodontal ligament cells which are still attached to the root. A small container of Hank's Balanced Salt Solution can be purchased in dental emergency kit form at many drug stores. Contact lens solution is not an acceptable storage medium.
5. The tooth should not be wrapped in tissue or cloth. The tooth should never be allowed to dry.
6. Child should be taken to a dentist or hospital emergency room for evaluation and treatment.
7. Radiographs may need to be taken of the airway, stomach, and mouth if the tooth cannot be found.
8. Tetanus prophylaxis should be considered if the dental socket is contaminated with debris.

DENTAL OFFICE TREATMENT FOR AN AVULSED TOOTH

I. Primary Tooth

The primary avulsed tooth is generally not reimplanted to avoid injury to the developing permanent tooth bud (Fig. 39.5).

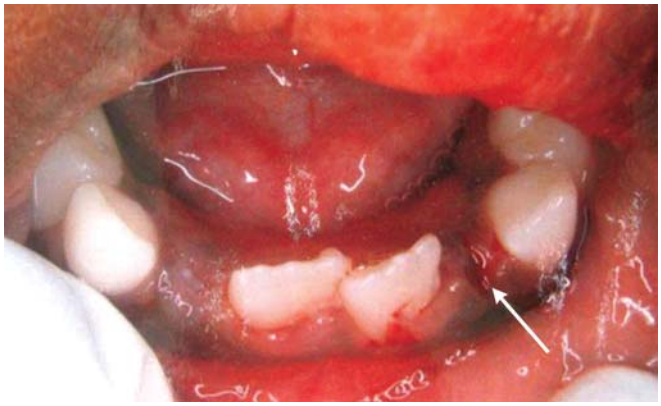


Fig. 39.5: Avulsed deciduous mandibular left lateral incisor

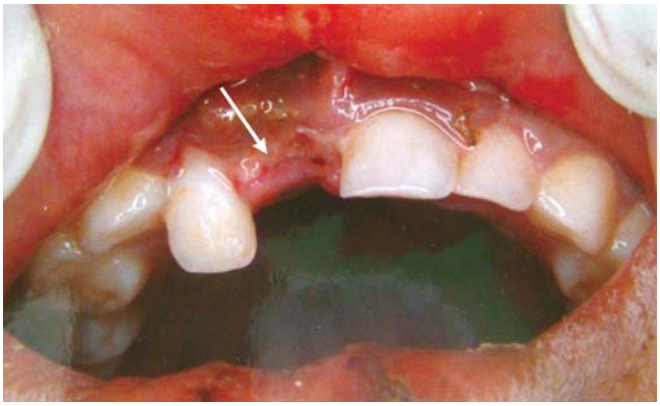


Fig. 39.6: Avulsed permanent maxillary right central incisor

II. Permanent Tooth

1. The tooth should be placed (Fig. 39.6) in Hank's Balanced Salt Solution.
2. Take a medical and dental history, and perform a physical examination. Rule out CNS injury.
3. Examine the orofacial area. Inspect the oral soft tissue for embedded tooth fragments, lacerations, or ecchymosis (bruising). Palpate the teeth and dentoalveolar area to check for mobility. Evaluate TMJ function.
4. If the tooth is missing, rule out aspiration or ingestion.
5. Take a maxillary occlusal radiograph, as well as a lateral anterior radiograph of the injured area. Consider taking a panoramic radiograph to rule out condylar or mandibular fractures.
6. Gently aspirate the injured area without entering the socket. If a clot is present, dislodge and remove it using light saline irrigation. Do not curette the socket.
7. The tooth should be carefully held by the crown, and not by the root. The avulsed tooth should be reintroduced into the dental socket slowly.

40 Occupational Hazards in Dentistry

CM Marya

In carrying out their professional work, dentists are exposed to a number of occupational hazards. These cause the appearance of various ailments, specific to the profession, which develop and intensify with years. In many cases they result in diseases and disease complexes, some of which are regarded as occupational illnesses. Close contact with the patients, with their saliva and blood, exposes the dentist to occupational biohazards, mainly of the contagious kind. Dental professionals are at risk for exposure to numerous biological, chemical, environmental, physical, and psychological workplace hazards. These hazards include but are not limited to the spectrum of blood borne pathogens, pharmaceuticals and other chemical agents, human factors, ergonomic hazards, noise, vibration, and workplace violence.

PREVALENCE

Jacobsen N (1991) reported occupational health complaints such as musculoskeletal problems (3%), eye, respiratory and systemic complaints (13%), and dermatosis (40%) reported by Pulic Health Dentist of Norway.

Katelaris CH (1996) reported glove dermatitis and latex allergy at 22% and 9% respectively in dental personnel at a major dental school in Sydney, Australia.

A study on Belgian dentist in 2006 by Gijbels F revealed the incidence of low back pain (54%), vision problem (52%), allergies (23%), auditory disorders (20%), infections (9%) and diminished sensitivity at the finger tips (6%).

DEFINITION

Occupational hazard can be defined as a risk to a person usually arising out of employment. It can also refer to a work, material, substance, process, or situation that predisposes, or itself causes accidents or disease, at a work place.

The history of occupational hazard awareness can be traced back to the 18th century when Bernadino Ramazzini, who is referred to as the father of occupational medicine, recognized the role of occupation in the dynamics of health and diseases.

The practice of dentistry exposes dental professionals to a variety of work-related hazards.

These include:

- Working in a sedentary state
- Working at a high level of concentration for long hours
- Working with anxious patients
- Exposure to microbial aerosols generated by high-speed rotary hand pieces
- Exposure to various chemicals used in clinical dental practice
- Other hazards

Despite numerous technical advances in recent years, many occupational health problems still persist in modern dentistry. These include percutaneous exposure incidents; exposure to infectious diseases (including bioaerosols), radiation, dental materials, and noise; musculoskeletal disorders; dermatitis and respiratory disorders; eye injuries; and psychological problems.

Strained posture at work destabilizes the osteoarticular system and causes overburdening of the spine. The overburdening also affects certain groups of muscles and joints. This brings about diseases of the musculoskeletal system and of the peripheral nervous system. Also, the functioning of the respiratory, cardiovascular and alimentary systems is disrupted. Dental medicaments and materials as well as disinfectants used in dental surgeries cause allergies and skin diseases. The noise of suctions, saliva ejectors, turbines, engines, amalgamators, compressors, etc. causes impaired hearing.

Major occupational hazards are:

1. Biological health hazards
2. Physical hazards
3. Chemical hazards
4. Musculoskeletal disorders and diseases of the peripheral nervous system
5. Hearing loss

6. Radiation exposure
7. Stress
8. Legal hazards
9. Other risks

Biological Health Hazards

Dentists constitute a group of professionals who are likely to become exposed to biological health hazards.

These hazards are constituted by infectious agents of human origin and include prions, viruses, bacteria and fungi as shown in Table 40.1. All members of the dental team are at risk of exposure to hepatitis B virus (HBV), HIV infection, and other types of communicable infections. Several of the common viral agents that can cause hepatitis have been detected in body fluids including saliva and blood. The viruses most commonly implicated include hepatitis A virus (HAV), HBV, and hepatitis C. It is desirable all the staff be vaccinated properly against hepatitis B infection because of the risk of body fluid borne infection.

A dentist can become infected either directly or indirectly. In the first case, microorganisms can pass into organism, through a cut on the skin of his/her hand while performing a medical examination, as a result of an accidental bite by the patient during a dental procedure, or through a needle wound during an anesthetic procedure.

Indirect infection sources include: Aerosols of saliva, gingival fluid, natural organic dust particles (dental caries tissue) mixed with air and water, and breaking free from dental instruments and devices.

The following are the main entry points of infection for a dentist: epidermis of hands, oral epithelium, nasal epithelium, epithelium of upper airways, epithelium of bronchial tubes, epithelium of alveoli, and conjunctival epithelium.

Physical Hazards

The dentist and the clinical staff are at risk of physical injuries during many dental procedures. Sources of physical injury can include debris from the oral cavity striking the eyes, cuts from sharp instruments, or puncture wounds from needles or other sharp instruments. Such injuries can result in the transmission of serious infectious disease to the dental worker.

Percutaneous exposure incident (PEI) is a broad descriptive term that includes needlestick and sharp injuries, as well as cutaneous and mucous exposures to blood and serum. The most common of them is from needles and drilling instruments such as burs. From the occupational viewpoint, PEI represents the most efficient method for transmitting blood borne infections between patients and health care workers. Needlestick injuries and cuts from sharp objects and instruments (percutaneous injuries) have been reported in 1 to 15 Percent of surgical procedures mostly associated with suturing. In the United States more than 800,000 needle stick injuries occur each year despite continuing education and efforts to prevent them.

Eye injuries may occur from projectiles such as bits of calculus during scaling procedures and splatters from body fluids (bacterial and viral aerosols) while using high-speed hand pieces.

Another potential source of eye injury is the intense dental curing light. Users of dental curing lights should be advised to employ protective eyewear during use. The use of protective eyewear is an important means of preventing occupational injury related to the use of dental curing lights and high-speed rotary instruments. Injury from splatters and projectiles including calculus and flying debris during cavity preparation is a common cause of damage to the eyes, and the use of protective eyewear should be emphasized.

Chemical Hazards

The chemical environment is one of the most rapidly expanding components of the work environment because new chemicals and solutions are being introduced regularly.

Many of these chemicals are among those whose health effects may not be known and may pose health problems taking years to manifest. Many biomaterials and auxiliary products used in dentistry are chemically reactive. Hazardous chemical agents used in clinical dentistry include mercury, powdered natural rubber latex (NRL), disinfectants, and nitrous oxide (N_2O). By far the most important and most dangerous of these agents is mercury.

Mercury

Its use in dental amalgam has the potential for continuous occupational exposure of a dental practitioner to mercurial vapor which can be absorbed via the skin and the lungs. The active component in the mercurial vapor has a particular affinity for brain tissue.

Mercury poisoning can be characterized by tumors of the face, arms, or legs and can also be associated with progressive, tremulous illegible handwriting and slurred speech. All dental personnel should be alerted of the risk of mercurial poisoning and should be familiar with the preventive measures provided by the FDI against mercurial poisoning. It is advisable to conduct regular mercury vapor level assessments in clinical settings; receive episodic individual amalgam blood level tests; and use goggles, water spray, and suction during the removal of old amalgam restorations.

Latex Hypersensitivity

Gloves and mask form an integral part of dentist's protective equipment. Latex gloves dusted with corn starch powder are most often used. The gloves and the mask form an efficient barrier against most pathogens; they also constitute a very good barrier against viruses, provided they are intact. However, they may also be a source of allergies, primarily in those persons who use rubber products on a regular basis.

The continued use of powdered natural rubber latex (NRL) gloves and disinfectants has predisposed clinical dental workers

Table 40.1: Biological health hazards in dentistry

Category	*Transmission to humans*	*Effect on humans*
Prions	Directly (cut, infection)	Creutzfeldt-Jacob's disease
Viruses		
Viruses (*adenoviridae*)	Air-droplet, directly	I –Adenoviral fever
Viruses (*flaviviridae*) virus of hepatitis C (HCV)	Directly (cut, infection), through blood, blood serum and other human body fluids	I – Hepatitis, frequently in the form of a chronic cirrhosis; C – hepatic carcinoma
Viruses (*flaviviridae*) virus of hepatitis G (HGV)	Directly (cut, infection), through blood, blood serum and other human body fluids	I - Hepatitis
Viruses (*hepadnaviridae*) virus of hepatitis B (HBV)	Directly (cut, infection), through blood, blood serum and other human body fluids, especially wound exudate, saliva	I – Hepatitis, frequently in the form of a chronic cirrhosis; C – hepatic carcinoma
Viruses (*hepadnaviridae*) virus of hepatitis D (HDV = DELTA + HBV)	Directly (cut, infection), through blood, blood serum and other human body fluids	I – Hepatitis, frequently in the form of a chronic cirrhosis
Viruses (*herpesviridae*) *herpes simplex virus* (HSV)/simple herpes virus (type 1 and 2)	Directly: Through kissing (most frequently – type 1), through sexual intercourse (most frequently – type 2), through a cut in the skin, through hand contact encephalitis	I – Herpes: Vesicular inflammation of tunica mucosa of oral cavity and urinary – sexual organs, skin inflammations (eczema and vesicular eruption), keratitis
Viruses (*orthomyxoviridae*) viruses of influenza (type A, B, and C)	Air-droplet	I – Influenza, pneumonia
Viruses (*retroviridae*) human immuno-deficiency virus (type HIV-1, HIV-2)	Directly (through blood, sexual intercourse homo- and heterosexual), through placenta to fetus	I – AIDS (acquired immunodeficiency syndrome), atrophy of cellular immunity through gradual destruction of lympho-cytes T, progressive neuropathy, accompa-nying infections, death; C - neoplasms
Bacterias Bacteria (gram-negative facultative anaerobic bacteria) *Actinobacillus actinomycetemcomitans*	Orally, air-droplet	I – Localized juvenile periodontitis (LJP – localized juvenile periodontitis)
Bacteria (*actinomycetes*) *Actinomyces gerencseriae*	Orally, directly (cuts)	I – Actinomycosis, nodular suppurative lymphadentitis
Bacteria (*actinomycetes*) *Actinomyces israelii*	Orally, directly (cuts)	I – Actinomycosis, nodular suppurative lymphadentitis
Bacteria (gram-negative anaerobic bacteria) *Bacteroides fragilis*	Endogenic resulting from cuts,operation, bites	I – Pneumonia, oral cavity inflammation, periodontitis, dermatitis, inflammation of female genitals, enteritis, septic emia
Bacteria (gram-negative anaerobic bacteria) *Fusobacterium necrophorum*	Directly, endogenic(resulting from damaged tissues)	I – Infections of oral cavity, respiratory system, urinary-sexual system, skin, connective tissue, bone, intestine
Bacteria (gram-negative aerobic coccus bacteria) *Neisseria meningitidis*	Air-droplet, directly	I - Meningitis

Contd…

Contd...

Category	*Transmission to humans*	*Effect on humans*
Fungi Fungi (imperfect fungi, anascogenic yeasts) *Candida albicans*	Directly	I – Candidiasis of skin, nails, oral cavity, vagina, rarely internal organ candidiasis – usually occurring in specific microclimatic conditions (high humidity and temperature) and in decreased immunity; A – endogenic allergic reactions
Fungi (imperfect fungi, anascogenic yeasts) *Candida tropicalis*	Directly	I – Candidiasis of skin, nails, oral cavity, vagina, rarely internal organ candidiasis – usually occurring in specific microclimatic conditions (high humidity and temperature) and in decreased immunity

(I – infectious or invasive activity; C – carcinogenic activity; A – allergenic activity)

to hand dermatitis, contact dermatitis, contact urticaria, and allergic dermatitis. The most serious potential hazard associated with the continued use of powdered NRL gloves in dental practice is latex sensitization caused by exposure to aerosolized NRL protein. This can result in dermatitis on the hands. This occurs with such frequency that it is now recognized as an occupational hazard in dentistry.

Nitrous Oxide (N_2O)

It has been associated with neurological abnormalities in healthcare workers chronically exposed to N_2O. Retrospective surveys of dental and medical personnel have linked occupational exposure to N_2O with a number of health problems and reproductive derangements.

Transient irritative reactions of the eyes and airways have been observed mostly associated with exposure to volatiles from resin based materials, X-ray chemicals, and cleansers. These include procaine, soaps, eugenol, iodine, formalin, phenol, and other disinfectants.

Cyanoacrylate (CA) Toxicity

Cyanoacrylate (CA) and its homologues have a variety of dental applications as adhesives. The increasing use of CA in dentistry, particularly as adhesive and sealing glue, has raised concerns regarding its potential toxicity in humans. Reported toxicity of CA is uncommon in the dental workplace, but may manifest as conditions such as urticaria, contact dermatitis and other dermatoses. Dental staff using CA adhesives should avoid direct contact with CA and use appropriate personal protective measures. Maintaining higher levels of humidity, optimizing room ventilation and using special air conditioning filters in the working environment may be useful in minimizing the toxicity of volatile CA adhesives.

Musculoskeletal Disorders and Diseases of the Peripheral Nervous System

At work, the dentist assumes a strained posture (both while standing and sitting close to a patient who remains in a sitting or lying position), which causes an overstress of the spine and limbs. The overstress negatively affects the musculoskeletal system and the peripheral nervous system; above all, it affects the peripheral nerves of the upper limbs and neck nerve roots. The posture of the dentist at work, with the neck bent and twisted, an arm abducted, repetitive and precise movements of the hand, are a frequent cause of the neck syndrome and of pain within the shoulder and upper extremities.

Operations carried out during extractions stress not only the elbow joint and the wrist joint but may result in chronic tendon sheath inflammation. The long-term effect of all those adverse circumstances occurring in the work of the dental doctor may lead to diseases described as cumulative trauma disorders. The most common injuries reportedly experienced by the dental hygienist are musculoskeletal in nature. The need to work in a fixed working position using a continuous repetitive motion can predispose the clinical dental worker to wrist-ache, lower backache, and neckache.

Carpal tunnel syndrome is also seen in dental professionals due to the vibrations of hand instruments.

Hearing Loss

The noise of suctions, saliva ejectors, turbines, engines, amalgamators, compressors, etc. may causes impaired hearing. The noise levels of modern dental equipments have now generally fallen below 85 dB (A), the widely used benchmark standard, below which the risk of hearing loss is believed to be minimal. Still some dentist may be at risk specially where faulty or older equipment is used.

Radiation Exposure

Exposure to both ionizing and nonionizing rediation may occur in dental practice.

During an average radiological examination, the radiation dose received by an individual is generally low and relatively few cells are damaged. Though cellular repair is expected, it is not necessarily perfect. Thus, the effect of even low levels of exposure to ionizing radiation over periods of time may accumulate and could represent a potential hazard to health. Radiation effects are generally categorized as somatic and genetic. Somatic effects appear within a time frame of a few hours to years. Depending on the dose received and its duration, the consequence is greater for high doses incurred in short time periods. Genetic effects are also a cause for concern at the lower doses used in dental radiology. The radiation doses may be small and appear to cause no observable damage, but the probability of chromosomal damage, with the consequence of mutations giving rise to genetic defects, can make such doses significant, when considered for a very large population. Dental staff should take steps to protect themselves during exposure by standing behind protective barrier, use of radiation monitoring badges and regular equipment checks and maintenance.

Nonionizing radiations have become a cause of concern among dentists with the use of ultraviolet and blue light to cure or polymerize various dental materials such as composite resins, sealants and bonding agents. Exposure to these wavelengths can cause damage to various structures of the eyes including the cornea, lens and the retina. Use of safety shields and glasses are recommended as they are protective.

Stress

Stress is the most common psychological condition that occurs in the dental profession. Stress situations form an inherent part of a dentist's everyday work. Although seldom discussed, they should be considered in view of the hazards connected with this profession, a profession which requires that a dentist should act in two roles: as a psychotherapist and a manually skilled operator.

Many clinical situations are the source of stress to a dentist and these include, among others, procedures connected with anesthetization of patients, overcoming of pain and fear, unexpected emergency situations in which a patient's health or life is in danger, or procedures with uncertain prognosis.

The following factors, such as the necessity to keep a proper professional standard, aspiration to achieve technical perfection, causing pain or fear in patients, the necessity to cope with cancelled visits or late arrivals by patients, having to cope with different levels of cooperation with patients, are some of the very important sources of stress in everyday dental practice.

Legal Hazards

In every country there are relevant statutes and regulations which apply to the practice of dentistry. The contravention of any of these may warrant that legal actions be brought against a dental practitioner particularly in developed countries where the citizens appear more aware of their rights. To help assure a safe work environment in dental treatment, the hazard awareness and prevention of legal risks should be made known to all clinical workers of the dental hospital/clinic.

Other Risks

Mild neuropathy among dental professionals has been shown to be associated with high frequency vibrations from dental equipments, particularly high and low speed handpieces and ultrasonic scalers.

Prevention of Occupation Hazards

Health risks in dentistry may arise as new technologies and materials are developed. However, once identified and recognized as risk, new guidelines, precautions, and protocols are often rapidly instituted to greatly reduce or even eliminate the occupational hazard.

Education is one of the important strategies for the prevention of occupational injuries and diseases. The role of one's occupation as an important factor in maintaining personal health needs to be constantly emphasized so workers understand any possible negative health implications of their jobs and how to minimize them. Concerning prevention, the international literature focuses mostly on infection control and proper handling of potentially infected materials, owing to the high profile of dentistry regarding transmission of infection. Barrier techniques include gloves, masks, protective eye wear, high power suction and good ventilation to reduce aerosols and vapor dangers. Hypoallergenic nonlatex gloves are proposed to deal with latex allergy. Lead aprons, periodic maintenance of the X-ray machine and radiation level sensors prevent radiation hazard.

41 Infection Control in Dentistry

CM Marya

Most dentists are solo practitioners working in outpatient, ambulatory care facilities. In those settings, no epidemiologists or other hospital infection control experts track possible health care associated (i.e. nosocomial) infections or monitor and recommend safe practices. Implementing safe and realistic infection control procedures requires the full compliance of the whole dental team. Instruments used frequently in dental practice generate spatter, mists, aerosols or particulate matter. Unless precautions are taken, there is a high possibility that patients and dental health care personnel (DHCP) will be exposed to blood and other potentially pathogenic infectious material. DHCP include dentists, dental hygienists, dental assistants, dental laboratory technicians (in-office and commercial), students and trainees, contract personnel, and other people not directly involved in patient care but who could be exposed to infectious agents (such as administrative, clerical, housekeeping, maintenance or volunteer personnel).

Previous Centers for Disease Control and Prevention (CDC) recommendations regarding infection control for dentistry focused primarily on the risk of transmission of blood borne pathogens among DHCP and patients and use of universal precautions to reduce that risk.

The relevance of universal precautions to other aspects of disease transmission was recognized, and in 1996, CDC expanded the concept and changed the term to *standard precautions*.

Standard precautions integrate and expand the elements of universal precautions into a standard of care designed to protect HCP and patients from pathogens that can be spread by blood or any other body fluid, excretion, or secretion. Standard precautions apply to contact with 1) blood; 2) all body fluids, secretions, and excretions (except sweat), regardless of whether they contain blood; 3) nonintact skin; and 4) mucous membranes. Saliva has always been considered a potentially infectious material in dental infection control; thus, no operational difference exists in clinical dental practice between universal precautions and standard precautions.

Fortunately, by understanding certain principles of disease transmission and using infection control practices based on those principles, dental personnel can prevent disease transmission. The underlying assumption for infection control practices is that all persons are to be treated as if they are infected and infectious.

INFECTION CONTROL

It refers to a comprehensive and systemic program that, when applied prevents the transmission of infectious agents among persons who are in direct or indirect contact with the health care environment.

Why is Infection Control Important in Dentistry?

- Both patients and dental health care personnel (DHCP) can be exposed to pathogens
- Contact with blood, oral and respiratory secretions, and contaminated equipment occurs
- Proper procedures can prevent transmission of infections among patients and DHCP.

The principles of infection control are:

1. Stay healthy: This principle emphasizes the need for dental personnel to be and stay healthy. Strategies include immunizations; postexposure management and medical follow-up by a qualified health care professional; routine hand hygiene procedures; and maintaining hand health.
2. Avoid contact with blood and body fluids: The primary methods to avoid contact with blood and other potentially infectious materials are—handle sharp instruments with care, use safety devices when appropriate, correctly manage occupational exposures to blood, and wear personal protective equipment (PPE) (gloves, protective clothing, and face and eye protection).
3. Limit the spread of contamination: This principle is accomplished by—covering surfaces using surface barriers or cleaning and disinfecting surfaces that are likely to become contaminated; minimizing sprays and splashes

to reduce contamination (high volume evacuation, dental dams); and properly disposing of medical waste.

4. Make objects safe for use: The primary methods to make objects safe for use are—cleaning and heat sterilizing patient care items that contact bone, enter previously sterile tissues, or touch mucous membranes before use; monitoring sterilization processes; and following manufacturer's instructions for use and sterilization.

TRANSMISSION OF INFECTION

In order to effectively guard against both the acquisition and transmission of infectious diseases, it is helpful to consider potential sources of infection and how they interact. Interplay of modes of disease transmission in dental office is shown in Figure 41.1.

The two principle *modes of disease transmission* in which infectious diseases are acquired in dentistry are:

1. Contact
   a. Direct contact: Human-human touch. Contact with microorganisms at the source.
   b. Indirect contact: Human-object/animal-human touch. Contact with contaminated items such as surfaces especially dental office equipment and/or instruments including contaminated sharps.
2. Droplet Infection
   a. Splatter of blood, saliva or nasal secretions onto broken mucosa or skin.
   b. Airborne by aerosols of microbes.

The three principle routes of entry of microorganisms into the body are:

1. Inhalation
   a. *Direct inhalation*: Inhalation of small particles of moisture (spatter) generated when a person coughs or sneezes, or when water is aerosolized to a fine mist during dental procedures. Risk of disease transmission is usually limited to persons in close proximity to the droplet source.
   b. *Indirect inhalation:* Inhalation of particles <5 microns in diameter formed by dehydration of airborne droplets containing microorganisms that can remain suspended in the air for long periods of time or which settle on surfaces and can be readily reintroduced to the environment.
2. Ingestion: Whereby droplets of saliva/blood or particles from instruments are swallowed.
3. Autoinoculation/percutaneous injury: Autoinoculation occurs as a result of the operator touching his/her own mucous membrane or nonintact skin surface with contaminated patient care items or contaminated personal protective barriers. Percutaneous injuries are those that occur as a result of breaking the skin especially with a contaminated sharp instrument.

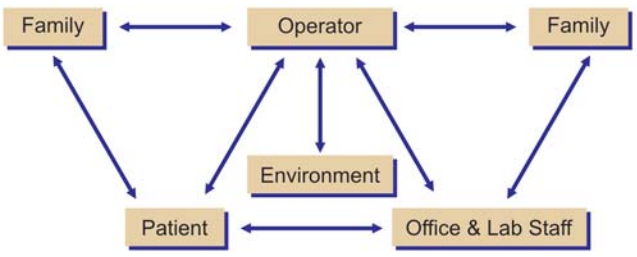


Fig. 41.1: Modes of disease transmission in dental office

Aim

The aim of infection control is to create and maintain a safe clinical environment to eliminate the potential for diseases transmission from dentist to the patient or the patient to the dentist or from patient to patient (Fig. 41.2).

Dental procedures and instruments are associated with widely variant amount of body fluids. Hence, infection control should be procedurally based and not patient based.

In addition to standard childhood vaccination schedule additional immunization are recommended for health care workers.

STANDARD PRECAUTIONS

- Apply to all patients
- Integrate and expand universal precautions to include organisms spread by blood and also,
  - Body fluids, secretions, and excretions except sweat, whether or not they contain blood
  - Nonintact (broken) skin
  - Mucous membranes

British Dental Association advices that all new staff must be appropriately trained in infection control procedures prior to working in the practice. Training should equip staff to understand:

- How infections are transmitted
- The practice policy on decontamination and infection control

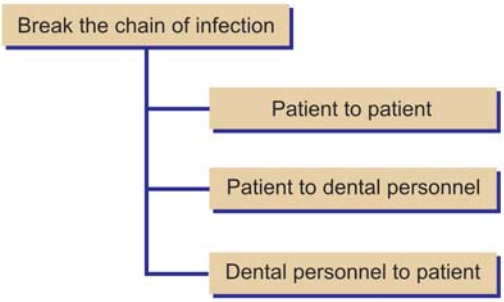


Fig. 41.2: Elimination of disease transmission at each phase

- What personal protection is required and when to use it
- What to do in the event of accidents or personal injury.

COMPONENTS OF INFECTION CONTROL

1. Immunization
2. Patient screening
3. Hand hygiene
4. Barrier techniques
5. Needle and sharp instrument safety
6. Instrument sterilization and disinfection
7. Surface disinfection and general operatory asepsis
8. Radiographic asepsis
9. Laboratory asepsis
10. Disposal of contaminated wastes

1. Immunization

Dental personnel can reduce the risk of contracting infectious diseases by maintaining their health and immune status. Following the series of hepatitis B vaccinations, there should be confirmation that an adequate antibody titer has been reached (10 International Units/liter).

Dental personnel should maintain up-to-date immunization records that include vaccination against:

a. Hepatitis B
b. Rubella
c. Measles
d. Mumps
e. Influenza
f. Poliomyelitis
g. Tetanus/diphtheria

Testing for tuberculosis is recommended following a suspected exposure.

2. Patient Screening

Complete medical history should be taken for every new patient and updated during recall appointments to determine infectious status.

Screening is especially useful when patients report positive disease status for blood borne disease as this reduces questions about the 'unknown' should there be a percutaneous injury to the operator during dental treatment.

3. Hand Hygiene

Hand hygiene in health care facilities is the most important aseptic procedure in the prevention of health care associated infections. Hand hygiene significantly reduces microbes on the hands and protects both patients and the dental staff. The purpose of washing is twofold—to reduce the both transient and resident flora for the duration of a procedure to protect the operator in the event that there is nonintact skin on the hand. Additionally, in the event that the gloves become nonintact during the procedure (unknown to the operator), this reduces the numbers of organisms to which the patient will become exposed. Handwashing products include plain soap and agents with antimicrobial activity. The wearing of gloves does not replace handwashing, but is an adjunct providing consistent protection from blood-borne pathogens.

Hand hygiene is important because:

- Hands are the most common mode of pathogen transmission
- Reduce spread of antimicrobial resistance
- Prevent health care associated infections

Although, handwashing depends primarily on a mechanical effect and any liquid soap is acceptable, because skin bacteria can rapidly multiply under gloves if hands are washed with soap that is not antimicrobial, thorough handwashing with a chemically active anti-microbial soap is recommended. Bar soaps are not recommended (Fig. 41.3).

The following agents have been found to be effective:

a. 2 to 4 percent Chlorhexidine
b. 0.3 to 1 percent Triclosan
c. 0.6 percent Parachlorometaxylenol (Pcmx)
d. 60 to 70 percent Propanol

In addition, chlorhexidine and triclosan exhibit substantivity or a residual effect.



Fig. 41.3: Efficacy of hand hygiene preparations in killing bacteria

Components of Good Handwashing Include

- Cleaning nails and skin thoroughly to remove all visible soil
- Rinsing well to remove all visible soap
- Drying thoroughly to reduce risk of skin chapping.

Indications for Hand Hygiene

a. When hands are visibly soiled;
b. After barehanded touching of inanimate objects likely to be contaminated by blood, saliva, or respiratory secretions;
c. Before and after treating each patient (e.g. before glove placement and after glove removal) and before leaving any patient care (e.g. dental operatory, radiology), laboratory or instrument processing area;
d. Before donning gloves; and
e. Immediately after removing gloves.

Wash Technique

Use of artificial nails is contraindicated as is use of colored nail polish. Nails should be short enough to allow thorough cleaning and to prevent tears. Sharp or broken nails encourage glove tearing and should be avoided.

All hand jewellary should be removed, however, it is not the purpose of the infection control program to alienate the reader on personal or religious grounds, and therefore only those rings which are significantly raised and/or are multifaceted and may cause injury to the patient or readily cause glove tears should be removed. Watches or bracelets should be maintained under the cuffs of the clinic jackets to protect the wearer from spatter of blood and saliva.

Hands are always washed at the start and end of each clinic session, morning and afternoon. This has formerly been called the 'long wash technique' and differs from usual technique only by the additional cleaning of fingernails which should be done anytime there is visible soil under the fingernails.

a. Wet hands from fingertips to wrist with cool water
b. Place liquid soap on nailbrush and on hands
c. Clean the fingernails with brush until no visible soil remains, leave brush in sink
d. Scrub hands vigorously
e. Rinse with cool water until all traces of soap are removed
f. Dry thoroughly.

The wash without the use of a nail brush is used:

a. Prior to glove placement and following glove removal.
b. After bare handed touching of inanimate objects likely to be contaminated by blood or saliva
c. Before leaving the dental operatory.

The shorter handwash technique is as follows:

a. Wash the hands using a liquid soap for 15 seconds
b. Rinse under running water for 10 seconds or until all traces of soap are removed
c. Dry thoroughly with one or two paper towels and ensure proper drying.

4. Barrier Techniques — Personal Protective Equipment (PPE)

Personal protective equipment (PPE) is designed to protect the skin and the mucous membranes of the eyes, nose, and mouth of dental health care provider from exposure to blood. Use of PPE is dictated by the exposure risk posed by the procedure, not by the known or suspected serologic status of the patient. Primary PPE used in health care settings includes gloves, surgical masks, protective eyewear, face shields, and protective clothing (e.g. long sleeved gowns, jackets). Shoe and head covers are less frequently used types of PPE, but should be considered if contamination is likely.

Personal protective equipment should be placed in the following order:

1. Clothing
2. Mask
3. Glasses
4. Wash hands, place gloves.

Removal of PPE:

1. Gloves
2. Mask
3. Glasses
4. Wash hands.

1. Protective Clothing

Protective outerwear is worn to reduce exposure to debris in spatter. Clinic outerwear is to be fully buttoned, has long sleeves with elasticized cuffs and a high neck.

In all cases, clothing must be changed daily, although clothing that has become visibly soiled must be changed immediately.

Contaminated clinical wear should be taken home in a plastic bag and laundered using a high temperature cycle (60-70°C) with a normal bleach concentration followed by machine drying (100°C or more), (or dry cleaned) and pressed.

Use of disposable gowns may be considered when performing surgical procedures and treating known carriers of infectious diseases (e.g. HIV positive and HBsAg positive patients). This is done to protect the person or persons performing the laundry.

Following patient care, surgical gowns and protective clothing is considered contaminated. Because of this, it is not to be worn outside of the clinic environment in lectures, leisure or eating areas. If contaminated clothing cannot be changed, a clean lab coat must be worn over top as a second choice. Because there is no simple way to tell which clothing is contaminated, once placed, all outerwear is considered contaminated.

2. Masks

Dental health care workers must wear masks when spatter of blood or body fluids is likely (i.e. when using hand pieces, prophy angles, etc.).

Masks are to be worn when procedures that result in aerosol production are performed. Protection from these masks only affords protection for those particles 5 μm and larger. In order to afford even this protection, the mouth and the nose have to be covered.

Masks must also be worn if dental personnel have transmissible respiratory infections.

To ensure that the barrier protection afforded by a mask is not compromised:

- Place by covering the mouth and nose completely and the mask is adjusted firmly on the bridge of the nose
- Once placed, masks should not be touched
- If a mask should slip during treatment, place overgloves and replace with a new pair, correct mask and dispose overgloves

- Visibly soiled or moist masks should be changed
- When a mask is no longer necessary for patient care it should be removed and discarded
- Masks should be removed and discarded when using the phone or leaving the clinic
- Masks should not be worn below the nose or below the chin
- Masks that have been removed should be discarded, not handled bare handed except for removal, placed on countertops, or placed in pockets.

3. Protective Eyewear

Protective eyewear must be worn by patients and all clinical personnel during all procedures at all times:

1. When performing procedures that can cause spatter or aerosols including laboratory procedures
2. When performing procedures that produce projectiles including laboratory procedures
3. When working with or in proximity to chemicals which emit fumes especially in the laboratory
4. When it is likely that unprotected eyes will be exposed to any type of physical injury or splashes from corrosive or toxic chemicals (e.g. sodium hypochlorite) including the laboratory.

Everyday eyewear may not provide sufficient protection from spatter — special protective glasses, or goggles are required. Sideshields on the glasses increase the level of protection. If a face shield is worn, a mask is still required under the shield. All eye protection must be disinfected between patients to avoid possible contamination or infection.

Protective lenses must be worn by patients, students, and clinical and support staff during active patient care.

4. Gloves

Gloves reduce hand contamination and protect HCW particularly from pathogens that result in infection. However, the use of gloves does not eliminate the need for handwashing both prior to placement and following removal of gloves.

Gloving is recommended in surveying only if a lesion or a wound exists on the examiner's hand. Gloves should not be used when greeting patients, handling records or radiographs.

Gloves are task specific. The different types of gloves worn in the dental office are:

i. Examination gloves
ii. Over or cover gloves
iii. Utility gloves
iv. Under gloves
v. Surgical gloves

Gloves reduce hand contamination by 70 to 80 percent, prevent cross-contamination and protect patients and HCW from infection. The use of gloves does not eliminate the need for handwashing both prior to placement and following removal.

i. Examination/treatment gloves—latex, vinyl, nitrile, neoprene
Gloves are worn whenever contact with blood, saliva, mucous membranes or blood/saliva contaminated objects or surfaces are anticipated and under utility gloves during cleaning.

- A new pair of gloves is worn for each patient
- Once treatment gloves have been placed, nothing else should be touched other than the patient and those instruments, equipment, and supplies that have been prepared solely for the use of that patient
- Treatment gloves are covered with over gloves when leaving the operatory to access any other part of the clinic (except when using the telephone)
- Treatment gloves and masks should be removed when leaving the clinic
- Gloves (and mask) should be removed when using the telephone
- Hands are washed prior to placement and immediately following removal of gloves.

ii. Over gloves/cover gloves
These gloves help to use time more efficiently and to protect the skin. The purpose of these gloves is to reduce the number of treatment gloves used, to use time more efficiently when supplies or equipment need to be accessed, and to reduce the number of washes required due to glove changing—in short, to reduce resource use.

Care must be taken to avoid contamination to the outside of the over gloves by touching your clothing, hair, mask, or glasses. Over gloves are not used directly on any item that will be used in the mouth, e.g. rubber dam, fluoride trays, polishing cups, soflex discs.

Over gloves are used when:

- Supplies or equipment are retrieved or returned to the dispensary or from the unit mobile
- The operator is charting
- Obtaining supplies from the mobile with the use of the cotton forceps

Any item that will be used directly in the mouth is not to be handled directly with over gloves.

Location of Over Gloves

- Taped to the sides of the mobile cabinets for procedures such as patient examination and charting during non-aerosol producing procedures
- On the paper towel dispenser (for right-handed) or the chart holder (for left-handed) and covered by a bib for aerosol or spatter producing procedures.

iii. Utility gloves
Heavy-duty utility gloves should be used during all disinfection and cleaning procedures to reduce the increased risk of

percutaneous injury during instrument cleaning. For postoperative cleaning, treatment gloves are worn under utility gloves to afford protection to the operator when placing the utility gloves in their sterilization bag. After use they are to be washed, dried and bagged with nail and suction brushes.

iv. Under gloves
They are cotton gloves worn under the treatment glove for those operators experiencing discomfort to the skin. They are to be replaced following each patient and washed with outerwear.

v. Sterile surgeon's gloves and double gloving during oral surgical procedures

1. Sterile surgeon's gloves should be worn when performing oral surgical procedures.
2. Effectiveness of wearing two pair of gloves to prevent disease transmission during oral surgical procedures is not yet clear. The majority of studies among HCP and DHCP have demonstrated a lower frequency of inner glove perforation and visible blood on the surgeon's hands when double gloves are worn; however, the effectiveness of wearing two pair of gloves in preventing disease transmission has not been demonstrated.

Latex Allergy

Any dental healthcare worker, student, or patients who demonstrates a hypersensitivity to latex should be diagnosed for this hypersensitivity and take precautions to avoid further exposure including wearing an allergy alert label.

Ensure a latex safe environment for patients and DHCP with latex allergy.

The concern has been raised about the possibility of progression of type IV (delayed) latex hypersensitivity to type I (immediate) hypersensitivity.

Latex allergy (type I hypersensitivity to latex proteins) can be a more serious systemic allergic reaction, usually beginning within minutes of exposure but sometimes occurring hours later and producing varied symptoms. More common reactions include runny nose, sneezing, itchy eyes, scratchy throat, hives, and itchy burning skin sensations. More severe symptoms include asthma marked by difficult breathing, coughing spells, and wheezing; cardiovascular and gastrointestinal ailments; and in rare cases, anaphylaxis and death.

DHCW with contact dermatitis possibly due to latex gloves exposure, should switch to another glove and promptly seek medical diagnosis. Emergency treatment kits with latex free products should be available at all times.

The following precautions should be considered to ensure safe treatment for patients who have possible or documented latex allergy (CDC: Guidelines for Infection Control in Dental Health Care Settings — 2003):

- Be aware that latent allergens in the ambient air can cause respiratory or anaphylactic symptoms among persons with latex hypersensitivity. Patients with latex allergy can be scheduled for the first appointment of the day to minimize their inadvertent exposure to airborne latex particles.
- Communicate with other DHCP regarding patients with latex allergy (e.g. by oral instructions, written protocols, and posted signage) to prevent them from bringing latex containing materials into the treatment area.
- Frequently, clean all working areas contaminated with latex powder or dust.
  Have emergency treatment kits with latex free products available at all times.
- If latex related complications occur during or after a procedure, manage the reaction and seek emergency assistance as indicated. Follow current medical emergency response recommendations for management of anaphylaxis.

5. Intraoral Barrier Technique

1. Rubber dam
   A rubber dam should be used whenever possible for improved vision and access and to reduce dental personnel's exposure to microorganisms in patient's blood and saliva.
2. Preprocedural mouthrinse
   Patient's use of an antimicrobial mouthwash of 0.12 percent chlorhexidine gluconate solution for 30 seconds prior to intraoral procedures reduces the number of viable oral organisms. No scientific evidence indicates that preprocedural mouthrinsing prevents clinical infections among oral health care workers. Although, studies have demonstrated that a preprocedural antimicrobial rinse (e.g. chlorhexi-dine gluconate, essential oils or povidone-iodine) can reduce the level of oral microorganisms in aerosols and spatter generated during routine dental procedures, and can decrease the number of microorganisms introduced in the patient's bloodstream during invasive dental procedures.

5. Needle and Sharp Instrument Safety

Needle stick/sharp instrument injuries are of major concern to health care workers.

Sharp ends of any instrument or device should be angled away from both the doctor and the coworkers when receiving, handling or passing such instruments. Used needles should not be bent or broken prior to disposal. Unsheathed needles are placed directly into the designated, puncture-proof disposal container along with any other sharp instruments such as acid etch applicator needles, endodontic files, burs, Bard Parker and scalpel blades, and metal matrices.

Center for Disease Control and Prevention (CDC), recommends that for procedures involving multiple injections with a single needle, the unsheathed needle should be placed in a location where it will not become contaminated or contribute to unintentional needle sticks between injections. If the decision is made to recap a needle between injections, a

one-handed "scoop" technique or a mechanical device designed to hold the needle sheath is recommended.

Sharp instruments or corrosive liquids should not be passed over the patient's face.

Occupational exposure to blood/body fluids:

Exposures to human blood/body fluids include puncture wounds due to a needle stick or sharp instrument, bites and scratches as well as exposures due to a splash of body fluid onto any mucous membrane and/or non-intact skin. These incidents are termed "significant exposures".

Postexposure Protocol for Occupational Exposure to Blood/Body Fluids

1. Stop the procedure immediately
2. Inform patient
3. Remove gloves and apply first aid as required
4. Injuries to the skin should be washed well with soap and running water and bleeding at the injured site can be encouraged while washing
5. First aid measures should be applied to stop bleeding if required
6. Mucous membranes should be flushed well with water. When splashes have occurred to the eye, the eyewash station is to be used to thoroughly flush the eyes
7. Clinical support staff should be notified to arrange for the completion of the treatment
8. The clinical support staff should ask the patient to submit blood for the appropriate blood tests; (microbiology and serology) for HIV, etc.

6. Instrument Sterilization and Disinfection

Definitions:

The following terms are used to describe processes which involve different levels of destruction of microorganisms to which dental instruments and materials may be exposed.

Sterilization	A process which will destroy *all* forms of life applied especially to microorganisms
Disinfection	The destruction or inhibition of *most* pathogenic agents on inanimate objects by chemical or physical means — disinfection cannot occur in the presence of organic debris
Levels of disinfection	• Used for instruments, equipment, and surfaces that do not require sterility or cannot be practically sterilized • There are three levels — high, intermediate, and low with the intended use for patient care determining the level of decontamination

Contd...

Contd...

Sanitization	The process of removing organic debris in order that disinfection can occur
Bacteriostatic	An agent that will inhibit increases in the number of bacteria
Bactericidal, fungicidal, virucidal	An agent that will destroy (kill) bacteria, fungi or viruses

Determining What Should Be Sterilized, Disinfected, Or Discarded

The Spaulding system is a standard system of classification for sterilization and disinfection. It classifies instruments according to their use which in turn determines how they will be decontaminated.

Dental instruments are classified into three categories—critical, semicritical, or noncritical—depending on their risk of transmitting infection and the need to sterilize them between uses

- **Critical:** Surgical and other instruments used to penetrate soft tissue or bone are classified as critical and should be sterilized after each use. These devices include forceps, scalpels, bone chisels, scalers, and burs.
- **Semicritical:** Instruments such as mirrors and amalgam condensers that do not penetrate soft tissues or bone but contact oral tissues are classified as semicritical. These devices should be sterilized after each use. If, however, sterilization is not feasible because the instrument will be damaged by heat, the instrument should receive, at a minimum, high-level disinfection.
- **Noncritical:** Instruments or medical devices such as external components of xray heads that come into contact only with intact skin are classified as noncritical. Because these noncritical surfaces have a relatively low risk of transmitting infection, they may be reprocessed between patients with intermediate-level or low-level disinfection or detergent and water washing, depending on the nature of the surface and the degree and nature of the contamination.

Critical	Touches bone or penetrates soft tissue — must be sterilized
Semicritical	Touches mucous membranes but will not touch bone or penetrate soft tissue — sterilize or high level disinfection, if sterilization will alter the item
Noncritical	Has contact with intact skin — intermediate to low-level disinfection or simple cleaning

When an instrument which requires sterilization or high level disinfection cannot withstand the rigors of this process repeatedly, and the cost is not inhibitive, then it is considered a disposable item.

Preparation for Instrument Sterilization/Disinfection

Instruments have to be cleaned prior to sterilization or disinfection to dislodge blood, saliva and other debris, which may act as barriers to the sterilization/disinfection process. The following procedures are to be followed:

1. Initial Storage: Contaminated instruments should be immersed in a sink of water (Faculty) or in a pre-soak disinfectant immediately after use to avoid drying and hardening of organic debris.
2. Removal of Debris: Debris must be removed prior to sterilization; otherwise the item will not be sterile even though it has been processed. Debris can be removed either by manual scrubbing (Faculty), use of an ultrasonic cleaner, or use of specialized instrument washers which are not unlike dishwashers (however, a dishwasher designed for home use is not adequate for this purpose). Hand scrubbing is effective but risk for accidental puncture increases.

   Manual Scrubbing:
   a. Must wear utility gloves to minimize risk of skin puncture
   b. Immerse instruments in detergent solution and scrub with a soft brush, holding both brush and instrument under the water surface to prevent aerosolizing and splashing
   c. Rinse and dry instruments. Wet instruments increase the risk of tearing any sterilization packaging system which utilizes paper and may contribute to rusting of instruments in a dry heat oven
   d. Immerse, wash, and dry instrument trays or cassettes.
3. Inspection: Prior to placement of instruments into a chemical disinfectant or packaging for sterilization, they should be checked for cleanliness and dryness, signs of rust or cracks and proper opening and closing. Ensure that no organic or inorganic matter remains. Hinged instruments should be opened wide for inspection, dried carefully, and lubricated prior to bagging.
4. Wrapping (bagging):
   - The principal objective in wrapping is to protect sterilized instruments from environmental contamination
   - Cleaned instruments are not decontaminated and, therefore, must be handled with gloves
   - Use correct packaging for sterilization needs.
5. Sterilization: Instruments which can tolerate heat are generally sterilized by one of the following methods
   1. Steam under pressure — gravity displacement or prevacuum sterilizer
   2. Dry heat — static air or forced air
   3. Unsaturated chemical vapor.

Instruments that cannot tolerate heat are processed with high level disinfectants (formerly called "immersion sterilization" to be discussed under "disinfection") or with low temperature sterilization, either ethylene oxide gas or hydrogen peroxide gas plasma.

What follows is a brief overview of recommended heat sterilizers. To ensure the integrity of the sterilization process, the operating and maintenance instructions supplied by the manufacturer should be followed carefully.

1. Steam, Vapor Under Pressure (Autoclave) (Fig. 41.4)

For sterilization to be effective, items being processed require exposure to direct steam contact at the required temperature and pressure for the specified time. Pressure serves as the means to obtain the high temperatures needed to kill microorganisms.

High temperature of the steam, 121 to 132°C (250 to 270°F). Time required to kills microorganisms is 3 to 20 minutes, depending on the type of sterilizer and wrapping.



Fig. 41.4: Example of an autoclave

Advantages	*Disadvantages*
• Effective against most spore forming organisms	• Causes rust and corrosion in unprotected carbon steel instruments. Anti–rust agents can be used to reduce this effect
• Quick and easy to use	• May damage heat sensitive materials
• Penetrates fabric and paper wrapping	• Dulls unprotected cutting edges
• Reliable, can be monitored	• Bacillus stearothermophilus

2. Dry Heat (Fig. 41.5)

Dry heat sterilizes less efficiently than moist heat because as proteins dehydrate and dry, their resistance to denaturation

increases. A higher temperature is required for a dry heat unit than for a steam processor. In order for sterilization to occur, the cycle must be brought to correct temperature and then maintained at that temperature.

Actual time needed to sterilize instruments will depend on the size and arrangement of the load, the type of wrapping material and unit efficiency. A typical dry heat cycle is 1 hour at 170°C or 2 hours at 160°.

Advantages	*Disadvantages*
• Reliable • No rust or corrosion of previously dried instruments • Little maintenance • Has monitoring capabilities	• Longer processing times • Damages some plastics • Scorches paper of cloth wrappings • Can destroy the temper of metal instruments and melt solder joints • Cycle must be uninterrupted - start complete cycle over if unit door is opened to add forgotten items



Fig. 41.5: A dry heat sterilizer

3. Chemical Vapor (Chemiclave) (Fig. 41.6)

Chemical vapor sterilizers use a specific mixture of formaldehyde, alcohols, ketone, acetone and water under pressure at 132°C (270°F) to achieve sterilization. Sterilization requires 20 to 40 minutes and the chemical solution must only be used once.

Advantages	*Disadvantages*
• Relatively quick; no drying time • Minimal rusting or corrosion • Reliable • Works with paper packaged articles • Has monitoring capabilities	• Produces offensive odor • Would not penetrate fabric wrapping • Damages plastics • High cost of special solutions



Fig. 41.6: A chemical vapor sterilizer

Heat Transfer (Bead Type) (Fig. 41.7)

These sterilizers use extremely hot rapid airflow to achieve sterilization in approximately six minutes. However, because they provide such inconsistent heating with significant temperature variation, they are used only at chair side for files and burs. Instruments used during that procedure must be processed in the usual manner for the following patient.

Recommended Methods of Sterilization of Various Dental Items

Handpieces and other items:

- All high speed and surgical handpieces, low speed contra-angles, prophy angles, and nose cones must be subjected to heat sterilization.

Instrument Sterilization:

- All instruments and all items that are able to withstand repeated exposure to heat must be heat sterilized between patients.



Fig. 41.7: A hot bead sterilizer

The following instruments and items (but not limited to) must be heat sterilized between patients:

a. All hand and orthodontic instruments;
b. All burs and bur changers, including contaminated laboratory burs and diamond abrasives;
c. All endodontic instruments;
d. Air-water syringe tips;
e. High-volume evacuator tips;
f. Surgical instruments;
g. Ultrasonic periodontal scalers and tips; and
h. Electrosurgery tips:
i. Metal impression trays; and
j. Intraoral radiographic equipment that can withstand heat sterilization.

Packaged and/or unpackaged instruments should be sterilized in accordance to CDC guidelines.

The purpose of cleaning the instruments prior to sterilization is to reduce the amount of blood, saliva, microbes and other materials that can insulate microorganisms from the sterilizing agent.

Some items that may be chemically sterilized include, but are not limited to the following:

1. Glass mixing slabs;
2. Metal or plastic spatulas;
   Plastic/glass items not meant to be disposed of, glass dappen dishes; that cannot withstand heat;
5. Mirrors for intraoral photography;
6. Some cheek retractors; and
7. Handles for brush tips.

All instruments and all items that are able to withstand repeated exposure to heat must be heat sterilized between patients, e.g. burs, endo items, metal impression trays.

Single Use Items

All single use or disposable items, labeled as such, used in patient treatment must be discarded and not reused. Some of the single use items include: Disposable needles and syringes; local anesthetic carpules; saliva ejectors, high volume evacuator tips and air water syringe tips; polishing disks, cups, points; prophy angles, cups, and brushes; fluoride trays; disposable impression trays; gloves, masks, orthodontic wires, bands and brackets, matrix bands. These items are disposable and must be properly disposed off as single use items. These items are neither designed nor intended to be cleaned, disinfected, or sterilized for reuse.

Disinfection

Disinfection is the use of a chemical to remove most forms of life on an instrument, device, or environmental surface (operatory surface). This is done either because it cannot be processed in a sterilizer due to its ability to withstand high temperatures or due to its size.

7. Surface Disinfection and General Operatory Asepsis

- Contaminated surfaces are disinfected routinely following each patient visit. These include but are not limited to the following: All those areas that were covered with barriers, bracket table, countertops, mobile air/water syringe handles, suction and saliva ejector couplings, dental chair, operator and assistant stools, soap and towel dispenser areas and X-ray viewer and switch.
- Preclean and dry all surfaces prior to disinfection. Known as "sanitization", this removal of organic material is critical since disinfectants are not effective in the presence of organic matter. Water based disinfectants, particularly those that contain a detergent are more effective than alcohol based disinfectants.
- Utility gloves are used during disinfection to reduce risk to the operator from pathogens as well as the chemical disinfectant.

The surface is left to air dry for the exposure time recommended by the product manufacturer. Excess disinfectant may be wiped away with a clean paper towel after this time has expired.

Methods	*Standard sterilizing conditions*	*Dental instruments/materials sterilized*
Steam autoclave	20 min at 121°C (15 psi)	Condensers, dappen dishes, endodontic instruments, glass slabs, impression trays, orthodontic pliers, polishing and sharpening stones,surgical instruments
Chemical vapor	20 min at 132°C (20-40 psi)	Stainless steel handpieces, burs, carbon steel hand instruments, mirrors, needles, rubber dam equipment,stones, water-air syringe tips
Dry heat oven	60-120 min at 160°C	Burs, endodontic instruments, condensers, dappen dishes, glass slabs, carbon steel hand instruments, orthodontic pliers, stones, water-air syringe tips
Ethylene oxide	10-16 hr at 61°C	Condensers, dappen dishes, endodontic instruments, glass slabs, impression trays, orthodontic pliers, stainless steel handpieces, burs, carbon steel hand instruments, mirrors, needles, rubber dam equipment, rubber items, saliva evacuators, surgical instruments, ultrasonic scaling tips

8. Radiographic Asepsis

Wear gloves when exposing radiographs and handling contaminated film packets. Use other PPE (e.g. protective eyewear, mask and gown) as appropriate if spattering of blood or other body fluids is likely.

Use heat-tolerant or disposable intraoral devices whenever possible (e.g. film-holding and positioning devices). Clean and heat-sterilize, heat-tolerant devices between patients. At a minimum, high-level disinfect semicritical heat-sensitive devices, according to manufacturer's instructions.

Transport and handle exposed radiographs in an aseptic manner to prevent contamination of developing equipment. After exposure of the radiograph and before glove removal, the film should be dried with disposable gauze or a paper towel to remove blood or excess saliva and placed in a container (e.g. disposable cup) for transport to the developing area. The following apply for digital radiography sensors:

Clean and heat-sterilize, or high-level disinfect, between patients, barrier protected semicritical items. If the item cannot tolerate these procedures then, at a minimum, protect with an FDA cleared barrier and clean and disinfect with an EPA registered hospital disinfectant with intermediate level (i.e. tuberculocidal claim) activity, between patients. Use of a barrier does not always protect from contamination. Consult with the manufacturer for methods of disinfection and sterilization of digital radiology sensors and for protection of associated computer hardware.

9. Laboratory Asepsis

Items such as impressions, jaw relation records, casts, prosthetic restorations and devices that have been in the patient's mouth are potential sources for cross-contamination and should be properly disinfected prior to shipment to a dental laboratory.

Dental prostheses or impressions brought into the laboratory can be contaminated with bacteria, viruses, and fungi. Dental prostheses, impressions, orthodontic appliances, and other prosthodontic materials (e.g. occlusal rims, temporary prostheses, bite registrations, or extracted teeth) should be thoroughly cleaned, disinfected with an EPA registered hospital disinfectant with a tuberculocidal claim, and thoroughly rinsed before being handled in the in-office laboratory or sent to an off site laboratory.

The best time to clean and disinfect impressions, prostheses, or appliances is as soon as possible after removal from the patient's mouth before drying of blood or other bioburden can occur.

In the laboratory, a separate receiving and disinfecting area should be established to reduce contamination in the production area. Bringing untreated items into the laboratory increases chances for cross infection.

Receiving area: A receiving area should be established separate from the production area. Countertops and work surfaces should be cleaned and then disinfected daily with an appropriate surface disinfectant used according to the manufacturer's directions.

If no communication has been received regarding prior cleaning and disinfection of a material, the dental laboratory staff should perform cleaning and disinfection procedures before handling.

If laboratory items (e.g. burs, polishing points, rag wheels, or laboratory knives) are used on contaminated or potentially contaminated appliances, prostheses, or other material, they should be heat-sterilized, disinfected between patients, or discarded (i.e. disposable items should be used).

Waste generated in the dental laboratory (e.g. disposable trays or impression materials)which does not fall under the category of regulated medical waste, it can be discarded with general waste. Personnel should dispose of sharp items (e.g. burs, disposable blades, and orthodontic wires) in puncture-resistant containers.

10. Disposal of Contaminated Wastes

Disposable materials such as gloves, masks, wipes, paper drapes and surface covers that are contaminated with body fluids should be carefully handled with gloves and discarded in sturdy, impervious plastic bags to minimize human contact.

Biomedical waste or infectious waste includes:

1. Anatomical waste:
   a. Human anatomical waste
      Human tissues, organs and body parts, but excluding teeth, hair and nails
   b. Animal anatomical waste
2. Nonanatomical waste
   a. Microbiology laboratory waste
      Lab cultures, stocks or specimens, vaccines and materials in contact with them
   b. Blood and body fluid waste
      Fluid blood and blood products, items saturated or dripping with blood, body fluids contaminated with blood and body fluids removed for diagnosis or removed during surgery, treatment or autopsy, but excluding urine or feces
   c. Waste sharps
      Clinical and lab materials consisting of needles, syringes, blades or laboratory glass capable of causing cuts or punctures.

TREATMENT ROOM FEATURES

The current design of many treatment rooms may not be conducive to ideal planning for infection control. Changes can be made in routine so that updated, prefer systems can be adapted. When renovations or a new dental office or clinic are anticipated, plans must reflect the most advanced knowledge available relative to safety and disease control. The objective should be to have materials, shapes, and surface textures that facilitate the use of infection control measures.

Disinfection table

Type	*Level*	*Major advantages*	*Major disadvantages*
Glutaraldehyde	Sterilant/High level	• Good materials compatibility • Active in presence of organic material • Prolonged activated life	• Slow mycobactericidal activity (up to 10 hours) • Coagulates blood and fixes tissue to surfaces
Hydrogen peroxide	Sterilant/High level	• Environmentally compatible • Compatible with plastics and elastomers • Does not coagulate blood and fix tissue to surfaces	• Poor metal compatibility for brass, zinc, copper, and nickel/silver plating • Serious eye damage if contacted
Orthophthaldehyde	Sterilant/High level	• Fast acting • Good materials compatibility • Does not coagulate blood and fix tissue to surfaces	• Stains proteins gray • Disposal can be problematic (should not be poured into sewer)
Peracetic acid	Sterilant/High level	• Fast acting • Good materials compatibility • Does not coagulate blood and fix tissue to surfaces	• Low temperature immersion system (not just a chemical) • Concentrated solution can cause serious eye and skin damage
Superoxidized water	High level	• Environmentally compatible • Rapidly effective	• Equipment required (additional cost) • Does not work well in presence of organic material
Chlorine releasing compounds- hypochlorite	Intermediate level/low level	• Inexpensive • Rapidly effective	• Requires daily mixing • Not compatible with metals and can also damage plastics, vinyls, fabrics
Chlorine dioxide	Sterilant/high level/ intermediate	• 6 hours for sterilization • 3 minutes for disinfection	• Requires daily mixing • Not compatible with aluminum • Adequate ventilation required
Iodophors	Intermediate level	• Biocidal activity within 5-10 minutes	• Requires daily mixing • Corrosive • Stains • Irritation of tissues • Allergenicity
Complex (synthetic) phenols	Intermediate level	• Useful on metal, glass, rubber, and plastic	• Skin and eye irritation • Degrades some plastics and etch glass over prolonged use
Alcohols (ethyl and isopropyl)	Not recommended		• Exposure to alcohol denatures and dehydrates proteins making them insoluble and adherent to most surfaces which can protect them from disinfectant property of alcohol or other chemical
Quaternary ammonium compounds	Low level	Not recommended	• Inactivated by organic matter
Quats/alcohols	Intermediate	Tuberculocidal activity	• Sanitization step has to be done with a water based cleaner

1. Unit

- Designed for easy cleaning and disinfection with smooth, unulcerated surfaces
- Removable hoses that can be cleaned and disinfected
- Hoses that are not mechanically retractable but are straight, not coiled, with round smooth outer surfaces
- Syringes with removable autoclave tips or fitted for disposable tips
- Handpieces that can be disinfected.

2. Dental Chair

- All foot operated controls. If manually operated, overlay to cover buttons that can be recovered for disinfection if needed
- Surface and seamless finish of easily cleaned plastic material that withstands chemical disinfection without discoloring; cloth upholstery to be avoided.

3. Light

- Foot activated switches
- Removable handle for sterilization.

4. Clinician Stool

- Smooth plastic material that is easily disinfected and has a minimum of seams and creases.

5. Floor

- Carpeting should be avoided
- Floor covering should be smooth, easily cleaned, non-absorbent.

6. Sink

- Wide and deep enough for effective handwashing to the elbows
- Water and soap with electronic, knee or foot operated controls
- Separate room or area for contaminated instrument care.

7. Supplies

- All sterilizable or disposable.

8. Waste

- Receptacle with opening large enough to prevent contact with sides when material dropped in
- Heavy duty plastic bag linear to be sealed tightly for disposal
- Small receptacle near treatment area to receive contaminated sponges and other waste.
- Small bag to be tied tightly for disposal in large waste receiver.

Use and Care of Handpieces, Antiretraction Valves, and Other Intraoral Dental Devices Attached to Air and Water Lines of Dental Units

Routine between patient use of a heating process capable of sterilization (i.e. steam under pressure [autoclaving], dry heat, or heat/chemical vapor) is recommended for all high speed dental handpieces, low speed handpiece components used intraorally, and reusable prophylaxis angles. Manufacturer's instructions for cleaning, lubrication, and sterilization procedures should be followed closely to ensure both the effectiveness of the sterilization process and the longevity of these instruments.

Internal surfaces of high speed handpieces, low speed handpiece components, and prophylaxis angles may become contaminated with patient material during use. This retained patient material then may be expelled intraorally during subsequent uses. Restricted physical access, particularly to internal surfaces of these instruments limits cleaning and disinfec-

Disinfection table

Types	*Modes of spread*
Tuberculosis	Droplet nuclei, sputum, saliva
Syphilis	Direct contact, transplacental
Gonorrhea	Direct contact, indirect contact
Whooping cough, pertusis	Direct contact with discharges
Infectious perotitis (mumps)	Direct contact (saliva), air borne droplet
Poliomyeliltis	Direct contact (saliva), droplet, fecal – oral
Influenza	Nasal discharge, respiratory droplets
Rubeolla (measles)	Direct contact, saliva, air borne droplet
Rubella (German measles)	Nasophangeal secretions, direct contact, air borne
Streptococcal sore throat Scarlet fever	Respiratory droplets, direct contact
Abscesses, boils impedigo, bacterial pneumonia	Saliva exudates and nasal discharge
Candidiasis	Secretions, excretions
Pneumonia, pneumococcal Pneumonia	Droplet, direct contact, indirect
Acquired immune deficiency syndrome (AIDS)	Blood and blood products (infected needles), sexual contact
Hepatitis A (infectious hepatitis)	Transplacental and perinatal
Hepatitis B	Blood saliva and all body fluids, sexual contact, perinatal
Chickenpox	Direct contact, indirect contact, air borne droplet

tion or sterilization with liquid chemical germicides. Surface disinfection by wiping or soaking in liquid chemical germicides is not an acceptable method for reprocessing high speed handpieces, low speed handpiece components used intraorally, or reusable prophylaxis angles.

Because retraction valves in dental unit water lines may cause aspiration of patient material back into the handpiece and water lines, antiretraction valves (one-way flow check valves) should be installed to prevent fluid aspiration and to reduce the risk of transfer of potentially infective material.

High speed handpieces should be run to discharge water and air for a minimum of 20 to 30 seconds after use on each patient. This procedure is intended to aid in physically flushing out patient material that may have entered the turbine and air or water lines. Use of an enclosed container or high velocity evacuation should be considered to minimize the spread of spray, spatter, and aerosols generated during discharge procedures. Additionally, there is evidence that overnight or weekend microbial accumulation in water lines can be reduced substantially by removing the handpiece and allowing water lines to run and to discharge water for several minutes at the beginning of each clinic day. Sterile saline or sterile water should be used as a coolant/irrigator when surgical procedures involving the cutting of bone are performed.

Categories of biomedical waste

Waste category no.	*Waste category type*	*Treatment and disposal*
Category No. 1	**Human Anatomical Waste** (human tissues, organs, body parts)	Incineration/deep burial
Category No. 2	**Animal Waste** (animal tissues, organs, body parts carcasses, bleeding parts, fluid, blood and experimental animals used in research, waste generated by veterinary hospitals colleges, discharge from hospitals, animal houses)	Incineration/deep burial
Category No. 3	**Microbiology and Biotechnology Waste** (wastes 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, wastes from production of biologicals, toxins, dishes and devices used for transfer of cultures)	Local autoclaving/microwaving/incineration
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	**Solid Waste** (items contaminated with blood, and body fluids including cotton, dressings, soiled plaster casts, lines, 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
Category No. 9	**Incineration Ash** (ash from incineration of any bio-medical waste)	Disposal in municipal landfill
Category No. 10	**Chemical Waste** (chemicals 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

Other reusable intraoral instruments attached to, but removable from, the dental unit air or water lines such as ultrasonic scaler tips and component parts and air/water syringe tips should be cleaned and sterilized after treatment of each patient in the same manner as handpieces, which was described previously.

Some dental instruments have components that are heat sensitive or are permanently attached to dental unit water lines. Some items may not enter the patient's oral cavity, but are likely to become contaminated with oral fluids during treatment procedures, for example, handles or dental unit attachments of saliva ejectors, high speed air evacuators, and air/water syringes. These components should be covered with impervious barriers that are changed after each use or, if the surface permits, carefully cleaned and then treated with a chemical germicide having at least an intermediate level of activity.

SINGLE-USE DISPOSABLE INSTRUMENTS

Single-use disposable instruments (e.g. prophylaxis angles; prophylaxis cups and brushes; tips for high speed air evacuators, saliva ejectors, and air/water syringes) should be used for one patient only and discarded appropriately. These items are neither designed nor intended to be cleaned, disinfected, or sterilized for reuse.

HANDLING OF BIOPSY SPECIMENS

In general, each biopsy specimen should be put in a sturdy container with a secure lid to prevent leaking during transport. Care should be taken when collecting specimens to avoid contamination of the outside of the container. If the outside of the container is visibly contaminated, it should be cleaned and disinfected or placed in an impervious bag.

USE OF EXTRACTED TEETH IN DENTAL EDUCATIONAL SETTINGS

Extracted teeth used for the education should be considered infective and classified as clinical specimens because they contain blood. All persons who collect, transport, or manipulate extracted teeth should handle them with the same precautions as a specimen for biopsy. Universal precautions should be adhered to whenever extracted teeth are handled; because preclinical educational exercises simulate clinical experiences, students enrolled in dental educational programs should adhere to universal precautions in both preclinical and clinical settings. In addition, all persons who handle extracted teeth in dental educational settings should receive hepatitis B vaccine.

Before extracted teeth are manipulated in dental educational exercises, the teeth first should be cleaned of adherent patient material by scrubbing with detergent and water or by using an ultrasonic cleaner. Teeth should then be stored, immersed in a fresh solution of sodium hypochlorite (household bleach diluted 1:10 with tap water) or any liquid chemical germicide suitable for clinical specimen fixation.

Persons handling extracted teeth should wear gloves. Gloves should be disposed of properly and hands washed after completion of work activities. Additional personal protective equipment (e.g. face shield or surgical mask and protective eyewear) should be worn if mucous membrane contact with debris or spatter is anticipated when the specimen is handled, cleaned, or manipulated. Work surfaces and equipment should be cleaned and decontaminated with an appropriate liquid chemical germicide after completion of work activities.

BIOMEDICAL WASTE MANAGEMENT

Color coding and type of container for disposal of biomedical wastes

Color coding	*Waste category*
Yellow	Category 1, 2, 3 and 6
Red	Category 3, 6 and 7
Blue/white	Category 4 and 7
Black	Category 5, 9 and 10

The Biomedical waste means any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities.

It shall be the duty of every occupier of an institution generating biomedical waste which includes a hospital, nursing home, clinic, dispensary, veterinary institution, animal house, pathological laboratory, blood bank by whatever name called to take all steps to ensure that such waste is handled without any adverse effect to human health and the environment.

The segregation, packaging, transportation and storage shall be done as under:

1. Biomedical waste shall not be mixed with other wastes.
2. Biomedical waste shall be segregated into containers/bags at the points of generation prior to its storage, transportation, treatment and disposal. The containers shall be labeled.

4 Section

Behavioral Sciences

42 Sociology as Applied to Dental Public Health

Manik Razdan, CM Marya

Majority of dentists would find it surprising to know that sociology is an indispensable tool of dental public health when it comes to improving oral health of the population. The relationship of dental care and oral health is an apparent one. If you have a toothache, common sense suggests that you go and see a dentist. Our dependence on modern medicine has become so great that we think of nothing else but a doctor when it comes to fighting disease. Majority of people breed the misconception that technological advancement in medicine has brought about the decline of several diseases. Fact of the matter is that generally improved health of the population is not because what happens when people fall ill has changed but because people don't fall ill that often.

DEFINITION

Medical sociology is concerned with the relationship between social factors and health, and with the application of sociological theory and research techniques to questions related to health and the health care system. *(U.S. National Library of Medicine)*

The chief role of sociology in public health remains its evaluation of those macro components of society that affect public health at the population level. Such evaluations provide an understanding of why inequalities in health exist, and they help elaborate upon the mechanisms and processes that sustain these inequalities. Further, sociology reveals the mechanisms for long-term changes that may lead to a reduction in health inequalities.

HISTORICAL ROLE OF MEDICINE

Huge amount of evidence gathered by researchers suggests that very little of the decline in mortality rates observed over the past century can be attributed to improvements in medical care. In fact hospitals and surgical procedures of the late 19th century and early 20th century did more harm than good to the patient. Surgical procedures were not systematically reviewed and there was no evidence that they were effective. Hospital wards were unhygienic and un-segregated and therefore patients admitted for treatment stood a high risk of infection from other patients. Most drugs used except few like Mercury, digitalis and cinchona were largely ineffective and their effectiveness if any was mainly placebo effect.

First drugs that are believed to have influenced mortality rates appeared much after mortality rates for infectious diseases had almost already bottomed. For instance in UK in 1838, mortality rate due to tuberculosis was 4000 deaths per million populations. When tubercle bacillus was identified as the causative organism, mortality rate from TB had already dropped to 1900 deaths per million people. By 1948, when anti-tubercular drugs were first developed, mortality due to TB dropped further down to 200 deaths per million people and by 1954 when BCG vaccine for protection against TB was developed, the mortality rate had almost bottomed down at 100 deaths per million people. Improvement in mortality rates of only few infectious diseases such as polio and diphtheria probably can be attributed to medical breakthroughs like (immunization programs in this case).

The generally improved health that we enjoy today is more because of the social changes that have accompanied over millennia of evolution. In the following section we will see how these social changes that accompanied evolution have influenced the health of man as well as the kind of disease that has inflicted him.

EVOLUTION OF HUMAN SOCIETY

The complex manner in which our society is structured today is relatively recent. For most of our evolution, we have lived as hunters-gatherers without any form of settled agriculture for subsistence. Around 10,000 BC, with the development of agriculture, the hunter-gatherer way of living rapidly transformed into densely populated settlements and the simplistic society of hunter-gathers gradually evolved into a much more complex society. Today we are so conditioned for a societal living that the influence of our social environment

can be seen in all spheres of our life and health is no exception to this. Influence of the social environment on man's health is evident in the variation in disease patterns that accompanied changing human society.

VARIATION IN DISEASE PATTERNS WITH CHANGING SOCIETY

Different diseases have threatened our health at different times throughout our history. We might view the reduction in mortality from some diseases as our victory over disease but while some diseases have become less important due to reduced incidence, others have emerged as major public health problems. Changing complex social processes along with biological processes have been continuously altering the balance between man and disease. Four distinct characteristic patterns of disease have been identified.

Disease Patterns in Pre-agricultural Society

Without any form of settled agriculture for subsistence, humans before about 10,000 B.C. lived as hunters-gatherers and in band societies. Survival depended heavily on mother-nature for availability of food which was gathered by searching and collecting wild fruits and flowers and also by stalking and hunting wild animals. Men had to fetch food for themselves and their families and therefore population densities of these band societies remained pretty low.

Without the ability to create and control fire, food was consumed in uncooked and raw state. Personal hygiene lacked and there was excessive exposure to soil and dirt which made zoonotic diseases (those that are caused by parasites) quite common. Infectious diseases and chronic diseases were rare. Other major hazards to health were starvation and death due to physical injuries from the environment or while hunting or by being hunted.

Disease Patterns in Agricultural society

Development of agriculture led to permanent settlement of humans and higher population densities since starvation decreased as more mouths could be fed by agriculture. Humans learned to create and control fire and started cooking their food for consumption. Consumption of cooked food and decreased exposure to soil and dirt led to a decline in zoonotic diseases.

In the absence of sanitation, permanent settlement frequently led to contamination of water from human waste which greatly increased the risk of infection from contaminated water. Cereals became part of staple diet and this narrowed the range of nutrients available in diet which crucially reduced body's resistance to infections that became increasingly common. Diseases that became common at that time were cholera (due to water contamination), diarrhoea and dysentery (due to contaminated food) and vector borne diseases such as plague (from house rats).

Disease Patterns in Early Industrial Society

Invention of the cotton gin in the nineteenth century stimulated rapid industrialization in the west. As people in villages and hamlets gave up farming which was the predominant occupation in the beginning of the industrial phase, they migrated to towns and cities for jobs in factories that were rapidly springing up.

The large-scale, rapid and unprecedented migration of people led to incredible rise in population densities of towns and cities which in the absence of laws governing health and safety at work and other laws for protection of workers' rights gave rise to impoverished working and living conditions. Diseases such as tuberculosis and occupational hazards became common in addition to the infectious diseases of the agricultural society that continued to dominate in this era too.

Disease Patterns in Modern Industrial Society

We have come a long way since industrialization began in 19th century. Technological advancement in agriculture has ensured surplus food stalk even in developing countries like India. Other public health reforms mainly sanitation and provision of safe drinking water supply have kept the predominant infectious diseases of agricultural and early industrial society under control.

Introduction of laws governing health and safety at work and for protection of workers' rights, has led to an improvement in living and working conditions of factory workers in the west. With no more scarcity of food, control of infectious diseases, improved living and working conditions and greatly reduced occupational and environmental hazards, the world we live in today is a much safer society than before.

As a result life expectancy at birth has considerably increased in almost the entire world except few countries like Afghanistan certain African countries. A new set of diseases however has become increasingly common. Diseases such as obesity, degenerative diseases (like osteoarthritis, atherosclerosis and cancer) and other chronic illnesses (like diabetes, hypertension etc.) are major public health problems today. The increase in the incidence and prevalence of these diseases has been brought about by improved socio-economic conditions in today's society.

CHANGING SOCIETY AND PATTERNS OF DENTAL DISEASES

Influence of social changes is not limited to general illnesses only. In several archeological excavations of earlier human settlements, archeologists have found human skulls with almost intact dentition. The diet of pre-agricultural times was non-refined and coarse and attrition of teeth was severe.

Development of refined sugars at the end of agricultural period brought about the rise of dental caries which previously was unknown to humans. Since at that time, refined sugars

were available to the rich and aristocratic families only, large proportion of the population remained protected from dental caries. Dramatic rise in the incidence and prevalence of dental caries took place in the early industrial phase when refined sugars came within the reach of common man. Again during World War II when table sugar was rationed due to scarcity, significant decline in incidence of dental caries was witnessed in Britain. Decline in caries incidence observed in the past 2 or 3 decades in the west can be attributed to the change in social circumstances (introduction of fluoridated toothpaste) more than anything else.

Longer life expectancy also has had its implications on the pattern of dental diseases. Dental diseases being chronic in nature, their effects accumulate with increasing age. Dental diseases like root caries and oral cancer and conditions like edentulousness have become more common since they are most often seen in older age group and because more people are living longer than before.

From the discussion till now, it is clear that social factors have always had their influence on our health and that the historical role of medicine in improving our health has been minimal. But today, a lot of emphasis is laid on treatment oriented hospital based medical care. We seem to have got disillusioned by this myth that curative care is the answer to our health problems.

THE SOCIO-ENVIRONMENTAL APPROACH (SOCIAL MODEL)

During the later years of 1980s, the theory of general susceptibility became more explicitly formulated as the socio-environmental approach. Research efforts focus on identification of broad factors that make and keep people healthy rather than factors that cause disease. It is concerned with factors improving population's health rather than factors causing disease in individuals and therefore forms the basis of health promotion strategies.

Five broad factors can be targeted to improve population health:

- Social and economic environment
- Physical environment
- Personal health practices
- Individual capacity and coping skills
- Access to health services

Social and environmental factors constitute risk conditions that affect health and well being directly and through numerous behavioral, physiological and psychological factors that they engender. Risk conditions are more or less similar to risk factors except that risk conditions are viewed at population level while risk factors are viewed at individual level.

Social environmental approach has found support when comparisons are made between data on population health from different countries. Population health is best in countries which have lowest levels of social class differences, have laws to regulate and maintain physical environment conducive to good health, have high education levels among the countrymen and have equitable access to health services.

HEALTH AND SOCIAL FACTORS

Vast amount of evidence exists that indicate a close relationship between health and social factors. Social scientists have observed a strong correlation between health and social characteristics namely social class (as determined by occupation, income and education), age, gender and ethnicity.

Social Class Inequalities in Health

Social circumstances that individuals experience are not homogeneous throughout the society. Instead members are stratified into different social classes that are arranged in a hierarchical pattern. Social stratification has been a feature of civilizations since the first civilization came into being and it sectors the present societies even today although the basis on which societies have been stratified through history has changed over time. The change in basis of social stratification occurs as the factors crucial to preservation and development of the society change.

In medieval England where agriculture was the predominant occupation, the society was stratified on the basis of ownership of land. Dukes who owned large estates of land were socially more powerful than the tenant farmers who cultivated their land. Spirituality has always been a feature of our great country but in medieval times India was a mosaic of small kingdoms which were constantly at war with each other. Needless to mention, those involved in spirituality (Brahmins) were at the top of the social ladder followed by the soldier class (kshatriyas). Capitalist industrial societies of today especially the western societies are economically driven and social stratification is based on the socio-economic class as determined by income, occupation and education.

Registrar General's Classification of Social Classes

In UK, Registrar General's Classification of Social Classes has been most widely used as a basis of social stratification for the purpose of medical and dental research.

This system of classification divides the population into five social classes with social class III further subdivided into non-manual (III N) and manual (III M) classes. The social classes are:

- Social Class I (Professional) : Doctors, Lawyers
- Social Class II (Intermediate) : Managers, Accountants
- Social Class III N (Skilled Non-manual) : Office clerks
- Social Class III M (Skilled Manual) : Carpenters, Bus drivers

- Social Class IV (Semi-skilled Manual) : Bus conductors
- Social Class V (Unskilled Manual) : Dock Workers

It is an occupation based system of classification and it groups occupations into different social classes according to their skill level and general social standing in the community. Families are classified according to the occupation of the head of the household. Men are allocated into different social classes according to their occupation, women according to their husband's and children according to their father's. Retired and unemployed men are classified according to their occupation during the last significant period of employment. Unmarried, widowed or divorced women are classified according to their own occupation.

Research evidence collected in UK suggests that mortality increases in a stepwise fashion as we move from social class I to social class V with mortality rate in social class V almost twice of that in social class I. The social gradient observed in mortality rates is due to all causes in both sexes and across all age groups.

A report was published in 1980 to explain the difference in mortality rates across the social classes came up with four different explanations:

- Artifact Explanation: The association between social class and health is an artifact of the manner these concepts are measured.
- Social Selection Explanation: It is not social class that determines health instead it is health that determines social class.
- Behavioral/Cultural Explanation: Social class determines health through health-promoting and health-damaging behaviors.
- Materialistic Explanation: Social Class determines health through social class differences in material circumstances of life.

Material explanation and to some extent behavioral explanation has found maximum support from the social scientists. Factors like health damaging effects of air pollution and occupational exposure to physical, chemical and biological hazards, poor access to health services, stressful work environment, unhygienic and unhealthy living conditions and unemployment could contribute to social class differences in health as these factors are more likely to be experienced by people in lower manual classes as compared to people in non-manual middle and upper classes.

SOCIAL CLASSES AND THE REACTION OF EACH TO DENTAL CARE

The Upper Middle Class: It is defined here as "the professional and business executive group, well educated, living in preferred areas in well maintained, usually spacious homes". The members of this class "seek out expert advice, and in areas where they feel it is important, follow the advice with considerable religiosity. They take a long range view of life and want to feel, prepare to know how to prevent or at least to deter as long as possible the unavoidable: aging, disease, decay and death". They value their teeth, are interested in preventive dentistry and actively pursue various type of dental care. The dentist is visualized as a professional who not only repairs teeth and stop pains, but also prevents decay and loss of teeth and make a person's teeth more attractive and useful. The members of upper middle class are much impressed with the desirability of having their own teeth as long as possible. They "think of themselves as highly rational people, willing to be swayed only by authoritative sources."

The Lower Middle Class: It includes generally the owners of small business, minor executives, teachers, salesman, and white-collar workers. "They are a highly moralistic group, usually with at least a high school education, and live in well-maintained, clean, pleasant neighborhoods." They are inclined to admire and imitate the upper middle class, but their behavior is not necessary motivated by same consideration. They are not as individualistic as the upper middle group; they are the most compulsive in their dental care attitude and practices of any social class. "The dentist is regarded as an authority- not always a friendly authority (as tends to be the case among upper middle class people) but someone who 'fixes' teeth. The dentist is also viewed as one who gives directions as to how teeth should be cared for and who is useful for preventive dentistry. Training in dental health habits begin early in the group and is followed with persistence, though not always with accompanying flexibility. The necessity to be cleaned, good, conforming, and socially presentable makes for a high standard of dental care among this status level.

The Upper Lower Class: It is regarded as "the group which needs to become the objective of major educational efforts regarding care, and this is primarily because they are the most accessible to these attempts and offer the best possibilities of behavioral and attitudinal changes". The upper lower class people are generally skilled and semi skilled blue-collar workers. At present they enjoy a high standard of living as measured by income, but they are people of limited education and live in modest neighborhoods; they are law abiding, respectable and hard working citizens. "They set fewer regulations for themselves than the lower middle class and are indulgent of themselves and permissive with their children. In rather sharp contrast to higher status group, upper lower class people are reigned to whatever happens and feel there is little they can do to stave off the inevitable," including the loss of their teeth. On the basis of this attitude, it is probable that they do not receive professional dental care geared to maintaining their own teeth. They acquire artificial dentures at a relatively early age and are reasonably happy with them. "Self-medication, based on popular notions of what illness is and what remedies are apt to relieve or cure it, does interest

them. As for physicians or dentists, they typically do not have continuing personal relations with authority figures of this type." They instruct their children how to care for their teeth, but the children are more or less on their own after that.

The Lower Class: Now it is called underprivileged or disadvantaged, is estimated to constitute about 20 percent of our urban populations. It consists of the unskilled laborers, people who shift from job to job, have a limited education, live in slum areas, and exhibit(from a middle class point of view) no stable pattern of life. As a group they are the ones who reveal the most consistent neglect of teeth, and because of their cultural differences from the middle class, they require careful understanding if they are to receive adequate care in public health facilities.

Trihart has documented attitudes of underprivileged people toward heath care based on two workshops and understanding the underprivileged child, held in 1968 and conducted by Frank B. W. Hawkinshire.

Castration complex: There is a reluctance to be at the complete mercy of the health practitioner. This is marked by reluctance to have a general anesthetic or sedation for dental or surgical procedures.

Contradiction of common sense: Some dental or medical procedures such as the continuation of a drug after acute symptoms have subsided seem to contradict common sense. It is recommended that a common sense approach rather than a scientific approach be used in giving dental advice or dispensing drugs.

Coming in crowds: Disadvantaged people do not like to be outnumbered by the people providing treatment. For this reason, they tend to come in crowds, with family and friends, as visit to private dental office may be a terrorizing experience.

The last-ditch effort: The disadvantaged individual often turn to medical or dental treatment by health professionals as a last resort after all individual efforts have failed. They are in a sense challenging health professionals to salvage something from an almost hopeless situation.

If it hurts, you are a quack: This group has the general feeling that medical and dental treatment should be painless and, if it hurts, the health practitioner is not an expert.

Unclean or dirty feeling: The aseptic cleanliness of a dental office or clinic may convey the feeling of personal uncleanliness. The feeling may be reinforced by the dentist washing his hands after he treats the disadvantaged person. Such simple procedures as hand washing should be explained.

The clinic was built there, not here: Since many health facilities, such as hospitals and outpatient clinics, are located at inconvenient places for underprivileged, many of them tend to think and say, "if you really cared about us you would have built the hospital or clinic here instead of there."

Cold professional attitudes: Many disadvantaged people complain about the cold, impersonal, objective attitude and conduct of health professionals. They value empathy as well as professional competence as an essential characteristic of the practitioner.

Difference in pain threshold: There may be a wider variation in the pain threshold of the disadvantaged than in the population in general. The pain threshold for those in poor health may be low. Patients should be prepared if it is to be occured.

Complication of the unknown: Fear of the unknown is a natural human tendency. This feeling is accentuated with unprivileged people since there are so many things that are unknown to them.

The pills don't work: There is a tendency to expect immediate results from the administration of any drug. Any time lag between administration of a drug and relief from symptoms may be considered a failure of the drug and its use may be discontinued.

Appointments not important: Appointments of any kind have never been an integral part of the lives of the underprivileged. There is no reason to expect them to consider dental appointments as a means of conserving their time as well as the practitioner's patience and understanding, are essential in educating them to the value of keeping appointments.

Teeth lost any how: There is a feeling that despite competent and conscientious personal and professional care, the ultimate loss of teeth is one of the natural vicissitudes of life. Patience, understanding and continuing education are essential to overcome this fatalistic attitude.

Traditions: Contrary to some beliefs widely held by the more affluent segments of our society, impoverished families and neighborhoods have strong and deep seated traditions. To communicate and deal with disadvantaged people,it is important that these traditions should be recognized and understood. It is also important that these traditions should not be discredited unless they are actually harmful to health.

Social Class Inequalities in Health in India

To understand the influence of socioeconomic status on the health of the individuals, a system of socioeconomic classification is required so that health of people among different socioeconomic strata can be compared.

Although defined differently in different societies, 'social class seems to be closely bound up with economic status, level of education, standard of living, attitudes and expectations and exposure to different degrees and types of stress. More importantly, it seems to have direct bearing on the external resources and internal mechanisms available to individuals in attempting to deal with health problems' (WHO, 1976).

Occupation of the individual has been traditionally used as the basis for social classification worldwide, the oldest being the Registrar General's Classification in England and Wales. But using social classification based on occupation alone has its own set of disadvantages. Moreover, unlike in UK where Registrar General's System of Classification of Socio-economic Status exists, there is no practical system of classification of socio-economic status in India. Two classifications that have been traditionally used to determine socio-economic standing of people in India are Poverty Line and the Caste System.

Poverty Line

The term poverty has been used in two ways. Absolute poverty refers to a standard of living that cannot sustain life. Relative Poverty refers to the situation in which the resources (of those in relative poverty) are so seriously below those commanded by the average individual or family that they are, in effect, excluded from ordinary living patterns, customs and activities. In India, Line of Absolute Poverty is described as expenditure required for daily calorie intake of 2400 per person in rural areas and 2100 in urban areas. This expenditure was officially estimated as Rs. 181.50 per capita per month in rural areas and Rs. 209.50 per capita per month in urban areas at 1991-92 prices (Statistical Outlines of India, 1995-96).

People with very low household incomes (income less than this expenditure of the whole family) are classified as poor people. Level of poverty line last revised was in 1999-2000 at Rs. 362.68 per capita per month for the rural populace and Rs. 454.11 per capita per month for the urban populace at 1991-92 prices. Shortcoming is evident. This system of classifying the poor is impractical because the poverty line itself is set at a very low level.

Caste System

In Indian communities, especially in rural India, caste is an important basis of social differentiation. The caste groups are hierarchical and carry different degrees of social prestige. Caste System is a social system that emerged in medieval India as flexible system of classification of occupation for the purpose of efficient and smooth functioning of the society. The system applies to followers of Hinduism where in people doing menial jobs such as cleaning of streets and drains, garbage collection etc. were considered belonging to the lower caste. Over the centuries, the system has become rigid and children of lower caste people by default belong to lower caste now.

Use of caste system as a system of social standing is limited in that it applies only to Hindus who comprise about 84% of the total population. Another limitation is that neither all people belonging to the lower castes are economically backward nor are all people belonging to upper castes doing well financially.

Dilemma of Socioeconomic Classification

Although the caste system and poverty line have been traditionally used as a basis of social standing, the utility of these systems is crippled by some major drawbacks that accompany the design of these classification systems. With a non-existent occupation-based social classification system, other measures of social differentiation need to be looked into. Other measures of social classification that may be of significance are Education, Income and Purchasing Power.

Education

Education can be used as a basis for social classification but like occupation based socio-economic classification systems (such as Registrar General's System of Classification of Socio-economic Status), it faces similar drawbacks. Neither are all well educated people fortunate enough to be working in well-paid jobs nor all uneducated people are unemployed or in menial lowly-paid jobs.

Income

Income is a very strong indicator of social status. However the problem in using it for social classification is that first, the cost of living markedly varies from place to place such that someone with a high standard of living in a town like Gorakhpur may not be able to afford similar life style in a city like Mumbai. Secondly, people in India are not especially comfortable discussing their income and this makes it difficult to accurately classify them into the right income brackets and therefore right social class.

Purchasing Power

Purchasing power seems to be most valuable in classifying people socially. Purchasing power is the disposable income available to people as a means of buying goods and services. These services include private healthcare. While the private hospitals and clinics cater to the needs of those who can afford their fees, government funded hospitals and dispensaries mainly cater to the healthcare needs of those who cannot afford to seek care in private hospitals and clinics.

AGE INEQUALITIES IN HEALTH

One may argue that age is not a social characteristic but it is a biological characteristic instead. I must admit that age is certainly a biological characteristic if we see it in the literal sense, but its close correlation with certain social circumstances that are seen characteristically with different age groups, makes it an influential determinant of health in ways other than as a biological determinant.

For instance, debilitating degenerative disease like osteoarthritis is usually seen in the elderly. This is how age influences health biologically. But the immobility and therefore

disability that accompanies osteoarthritis have social implications like inability to go to a dentist which in turn may affect the individual's oral health. Limited financial resources post-retirement and social isolation are other social characteristics that are seen in the older age group that adversely affect health of individuals. This is especially true for developed nations where the elderly after retirement are dependent on the state for social welfare and the common trend is that of nuclear families.

Things are somewhat different in the predominantly agricultural Indian society where 42.6% of the working class is employed in agriculture without any age of retirement. Pension schemes and age of retirement are limited to government employees and they form a small proportion of the Indian productive class. Joint family tradition ensures that there are young physically-abled people to accompany the disabled elderly to the hospitals.

While the health gap among different age groups may not be as wide in India as it is in the developed countries. The gap is due to widen as our society progressively shifts towards a westernized economy with increasing trend of nuclear families.

GENDER INEQUALITIES IN HEALTH

It is imperative to know that the terms sex and gender that we often use interchangeably actually are two different things. While sex of an individual is governed by the anatomical and physiological characteristics of his or her body, gender is the social interpretation ascribed to the behaviour of an individual in his or her social environment. Society expects men and women to behave according to the predefined roles that are socially acceptable. For majority of people, sex and gender are same but sometimes when conflict arises between the two, it leads to gender identity crisis.

How gender of an individual affects his or her health depends upon the cultural and societal norms of that particular society. Research evidence indicates that women generally have more number of days in consultations as well as admissions at hospitals. Although child birth is the main reason for this difference, even when maternity consultations and admissions are excluded, women still have higher number of visits to the clinics and hospitals.

This is because first, in our society women are expected to take care of the children and the elderly. With men in traditional Indian families being employed and women being home makers, they usually accompany the dependents in the family like parents-in-law and children to the doctor. They often utilize this opportunity to seek care for their health problems. Secondly, being care-takers at home, they are able to spare time to visit a doctor when required while men are bound in their professional commitments.

ETHNIC INEQUALITIES IN HEALTH

Health inequalities have also been observed to be closely associated with ethnicity of individuals. Unlike Race which is based on biological features of an individual (most commonly colour of the skin), Ethnicity is based on common cultural features that individuals share like language, eating habits, family patterns, homeland etc. What common cultural features of individuals form an ethnic group is subject to variation depending on the society in context of which the term is being used.

In countries like UK, migrants from the subcontinent like Indians, Pakistanis and Bangladeshis form the major chunk of ethnic minority group along with Africans and Chinese. India is divided into states mainly on the basis of language such that Biharis, Maharashtrians, Kashmiris, Punjabis, Malayalis, Tamils etc. are all different ethnic groups. Some states like Madhya Pradesh, Uttar Pradesh and Bihar have been further subdivided recently again on ethnic basis.

Delhi and Mumbai have been the top destinations for migration of people from all over India for economic reasons. In Delhi, working migrant class mainly comprises of people from neighbouring states of Punjab, Haryana, UP and Bihar. Evidence suggests that poor health in general that is seen to be associated with people from eastern UP and Bihar is due to the poor working and living conditions they experience since majority of them belong to lower manual socio-economic classes. People from these states are usually employed in either unskilled manual occupation like rikshaw-pullers and laborers or are employed in skilled manual occupation like electricians, plumbers and masons. If the general population and ethnic minority individuals are stratified according to occupation, then the health inequalities seen between the ethnic minorities and general population disappear.

CULTURAL PATTERN AND CONCEPTS TABOOS AS RELATED TO HEALTH

The cultural concepts of disease and therapy throughout the world are diverse. This diversity equally applies to oral diseases and treatment. Since time immemorial the teeth, the mouth, and the face have held seemingly intrinsic, fascination for the mankind. They have been continued to be the subject of many oral and written beliefs, superstitions and traditions and the objectives of the wide range of mutilatory practices.

Recorded history is full with description of methods used by a range of ancient and relatively contemporary cultures to combat the symptoms and effects of diseases, affecting the teeth and other oral structures.

Culture

Culture may be defined as a shared and organized body of customs, skills, ideas and values which is transmitted socially from one generation to another. Human beings in groups as well as individually react to their environment in terms of their culture.

Public health workers face difficulties in programme planning. Because of long-standing tradition and misconceptions, patient education is needed to overcome this

cultural barrier. It is one of the important developments in public health during the last decade that the social scientists have been called into aid in adapting new health program to existing cultural patterns.

Mutilations of Teeth and Oral Soft Tissues

Since antiquity the practice of decorating and mutilating the human body has held an intrinsic fascination for mankind. Of the various forms of body decoration and mutilation which may be encountered in contemporary societies, mutilation and adornment of the teeth and oral soft tissues comprise a group of practices of obvious significance to students and practitioners of dentistry.

Tooth Mutilations

The practice of deliberate mutilation of human dentition is a phenomenon which is known to have existed since prehistoric times in an ethically and geographically diverse range of people. Most of these customs are observed among peoples living in tropical regions of the world. These practices included non-therapeutic tooth extractions, breathing off of tooth crown, alteration in the shape of crown by filling and chipping, dental inlay work, staining of teeth, and practices such as placement of gold crowns for adornment purpose.

Tooth Avulsion

The practice of tooth avulsion is common among Australian aboriginal tribes and in Africa. The various reasons for this kind of practices are tribal identification, initiation rite, sign of ceremonial sacrifice, esthetics, fashion, cultural mimicry etc. While some people perform ritual tooth mutilation for spiritual reasons, other may do it for fashion.

Waarusha and Masai people of Tanzania who practiced removal of permanent central incisors indicate that the space left provide a route allowing passage of fluids in the event the person is unable to open his mouth.

The enucleation of unerupted deciduous teeth confined to certain region of Africa including Nigeria and Tanzania is considered to confer therapeutic benefit upon children. The practice of blackening the teeth among Jivaro Indian people of Peru and Ecuador is carried out in order to prevent dental caries.

Dental Inlays and Crowns

The use of dental inlays and crowns for adornment purpose is a form of non-therapeutic tooth mutilation encountered among contemporary people within the outside tropics. In general these practices are usually carried out for purposes of beautification to signify wealth or to signify some event.

The practice of placing decorative inlays was also carried out in India in previous times. The teeth of important people such as Maharaja's were reportedly inlayed with glass or pearls. The people of ancient Roman civilization were familiar with dental restoration of gold. Among Muslims, the presence of a gold crown on a front tooth is used to signify that the wearer has visited Mecca.

Tattooing

Tattooing of soft tissues is a practice which remains relatively popular in many non-tropical and tropical areas of the world. Tattooing of the skin is most commonly encountered, Tattooing of the lip and gingiva is occasional seen. Tattoos in the oral region must be distinguished from other forms of diffuse, intrinsic or acquired pigmentation of the oral mucosa. Tattooing is largely confined to countries in the region of North Africa and the Middle East.

In these countries, tattooing of maxillary alveolar gingiva is mainly practiced by females especially those belonging to the Muslim faith. According to Gazi the gingiva may be tattooed when females reach puberty or when they become married. This custom may be practiced by men to relieve the pain association with diseased gums. This particular use of the custom implies a belief that gingival tattooing has therapeutic benefit.

The technique of gingival tattooing involves painting the gingiva with a layer of pigmented material (usually carbon) which is then impregnated into the gingival mucosa by means of sharp thorns or needles which pierce the mucosa. A bluish black colouration is usually achieved with gingival tattoos. This carbonized material used to tattoo the gingiva may be obtained from calcified mass, burned wood or from lamp black.

Other forms of soft tissue mutilation which may be encountered among people in the tropical regions of the world are;

1. Piercing of lips and perioral soft tissues and the insertion of materials such as wood, ivory or metal.
2. The temporary piercing of orofacial soft tissues for ceremonial purposes.
3. Uvulectomy and facial scaring.

TABOOS RELATED TO DENTISTRY

The term taboos mean misconcepts or misbelief. Any of the negative traditions and behaviors generally regarded as harmful to social welfare.

Some of Popular Taboos in India

1. Lot of people who are required to undergo extraction of the teeth are reluctant to undergo treatment because they are afraid that they will lose their eye-sight.
2. Some people who came to the dentist with the complaint of decayed teeth demand that the dentist should show worms from their teeth because they believe that dental decay is caused by worms.

3. When deciduous teeth exfoliate children as well as their parents believe that if they keep the exfoliated teeth under a rock or through on top of the roof they will get teeth as strong as stone. And they also believe that if they keep their exfoliated teeth in a rat hole they will get teeth as strong and sharp as rat teeth.
4. Cultural practices such as prolonged breastfeeding and the use of sugar based substances in infant bottle feeding mixtures - both of these practices sometimes being extended up to the time a child is 3-4 years of age in the tropics - may be associated with unusual caries pattern in children.
5. Jains of North India, consider taking an injection as taboo, so strong in their belief that they go to the extent of getting a tooth extracted without a local anaesthetic injection.
6. If the scaling is done, the tooth may become loose.
7. Some people believe that if the child has born with neonatal teeth, it is danger to grandparents.

Other Taboos

1. Some people believe that if they undergo family planning operation like vasectomy they will get nervous weakness.
2. One of the popular beliefs in some communities is that children are God given gifts so they are reluctant to undergo family planning methods.
3. Some religious beliefs are so strong that if they get some serious and debilitation disease; instead of consulting doctor, they will go to a witch doctor or black magician for their diseases, who are supposed to drive away the evil forces losing the disease.

MEDICAL ANTHROPOLOGY

Medical anthropology is about how people in different cultures and social groups explain the causes of ill-health, the types of treatment they believe in, and to whom they turn in if they get ill. It is also about how these beliefs and practices relate to biological changes in the human organism, in both health and disease.

Medical anthropology therefore includes:

- Study of traditional medical systems.
- Study of people's response to various modes of therapies.
- Evolutionary processes of adaptation to disease both paleopathology and medical ecology.

HISTORY OF MEDICAL ANTHROPOLOGY

There are four areas which have led to emergence of medical anthropology as a distinct subdiscipline of anthropology:

1. Physical anthropological studies in areas like evolution, adaptation, comparative anatomy, racial types, genetics and serology.
2. Traditional ethnographic interest in primitive medicines under religion, witchcraft and magic.
3. Culture and personality studies in collaboration with psychiatrists.
4. International public health programs after the World War II

Definitions of Medical Anthropology

U.S. National Library of Medicine defines anthropology as the study of the origin, development and nature of the human species through biological, sociocultural, archaeological and linguistic perspectives.

Medical anthropology encompasses the study of medical phenomena as they are influenced by social and cultural features and social and cultural phenomena as they are illuminated by their medical aspects (Richard Lieban, 1973).

Medical anthropology is a biocultural discipline concerned with both the biological and sociocultural aspects of human behavior, and particularly with the ways in which the two interact and have interacted throughout human history to influence health and disease. (Foster and Anderson, 1978).

TRADITIONAL MEDICAL SYSTEMS

Various labels have been given to the traditional medical systems

- Primitive medicines
- Non western medicines
- Tribal medicines
- Folk medicines
- Indigenous medicines
- Ethnomedicines

Characteristics of Traditional Medical Systems

- Subsystems of culture and therefore integrated and interrelated to the whole of culture
- Close integration with religious and political subsystems
- Have cultural aspect in including basic concepts, theories, normative practices and shared mode of perception about disease and health
- Have social aspect in including organization of specific roles (doctor, patient, shaman) and rules governing these roles in specialized settings
- Contain curative, preventive, promotive, diagnostic aspects.

THE RELATION OF SOCIOLOGY TO ANTHROPOLOGY

Anthropology in its broadest sense is the science of man, — physical, intellectual, and social. There is a sociological aspect to some parts of anthropology; for example, that which refers to sociological characteristics and to the natural habitat of man. But anthropology in its limited view should really only include the natural history of mankind. It does

not include such sciences as biology, psychology, sociology, political science, or economics. There are many divisions of the subject of anthropology such as somatology, or the determination of physical characteristics anthropometry, which relates to the system of measurement of mankind; ethnology, which treats of racial characteristics; and ethnography, which concerns itself with the origin, subdivision, and distribution of races over the earth's surface. But not one or all of these combined could be substituted for sociology.

Sociology in public health is reflected in the myriad of sociological concepts that pervade the practice of public health. More than any other social science, sociology has the discussion of socioeconomic status at its very core. Social-class variation within society is the key explanatory variable in sociology—for everything from variation in social structure to differential life experiences of health and illness. Inequalities in health are directly related to social and economic inequalities. Much of later-twentieth-century public health is devoted to the reduction of these inequalities.

43 Child Psychology

Bhavna Gupta, Anil Gupta

Psychological development is a dynamic process, which begins at birth and proceeds in an ascending order through a series of sequential stages manifesting into various characteristic behavior. These stages are governed by genetic, familial, cultural, interpersonal and interpsychic factors.

DEFINITIONS

Psychology: It is the science dealing with human nature, function and phenomenon of his soul in the main.

Child psychology: It is the science that deals with the mental power or an interaction between the conscious and subconscious element in a child.

Emotion: An effective state of consciousness in which joy, sorrow, fear, hate or the likes are expressed.

A feeling or mood which manifests into motor or glandular activity.

Behavior: It is any change observed in the functioning of the organism.

Behavior management: The means by which dental health team effectively and efficiently performs treatment for a child and simultaneously instills a positive dental attitude in the child (Wright, 1975).

It can also be considered as an attempt to alter the child's behavior and emotion in a beneficial manner according to the laws of society.

IMPORTANCE OF LEARNING CHILD PSYCHOLOGY

- To understand the child better
- To teach the parents and child the importance of primary and preventive care
- To gain the confidence of child and of the parent
- To deliver the dental services in a meaningful and effective manner
- To know the problem of psychological origin
- To establish effective communication with the child and the parent
- To have better treatment planning and interaction with other discipline
- To produce a comfortable environment for dental team to work.

THEORIES OF CHILD PSYCHOLOGY

Broadly classified into 2 groups.

I. Psychodynamic theories
   - Psychoanalytic Theory by Sigmund Freud (1905)
   - Cognitive Developmental Theory by Piaget (1952)
   - Psychosocial Theory by Erik Erikson (1963).

II. Behavioral theories
   - Classical Conditioning Theory by Ivan Pavlov (1927)
   - Operant Conditioning Theory by B.F.Skinner (1938)
   - Hierarchy of Needs by Abraham Maslow (1954)
   - Social Learning Theory by Albert Bandura (1963).

I. Psychodynamic Theories

1. Cognitive Development

Jean Piaget, a Swiss psychologist, has elaborated the most comprehensive theory of cognitive development. Many of his conclusions were based on experiments conducted on his own children over a number of years.

Piaget's Major Concepts

Piaget believed that the genetic endowment provided the individual with an invariant pattern or structure to develop. He proposed two types of cognitive structures the schemas, and the operations, to explain the process of development. Schemas are relatively simple mental structures present from birth onwards. They are the internal representations of some specific action or behavior.

2. Psychoanalytic or Freudian Theory (1905)

Freud elaborated the most comprehensive theory of emotional development, mainly derived from clinical work with adult patients.

Piaget's cognitives structure to explain the process of development

Concepts	*Description*	*Examples*
Adaptation	Basic process of all human activity, including assimilation and accommodation.	Pupils alter size according to brightness. Language changes according to whether the person is friend or stranger.
Assimilation	Adaptation of experiences or objects in accordance with existing strategies or concepts.	A baby assimilates when he/she reaches for a toy. Inclusion of new object into existing category.
Accommodation	Modification of strategy as a result of new experience or information.	Baby alters grasp to get hold of differently shaped object. Concept of justice is changed after experience of war.
Equilibration	The process of balancing assimilation and accommodation.	Change of strategy to solve problem, e.g. from trial and error to systematic search.
Schema	Internal representation of some specific action, present from birth.	In the infant, suckling and grasping responses.
Operations	Internal cognitive rules that arise during later childhood.	Multiplication and division acquisition of conservation concepts for number, volume and weight.

Piaget's stages of cognitive development

Stages	*Age*	*Key features*
Sensorimotor	0-2 years	Recognizes self as distinct from other objects in the world. Able to initiate actions, e.g. to reach out to grasp object. Achieves object permanence (objects exist even when no longer visible).
Preoperational	2-7 years	Uses language and is able to represent objects by images and words. Thinking is egocentric (difficulty in recognizing another point of view). Thinking is animistic (every object has feelings and thoughts). Objects classified solely on basis of single feature, for instance color or shape.
Concrete operational	7-12 years	Thinks logically about objects and events. Achieves conservation of number (age 6), volume (age 7) and mass (age 9). Objects classified on several dimensions as well as in a rank series, e.g. size.
Formal operational	12 years and upwards	Thinks logically about abstract propositions and is able to test hypothesis. Becomes concerned about the hypothetical, the future and ideological problems.

A major criticism of Freudian theory is that its concepts do not tend themselves readily to empirical or scientific investigation, so that it is difficult to prove or disprove the validity of the theory.

There are three levels of consciousness

- *Conscious level*—Contact of brain and internal world
- *Preconscious level*-Available memory of brain
- *Unconscious level*—Repressed memory

Basic Psychic structure

It includes:

Freud's psychic triad

- ID
- EGO
- SUPEREGO

ID- (0-2 yrs): Means 'It' in latin word. It is present in unconscious domain of the mind. It is present at birth. It is instinctive in nature, It obeys no laws. It is governed by pleasure principles, strives for immediate pleasure and gratification. Delay in gratification leads to emergence of ego

EGO- (2-4 yrs): Means 'I' in latin word. Ego is governed by reality principle to achieve gratification in socially accepted ways, decision making component. It is concerned with memory and judgement.

SUPEREGO- (>5 yrs): 'Overeye' in latin word, last to develop.

It is determined by the regulation imposed on the child by parents, society and culture. It is an internalized vision of society norms and behavioral standards that produce the feeling of shame and guilt.

The expression of discomfort as a result of conflicts between these above mentioned triad can be expressed as:
Oedipus complex- Attraction of male child to mother, strive to imitate the father to gain the affection of mother.
Electra Complex- Attraction of female girl child to father.

Oral Stage (0-1 year)

The oral region (mouth, lips and tongue) is the main source of satisfaction or pleasure. Adequate and regular feeding is of prime importance to the infant. There should however be a balance between too much and too little. Otherwise, the infant becomes overinvolved or 'fixated' at this stage, and is unable to make the transition to the next developmental stage.

Anal Stage (2-3 years)

The main feature of this stage is the child's acquisition of voluntary bowel and bladder control. The child becomes increasingly aware of his ability to regulate and modify his excretory and digestive functions. The increased control of these functions is matched by similar gains in locomotor and cognitive skills.

Phallic Stage (3-5 years)

The child becomes increasingly aware of his/her genitals, the enjoyment to be derived from them and the differences between the sexes. Freud developed these ideas most clearly for boys and coined the term Oedipus complex to describe the conflictual situation arising between the boy and his parents during this phase

Latency Stage (5-12 years)

This period is so called because of its relative tranquility compared with the emotionally stormy periods of the phallic and genital periods. Freud believed that sexual feelings subside after the resolution of the oedipal crisis.

Genital Stage (12-18 years)

The endocrinological and physiological changes occurring at puberty rekindle the individual's interest in sexual matters and heterosexual relationships. Freud regarded heterosexual relationships as the norm.

3. Erikson: Psychosocial Theory

Erikson, a trained psychoanalyst, was particularly interested in and influenced by anthropology, so that his major contribution has been to give development theory in a social and cultural dimension, hence he termed psychosocial rather than psychosexual. He elaborated a phase or stage theory covering the whole lifespan from birth to death.

II. Behavioral Theories

1. Classical Conditioning Theory

It was given by Ivan in 1927. Classical conditioning occurs when two stimuli are paired together. This theory was put forward by Ivan Pavlov which is based on stimulus response theory reflex. When two stimuli occur together at the same time, resulting in a response, this response can also be obtained by stimulating any one of the original stimuli.

Use in Dentistry

The children are usually scared of the sound of the bur and the dentist is also usually present at that time. Therefore the child associates the fear of the bur with the dentist. Therefore whenever a dentist tries to come near him to perform a treatment, the child starts crying due to fear and will remain scared
Extinction: Extinction of conditioned Behavior results, if the association between the conditions and the unconditioned response is not reinforced.
Discrimination: It is opposite of generalization the child should be able to differentiate between the medical doctor and a dentist.

2. Operant Conditioning Theory: Instrumental or Operant Conditioning (Skinners; 1938)

When the child actions are reinforced and rewarded. It is contended that rewarded behavior is behavior that is likely to be repeated.

Freud's stages of psychosexual development

Stages	*Age*	*Major developmental task*	*Adult characteristics arising from incomplete resolution of the stage*
Oral	0-1	Weaning	Addictive Behavior such as smoking, drinking and overeating; also passivity and gullibility.
Anal	2-3	Toilet training	Obsessional, obstinacy or the opposite (For example, extreme untidiness).
Phallic	4-5	Oedipus complex; identification with parent of same sex	Vanity, restlessness (and the opposite)
Latency	6-12	Development of ego defense mechanisms	None
Genital	13-18	Mature sexual intimacy in adulthood	Adults who have successfully integrated earlier stages should emerge from this stage with a clear sense of their own identity and interests.

Various behaivor patterns (Internal psychological factor + external social factors) ERIKSON

Name	*Definition*	*Example*
Denial	Denial is the inability or reluctance to accept the psychological impact of a potentially stressful event or situation	The child denies stealing eventhough it is obvious that he is responsible. This is because the open admission of the theft would induce such a loss of self esteem and sense of guilt that it becomes impossible, hence the use of denial
Rationalization	Rationalization is a strategy to excuse or minimize the psychological consequences of an event	The child who fails to gain selection to the school football team may say to his friend that I don't like football anyway, so I am not bothered about playing for the team
Regression	Regression is the occurrence of developmentally immature behavior, often at times of stress	Many children have a recurrence of enuresis at the start of primary school
Displacement	Displacement is the transfer of hostile or aggressive feelings from their original source to another person usually less important	A school child may be aggressive in the playground with other pupils rather than be aggressive towards the teacher in the classroom
Reaction formation	Transfer of hostile or aggressive impulses into their opposite, more socially desirable form	The over solicitous concern for the welfare of his sibling may indicate that the child has underlying feelings of jealousy and rivalry
Sublimation accepted form	Transfer of unacceptable impulses into a socially acceptable impulse	Aggressive and competitive impulses are utilized
Intellectualization	Discussion of emotionally significant event in an abstract or logical manner without acknowledgement of the emotional component	Improved prognosis for childhood leukemia means that the emotional distress caused by the condition is now much less

Erikson's life cycle theory of development

Age	*Phase*	*Task*
0-1	Trust versus mistrust	Establishment of social relationships. Good outcome – Secure, stable relationships. Bad outcome – insecure, unsatisfactory relationships.
2-3	Autonomy versus shame, doubt	Beginning of independence and of skill acquisition. Good outcome – capable and competent. Bad outcome – dependent and unsure.
4-5	Initiative versus guilt	Successful pursuit of certain goals or aims. Good outcome – confident about skills. Bad outcome – hesitant, uncertain.
6-12	Industry versus inferiority	Acquisition of scholastic and social skills. Good outcome – literate, numerate and socially integrated. Bad outcome - failure to acquire scholastic skills, socially isolated.
13-18	Identity versus role confusion	Clear sense of own individuality and of aims in life. Good outcome – suitable career choice, satisfactory heterosexual relationships. Bad outcome – uncertain of career, poor peer relationships.

Contingency Management

The modification of the child's behavior by the addition or removal of the Reinforcers. These can be two types: *Positive reinforcers:* The presence of these increases the frequency of the behavior.

Negative reinforcers: The withdrawal of these leads to the increase in frequency of the behavior.

Omission – Removal of pleasant response after a particular response, e.g. favorite toy taken away for a short time.

Punishment – Introduction of an aversive stimulates into a situation to use the undesirable behavior.

Reinforcers can be:

a. Material: Giving the children small gifts like pencils and rubbers after the dental treatment has been done.
b. Social: The events that influence a child's behavior: praise and shaking hands with the child before and after the dental treatment has been done
c. Activity: The child is given an opportunity to do a task after the desired behavior has been shown by the child in the dental clinic. The child can go and play in the garden with his friends once his treatment has been done.

3. Hierarchy of Needs: Maslow (1954)

Maslow believed in the self-actualization theory, i.e. the need to understand the totality of a person. He gave forward the following thoughts.

The needs are arranged in a hierarchy and as one general type of need is satisfied, another higher order need will emerge. The desires from most basic biological needs to the more psychological ones become important only after basic needs have been satisfied.

Motivation is constantly required and is a never ending, fluctuating complex present in almost all organisms.

Pain avoidance, tension reduction and pleasure act as sources of motivating behavior.

4. Social Learning Theory: Bandura (1963)

Social learning theory is thought to be the most complete, clinically useful and theoretically a sophisticated form of Behavior therapy. As compared to operant and classical conditioning, this theory is:

- More rational
- Provides more explanatory concepts
- Encompasses a broader range of phenomenon

The learning of behavior is affected by four principle elements:

Antecedent determinants

The conditioning is affected if the person is aware of what is occurring.

Consequent determinants

Person's perception and expectancy (cognitive factors) determine behavior.

Modelling

Learning through observation eliminates the trial error search. It is not an automatic process but requires cognitive factors and involves four processes which are:

- Attentional processes.
- Retention processes.
- Reproduction processes.
- Motivational processes.

Self-regulation

This system involves a process of self-regulation, judgement and evaluation of individual's responses to his own behavior.

OTHER THEORY

Mahler's Theory (1933)

This theory relates the personality development and the early childhood object relations. They divided the period of childhood into three stages from 0–36 months. The merit of this theory is that it can be applied to the children whereas the demerit is that it is not a very comprehensive theory.

44 Behavior Management in Community Dentistry

Sadanand K, Anil Gupta

Behavior is defined as any change in the functioning of an organism. Behavioral dentistry is an interdisciplinary science which needs to be learned, practiced and reinforced in the context of clinical care and within the community oral health care delivery systems. It is as much of clinical skill as it is a science. It is not the application of individual techniques created to deal with children, but rather a comprehensive methodology meant to develop a relationship between the child and the pedodontist. It should be viewed as sum of all efforts made to achieve patients trust, confidence and relieve his pain and fear.

Most behavior is learned during childhood and child behavior reflects in one or other form during adulthood. The study of human behavior does not lend itself to randomized controlled clinical trials. Hence, it is very difficult to say that one technique of behavior management is better than the other.

This chapter deals with various types of behaviors encountered in dentistry and their management.

Behavior management is the means by which the dental team effectively and efficiently performs treatment of the child and at the sametime, installs a positive dental attitude.

Behavior shaping: It is that procedure which very slowly develops behavior by reinforcing successive approximations of the desired behavior until the desired behavior comes to be.

DOCUMENTATION/CATEGORIZING BEHAVIOR

The Frankel Scale is recommended as a way to meet this criterion without having to make extensive notes in the chart. A system of plus and minus can be used to approximate the Frankel Scale.

I. Frankel Behavior Rating

Category # 1

(– –) Definitely negative. Child refuses treatment, cries forcefully, fearfully, or displays any agitated, overt evidence of extreme negativism. Combative, thrashing, verbal, unable to be restrained, need to terminate procedure.

Category # 2

(–) Negative. Reluctant to accept treatment and some evidence of negative attitude (not pronounced). Slightly combative, verbal, slightly agitated, able to be restrained and procedure safely completed.

Category # 3

(+) Positive. The child accepts treatment but may be cautious. The child is willing to comply with the dentist, but may have some reservations. Quiet, not combative, cooperative, non-verbal.

Category # 4

(+ +) Definitely positive. This child has a good rapport with the dentist and is interested in the dental procedures. Happy, helpful.

II. Wright's Classification (1975)

1. Cooperative
   a. Cooperative.
   b. Lacking cooperative behavior.
   c. Potentially cooperative behavior.

2. Uncooperative
   a. Uncontrolled/hysterical.
   b. Tense cooperative.
   c. Defiant behavior.
   d. Timid behavior.
   e. Whining behavior.
   f. Stoic behavior.

VARIABLES INFLUENCING CHILD BEHAVIOR

Parental Influences

Parents play a very important role in child's psychological development which has a profound effect on the behavior of child. The parent's influences have been termed as "one tailed" where parent is an independent variable and child is the dependent variable.

This parental influence may be grouped under following headings:

1. **Overprotective parents:** they take excessive care of their children. Children are not permitted to take any decisions on their own. Such children are submissive, shy, and anxious and fear new situations and lack self-confidence. There are many reasons for such parental behavior such as, mothers who have conceived after long time, single child, etc.
2. **Overindulging parents:** Here parents give child whatever they want without any restraint. The child becomes spoilt and is used to getting his own way. These children will try to dominate over the dentist and it is very difficult to establish a good rapport with such children.
3. **Under affectionate parents:** the child is devoid of love and affection. It may be mild detachment, indifference or neglect. Such children are shy, indecisive but well behaved. They respond with when treated with love.
4. **Authoritarian parents:** Here the parents try to instill a high level of discipline in the form of physical punishment and verbal ridicule. Such children show a heightened gradient of avoidance and try to evade or delay the response.
5. **Rejecting parents:** Children face such situation when parents have an unwanted child, unhappy marriage, child interfering parents career etc. Such children are anxious, overactive, disobedient and are most difficult to deal in the clinic.

Past Medical and Dental Experiences

Children who have pleasant past medical experiences are more likely to be cooperative; and those with an experience of pain and fear will be non-cooperative. The emotional quality of past visits rather than the number of visits is significant.

Home Environment

Home is the first place where the child learns to behave. Children from broken home will feel insecure, inferior and depressed.

a. Maternal Behavior

High anxiety of parents affects the child's behavior negatively. Children of all ages can be affected by their mother's anxiety; the effect is greatest with those under the age of 4 years.

b. Family Influences

Attitudes of parents and internal conflicts in family can have a profound effect on child behavior.

School Environment

High IQ children are known to have high acceptance of dental treatment.

Position of the Child in the Family

The position of the child in the family plays a very important role in the type of behavior exhibited by the child:

- *First child*-Uncertainty, mistrustfulness, insecurity
- *Second child*-Independent, aggressive, extrovert
- *Middle child*-Aggressiveness, inferiority
- *Last child*-Secure, confident, immature, envy.

Sibling Rivalry

Sibling relationships do influence the child's behavior. The dominance by an other sibling and the child's dictorial and dominance of younger sibling the child's personality. Rivalry and jealously between siblings for the affection of parents and others members of the family does influence the child's behavior.

Socioeconomic Status

High authority of parent in low socioeconomic status is observed as compared to medium and high socioeconomic status. In high socioeconomic status group we may have a child who develops normally as he is provided with all necessary things for psychologic development or we may have a child who is spoilt as he used to get whatever he wanted.

CLINIC SETUP

1. Ambience of the Dental Clinic

The dental clinic should be pleasing and attractive. The clinic environment should relax the patient and keep him engaged till his treatment begins. It should be well equipped with:

- Toys
- Playroom
- Tape recorder
- TV showing cartoons
- Aquarium
- Cartoon posters.

2. Personality of the Dentist

- Casual, confident and friendly
- Total command of the situation
- Never loose temper
- Call child with nick name or first name
- Encourage the child.

3. Time and Length of Appointment

The duration of the appointment should not be more than half an hour, as the child tends to loose patience. No appointment should be scheduled during naptime or soon after an emotional experience like death. The appointments should be kept preferably in the morning time. No loss of time should take place during the appointed time. The instruments should be arranged in advance.

4. Use of Euphemisms (Substitute Words)

The use of fear promoting words like Needle and injection should be avoided. The use of Euphemisms should be encouraged. They are the substitute words and are less provoking.

Euphemisms

- Rubber dam –Rain coat
- Needle prick-mosquito bite
- Radiograph as tooth picture.

5. Use of Flattery, Reward and Praise

Tiny gifts, stickers if given after the treatment have a great influence on the Child's behavior. They tend to make the child happy. Praising a child or a pat on his back after good behavior goes a long way in gaining his confidence.

6. Parent Counseling

This is a very important aspect to be considered. The parents should keep the following points in mind:

- Not to voice their own fears
- Never use dentistry as a threat
- Mothers presence reduces the fear of the child.

7. Child and Parent Separation Vs Parental Presence

The presence of parents in the dental operatory during treatment has been a concern historically. There may be limitations based on infection control, patient flow, or confidentiality. Some studies have shown children less than three years of age respond better if their parents are present. At a minimum, parents should be encouraged to participate in examination appointments if possible. Parental presence is inappropriate for conscious sedation and general anesthesia.

Disadvantages of Parental Presence

- Repeat the orders of the dentist, annoyance
- Inject orders
- Dentist unable to use voice control
- Child s attention is divided
- Dentist s attention is divided.

Advantages

- Can be supportive in communicating
- Child below 2–3 years.

BEHAVIOR MANAGEMENT

It is a known fact that most of the dentists do not feel comfortable working with the children. Any dentist who regularly treats children has seen them crying, wiggling and kicking, tantrums and varieties of avoidance behavior. Experience and management techniques of the dentist are the key factors in this area of Dentistry.

Behavior management can be of two types:

- Non-Pharmacologic Behavior management
- Pharmacologic Behavior management (Conscious Sedation and General Anesthesia)

Behavior management could be started even before the child actually comes for dental treatment to the clinic.

Preappointment Behavior Modification

The preappointment experience entails bringing the child to the dental office for a tour and orientation. The child meets the receptionist, dental assistant and dentist. If this goes well, in that case the child is made familiar with certain dental equipment. This removes any unfavorable imaginations of the dental office and its personnel for the child.

Other Methods

a. Films.
b. Videotapes.
c. Preappointment mailing.

Non-Pharmacologic Behavior Management

Commonly used Non-Pharmacologic Behavior management methods are:

1. Communicative management (Chambers).
2. Systematic Desensitization (Wolpe).
3. Tell Show Do (Addelston).

4. Modelling (Bandura).
5. Voice Control.
6. Contingency management.
7. Hypnosis.
8. Aversive Conditioning.

1. Communicative Management

It is the most basic form of behavior management and is the first step in treating a child. The objective is to develop a rapport with the patient and gain his trust. Use of euphemisms as described before is essential for effective communication. It can be used in solo or it may be combined with other techniques like voice control, tell show do, reinforcement, etc to make them more effective.

Types of Communication:

a. Verbal.
b. Non-verbal.

Non-verbal communication may be in the form of patting, smile, acknowledging good behavior and by showing concern.

2. Systematic Desensitization

This technique is based on the work of Joseph Wolpe (1952). It involves gradual exposure of the child to least stressful objects to the most stressful object. The child is taught a competing response like relaxation and then progressively more threatening stimuli are introduced. Desensitization is done in two steps:

1. Gradational exposure of the child to his or her fear.
2. Induced state of incompatibility with his or her fear.

3. Tell Show Do (TSD)

Knowingly or unknowingly most of us would be using this technique in treating child patient. This technique is related to systematic desensitization and was described by Addelston in 1959.

Here the dentist first explains the procedure to the patient in easy terms and in a way appropriate for child's understanding (Tell). Then he slowly demonstrates the procedure to the patient, e.g. using a mirror and probe on a model. (Show); and continues with performing the procedure as described (Do) (Figs 44.1 to 44.3).

4. Modelling/Imitation

Modelling in simple terms refers to imitating behavior by observation. It was developed by Bandura (1969) based on social learning principles. He believed that "learning occurs only as a result of a direct experience, i.e. by witnessing the behavior and the outcome of that behavior for other people".

Types of models:

a. *Live models*: The other children in the clinic who are undergoing any dental treatment. The best live models are the siblings usually the elder brother or sister. Therefore usually conduct the treatment of the elder child first so that the younger child can observe and model the behavior.
b. *Filmed models*: The model in this case is not present physically. We can have posters or small movies showing the famous cartoon characters like Mickey mouse brushing his teeth or a famous movie star being friendly to a dentist and getting his treatment done. The children readily imitate this behavior.

Benefits:

1. Stimulation of acquisition of new behavior.
2. Facilitates behavior management.
3. Extinction of fear.
4. Disinhibition of behavior avoided.

Ingersoll 1982 felt that modelling is most beneficial when compared to other means for dentally uneducated child.



Fig. 44.1: Tell



Fig. 44.2: Show



Fig. 44.3: Do

5. Voice Control

Voice control is a controlled alteration of voice volume, tone, or pace to influence and direct the patient's behavior. This technique can be used alone or with other methods like Hand over mouth exercise.

Voice control allows the dentist to inculcate more authority into his or her communication. It must indicate that I am incharge here. It is also a useful way of reframing a request that has been refused by the child. Even the facial expressions have an important role to play. They can convey to the child that the practitioner is serious and in control of the situation. It is the voice and the face that makes the dentist powerful in management of the child.

6. Contingency Management

It is a method where a child's behavior is altered by presenting or withdrawing a reinforcer (any thing which increases the likelihood of desired behavior). It can be of two types:

Positive reinforcement

If a child's particular behavior is encouraged by praise or by patting on his back, the possibility of same behavior being repeated increases. This is called as positive reinforcement.

Negative reinforcement

Withdrawing a toy from the child on performance of a undesirable behavior

Reinforcers can be of three types:

1. *Social Reinforcers* include positive voice modulation, facial expression, verbal praise, and appropriate physical demonstrations of affection by all members of the dental Team.
2. *Material*: Giving the children small gifts like pencils and rubbers after the dental treatment has been done.
3. *Activity*: The child is given an opportunity to do a task after the child in the dental clinic has showed the desired behavior. The child can go and play in the garden with his friends once his treatment has been done.

7. Hypnosis

This method is helpful in reducing anxiety and increasing pain threshold. It is an altered state of consciousness characterized by a heightened suggestibility to produce desirable behavioral and physiological changes.

The practice of this method requires prior training.

8. Aversive Conditioning (Kramer 1974)

This is term encompasses techniques which are used in management of non-cooperative children. They are Physical restraints and HOME. Consent from the parents is necessary before using these procedures:

(I) Physical Restraint

Physical restraint includes partial or complete immobilization with staff, parent, or devices to protect the patient and staff from injury during dental treatment. The use of restraints may be offensive to uninformed parents.

Types:

a. Active.
b. Passive.

They may also be divided based on area of use:

a. For body, e.g. papoose board, Pedi wrap.
b. For extremities, e.g. Velcro straps, beanbag.
c. For head, e.g. Head positioner.
d. For mouth, e.g. Bite blocks, Props.
e. Others, e.g. chair straps.

(II) Hand Over Mouth Exercise (Levitas 1974)

The objective of this technique is to gain attention of highly non-cooperative child who is not willing to receive any sort of communication from dentist. This procedure should be used for children above 4-6 years of age who do not have any handicapping conditions. Prior consent for the procedure should be obtained from the parents.

A hand is placed over the child's mouth and behavioral expectations are explained. The hand is removed, or reapplied, depending on the behavior of the patient.

Indications

Use of the hand over mouth technique is indicated for a healthy child who is able to understand and cooperate but who exhibits defiant or hysterical avoidance behavior.

Contraindications

Use of the hand over mouth technique is contraindicated in children if:

- The technique causes occlusion of the nasal passages and restricts breathing
- You are unable to obtain written informed parental consent
- The child is unable to understand and cooperate due to age, disability, or medication.

Variations of HOME
1. Hand over mouth and airway restriction.
2. Hand over mouth and nose and airway restricted.
3. Towel hand over mouth only.
4. Dry towel over nose/mouth.
5. Wet towel over nose/mouth.

Other Behavioral Management Technique

It includes:
1. Audio analgesia
2. Bio feed back
3. Coping
4. Implosion therapy
5. Humor

Decision Making

The choice of behavior management techniques must be based on an evaluation that weighs risks versus benefits to the child. The following considerations enter into the decision making:
- Urgency of care
- Need for cooperation
- Skill of the Practitioner
- Options available at each clinic
- Parental Considerations.

Decision Making Factors

Prior to choosing a technique you should consider the following factors:
- Alternative methods, including referral
- Dental needs
- Expectations of the parents or caregiver
- Emotional development of the child
- Past medical history
- Ability of caregiver or person accompanying child to give consent.

Consent

Decisions involving behavior management techniques must involve the parents and, if appropriate, the consent of the patient. Successful completion of dental services must be viewed as a partnership of dentist, parent, and child. When consent is required for any technique it must be informed consent prior to treatment. Documentation of consent may be by the use of specific forms or progress note entries.

Pharmacologic Behavior Management (Conscious Sedation and General Anesthesia)

Pharmacologic means of behavior management should be used only when the patients lack cooperative behavior or a systemic condition requires it.

Conscious Sedation

It is defined as a "minimally depressed level of consciousness that retains the patient's ability to maintain an airway independently and respond appropriately to physical stimulation and verbal command"(ADA 1993).

This procedure is useful for a nervous and apprehensive child requiring extensive treatment. Nitrous oxide–oxygen combination is the preferred drug of choice here.

Bennett (1978) has listed the following objectives for success of conscious sedation:
1. The patients mood should be altered
2. The child should remain conscious
3. The child should be cooperative
4. All protective reflexes should be intact and active.
5. All vital signs must remain stable and normal.
6. The child's pain threshold must be elevated.
7. Amnesia should occur.

Conscious sedation is contraindicated in patients with systemic conditions like epilepsy, bleeding disorders, respiratory problems, etc.

General Anesthesia

In contrast to conscious sedation here the patient is unconscious and unable to maintain respiration independently and loses all protective reflexes.

General anesthesia is indicated when:
1. The patient is mentally or physically handicapped.
2. All other techniques of behavior management have failed.
3. The patient is too young to cooperate.
4. Patient requiring extensive/immediate dental treatment which would otherwise require multiple appointments.

Contraindications

1. Systemic conditions where use of anesthesia is not advisable.

In both conscious sedation and General anesthesia written parental consent is a must.

5 Section

Dental Practice

45 Dental Practice Management

CM Marya

Since the time evolved, Dental practice has existed in one or the other form. But it is not so long that it has attained the status of a profession.

Webster's dictionary defines a profession as "a calling requiring specialized knowledge and often long and intensive academic preparation".

The dentist provides preventive, therapeutic and educational services, supporting total health for the control of oral diseases and the promotion of oral health.

Preventive

Methods employed to prevent oral disease and promote health (e.g. application of pit and fissure sealants, topical fluoride to teeth).

Therapeutic

Methods employed to arrest or control oral disease (e.g. restoration of carious teeth, scaling and root planning periodontally involved teeth).

Educational

Methods employed in both preventive and therapeutic aspects to explain concepts regarding oral disease and health, to demonstrate self-care techniques (e.g. teaching toothbrushing and flossing, diet counseling).

DEFINITION

Practice management can be defined as the organization, administration, and direction of a professional practice in a style that facilitates quality client care, efficient use of time and personnel, reduced stress to staff, and financial profitability.

To establish a good dental practice, first step is to establish a dental office and secondly managing the dental office, which includes personnel management, patient management and record management.

ESTABLISHMENT OF DENTAL OFFICE

Factors to be considered before establishing dental practice:

- Selection of place
- Selection of location
- Selection of building
- Financial assistance
- Selection of equipments and instruments
- Designing of dental office.

SELECTION OF PLACE

- Personal choice of dentist
- Depends on the population demography of the area; population density, age distribution and average salaries of the residents
- Depends on number of dentist practicing in a place
- Whether dentist knows local language or not
- Place which is well linked by road, rail, air is good for practice
- Good facilities for living
- Hobbies and interests of dentist
- Place where dental college are present for employment
- Depends on profession or job of spouse.

SELECTION OF LOCATION

- Depends on scope, style of practice and convenience
- In the heart of city as it is accessible for people from all the areas of city
- Location with a good public transport facility
- Location close to government commercial offices, corporate and business houses
- In residential areas it is good to practice in morning and evening time as office goers can get treatment done before going to office or after office time. Also, it is convenient for old people and housewives.

SELECTION OF BUILDING

- Building should be well ventilated, have proper water and drainage system as well as power connection
- Building should preferably be on ground floor and have parking facility for both dentist and patients
- Select place where more area is available than present requirement so that it can be expanded if required
- It is also possible to practice at home by making some alterations
- It is better to own dental office rather than taking it on rent.

FINANCIAL ASSISTANCE

- Many nationalized banks, private sector banks and state financial corporations give help to establish professional career for a new graduate.

SELECTION OF EQUIPMENTS AND INSTRUMENTS

- Should have basic equipments and instruments to run dental office and can keep on adding instruments as per need
- Selection of equipments depend on finance available
- During selection of equipments importance should be given to reputation of company and after sale services provided by company
- It is better to have autoclavable instruments especially hand pieces, scaler handle and tips
- Sterilized or pre-autoclaved materials should be preferred when one buys consumable materials like blades, suture materials, gloves, syringes, needles, etc.

DESIGNING OF DENTAL OFFICE

- While designing dental office consider functional, esthetic and utility value of available space
- Design should incorporate a spacious waiting area, work area with dental chair and dental unit, X-ray room, laboratory, resting place, toilets, etc.
- Placement of each electrical equipment, gadget which will be used by dentist presently and also in future should be considered while designing electrical connections
- It is better to have concealed electrical connection keeping in mind the lighting, fan, exhaust, compressor, X-ray unit, computer, dental chair, chair unit, music system and speakers, etc. and also have few additional electric points for future additional gadgets
- Know the exact position of dental chair and dental unit, washbasin, and laboratory to design inlets and outlets for water and drainage connections
- Floors and walls should be designed considering esthetics and whether they can be cleaned easily. Instead of having joints and grooves in tiled flooring, choose rubberized vinyl flooring which is easy to keep clean
- Waiting area should be spacious considering future number of patients also
- Design work area in such a way that even after placing dental chair in supine position there is enough space all around chair for operating stool and assistant
- Have separate X-ray room, autoclaving and sterilization chambers near work place
- Keep generators and compressors as much away as possible from workplace
- Visit many dental clinics before designing your own clinic, consult dentists for shortcoming and faults in their clinic
- Have insurance coverage against fire, burglary and riots.

MANAGEMENT OF DENTAL OFFICE

Types of Practice

Three ways of private practice are:

1. Solo dentist practice–dentist alone manages all types of cases according to his/her capacity (Fig. 45.1).
2. Group practice–dentists specialized in various specialities work together in the same office
3. Single dentist with call facility for specialist–in this type, dentist alone manages the clinical work but calls for a specialist when required.

Whatever be the type of practice, dentist should be able to manage the practice well.

PERSONNEL MANAGEMENT

- Daily communication and regular staff meetings to encourage the participation of all the personnel
- Appoint a full time receptionist, dental assistant and a person to clean dental office
- The clinic should open much before the scheduled appointment of the patient and the assistant should keep the required instruments autoclaved and ready.



Fig. 45.1: Dentist practicing solo

- Have sufficient amount of stock of materials and dental staff should know how to make economical use of materials
- Should have business association with a good dental laboratory which delivers work in time.

PATIENT MANAGEMENT

- Dentist should have good communication with patients to ensure quality oral health care services and patient motivation
- Appointments should be scheduled for patients for effective time management in the practice
- Dentist should explain about diagnosis, investigation, different treatment plans available, cost of treatment and mode of payment
- Instructions regarding care after extractions, maintenance of artificial dentures, oral health education, etc. may be given in written.

RECORD MANAGEMENT

- Record should be systematically maintained
- Written records include the dental and periodontal charts; case history, record of examinations, diagnosis, informed consent and treatment rendered
- Non-written records include photographs, radiographs, models and cephalometric tracings
- Receptionist should maintain book of accounts by keeping all bills of purchase of equipments, instruments, materials, stationary items and subscription for journals, travel expenses, fees for registration of seminars, conferences, receipt of water, electricity, telephone bills and record for salaries for staff, any donation given, etc.
- Many dental software programs are available for documenting patient record; spreadsheets with automatic accounting functions, data management, graphics, scheduling, communications and education (Figs 45.2 and 45.3).

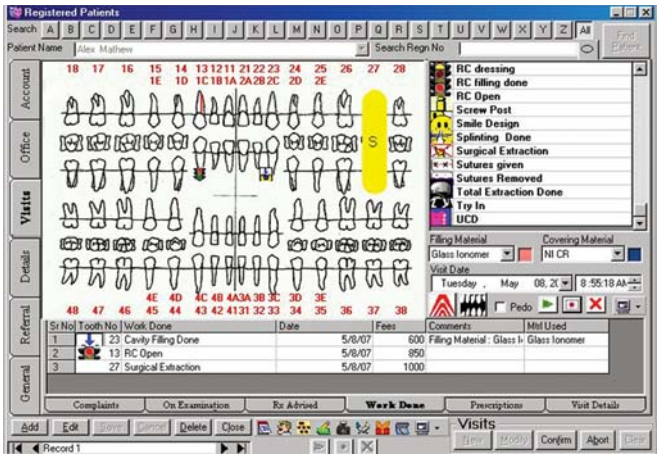


Fig. 45.2: Computerized dental charting

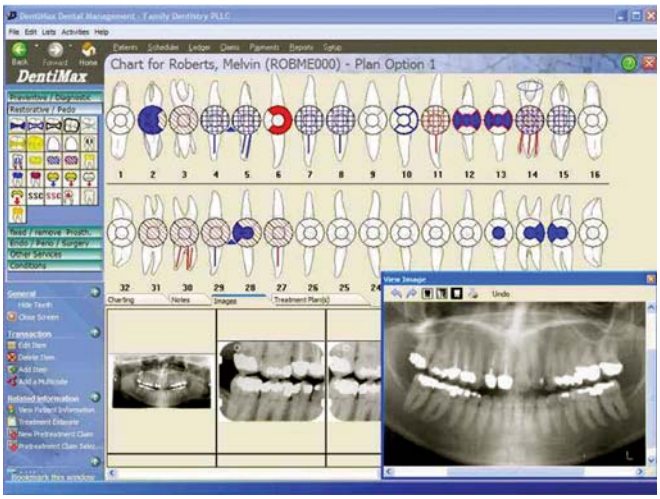


Fig. 45.3: Computerized patient record keeping including radiographs

Table 45.1: Ten fundamentals of dental practice management

Bruce J Lowy

I.	Communication: Dentist should have good communication with patients to ensure quality oral healthcare services and patient motivation.
II.	New patient management: The primary objective is to make new patients feel important by exceeding their expectations. This impresses people, and impressed patients accept higher levels of care and tend to refer more of their friends and relatives.
III.	Treatment presentation: Dentist should explain about diagnosis, investigation, different treatment plans available, cost of treatment and mode of payment.
IV.	Financial arrangements: Effective means to help patients make financial decisions that affect acceptance.
V.	Collections: Effective over-the-counter collection prevents many accounts from becoming delinquent and helps to preserve positive patient relationships.
VI.	Treatment planning and scheduling: Appointments should be scheduled for patients for effective time management in the practice.
VII.	Continuing care and recall: Provide patients with a specific diagnostic reason to return for their next appointment.
VIII.	Internal marketing: Many offices have found exceptional success using advertising via cable television, radio, mail, magazine, newspaper advertising, billboards, telephone directories and other traditional business avenues to stimulate new patient flow.
IX.	Managing the team: Daily communication and regular staff meetings to encourage the participation of all the personnel.
X.	Financial analysis and control: Maintain patient record along with fees charged on day to day basis Approach a C.A at initial stage of setting up the profession. Maintain book of accounts by keeping all bills of purchase of equipments, instruments, materials, stationary items and subscription for journals, travel expenses, fees for registration of seminars, conferences, receipt of water, electricity, telephone bills and record for salaries for staff, any donation given, etc.

ACCOUNTING AND OTHER FINANCIAL ASPECTS OF DENTAL PRACTICE (TABLE 45.1)

- Maintain patient record along with fees charged on day to day basis
- Approach a C.A at initial stage of setting up the profession
- Maintain records of all expenses on a day to day basis
- Start tax planning by investing in approved schemes as life insurance, public provident fund, N.S.C, tax saving bonds, etc.
- Start filling tax returns from 1st year of practice itself as it would help in being law compliant and also in obtaining loans in future and avoiding enquiries from tax authorities.

FACTORS INFLUENCING DENTAL PRACTICE

I. LEGAL: Each dentist must respect and be well aware of the law. Frequent review of the practice acts and/or regulations is recommended to keep the dentist up to date.
II. ETHICAL: Dentists are ethically and morally responsible for providing dental care to all patients, including those who have been or may have been exposed to infectious diseases.
III. PERSONAL: Factors such as general physical health, oral health and mental health should be given consideration. Dentist should go for routine physical examinations at least annually. Adequate physical health, vacation from work, recreation and participation in social activities ensures good mental health.

THE WAYS OF INITIATING A DENTAL PRACTICE

- Starting an own practice
- Buying an old practice and/or working with an associate dentist.

STARTING AN OWN PRACTICE

Advantages of starting a new practice:

- The geographic location of the practice is a self decision.
- One may incorporate any ideas, concepts, philosophies of practice or techniques according to his/her preference.
- One may plan, build or remodel a new facility or old facility to meet the needs.
- Employees are the people of own choice.
- He/she is the only decisive authority in the practice.

Disadvantages of starting a new practice:

- One needs a major amount of money or a large loan.
- Building a patient base requires several years and diligent effort in the practice.
- There is no assurance that the initial practice income will keep up with the financial outgo need.

BUYING AN OLD PRACTICE AND/OR WORKING WITH AN ASSOCIATE DENTIST

Advantages:

- One can start with an immediate income.
- The facility and the equipment are functional.
- No need to plan an office or be creative at the beginning of the practice experience.
- Patients are immediately available to treat.
- The change from previous professional activities (school or another practice) is not a major shock.

Disadvantages:

- The patients are devoted to the previous owner of the practice, and one must make a positive impression with them to gain their confidence and keep them in the practice.
- The previous owner may continue to treat the desirable patients while he or she is still in the practice, limiting the income and productivity.
- The employees are devoted to the previous owner.
- The equipment may be old and out of date, requiring an outlay of money.
- The building may be old and in need of repair, or in a geographic location that is not your choice.
- The previous dentist's work may have been of a different level of quality than desired in the practice, and the staff will have to be re-educated.
- The previous owner may want to stay longer than originally planned, and it may be difficult to take over the practice at the agreed time.

46 Forensic Dentistry

CM Marya

Forensic odontology is the practice related to law. Forensic is derived from the Latin word 'forum' which means court of law. Odontology refers to the study of teeth. Forensic Odontology, therefore, has been identified by Federation Dentaire International (FDI) as that branch of dentistry which, in the interest of justice, deals with the proper handling and examination of dental evidence, and with the proper evaluation and presentation of dental findings.

Forensic odontology, or forensic dentistry, is one of the most unexplored and intriguing branches of forensic sciences. It primarily deals with identification, based on recognition of unique features present in individual's dental structures. It can be considered as an area of specialization under dentistry as well as forensic medicine because knowledge of both the fields is vital for its activities.

DEFINITION

Forensic dentistry, or forensic odontology, is the application of dental and para dental knowledge to the solution of legal issues in civil and in criminal matters.

Knowledge of forensic odontology among dentists is essential to better understand the intricacies and subtleties specific to forensic science and criminal investigation.

CONSTITUENTS OF FORENSIC ODONTOLOGY

Forensic odontology mainly constitutes the following headings:

1. Postmortem dental identification and disaster victim identification
2. Age estimation
3. Anthropology
4. Bite mark analysis

Forensic dentists are responsible for six main areas of practice:

- Identification of found human remains
- Identification in mass fatalities
- Assessment of bite mark injuries
- Assessment of cases of abuse (child, spousal, elder)
- Civil cases involving malpractice
- Age estimation.

MEANS OF IDENTIFICATION

- *Teeth:* Natural and synthetic (fixed and removable)
- *Bone:* Trabecular pattern, tori and osseous anomalies
- *Presence of foreign bodies:* Implants, unretrieved amalgam particles, surgical instruments, bullets, fragments of various origins
- *Sinus configuration:* Maxillary and frontal
- *Skull sutures*
- *Soft tissue features:* Rugae (rugoscopy) and lip (cheiloscopy, quieloscopy) prints
- *Photographic comparison:* Facial or dental superimposition or approximation
- DNA.

Forensic odontology has an established domain with wide applications in:

- Identifying unknown human remains through dental records, and assisting at the location of a mass disaster
- Examination and evaluation of injuries to jaws, teeth, and oral soft tissues
- Eliciting the assisting in building up a picture of lifestyle and diet of skeletal remains at archeological sites
- Determining the gender of unidentified individuals
- Age estimation of both the living and the deceased
- Recognition and analysis of bite marks which occur with some frequency in sexual assaults, child abuse and personal defence situations
- Presenting evidence in court as an expert witness.

HISTORY

The first formally reported case of dental identification was that of the 80 years old warrior John Talbot, Earl of Shrews bury, who fell in the battle of Castillon in 1453.

The first forensic odontologist in the United States was Dr Paul Revere, who identified the body of Dr Joseph Warren,

(a revolutionary the British in 1775) through a dental bridge of silver and ivory that he had constructed two years previously.

Dental evidence was first accepted in the United States court in the Webster–Parkman case. Dr JW Webster allegedly stabbed, dismembered on November 23, 1849 in Bostan charred fragments of mineral teeth fused to gold were recognized as those of the deceased by Dr Nathan Parkman. This evidence was enough for the jury to a verdict of guilty of premeditated murder against Dr Webster who was subsequently hung.

The first treatize on forensic odontology was written by Dr. Oscar Amoedo in 1898 and was entitled L' Art Dentaire en Medicine Legale. Dr Oscar is also known as father of Forensic Odontology.

In 1937, in Chantilly, a murderer was convicted on the evidence of the bite marks that the victim inflicted during her struggle for life.

In 1946, Welty and Glasgow devised a system in which as many as 500 cards with dental data could be sorted in one minute by a computer.

The following year Taltersall wrote that he advocated the Hollerith system of punch cards and thought this would be very beneficial in compiling dental data.

Internationally, there is an obvious growth of interest in this field. There are organizations such as The Scandinavian society of Forensic Odontology, The Federation Dentaire International, The Canadian Society of Forensic Sciences, The American society of Forensic Odontology and The American Academy of Forensic Sciences.

ROLE OF TEETH IN DETERMINATION OF HUMAN IDENTITY

The most common role of the forensic dentist is the identification of deceased individuals.

Dental Identification

The dentition is significant in the human identification process primarily because teeth and the jaw structures can resist even the most severe environmental conditions and trauma. This is so, particularly for the teeth, because of the inherent durability of tooth enamel and of cementum.

The oral cavity seems to be so well insulated against the high temperature of fires that often even the supporting tissues surrounding the teeth are also well preserved. In addition, the dental restorations are frequently completely intact.

The following categories and terminology for body identification are suggested by the American Board of Forensic Odontology, for use in communicating the results of a forensic odontology identification investigation:

Positive identification: The antemortem and postmortem data match in sufficient detail to establish that they are from the same individual. In addition, there are no irreconcilable discrepancies.

Possible identification: *The antemortem and postmortem data have consistent features, but, due to the quality of either the postmortem remains or the antemortem evidence, it is not possible to positively establish dental identification.*

Insufficient evidence: *The available information is insufficient to form the basis for a conclusion.*

Exclusion: *The antemortem and postmortem data are clearly inconsistent. However, it should be understood that identification by exclusion is a valid technique in certain circumstances.*

Dental identification takes two main forms. Firstly, the most frequently performed examination is a comparative identification that is used to establish (to a high degree of certainty) that the remains of a decedent and a person represented by antemortem (before death) dental records are the same individual. Information from the body or circumstances usually contains clues as to who has died. Secondly, in those cases where antemortem records are not available, and no clues to the possible identity exist, a postmortem (after death) dental profile is completed by the forensic dentist suggesting characteristics of the individual likely to narrow the search for the antemortem materials.

Dental identification of humans occurs for a number of different reasons and in a number of different situations. The bodies of victims of violent crimes, fires, motor vehicle accidents and work place accidents, can be disfigured to such an extent that identification by a family member is neither reliable nor desirable. Persons who have been deceased for some time prior to discovery and those found in water also present unpleasant and difficult visual identifications. Dental identifications have always played a key role in natural and manmade disaster situations and in particular the mass casualties normally associated with aviation disasters. Because of the lack of a comprehensive fingerprint database, dental identification continues to be crucial in most parts of the world.

The postmortem dental remains can be compared with antemortem dental records, including written notes, study casts, radiographs, etc. to confirm identity. Clearly, individuals with numerous and complex dental treatments are often easier to identify than those individuals with little or no restorative treatment. The teeth not only represent a suitable repository for such unique and identifying features, they also survive most postmortem events that can disrupt or change other body tissues. The forensic dentist produces the postmortem record by careful charting and written descriptions of the dental structures and radiographs.

Postmortem Dental Profiling

Iain A Pretty and Dr. David Sweet suggest that when antemortem dental records are unavailable and other methods of identification are not possible, the forensic dentist can assist in limiting the population pool to which the deceased is likely to belong and thus increase the likelihood of locating antemortem dental records. This process is known as postmortem dental profiling. The information from this process will enable a more focused search for antemortem records. A postmortem

dental profile will typically provide information on the deceased's age, ancestry background, sex and socio-economic status. In some instances, it is possible to provide additional information regarding occupation, dietary habits, habitual behaviors and occasionally on dental or systemic diseases. The determination of sex and ancestry can be assessed from skull shape and form. Additional characteristics, such as cusps of Carabelli, shovel shaped incisors and multicusped premolars, can also assist in determination of ancestry. Sex determination is usually based on cranial appearance, as no sex differences are apparent in the morphology of teeth.

Denture Marking

Following major disasters, such as earthquakes, fires or floods, determination of the various individual physical and genetic characteristics of human dentition has proved to be very efficient in aiding the task of identification. Edentulous subjects, on the other hand, have lost all or most of the key features that have proven valuable in such cases, hence the process of identification is much difficult, unless the victims wear marked dentures. Labeled dentures can be of great assistance in the identification of individuals (Fig. 46.1).

Role of DNA Technology

Because of the resistant nature of dental tissues to environmental assaults, such as incineration, immersion, trauma, mutilation and decomposition, teeth represent an excellent source of DNA material. When conventional dental identification methods fail, this biological material can provide the necessary link to prove identity. Comparison of DNA preserved in and extracted from the teeth of an unidentified individual can be made to a known antemortem sample (stored blood, hairbrush, clothing, cervical smear, biopsy, etc.) or to a parent or sibling.

Genomic and Mitochondrial DNA in Forensic Dentistry

The genomic DNA is found in the nucleus of each cell in the human body and represents a DNA source for most forensic applications. The teeth are an excellent source of genomic DNA because PCR analysis allows comparing the collected postmortem samples to known antemortem samples or parental DNA.

Mitochondrial DNA is another type of material that can be used for body identification. Its main advantage is the high number of copies per cell (from hundreds to thousands of organelles). Second advantage is that mtDNA is inherited from mother only, not from father. Thus, an identical mtDNA can be obtained from siblings, their mother and maternal relatives. When the extracted DNA samples are too small or degraded, such as those obtained from skeletonized tissues, the likelihood of obtaining a DNA profile from mitochondrial DNA is higher than that with any marker found in genomic DNA.

BITE MARKS

Biting is a primitive type of assault. It is often used as the weapon of last resort. Consequently, bite injuries are frequently seen in circumstances of forcible rape, skirmishes between young children and hand to hand mortal combat. Since biting may be part of foreplay or other sexual activities, bite injuries are often seen in sex crimes, particularly among male homosexuals.

Most early forensic investigators analyzed marks left by dental casts in wax, clear overlays and other mediums. With the advent of electron microscopy and computer enhancement, these new technologies were applied to bite mark analysis. In addition to the attempts to link marks left on human tissue to the dentition of the perpetrator, there were many instances of bites in food or other inanimate objects used as physical evidence to place the accused at the scene of the crime.

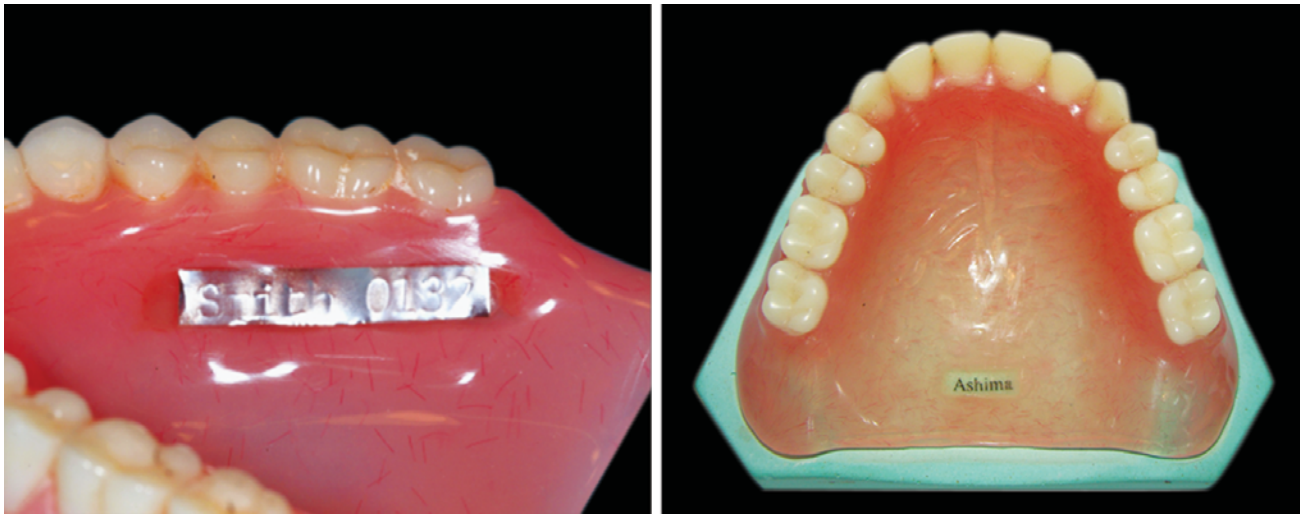


Fig. 46.1: Labeled dentures

For bites on human skin, a potential bite injury must be recognized early, as the clarity and shape of the mark may change in a relatively short time in both living and dead victims. Bite marks appear most often as elliptical or round areas of contusion or abrasion, occasionally with associated indentations. Since the skin marks are apt to change overtime, photographs provide the most reliable means of preserving the information. When there are indentations in the skin, or to preserve the three-dimensional nature of the bitten area, impressions should be taken to fabricate stone models.

Impression

An accurate impression of the bitten surface should be fabricated to record any irregularities produced by the teeth, such as cuts, abrasions, etc. Vinyl polysiloxane, polyether or other impression material available in the dental office that is recommended for fixed prosthetic applications can be used for this purpose.

Bite Sample

A sample of the suspect's bite should be recorded in centric occlusion using either a wafer of baseplate wax or a sample of silicone putty material designed for this purpose. This exhibit should be photographed immediately after it is recorded. This will provide an opportunity for future comparison of the photograph and the exhibit to verify that no distortion has occurred.

Forensic Physical Comparison of Exhibits

The most common methods to determine, if the suspect's teeth caused the bitemark include techniques to compare the pattern of the teeth (shape, size, position of teeth, individually and collectively) with similar traits and characteristics present in life sized photographs of the injury using transparent overlays.

The most accurate technique has been found to be a method using a computer. Other comparison methods include the direct comparison of the suspect's study casts (Fig. 46.2) with photographs of the bitemark, comparison of test bites produced from the suspect's teeth with the actual bitemark, and the use of radiographic imaging and scanning electron microscopy

The physical characteristics of both the bite mark wound and the suspect's teeth include (Fig. 46.3):

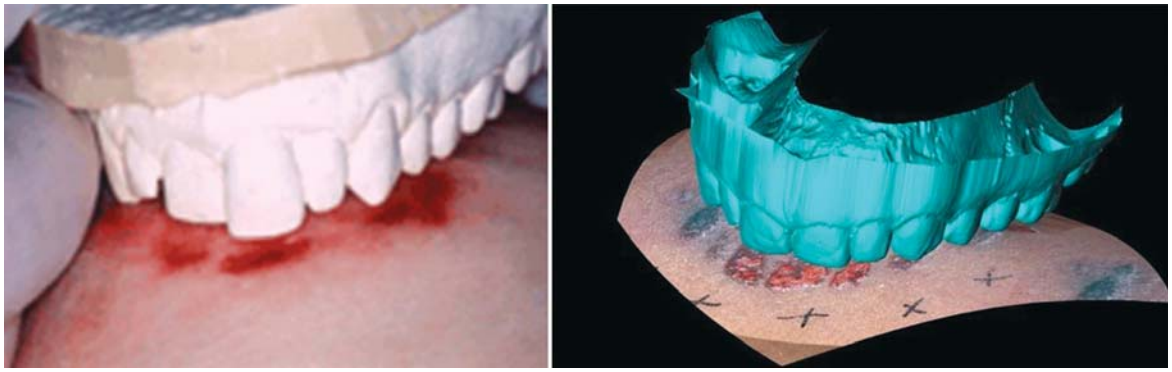


Fig. 46.2: Comparison between suspect cast and bite mark

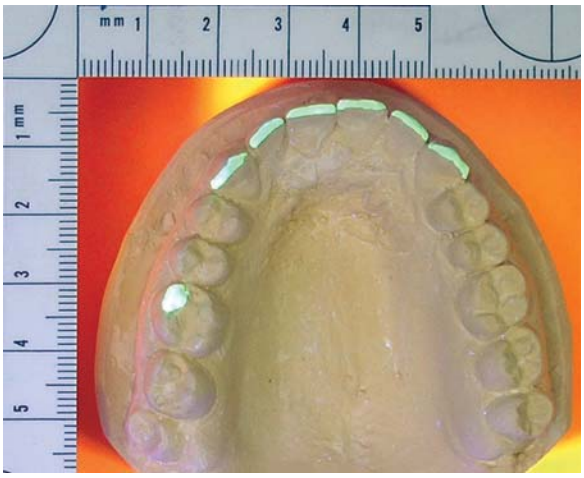


Fig. 46.3: Dental cast analysis for comparison with victim bite marks

- The distance from cuspid to cuspid
- The shape of the arch
- The evidence of a tooth out of alignment
- Teeth width and thickness, spacing between teeth
- Missing teeth
- The curves of biting edges
- Unique dentistry
- Wear patterns such as chips or grinding.

Steps in data collection for bite mark analysis (Box 46.1):

1. Recognition and initial assessment.
2. Swabs of skin.
3. Photographs.
4. Measurements, drawings.
5. Impressions.
6. Preservation of skin.
7. Follow-up photographs.

BOX 46.1: BITE MARKS ANALYSIS

- Bite marks are photographed with a scale
- Bite marks on skin are taken over repeated intervals
- Casts of impression are taken
- Impression traced onto transparencies
- Casts of suspect's teeth are taken
- Comparison between suspects's cast and bite marks.

The accuracy of tooth marks in skin can depend on the amplitude and direction of the biting forces, sucking action, whether the skin was penetrated and any movements by the assailant or victim during the biting episode. Inspite of a reasonably well established approach to the acquisition of bite mark evidence, there is continuing dispute about the methods and emphasis of analytical procedures. There is no consensus on the appropriate technical methods for evaluating the bite mark and potentially associated dental composition. The shape of the bite mark can give useful clues about the person who caused it and may lead to the implication or exclusion of an individual under investigation.

Saliva

Saliva is deposited on the skin during biting or sucking and this should be collected and analyzed. If swabbing the area would damage or alter the pattern, it should either not be done or accomplished only after all other preservation methods have been employed. Due to the difficulties of physically comparing an injury site on elastic and curved skin surfaces to the teeth of a suspect, it is suggested to consider using salivary DNA evidence to identify the bite perpetrator. David Sweet et al 1997 suggested a double swab method for recovering saliva.

Double swab technique: In the double swab method, the first swab is immersed in sterile distilled water to wet the cotton tip completely. The tip is then rolled over the surface of the skin using moderate pressure and circular motions. Rotating the swab on its long axis ensures maximum contact between the swab and the skin to wash the dried saliva from the surface and collect as much evidence as possible. The swab is then set aside to air dry completely (≥ 30 min).

The second swab is not moistened. Using similar pressure and movements as with the first swab, the dry tip is rotated over the skin to recover the moisture remaining on the skin's surface from the wet swab. The dry swab is rolled over the entire area to ensure all of the moisture is recovered and set aside to air dry completely (30 min). Because the swabs are collected from the same site, they are pooled together into a single sample. After collection, the filter paper discs and the single and double swab samples are adequately labeled and stored at 4°C (to reduce the degradation of salivary DNA) pending DNA extraction and quantitation.

MASS DISASTER

The world has experienced a plethora of mass disasters in recent years like hurricanes, earthquakes, floods, typhoons, mud slides, transportation mishaps, aircraft accidents, fires, volcanic eruptions, industrial accidents, terrorist acts and armed conflicts. The role that forensic dentistry and the forensic science community play in such disasters varies with the jurisdiction throughout the world. The identification of large numbers of casualties in mass disasters is complex and fraught with hazards, both physically and emotionally. Preplanning, organization, coordination, and disaster response exercises are the keys to successful disaster management. The major problems facing a forensic identification center in time of mass disaster are:

1. Large numbers of human remains.
2. Fragmented, commingled, and burned remains.
3. Difficulty in determining who was involved in the disaster.
4. Acquisition of meaningful medical and dental records and radiographs.
5. Legal, jurisdictional, organizational and political issues.

AGE ESTIMATION

The estimation of age at time of death is often an important step in the identification of human remains. If this age can be accurately estimated, it will significantly narrow the field of possible identities that will have to be compared to the remains in order to establish a positive identification.

Changes that are appreciable with increasing age are attrition, periodontal disease, and deposition of secondary dentine, root translucency, cementum apposition, root resorption, color changes and increase in root roughness.

The age determination from dental examination is possible from approximately 10 weeks intrauterine up to old age. The presence of neonatal line (birth line) in both dentine and enamel indicates live birth and a separate existence. It is possible that the time period of survival can be estimated by measuring postnatal deposition of these hard tissues.

Various methods such as Schour & Massler's method and Demirjian's method in children and Gustafson's method in

adults have been used for age estimation. Age estimation may also be done by dentine translucency and incremental lines of cementum.

In cases of age estimation, medical ethics and legal rules are the important factors, which should be considered.

Methods of Age Estimation in Adults

In general, methods are divided into three categories:
1. Morphological
2. Radiological
3. Biochemical

SEX IDENTIFICATION

Sex identification can be done using odontometric analyses using mandibular canine index, etc. The teeth, in particular canines are larger in males than in females but this method is insufficiently accurate when other objective methods are available. Microscopic examination of teeth in which the pulp tissue is examined for Barr bodies (present only in females) has been shown to be of value in burnt and mummified remains and is highly accurate. DNA analysis can also reveal sex. The method is based upon PCR analysis of DNA, sourced from the dental pulp, and the subsequent analysis of the amelogenin gene for sex determination. The teeth often remain the only source for DNA following incineration or other postmortem events.

INTERNAL AND EXTERNAL DOCUMENTATION AND COMMUNICATION PROBLEMS

In most jurisdictions, there are three or four legally admissible methodologies used to identify human remains: (1) visual identification, (2) fingerprints or footprint identification, (3) dental identification, and (4) DNA evidence.

The dental structures are highly resistant to destruction, but dental identification is also subject to available antemortem dental records and radiographs. Dental radiographs afford abundant objective evidence when antemortem and postmortem radiographs are compared. Full mouth dental and panorex radiographs detail unique and individual anatomy for comparison even in the absence of dental restorations.

A Forensic Dentistry Section should be an integral part of the organization of the disaster identification center. The role of the postmortem dental examination and dental radiology subsection is perhaps the most straightforward and uncomplicated part.

The comparison of antemortem and postmortem dental radiographs allows for the positive identification of victims by radiographic visualization of the anatomy of oral structures, existing restorations, materials, pathology, root canal therapy, previous surgical procedures, fractures and prosthetic devices. Dental charting methodology may use any good charting system, but must be consistent in its use in the Identification Center.

The task of personnel in the dental record section is the most difficult in the entire forensic dentistry arena since they are required to determine who was involved in the disaster, locate and procure antemortem records and radiographs, arrange for the delivery of these materials, and undertake the process of developing a composite antemortem record for each victim from the evidence supplied.

FORENSIC RADIOLOGY

Dental identification is a comparative technique. The dentition of the decedent is compared to dental records of a suspect. Sometimes the decedent's teeth are compared to antemortem written records although the most accurate and reliable method is by comparison of antemortem and postmortem radiographs.

Unlike subjective records which lack detail and can include errors, radiographs supply objective data through the precise recording of the unique morphology of dental restorations and dento-osseous anatomy.

For example, a written notation of a filling is of low specificity because other people have similar fillings. A radiographic rendition of that filling, however, shows its specific silhouette which is often unique. The uniqueness of a filling's shape is derived from the fact that it is hand carved by the dentist so that no two are alike. When fillings or teeth are not present, radiographs are particularly important because the written dental record is not likely to have any usable information but the radiographs are apt to show distinctive anatomy.

Objectives in Radiographic Comparisons

The objective of using radiographs in identification is to compare and evaluate similarities between antemortem and postmortem films. The tasks for the forensic investigator include six steps:
1. Securing antemortem radiographs.
2. Making postmortem radiographs.
3. Comparing meaningful features (those which are stable and distinctive).
4. Accounting for discrepancies.
5. Assessing uniqueness.
6. Verbalizing the degree of confidence in the identification.

The possible identification parameters can be teeth, anatomical landmarks, restorations, crowns, root canals, prosthesis, pathologies, periapical radiolucencies, etc.

Making Postmortem Dental Radiographs

It is desirable to postpone postmortem radiography until antemortem radiographs on a putative victim are received. In this way, comparative views of existing films can be made. Postmortem films should reproduce the angulations of antemortem films even if the antemortem views are not ideal.

What to Compare?

1. Number and arrangement of teeth (missing teeth, rotated teeth, spacing, extra teeth, impacted teeth).
2. Caries and periodontal bone loss.
3. Coronal restorations (visible in or on the crown).
4. Hidden restorations (bases under fillings, pins, root canal fillings, posts, and implants) seen only radiographically.
5. Bony pathology.
6. Trabecular bone pattern and crestal bone topography
7. Nutrient canals.
8. Anatomic bony landmarks.
9. Maxillary sinus and nasal aperture.
10. Frontal sinus.
11. Dental anatomy.

Limitations of Dental Radiography

A radiograph represents two dimensional shadows of three dimensional objects. Fillings on the cheek side of a tooth cannot be distinguished from those on the tongue side. Also, fillings can be obscured by superimposition of other fillings in the same tooth.

The various metals used in dentistry cannot be distinguished, all are radiopaque.

Artifacts and disparities produced by improper angulation, orientation, exposure, processing, labeling, and storage present potential difficulties which must be controlled.

CHILD ABUSE

Child abuse may be defined as any act of commission or omission that endangers or impairs a child's physical or emotional health and development.

Such acts include physical, sexual, or emotional abuse, as well as physical neglect, inadequate supervision, and emotional deprivation. Child abuse is second only to SIDS (Sudden Infant Death Syndrome) as the leading cause of death in children under one year of age. In older children, it is second only to accidents. The ultimate goal of the forensic dentist involves (1) Knowing the signs of child abuse and neglect, and (2) Fulfilling the legal and moral obligation to prevent further abuse by documenting the injuries by photographs or other means and reporting the matter to the police or social welfare agency.

Detecting Child Abuse in the Dental Office

History

When a child presents for examination, particularly if there is an injury involved, the history may alert the dental team to the possibility of child abuse. Indeed, the history may be the single most important source of information.

General Physical Findings

The child's nutritional state is poor and growth is subnormal.

Extraoral injuries are noted

There may be bruises or abrasions that reflect the shape of the offending object, e.g. belt buckle, strap, hand.

Cigarette burns or friction burns may be noted

Findings on Dental Examination

Both oral and facial injuries of child abuse may occur alone or in conjunction with injuries to other parts of the body. The oral lesions associated with child abuse are usually bruises, lacerations, abrasions, or fractures. Suspicion of child abuse should be particularly strong when new injuries are present along with older injuries.

Blunt forces may even cause tear of mucosa or the frenula, and may even lead to loosened or fractured teeth and jaws.

Documenting and Reporting Child Abuse

When one suspects child abuse, it is important to document the findings thoroughly. This record of the evidence is crucial for whatever legal proceedings may follow. Documentation may involve written notes, photographs, and radiographs. If the child requires medical attention, referral should be made to the proper resource.

CHEILOSCOPY

The external surface of the lip has numerous elevations and depressions that form a characteristic pattern, referred to as lip prints. Lip prints can be obtained from the crime scene from clothing, cups, glasses, cigarettes, etc. Impressions are made from the lower portion of the lower lip, an area always visible in any trace made. The various patterns included are vertical, intersected, branched, reticular and undetermined.

Various factors can alter lip printing. It has to be obtained within 24 hours after death. Lip prints depend upon whether the mouth is opened or closed. Any pathology or any postsurgical alteration may also change the pattern.

Although lip prints are unique to an individual, when the lines are not clear, the individual estimation is extremely difficult.

FORENSIC ANTHROPOLOGY

The science of forensic anthropology includes archeological excavation; examination of hair, insects, plant materials and footprints; determination of elapsed time since death; facial reproduction; photographic superimposition; detection of anatomical variants; and analysis of past injury and medical treatment.

The forensic anthropologist devotes more attention to the osseous material rather than dental evidence.

Anthropological examination of teeth can yield information useful in building the profile of unidentified individuals, e.g. Lund and Mornstad suggested that tooth measurements could indicate sex, while morphological features such as Carabelli's trait give clues to a person's ethnicity.

The greatest of these could be the anthropologist's intensive training and experience in distinguishing between human and nonhuman remains, determining age at death, racial affiliation, sex, stature, elapsed time since death, skeletal trauma, postmortem damage and alteration of the skeleton, and establishing positive identification based on skeletal and dental evidence.

Racial Affiliation

Racial affiliation is difficult to answer but some anatomical details, especially in the face, often suggest the individual's race. In particular, white individuals have narrower faces with high noses and prominent chins. Black individuals have wider nasal openings and subnasal grooves. American Indians and Asians have forward projecting cheekbones and specialized dental features.

Age and Stature

Examination of the pubic bone, sacroiliac joint, amount of dental wear, cranium, arthritic changes in the spine and microscopic studies of bones and teeth narrows the age estimate given by the anthropologist.

Time Interval since Death

Estimate is based on the amount and condition of soft tissue, such as muscle, skin and ligaments present, the preservation of the bones, extent of associated plant root growth, odor, and any carnivore and insect activity.

Evidence of Trauma

After the dirt and forest debris are removed from the bones using water and a soft brush, a number of faint cuts become visible in the left ribs and the midback.

Distinguishing Skeletal Traits

Further examination can reveal if the person sustained a fracture several years before death. The individual with a severely deviated nasal septum and presented evidence of a severe chronic nasal infection is noteworthy because if he sought medical help for the fractures or sinus condition, photo images may have been taken that would provide an excellent opportunity for positive identification.

COMPUTER ODONTOLOGY

Forensic computing - It is the process of identifying, preserving, analyzing and presenting digital evidence in a manner that is legally acceptable.

Role of computers in forensic dentistry is as follows:

- *Automatic dental code matching*
  Bites are run through the computer to find a match
- *OdontoSearch*
  Compare a data base of missing peoples, felons, government workers
- *Automatic dental identification system*
  A few minutes will produce a list of people who have the same dental code number
- *3D Bite mark analysis.*
  3D scans of dental casts are used to generate overlays using various pressure and deviation (Fig. 46.4).
  The overlays are compared with the photograph of the bite marks.

There has been a rapid acceptance and use of computers for management of all front office and many clinical procedures. Their use has presented new tools for solving difficult forensic problems and has created new concerns regarding their application in general dentistry.

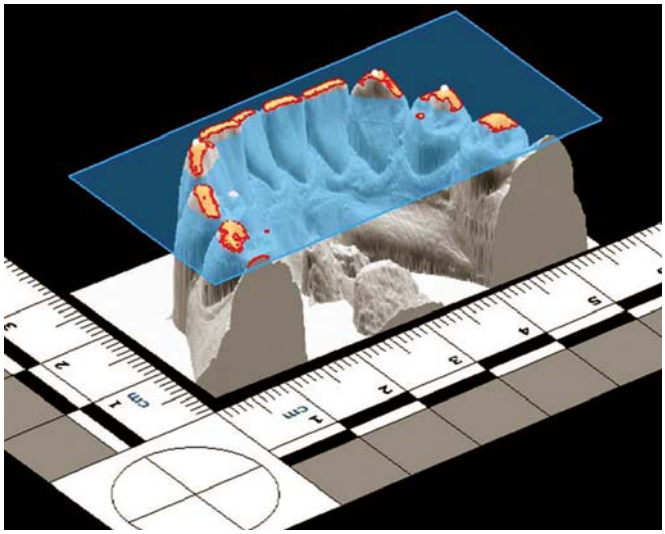


Fig. 46.4: 3D scans of dental casts are used to generate overlays

47 Computers in Dentistry

CM Marya

We are living in a jet age where value of time cannot be under estimated. Sophisticated new technologies are continually being introduced to dentistry because of the rapid scientific progress occurring today.

The development of the modern day computer was the result of advances in technologies and man's need to quantify. Papyrus helped early man to record language and numbers. The abacus was one of the first counting machines.Some of the earlier mechanical counting machines lacked the technology to make the design work.

Webster's dictionary defines "computer" as any programable electronic device that can store, retrieve, and process data.

A computer has certain unique features namely speed, memory, integrity, accuracy, reliability and versatility.

It comprises of two basic components: The hardware component and the software component.

The hardware component includes all the mechanical devices in the system, the electronic components that perform the physical functions. The software is an organized set of ready-made instructions which make the computer work.

A computer consists of a central processing unit (CPU), input device, output device and storage device.

PARTS OF COMPUTER

Computers are made up of many parts. These different parts perform one or more functions including output, input, processing, or storage.

Output Devices

Output devices send information from computer to the user. This information is usually in the form of sound and sight. Some common output devices are monitors, printers, and speakers (Fig. 47.1).

Input Devices

Input devices are the parts that let the user enter and manipulate information on a computer. These devices range from the standard keyboard and mouse, to scanners, microphones, joysticks, and light pens (Fig. 47.2).

There are some devices that can input and output. Some examples would be touch screen monitors (input by touch, output by sight) and force feedback joysticks.

On the Inside

The inside of the computer has many parts that all work together. These parts are generally found within the computer case.

Motherboard

The motherboard is the backbone of the computer (Fig. 47.3). It is the main circuit board of the computer. It holds the CPU, RAM modules and most of the circuitry. All adapter cards plug into the motherboard. The motherboard defines how much RAM, adapter cards, and the type of CPU the computer is going to have. The motherboard is home for the processor chip, PCI slots, and memory.

Processor (CPU)

The CPU, or the central processing unit, is the brain of the computer and the most important chip in the computer. This is the chip that does the "thinking" of the computer. When a program is run on the computer, the CPU performs the calculations and carries out the commands (Fig. 47.4).

These are the "pentium" and "AMD" chips. Processor speed is measured in Megahertz (Mhz) and Gigahertz (Ghz)[1 Ghz = 1000 Mhz].

Dual core processors combine two or more processors into a single package.

Memory (RAM)

This is where information is temporarily stored for the processor to use and manipulate before storing on the hard drive. The memory holds "short-term" information for the processor to use. Also known as RAM (random access memory).

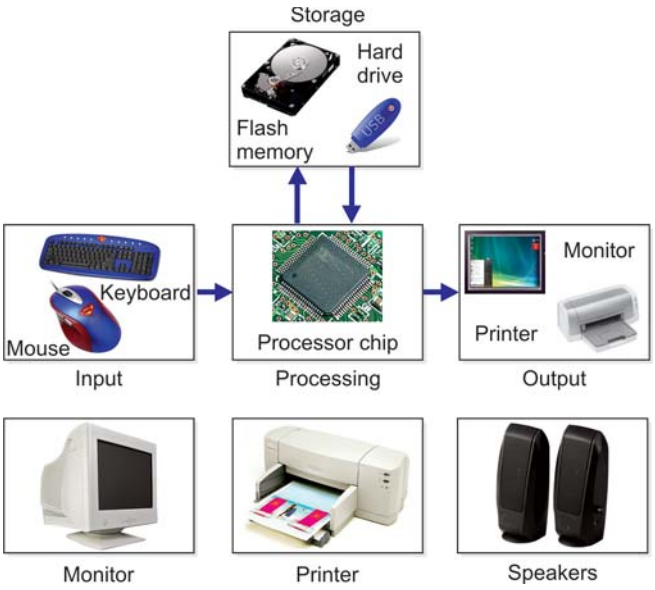


Fig. 47.1: Output devices



Fig. 47.2: Example of input devices

Information is stored in memory only when the computer is turned on. Ram is measured in Megabytes (Mb), which is storage capacity, not to be confused with Megahertz, which is speed (Fig. 47.5).

PCI

It is called as peripheral component interconnect. These are outlets in the motherboard that allow you to install extra components like sound cards, modems, video cards, and other devices. The Figure 47.6 shows different PCI card components.

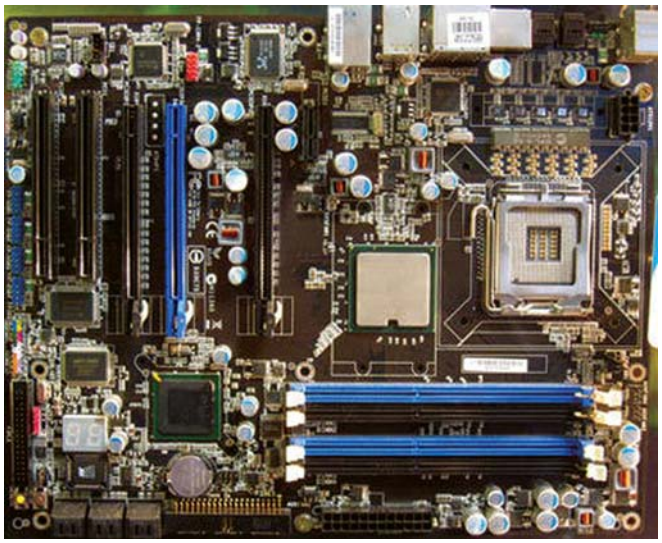


Fig. 47.3: Motherboard

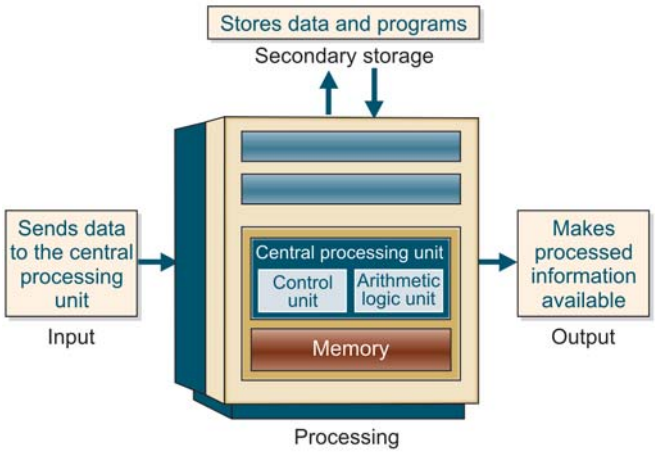


Fig. 47.4: Working of the central processing unit



Fig. 47.5: Memory card

Hard Drives

The hard drive is where all the information and programs on the computer is stored for later retrieval. The faster the rpm (revolutions per minute) of the platters (spinning disks in the hard drive that store data magnetically) in the hard drive, the faster it can read and retrieve data. The main concern about hard drive is the amount of space. All the information

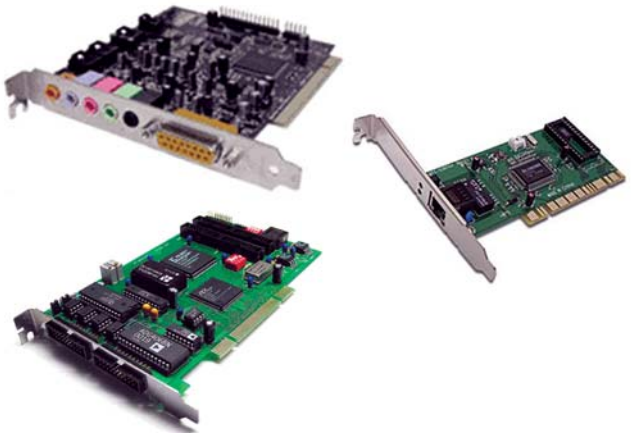


Fig. 47.6: Various peripheral component interconnect

accessed on the computer, all the documents, pictures, email messages, and programs are here. Unlike memory, the hard drive stores information even after the power is turned off. The image shows the inside of a hard drive (Fig. 47.7).

Floppy Drive

This is the slot in the front of computer where a disk is inserted to store data and move it to another computer (Fig. 47.8). Floppy disks are 3¼ inches in size, and hold 1.44Mb of data (Fig. 47.9).

DVD/CD Drive

CD and DVD drives allow the computer to read and burn CDs and DVDs. DVDs can hold a lot more data than CDs. Different kinds of CDs and DVDs can be rewritten, or played on a DVD player (Fig. 47.10).

Latest developments, in both hard and softwares, made it possible for computers to be utilized more in providing detailed information for each patient including extensive data that assist in health care planning, diagnostic information and decision-making. Computerized dental devices were also introduced for patient care. Dentists should attempt to take a step forward and try to adopt these new computer techniques and educate themselves to harness its advantages in their dental practice.

APPLICATIONS OF COMPUTERS IN DENTISTRY

Patient Record Management

The utilization of computer management system programs in dental practice promises to make life easier for the dentist. Even though computers are actually used in many dental offices; they are mostly used for word processing or preparing financial statements. There are clinical dental computer systems in use but still limited. To cater to the need of



Fig. 47.7: Hard drive



Fig. 47.8: Floppy drive



Fig. 47.9: Floppy disks



Fig. 47.10: A DVD drive

professional practice management, some of the dental administrative softwares are available. They can be used to maintain the record of the patients, their treatment needs, treatment provided and follow-up schedule (Fig. 47.11).

Also, the details regarding billing, payment made (Fig. 47.12), etc. can also be kept. It saves not only the time and paper but also the manpower. It increases the productivity of the dentist over a period of time, thus providing valuable information analyzing the practice.

Computers as Diagnostic AID

Dental Imaging

Computer-aided image interpretations is used to convert a radiographic image into a figure that can be stored in the computer wherein a sensor is used to replace the film in the mouth. One of the biggest advantages of digital imaging is the ability of the operator to postprocess the image. Postprocessing of the image allows the operator to manipulate the pixel shades to correct image density and contrast, as well as perform other processing functions that could result in improved diagnosis and fewer repeated examinations.

Even though a conventional film radiograph provides an esthetic image, a digital image is a dynamic one in which contrast and blur can be altered during interpretation for specific diagnostic purposes (Fig. 47.13). Accordingly, it is possible to detect small changes in the periapical or alveolar bone lesions and accurately estimate the depth of caries lesion. A digital radiography system considerably reduces the radiation dose given to the patient due to increased sensitivity of the sensors compared to X- ray films. Likewise, it eliminates the use of chemicals during film processing and saves time since the image is displayed immediately on a monitor. A computer color-matching system may also be used in color reproduction of porcelain restorations.

Digital imaging allows the electronic transmission of images to third-party providers, referring dentists, consultants, and insurance carriers via modem.

Current developments in esthetic dentistry have significantly improved clinician's ability in providing better esthetic service to the patients.

CAD/CAM

The CAD/CAM systems have been used mostly for the manufacturing of prosthetic fixed restorations, such as inlays, onlays, veneers and crowns (Fig. 47.14). A computer-aided image analysis system for crown root ratio measurement is utilized in bridge designs and abutment selection. Computer-assisted occlusal diagnosis using a T-Scan system may help and improve the practice of prosthodontics.

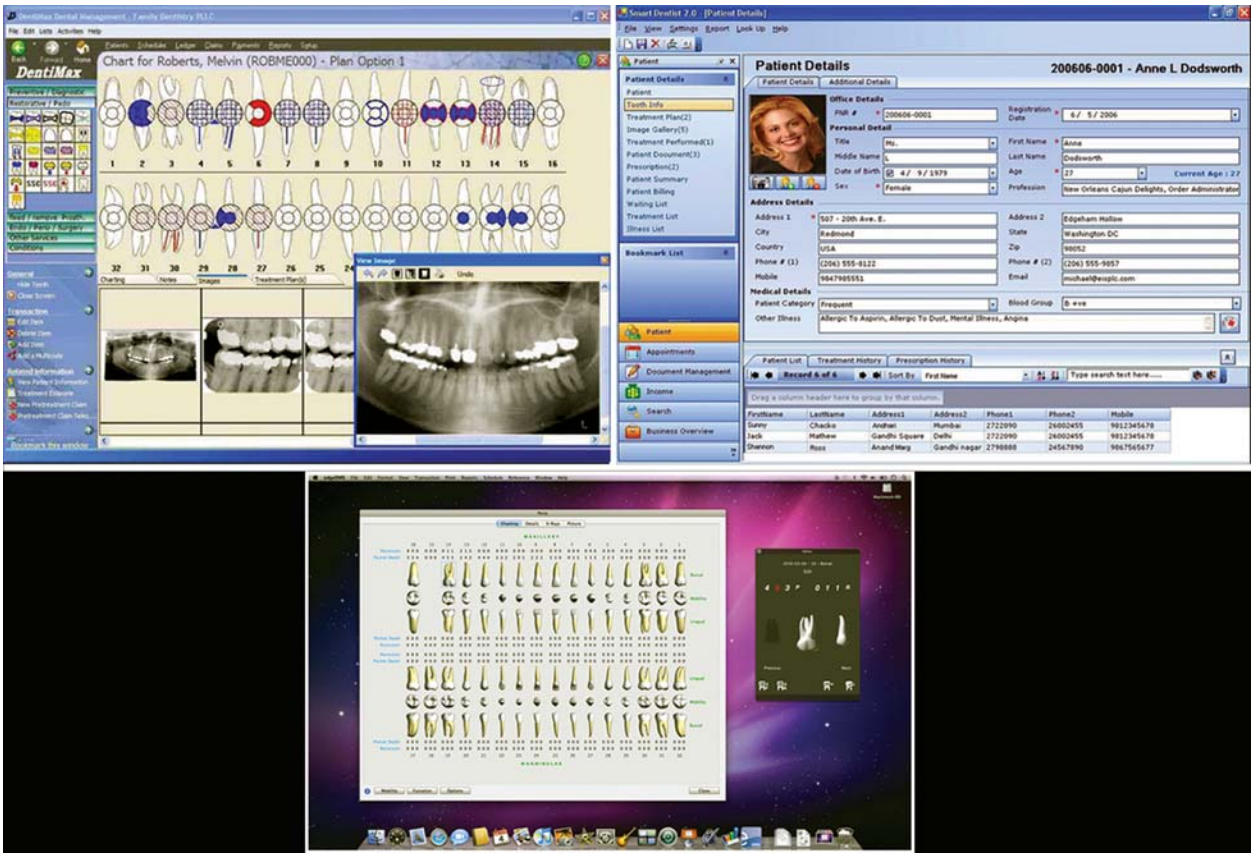


Fig. 47.11: Softwares for patient record management

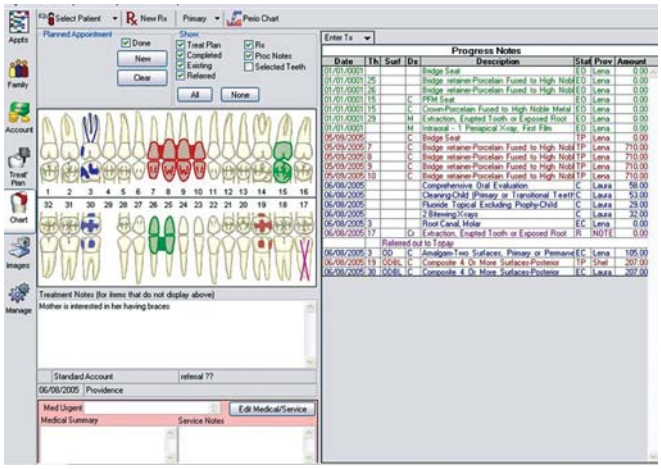


Fig. 47.12: Example of patient billing software

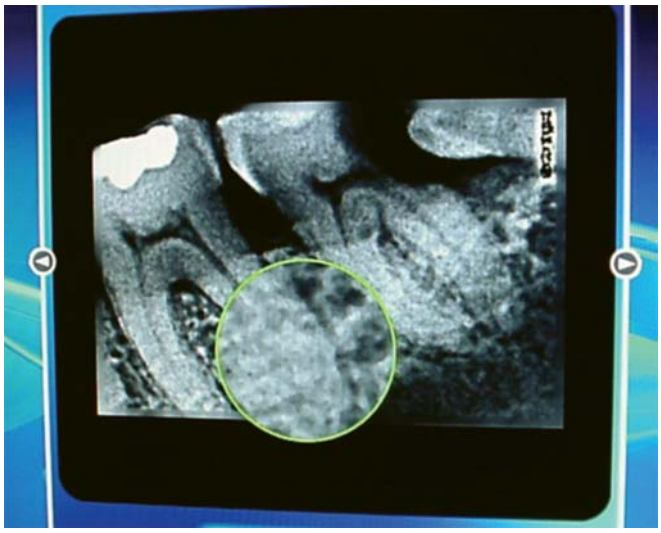


Fig. 47.13: A computer generated image



Fig. 47.14: CAD-CAM designing of prosthesis

Nowadays, there is a greater interest in the CAD/CAM systems for implant supported prosthesis, as they have been used for the manufacture of implant abutments and diagnostic templates in implant dentistry.

Dental CAD/CAM is the application of computer-assisted design and manufacture to dentistry. To this has been added a first step of capturing information, analogous to making an impression. CAD/CAM systems are technically complex instruments whose operation involves three distinct steps: Gathering information, designing the restoration and fabricating the restoration.

Computers in Orthodontics

Computer uses in orthodontics are not entirely new. Firstly, orthodontic practice management refers to applications that are used for the operation and the management of dental clinics. These applications include appointment arrangement, patient charting or examination form handling, electronic patient recording and the use of electronic patient's identification cards.

Secondly, digital recording applications refer to both computer hardware and software for recording and visualizing patient information in an electronic form. The information can be recorded using different devices such as digital camera, 3-dimension measurement device, intraoral scanner or intraoral video camera, digitizer and computerized tomography (CT) scanner. The applications in this group pave a way for computerized techniques to further analyze dental data for better diagnosis and treatment planning.

Thirdly, diagnosis and treatment planning applications can be separated into two groups, those for cephalometic analysis (Fig. 47.15) and those for dental model analysis (Fig. 47.16). The techniques that are applied to these applications range from expert systems, pattern recognition, image processing both in 2-dimension and 3-dimension, and surgical simulation.

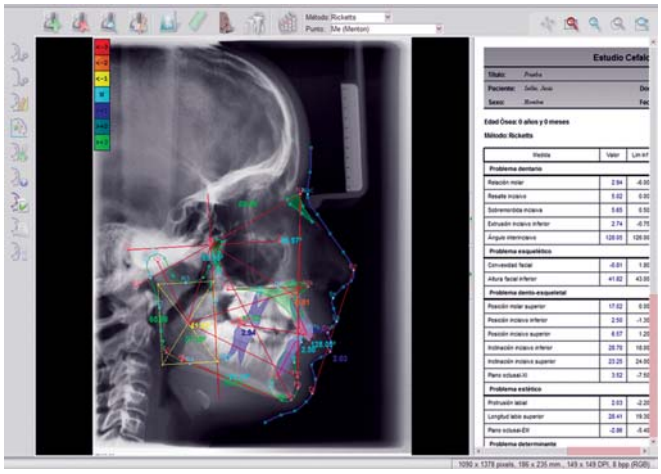


Fig. 47.15: Computerized cephalometric analysis

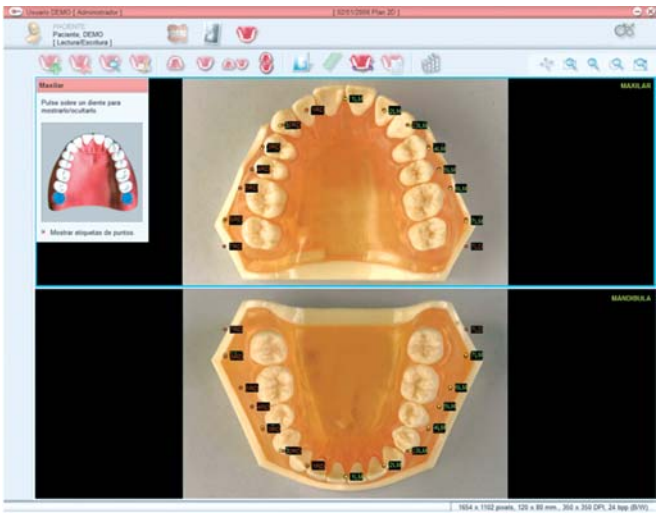


Fig. 47.16: 2-D model analysis



Fig. 47.17: PC-based automated periodontal probe

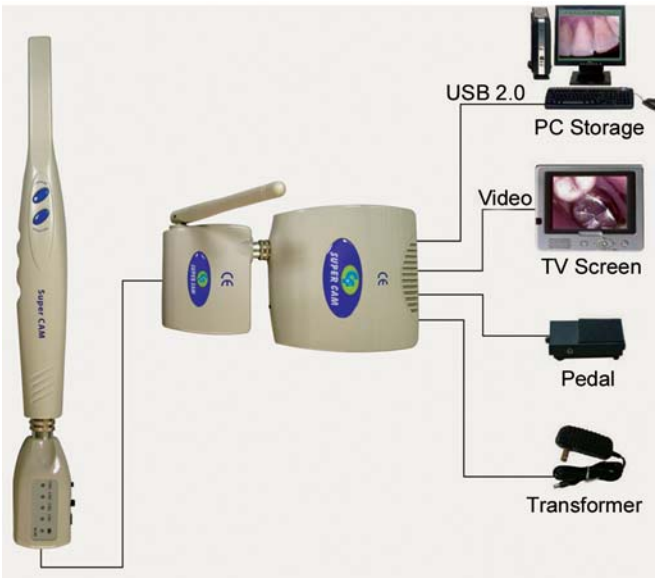


Fig. 47.18: Intraoral camera

Finally, the applications for orthodontic treatment and progress review are those for measurements of variables that are involved in the treatment and those for tracking the movement of teeth as outcomes of the treatment. Similar to diagnosis and treatment planning application, the work in this group generally applies image processing techniques, such as three-dimensional imaging and modeling, to visualize dental information.

Computerized Periodontal Probe

The system consists of a probe handpiece, a digital readout, foot switch, computer interface and computer (Fig. 47.17). The actual measurement of pocket depth (or attachment level) is made electronically and transferred automatically to the computer when the foot switch is pressed.

INTRAORAL CAMERA

It can be used effectively and routinely, but only in a structured protocol for the camera's use is put in place. Intraoral cameras can be quite beneficial in three key areas: Educating new patients about treatment, reactivating the cases of former or long absent patients and performing routine continuing care. The intraoral camera enables the dentist to see detail inside the mouth that is not visible otherwise and provides a powerful medium to visually demonstrate to a patient their dental health.

An intraoral camera captures an image through a tiny microchip-sized camera (called as charged couple device or CCD) and image is sent through image processing electronics to produce full motion video image on a monitor.

Five key components of an intraoral camera comprise of a light source, optics, camera and processing electronics, handpiece and a monitor (Fig. 47.18).

Biostatistical Data Analysis

Researchers are usually concerned with huge storage of data, their faster retrieval when required and processing of data with the aid of various techniques. In all these operations, computer is a great help. It has added to the quality of research activity, providing analysis with greater ease and speed. The results are also reliable. The diagrammatic representation of data is also developed by computer. So, computer education should be given to all researchers so that they can use it for their research work.

Patient Education

It can be used to educate patients about diseases, prevention and cure (Fig. 47.19) by using the latest multimedia technology.

APPLICATIONS OF COMPUTERS IN DENTISTRY

- Patient record management
- Computers as diagnostic aid
- CAD/CAM
- Computers in orthodontics
- Computerized periodontal probe
- Intraoral camera
- Biostatistical data analysis
- Patient education
- Telecommunication
- Dental education

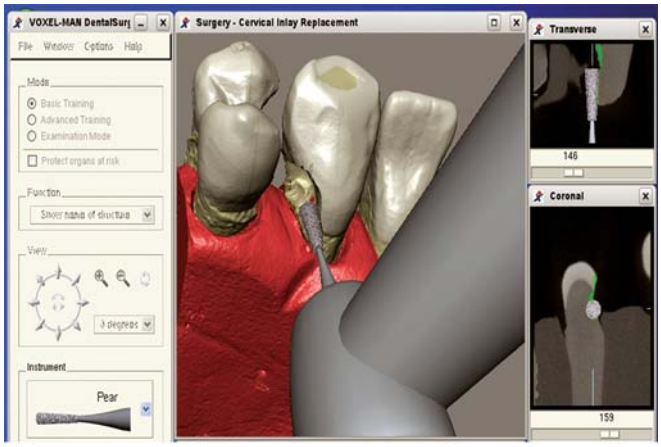
Telecommunication

The Internet is 'global network of networks', as it links computer networks all over the world. Today the Internet is





Fig. 47.19: Patient education software



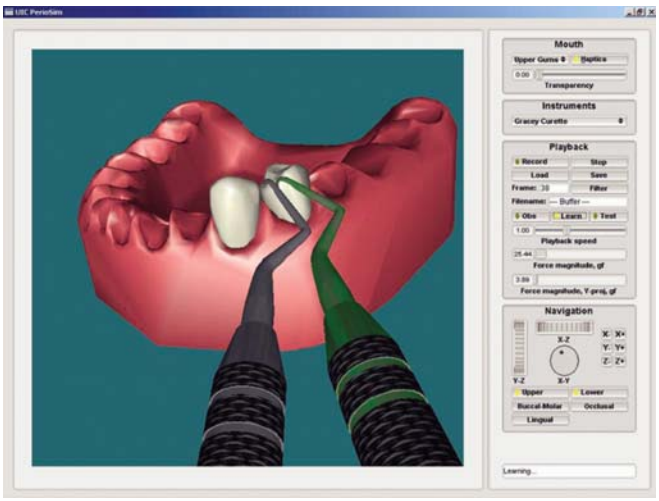


Fig. 47.20: Clinical dental education by virtual reality simulation with help of computers

used for commerce, education, research, entertainment. Many electronic journals, electronic books, teaching databases are available on the Internet nowadays.

The various tools used over Internet include electronic mail, newsgroups, FTP sites, world wide web, etc.

Dental Education

The advent of electronic support for dental education offers many possible improvements in the manner in which information is conveyed to students. Although dental schools are only beginning to implement these concepts and devices, there is indication that they will become increasingly common. Concepts can be more lucidly conveyed when images and mulitmedia are used effectively. Distances can be transcended, and information gathered from and conveyed to others without regard to physical limitations.

Computer-aided learning (CAL) material and clinical work is an efficient and convenient educational tool for educating under/postgraduate dental students (Fig. 47.20). There is a great potential for computer-based continuing professional education for dental practitioners, and the Internet provides access to such material. Greater computer literacy may result in a future where there is a shift away from traditional centers of learning to computer conferencing and distance learning.

48 Ergonomics in Dentistry

CM Marya

Ergonomics is the study of human performance and work-place design in order to maximize health, comfort and efficiency.

OSHA refers to the word "ergonomic" as the relationship of the human/environmental interface that does not produce injury.

Ignoring ergonomics principles can lead to Repetitive Strain Injury (RSI).

There are several names which are commonly used for Repetitive Strain Injury (RSI): Cumulative Trauma Disorder (CTD), and Work Related Musculoskeletal Disorder (WMSD).

MSDs (Musculoskeletal Disorder) include a group of conditions that involve nerves, tendons, muscles, and supporting structures such as intervertebral discs.

RSI is defined as cumulative trauma disorders resulting from prolonged repetitive, forceful, or awkward movements. These movements result in damage to the muscles, tendons or nerves.

Definition of Ergonomics: An applied science that coordinates the design of devices, systems and physical working conditions with the capacities and requirements of the worker. Also known as human engineering that is based on *proprioceptive derivation*.

The most significant risk factors for dentists were static loading of the neck and static loading and awkward positions of the hands. The greatest risk factors for dental assistants were twisting and turning of the back, extended reaches of the arms to access instruments, prolonged static postures, forceful exertions using dental instruments, and carving fillings.

For dentists, there was a statistically significant incidence of neck MSDs related to an increased frequency of indirect viewing of the patient's mouth and to poor to fair dental chair comfort. Increased reporting of hand work-related MSDs by dentists was related to extracting 10 or more teeth per week and to rating the lighting as fair or poor. The risk of back work-related MSDs for dentists was statistically related to fair or poor dental chair comfort and to sitting in the 9 or 10 o'clock position as opposed to the 11 or 12 o'clock position relative to the patient. Shoulder work-related MSDs for dentists were related to not always having a direct view of the patient's mouth and to the time spent working at the same location, based on spending greater than 5 years at the same location.

SIGNS AND SYMPTOMS OF MSDs

- Loss of coordination
- Decreased grip strength and cramping of hands
- Decreased range of working motion
- Excessive fatigue in the shoulders and neck
- Tingling, burning, or other pain in arms
- Numbness in fingers and hands

RISK FACTORS FOR MSDs

- Repetition of performed task
- Lack of rest/recovery between patients
- Awkward postures during work
- Contact stress
- Vibrations from instruments
- Poor workstation design and poor tools
- Improper work habits
- High forces needed to perform a task
- Poor fitness level
- Forceful exertions
- Poor nutrition
- Poor lighting

NECK AND SHOULDER

Dental personnel are required to adopt non-neutral postures for many of the clinical tasks they perform. Dentists, for example, most commonly use a combination of a flexed and right-side flexion position of the neck with a head-down position, often combined with shoulder abduction or flexion. Dental personnel assume these positions for the following reasons:

- To coordinate the relative positions between dentist and assistant,
- To obtain optimal view of teeth within the patient's mouth,
- To provide a comfortable position for the patient, and
- To maneuver complex equipment and reach for instruments.

Also contributing to the operator's physical fatigue are strained posture caused by the tilting of patients, use of non-ergonomic instruments, the failure to use the dental mirror, and inadequate lighting.

Much dental work requires high precision, and the muscles used in sustaining such activity are at risk of becoming fatigued and causing discomfort. Stability maintained through static muscle loading in the shoulder for prolonged periods could lead to fatigue and discomfort.

WRIST AND HAND

Dental work has also been associated with hand and wrist problems.

LOWER BACK PAIN

Static work in the sitting posture requiring spinal flexion and rotation has been associated with increased risk of lower back pain. Sitting increases loads on soft tissue structures of the lumbar spine and disks.

PSYCHOSOCIAL FACTORS AND WORK-RELATED MSDs IN DENTISTRY

Identified stressors include the psychological demands of doing meticulous surgery with little or no rest or diversion and time pressures.

Ergonomic conditions are simply the safest, most efficient, and easiest way to work. Improving the ergonomic delivery of dental services and accounting for working conditions in dental offices enhance the well-being and safety of patients, staff, and doctors.

According to OSHA, ergonomic conditions are desirable because they prevent repetitive MSD injuries and reduce errors that lead to accidental injuries to employees.

Operating height is the most important condition for maintaining the unstrained posture of the dental operator. An ergonomic dental treatment setting should allow the free orbiting range of the operator at an operating height determined by the provider. The patient lies in a full rest (supine) position because this has provided the dentist with the best position for applying vector forces to the teeth and the best access to the mouth, according to proprioceptive derivation.

The "ergonomic hazards" of common dental care settings are primarily due to:

1. The patient support and headrest design interfering with preferred operator positions.
2. The delivery system requiring the positioning of objects, including tilting of the patient back support.
3. Instrument designs that are inappropriate for enhanced performance skills.
4. Repetitive movement.

TYPES OF MSDs

- Neck and Shoulder Disorders
  - Myofascial Pain Disorder
  - Cervical Spondylolysis
  - Thoracic Outlet Syndrome
  - Rotator Cuff Tendinitis/Tears
- Back Disorders
  - Herniated Spinal Disk
  - Lower Back Pain
  - Sciatica
- Hand and Wrist Disorders
  - DeQuervain's Disease
  - Trigger Finger
  - Carpal Tunnel Syndrome
  - Guyon's Syndrome
  - Cubital Tunnel Syndrome
  - Hand-Arm Vibration Syndrome
- Raynaud's Phenomenon

PREVENTION OF ERGONOMIC INJURIES

- Identify risk factors
- Educate Dental Health Care Provider (DHCP) about ergonomic hazards and preventing MSDs
- Identify symptoms as soon as they become apparent
- Intervene quickly
- Change human behavior
- Consider ergonomic features for dental equipment (e.g. patient chairs, operator stools, hand/foot controls, instruments) when purchasing new equipment
- Modify working conditions to achieve optimal body posture
- Achieve optimum access, visibility, comfort, and control at all times

PREVENTION STRATEGIES WORKPLACE INTERVENTION

Minimize Extreme Joint Position

Keep wrist in neutral (i.e. straight) position. In addition, using a third-digit rest is more ergonomic than using a fourth-digit rest because it does not engage the wrist as much while guiding and positioning the handpiece.

Keeping the wrist straight and relaxed improves control. When the wrist is flexed backward or forward to position an instrument, tension increases in the tendons controlling the fingers, resulting in fatigue, which in turn decreases control and sensation.

Keep joints held at midpoint of range of motion.

PROVIDE SUFFICIENT SPACE

Awkward bending, twisting, and reaching places stress on the musculoskeletal system and can lead to discomfort

Permanently place equipment used in every clinical procedure within comfortable reach (within 20 inches of the front of the body).

Use mobile carts for less commonly used equipment

There should be a clear line of sight to the oral cavity and all required equipment.

ACCOMMODATE INDIVIDUAL PREFERENCES

Individuals working in the clinic vary in size, shape, training, and experience.

Ensure equipment and work areas, allow maximum flexibility to the individuals; examples may include:

- Allows right- or left-handed use
- Allows different working postures
- Provides a choice in methods used.

REDUCE PHYSICAL EFFORT

Avoid bent or unnatural postures.

Ideally, equipment should allow work in a relaxed and well-balanced position.

Dental Health Care Provider (DHCP) should adjust equipment to the appropriate height.

Positioning of the patient should be such as to allow easy access from the desired position.

Reduce the use of excess force.

Minimize highly repetitive movement.

Minimize sustained effort. Brief but frequent rest pauses can minimize fatigue and enhance productivity

Incorporation of a variety of different activities helps to shift musculoskeletal demands from one part of the body to another.

Maintain a neutral, balanced position—*position of an appendage when it is neither moved away from nor directed toward the body's midline; it also should not be laterally turned or twisted.*

Neutral postion includes:

Shoulders: Both shoulders level and held in their lowest, most relaxed position.

Shoulder injuries commonly experienced by dental hygienists, such as upper trapezius and levator scapulae myalgia, thoracic outlet syndrome, and supraspinatus tendinitis, are often related to muscle imbalance. If the patient's chair is too high, this causes the dentist to elevate the shoulders (Fig. 48.1) and can lead to neck problems and pinched nerves. Alternately, if the dentist chair is too high and the patient's chair is too low, the dentist will have to flex the neck down and bend the wrists back to compensate, which can lead to neck and hand problems (incorrect posture).

Arm: Forearms held in the same plane as the wrist and hand.

Elbow: Elbow held close to the operator's body at a 90° angle.

Wrist: It should be held straight and never be bent.

INSTRUMENT DESIGN

Goal: reduce force exertion; maintain hand/wrist in neutral position (no wrist bend)

The following factors should be considered:

- Overall shape/size
- Handle shape/size
- Weight
- Balance
- Maneuverability
- Ease of operation
- Ease of maintenance

HAND INSTRUMENTS

When selecting instruments, one should prefer instruments with

- Hollow or resin handles
- Round, textured/grooves, or compressible handles
- Carbon-steel construction
- Color-coding may make instrument identification easier

DENTAL HANDPIECES

- When selecting handpieces, look for
  - Lightweight, balanced models
  - Sufficient power



Fig. 48.1: Incorrect sitting posture

- Built-in light sources
- Angled vs. straight-shank
- Pliable, lightweight hoses (extra length adds weight)
- Swivel mechanisms
- Easy activation
- Easy maintenance

A smooth surface, a 15° angle of the shaft to the working end, and a distance of approximately 26 mm from the working end to the angle facilitate transitions between finger contacts on dental handpieces. This allows for a stable unstrained wrist and upper arm during procedures that require finite control.

LIGHTING

Goal: produce even, shadow-free, color-corrected illumination concentrated on operating field.

The Overhead light switch should be readily accessible.

Hand mirrors can be used to provide light intraorally.

Use of Fiberoptics for handpieces add concentrated lighting to the operating field.

MAGNIFICATION

There are two methods to increase visibility; to move closer to the object or to magnify it. Avoiding magnification leads to bending forward to move closer to see well Magnification helps to improve neck posture as it provides clearer vision. The *eye loupes* are used for magnification. Two types of magnification systems are available for dentistry: (i) single lens and (ii) multilens also called as telescopic loupes.

OPERATOR CHAIR

It should be such as to promote mobility and patient access; accommodate different body sizes.

It should be stable with a broad heavy base, provide lumbar support, preferably have hands free seat height adjustment and be fully adjustable. It should be readily mobile.

It should be so positioned properly (Tripod position: feet should be flat on ground and be shoulder width apart).

To determine the correct height of the operator chair first head of the fibula on the side of the leg should be located by placing a hand on the side of the knees. The head of the fibula is at the joint line between the head of the fibula and the lateral femoral condyle. The top of the seat should be in the level with the top of the head of the fibula. Thighs preferably should be slightly downward inclined or parallel with the floor.

PATIENT CHAIR

It should promote patient comfort; maximize patient access. It should be stable with fully adjustable head rest and have a hands free operation. It should support the patient's head, torso and feet.

POSTURE/POSITIONING

Operator

The operator and the staff should avoid static and/or awkward positions.

The patient should be positioned so that operator's elbows are elevated no more than 30 degrees (Fig. 48.2). One should adjust patient chair when accessing different quadrants.

At the correct height of operator chair the operator should be able to sit tall in the chair with legs separated, feet flat on the floor and the thighs parallel of preferably downward inclined or parallel to the floor as shown in Figure 48.3.

The operator's eye should be approximately 14 to 16 inches from the patient's oral cavity. The shoulders should be relaxed and not elevated. For this position of the shoulders, the elbows should be approximately even with the occlusal plane of the patient and held close to the body (Fig. 48.4).

One should maintain neutral posture; reduce force requirements by:

Ensuring that instruments are sharpened, well-maintained.

Use of automatic handpieces instead of manual instruments wherever possible.

Use full-arm strokes rather than wrist strokes.

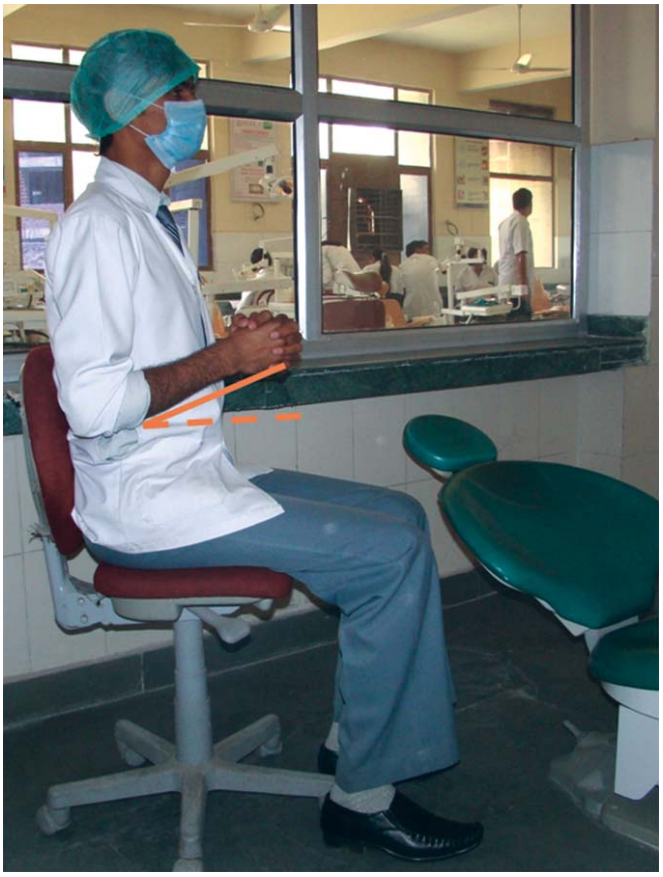


Fig. 48.2: Correct sitting posture (side view) with operator's elbows elevated no more than 30 degrees

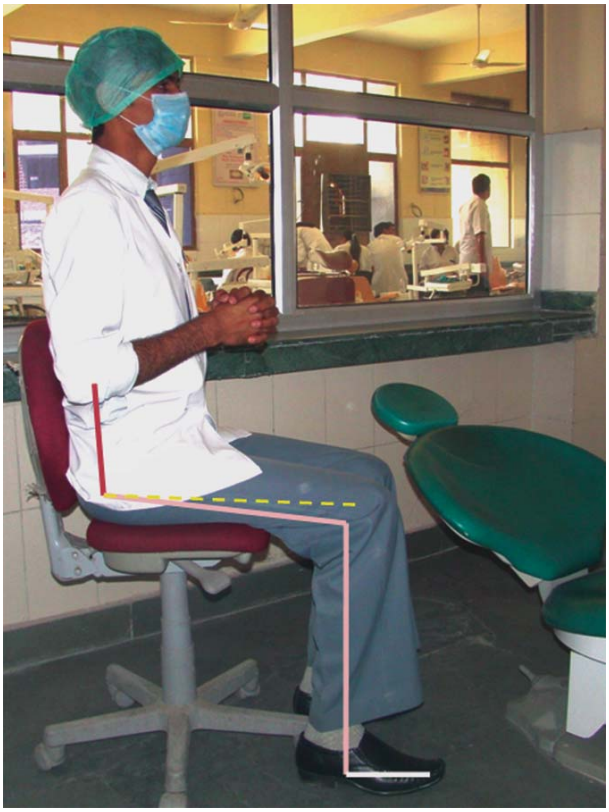


Fig. 48.3: Correct posture, the operator is seated in a comfortable, upright position, feet flat on the floor and the thighs preferably downward inclined or parallel to the floor



Fig. 48.4: Correct sitting posture

Patients

In the traditional working position the patient is placed in supine position with back of the dental chair almost parallel to the floor. To check the proper height of the patient chair the operator should fold the arms across the waist. The tip of the patient's nose should be lower than the elbow level position of the folded arms.

SCHEDULING

Scheduling should be such so as to provide sufficient recovery time to avoid muscular fatigue.

PERSONAL PROTECTIVE EQUIPMENT

Glasses

They should be light weight, clean, well-fitted

Use of magnifying lenses and head lamps should be encouraged.

Clothing

Should fit loosely, be light weight and pliable

Gloves

Be of proper size, light weight, and pliable

Should fit hands and fingers snugly

Should not fit tightly across wrist/forearm

Ambidextrous (i.e., non-hand specific) gloves exert more force than fitted gloves across palmar region of hand and may exacerbate symptoms of carpal tunnel syndrome.

ERGONOMICS CHECKLIST FOR DENTAL HEALTH CARE PROVIDERS

1. Equipments
   a. Properly designed dentist stool which promotes mobility and patient access.
   b. Properly designed dental chair.
   c. Even, shadow-free, color-corrected illumination on operating field.
   d. Magnification helps to improve neck posture as it provides clearer vision.
2. Positioning
   a. Proper dentist/ DHCP position.
   b. Proper patient position
   c. Maintain neutral wrist, elbow and shoulder position
   d. Proper wrist motion
3. Instruments
   a. Use instruments which reduce force exertion; maintain hand/ wrist in neutral position.
   b. Limit use of instruments which cause vibrations.
   c. Use of ergonomically designed instruments and handles.
4. Exercise
   a. Muscle strengthening exercise
   b. Chairside stretching exercise
5. Environment
   a. Comfortable temperature
   b. Comfortable noise level.

49 Consumer Protection Act

Avinash J, Swaroop Savanur

INTRODUCTION

Nature follows some set of rules in order to function properly. There is an order even in the chaos. Similarly, for human beings to co-exist, there needs to be order, scaffolding over which human behavior is gauged. Right vs. wrong is a subjective perception. As society has evolved over the years, there has been a consensus as to the righteousness of a particular action. There is an unwritten code of ethics that a human being follows in order to live freely in society. The scaffolding over which these laws are based, can be termed jurisprudence.

As dentists, or rather, as practitioners of treating fellow human beings, it goes without saying, that we too, have a code of ethics that governs the way we function. It is important to have our own set of rules, our domain, beyond which there would be a breach of the ethical code. Thus, we too, have, what is called as Dental Jurisprudence, which can be defined as the application of the principles of law as they relate to the practice of dentistry.

NATURE OF THE LEGAL SYSTEM

Generally, we do have laws like the Civil Penal Code, the Indian Penal Code, Law of Contractors, etc that does cater to liability of a action. However, they have the following disadvantages –

1. High litigation fees
2. Takes up a lot of time
3. Limited access to everyday consumers.

However, to safeguard the rights of the consumers and provide them with an easier way of settling grievances, a landmark Act called as the Consumer Protection Act was passed by the Indian Parliament. The principle of consumer protection is essentially the protection of the interest of consumers, medical or non-medical. But, we would discuss the Act with the limited viewpoint of the patient and the doctor or more specifically, the dentist.

The Consumer Protection Act, 1986 which came into force on 15th April, 1987 is a welfare legislation mainly titling towards the consumer just as the Industrial Disputes Act is loaded in favor of workers. The aims and objects of the Act are, as given in its Preamble, better protection of the interests of the consumer and for settlement of consumer disputes. It provides for speedy and inexpensive settlement of disputes within a limited time frame, as against civil actions which are costly and take years in coming to a settlement. Provisions of the Act are in addition to and not in derogation of any other law for the time being in force and are compensatory in nature.

Recently, the Act has been amended by the Consumer Protection (Amendment) Act, 1993, w.e.f. 18.6.1993. We shall deal selectively with provisions of the Act which are relevant to the Medical Profession, as they exist as on today. The meanings of legal terms are being restricted to such terms only as concern the Medical Profession.

Till 1995, the doctors were not liable to be prosecuted under the Consumer Protection Act. The Indian Medical Association was of the opinion that

The doctor-patient relation would be unduly affected

The doctors would adopt safer practices to prevent any risk of litigation.

They would adopt unnecessary diagnostic means just to rule out any other possibilities and even for simple ailments.

In a landmark judgment, IMA v/s V.P.Shanta and ORS III (1995) CPJ1 (sc) the Hon'ble Supreme held that professionals namely doctors are not immune from a chain or damages on the ground of negligence. Even if the complainant was provided free service, the same does not disentitle him from the benefit bestowed under the Act.

DEFINITIONS

Consumer: Under. The section 2(1) (d) of the Consumer Protection Act 1986 consumer has been defined as any person who –

buys any goods for a consideration which has been paid or promised or partly paid and partly promised or under any system of deferred payment and includes any user of such goods other than the person who buys such goods for consideration paid or partly promised or under any commercial purpose.

[hires or avails of] any services for a consider ablation which has been paid or promised or partly paid and partly promised or under any system of deferred payment and includes any beneficiary of such service other than the person who [hires or avails] the services for considerations paid or promised or partly paid and partly promised or under system of deferred payment when such service are availed of with the approval of the first mentioned person.

Complaint means - Any allegation, in writing made by a complainant that the services hired or availed of or agreed to be hired or availed of by him suffer from deficiency in any respect.

Service means - Service of any description which is made available to potential users and includes the provision of facilities in connection with banking, financing, insurance, transport, processing, supply of electrical or other energy, board of lodging or both, housing construction, entertainment, amusement or the purveying of news or other information but does not include the rendering of any service free of charge or under a contract of personal service.

Deficiency means - Any fault, imperfection, shortcoming or inadequacy in the quality, nature, and manner of the performance which is required to be maintained by or under any law for the time being in force or has been undertaken to be performed by a person in pursuance of a contract or otherwise in relation to any service.

Deficiency in service means any fault, imperfection or shortcoming or inadequacy in the quality, nature and manner of performance which is required to be maintained by or under any law for the time being in force or has been undertaken to be performed by a person in pursuance of a contract or otherwise in relation to any service.

Negligence: Negligence is the breach of a legal duty of care owed by a defendant (doctor) to a plaintiff (patient), which results in damage caused by the defendant to the plaintiff.

Supreme Court Decision on Service as Related to Medical Profession

Service rendered to a patient by a medical practitioner (except) where the doctor rendered service free of charge to every patient or under a contract of personal service), by way consultation, diagnosis and treatment, both medicinal and surgical, would fall within the ambit of 'service'.

The expression 'contract of personal service' cannot be confined to contracts for employment of domestic servants only and the said expression would include the employment of a medical officer for the purpose of rendering medical service to the employer. The service rendered by a medical officer to his employer under the contract of employment would be outside the purview of 'service'.

Service rendered at a Government hospital/health center/ dispensary or at non-government hospital/nursing home where no charge whatsoever is made from any person availing the service and all patients (rich and poor) are given free service- is outside the purview of the expression "service". The payment of a token amount for registration purpose only at the hospital/nursing home would not alter the position.

Service rendered at a non-government hospital/nursing home where charges are required to be paid by the person availing such services falls within the purview of the expression 'service'. Service rendered at Government hospital/Health center/Dispensary or at a non-government nursing home where charges are required to be paid by persons who are in a position to pay and persons who cannot afford to pay are rendered service free of charge would fall within the ambit of the expression 'service' irrespective of the fact that the service is rendered free of charge to persons who are not in a position to pay for such services. Free service, by such doctors and hospitals would also be 'service' and the recipient a 'consumer' under the Act.

Service rendered by a medical or hospital/nursing home cannot be regarded as service rendered free of charge, if the persons availing the service has taken an insurance policy for medical care where under the policy charges for consultation diagnosis and medical treatment are borne by the insurance company and such service would fall within the ambit of 'service' .

Similarly, where as a part of the conditions of service, the employer bears the expenses of medical treatment of an employee and his family member dependent on him, the service rendered to such an employee and his family members by a medical practitioner or a hospital/nursing home would not be free of charge and would constitute 'service'.

CONSUMER DISPUTES REDRESSAL AGENCIES

Redressal Forums have been established at three different levels :-

"District Forum" by State Government. At least one in each district or in certain cases one District Forum may cover 2 or more districts, or there may be two or more district forums in one district.

"State Commission" by State Government.

"National Commission" (National Consumer Disputes Redressal Commission) by Central Government.

District Forum

This shall consist of:

1. A person who is, or has been, or is qualified to be a District Judge, as its President.
2. Two other members shall be persons of ability, integrity and standing and have adequate knowledge or experience or have shown capacity, in dealing with problems relating to economics, law, commerce, accountancy, industry, public affairs or administration, one of whom shall be a woman.

Jurisdiction of the District Forum

The District Forum shall have jurisdiction to entertain complaints where the value of services and compensation claimed does not exceed Rupees Five Lakhs. Manner in which complaint shall be made

A complaint may be filed with a District Forum by -

1. The consumer to whom such service is provided or is agreed to be provided;
2. Any recognized consumer association, whether the consumer to whom the service is provided or is agreed to be provided is a member of such association or not;
3. One or more consumers, where there are numerous consumers having the same interest, with the permission of the district forum, on behalf of or for the benefit of all consumers so interested;
4. The Central or the State Government.

Procedure on Receipt of Complaint

The District Forum shall, on receipt of a complaint -

1. Refer a copy of such complaint to the opposite party directing him to give his version of the case within a period of 30 days or such extended period not exceeding 15 days as may be granted by the District Forum;
2. Where the opposite party, on receipt of a copy of the complaint, denies or disputes the allegations contained in the complaint, or omits or fails to take any action to represent his case within the time given by the District Forum, the District Forum shall proceed to settle the consumer dispute,
   i. On the basis of evidence brought to his notice by the complainant and the opposite party, where the opposite denies or disputes the allegations contained in the complaint.
   ii. On the basis of evidence brought to its notice by the complainant where the opposite party omits or fails to take any action to represent his case within the time given by the Forum;
   iii. Where the complainant or his authorized agent fails to appear before the District Forum on such day, the District Forum may in its discretion either dismiss the complaint in default or if a substantial portion of the evidence of the complainant has already been recorded, decide it on merits. Where the opposite party or its authorized agent fails to appear on the day of hearing, the District Forum may decide the complaint ex-party.
   iv. Where any party to a complaint to whom time has been granted fails to produce his evidence or to cause the attendance of his witnesses or to perform any other act necessary to the further progress of the complaint, for which time has been allowed, the District Forum may notwithstanding such default: -
      a. If the parties are present, proceed to decide the complaint forthwith; or
      b. if the parties or any of them is absent, proceed as mentioned above in (2) (iii);
   v. The District Forum may, on such terms as it may think fit at any stage, adjourn the hearing of the complaint but not more than one adjournment shall ordinarily be given and the complaint should be decided within 90 days from the date of notice received by the opposite party where complaint does not require analysis or testing of the goods and within 150 days if it requires analysis or testing of the goods.

Findings of the District Forum

If, after the proceedings, the District Forum is satisfied that any of the allegations contained in the complaint about the services are proved, it shall issue an order to the opposite party directing him to do one or more of the following things :

1. To return to the complainant the charges paid.
2. Pay such amount as may be awarded by it as compensation to the consumer for any loss or injury suffered by the consumer due to the negligence of the opposite party.
3. To remove the deficiency in the services in question.
4. To provide for adequate costs to parties.

Appeal Against Orders of the District Forum

Any person aggrieved by an order made by the District Forum may appeal against such order to the State Commission within a period of 30 days from the date of the order. The State Commission may entertain an appeal after 30 days if it is satisfied that there was sufficient cause for not filing it within that period.

State Commission

It shall consist of -

1. A person who is or has been a Judge of a High Court, who shall be its President;
2. Two other members (as for District Forum).

Jurisdiction of the State Commission

The State Commission has jurisdiction to entertain -

1. Complaints where the value of services and compensation claimed exceeds rupees 5 lakhs but does not exceed rupees 20 lakhs;
2. Appeals against the orders of any District Forum within the state;
3. Revision petitions against the District Forum.

Procedure to be Followed by State Commission

Same as for District Forum.

Procedure for Hearing Appeals

The State Commission may, on such terms as it may think fit and at any stage, adjourn the hearing of appeal, but not more than one adjournment shall ordinarily be given and the appeal should be decided within 90 days from the first date of hearing.

Appeals Against Orders of State Commission

Any person aggrieved by an order made by the State Commission may appeal against such order to the National Commission within a period of 30 days. The National Commission may entertain an appeal after 30 days if it is satisfied that there was sufficient cause for not filing it within that period

National Commission

This shall consist of -

1. A person who is or has been a Judge of the Supreme Court, who shall be its President. (No appointment under this clause shall be made except after consultation with the Chief Justice of India) .
2. Four other members (qualifications: As for District Forum/ State Commission).

Jurisdiction of the National Commission

The National Commission shall have jurisdiction—

a. To entertain
   i. Complaints where the value of services and compensation claimed exceeds Rs. 20 lakhs; and
   ii. Appeals against the orders of any State Commission.
b. To entertain revision petition against the State Commission.

Procedure to be Followed by the National Commission

A complaint containing the following particulars shall be presented by the complainant in person or by his agent to the National Commission or be sent by registered post, addressed to the National Commission: -

1. The name, description and the address of the complainant;
2. The name, description and address of the opposite party or parties, as the case may be, so far as they can be ascertained;
3. The facts relating to the complaint and when and where it arose
4. Documents in support of the allegations contained in the complaint
5. The relief, for which the complainant claims.

The remaining procedure and the procedure for hearing the appeal is similar to that for State Commission.

Appeal Against Orders of the National Commission

Any person, aggrieved by an order made by the National Commission, may appeal against such order to the Supreme Court within a period of 30 days from the date of the order. The Supreme Court may entertain an appeal after 30 days if it is satisfied that there was sufficient cause for not filing it within that period.

Limitation Period

The District Forum, the State Commission or the National Commission shall not admit a complaint unless it is filed within two years from the date on which the cause of action has arisen. In case, there are sufficient grounds for not filing the complaint within such period, extension may be granted.

Dismissal of Frivolous or Vexatious Complaints

Where a complaint instituted before the District Forum, the State Commission or the National Commission, as the case may be, is found to be frivolous or vexatious, it shall, for reasons to be recorded in writing, dismiss the complaint and make an order that the complainant shall pay to the opposite party such cost, not exceeding 10,000 rupees, as may be specified in the order.

Penalties

Where a person against whom a complaint is made or the complainant fails or omits to comply with any order made by the District Forum, the State Commission or the National Commission, as the case may be, such person or complainant shall be punishable with imprisonment for a term which shall not be less than one month but which may extend to three years, or with fine which shall not be less than 2,000 rupees but which may extend to 10,000 rupees or with both. In exceptional circumstances the penalties may be reduced further.

PREVENTIVE STEPS AGAINST LITIGATION

In the recent years more frequently patients have been suing and prosecuting doctors in Civil and Criminal Courts. The medical professionals have been exercising due caution while dealing with patients. With the coming into existence of compensation oriented Consumer Forums, the medical profession has been suddenly made to sit-up. What the doctors did till recent years in mutual trust could land them into trouble, if they do not exercise extra precautions.

Where the doctor feels that the patient is suffering from some major illness in which complications are pre-existing or are likely to occur, he should take proper precautions. The precautions desired to be taken may be summarized as " Do's and Dont's" which are as follows:-

Some Do's

1. Qualifications to be mentioned on the prescription. Qualifications mean recognized degrees/diplomas as regulated by the Indian Medical Degrees Act, 1916 as amended from time to time.
2. Avoid mentioning of scholarships/training/membership/ awards which are not qualifications.
3. Always mention date and timing of the consultation.
4. Mention age, sex, weight (if child).
5. Mention the condition of patient in specific/objective terms. Avoid vague/nonspecific terminology
6. If the patient/attendants are erring on any count (history not reliable, refusing investigations, refusing admission) make a note of it or seek written refusal preferably in local language with proper witness.
7. In complicated cases, record precisely history of illness and substantial physical findings about the patient on your prescription.
8. Record history of drug allergy.
9. Mention additional precautions, e.g. food, rest, avoidance of certain drugs, allergens, alcohol, smoking, etc. if indicated.
10. Mention whether prognosis is explained. If necessary take a signature of the patient/attendant, after explaining the prognosis in written local language.
11. In case of any deviation from standard care, mention reasons.
12. Mention if patient/attendant are/is under effect of alcohol/ drugs.
13. Mention where the patient should contact in case of your nonavailability/emergency.
14. Routinely advise X-rays in injury to bones/joints.

Some Dont's

1. Do not hesitate to discuss the case with your colleagues.
2. Do not hesitate to discuss the case with patients/ attendants.
3. Do not write Ayurvedic formulations.
4. Do not allow substitutions.
5. Do not examine the patient if you are sick, exhausted or under the effect of alcohol.
6. Never talk loose of your colleagues, despite intense professional rivalry. Never criticize your brother in profession.
7. The patient/attendants may incite you to say/do something. They may seek your comments on the other doctor's treatment. There is always a polite way to set aside their queries.
8. Remember, if you had seen the case from start you would done the same. If your colleague has made error of judgment regarding diagnosis or treatment, you never know under what circumstances this happened.
9. Do not adopt experimental method in treatment. If there is some rationale do it only after informed consent.
10. If you go back and read the Duties and Obligations of Doctors carefully and apply them religiously in your day to day practice, you are safe.

CONSENT

Another major and important thing is to obtain proper consent of the patient/attendant/relative.

The term '**consent** ' is defined as:

"When two or more persons agree upon the same thing in the same sense they are said to consent" as per the definition of 'consent ' given in section 13 of Indian Contract Act, 1872.

Who can given consent:

For the purpose of clinical examination diagnosis and treatment consent can be given by any person who is conscious, mentally sound and is of and above twelve years of age as provided under sections 88 and 90 of the Indian Penal Code, 1860.

Doctors are reminded that consent is taken under section 13 of the Indian Contract Act, 1872. This Act, however also provides under Section 11 that only those persons who are of and above 18 years of age are competent to enter into a contract. Since doctor-patient relationship amounts to enter into a contract, it is advisable that consent should be obtained, specially written consent, from parents/guardian of a patient who is below 18 years so that validity of the contract is not challengeable.

When a consent is not valid:

Consent given under fear, fraud or misrepresentation of facts, or by a person who is ignorant of the implications of the consent, or who is under 12 years of age is invalid (Sec. 90 I.P.C.).

In most of the cases, filed against the doctors it is alleged that no consent was obtained. Obtaining of consent will thus be a cornerstone of protection against litigation. Depending upon the circumstances in each case, consent may be implied, express or informed.

Implied Consent (Tacit Consent)

This is by far the most common variety of consent in both general practice and hospital practice. The fact that a patient comes to a doctor for an ailment implies that he is agreeable to medical examination in the general sense. This, however, does not imply consent to procedures more complex than inspection, palpation, percussion, auscultation and routine sonography. For other examinations, notably rectal and vaginal

and withdrawal of blood for diagnostic purpose, express consent (oral or written) should be obtained. For more complicated diagnostic procedures, e.g. lumbar, puncture, radiology,endoscopy, C.T. Scan, etc. express written consent should be obtained.

Express Consent

Anything other than the implied consent is express consent. This may be either oral or written. Express oral consent is obtained for relatively minor examinations or therapeutic procedures, preferably in the presence of a disinterested third party. Express written consent is to be obtained for:

i. All major diagnostic procedures.
ii. General anesthesia.
iii. For surgical operations.
iv. Intimate examinations.
v. Examination for determining age, potency and virginity, and in medico-legal cases.

Informed Consent

The concept of informed consent has come foreward in recent years and many actions have been brought by patients who alleged that they did not understand the nature of the medical procedure to which they gave consent. All information must be explained in comprehensible nonmedical terms preferably in local language about the (a) Diagnosis, (b) Nature of treatment, (c) Risks involved, (d) Prospects of success, (e) Prognosis if the procedure is not performed, and (f) Alternative methods of treatment. The physician's duty to disclosure is subject to the exceptions: (a) If the patient prefers not be informed and (b) If the doctor believes in the exercise of coming to a sound medical judgment, that the patient is so disturbed or anxious that the information provided would not be processed rationally or that it would probably cause significant psychological harm. This is known as Therapeutic Privilege. In such a case, it is advisable that the doctor should consult the patient's family physician. Revelation of risk is always a compromise between reasonable information and the danger of frightening off the patient from beneficial treatment. The three important components of such consent are information, voluntariness and capacity. (See Model Form of Informed Consent at the end of this Chapter).

Proxy Consent (Substitute Consent)

All the above types of consent can take the shape of Proxy Consent. Parent for child, close relative for mentally unsound/ unconscious patient, etc. Situations where consent may not be obtained

1. *Medical Emergencies*: The well being of the patient is paramount and medical rather than legal considerations come first.
2. *In case of person suffering from a notifiable disease*: In case of AIDS/HIV positive patients, the position in India regarding its being a notifiable disease or not is not yet clear. However, in England the Public Health (Infectious Diseases) Regulations, 1988 extend the provisions of notifiable diseases to AIDS but not to persons who are HIV positive.
3. Immigrants.
4. Members of Armed Forces.
5. Handlers of food and dairymen.
6. New admission to Prisons.

Model Form of Informed Consent

I ..... son of ..... aged ..... resident of ..... being under the treatment of ..... (state here name of doctor/hospital/nursing home) do hereby give consent to the performance of medical/surgical/ anesthesia/diagnostic procedure of ..... (Mention nature of procedure/treatment to be performed, etc.) upon myself/upon ..... aged ..... who is related to me as ..... (Mention here relationship, e.g. son, daughter, father, mother, wife, etc.).

I declare that I am more than 18 years of age.I have been informed that there are inherent risks involved in the treatment/procedure. I have signed this consent voluntarily out of my free will without any pressure and in my fell senses.

Place:

Date: **SIGNATURE**

Time: (To be signed by parent/guardian in case of minor)

NOTES:

1. This Consent Form should be signed before the treatment is started. These formats may be modified as per individual requirements or experiences of Hospitals/Nursing Homes.
2. These formats should be in local language and in certain cases it would be prudent to record a proper witness to signature consent.
3. Informed consent forms for various situations can be made for Nursing Homes/Hospitals. Help of lawyers may have to be taken. Detailed forms on Medical history can also be maintained. Keep all records in order and safely.
4. It is important to note that written consent should refer to one specific procedure. Obtaining a 'blanket' consent on admission does not have legal validity.

7. In case of a person where a court may order for psychiatric examination or treatment.
8. Under Section 53 (1) of the Code of Criminal Procedure, a person can be examined at request of the police, by use of force. Section 53 (2) lays down that whenever a female is to be examined, it shall be made only by, or under the supervision of a female doctor.

PROTECTION AGAINST OUTCOME OF LITIGATION

A tertiary level of protection against outcome of litigation would be to go for Insurance cover. *Professional indemnity insurance* cover became available for Doctors and Medical establishments only recently, i.e. from December, 1991.

The term "indemnity" means reimbursement, to compensate. The principle of indemnity is strictly observed in liability insurances. These insurances (e.g., Professional Indemnity Insurance) are designed to provide the insured person protection against the financial consequences of legal liability. If the insured is legally liable to pay damages to others, the policy will indemnify him subject to the terms, conditions and limitations of the contract. Indemnity is also available in respect of legal costs awarded against the insured as well as legal costs and expenses incurred by the insured with the written consent of the insurers in the defense of settlement of claims.

50 Comprehensive Dental Care

Anil Ankola

Barring the complete prevention of dental disease is an objective toward which the present state of dental science permits us to advance only part way, the next highest objective in the field of public health dentistry is comprehensive dental care.

It refers to the meeting of accumulated dental needs at the time a population group is taken into the program (initial care) and the detection and correction of new investments of dental disease on a semiannual or other periodic basis (maintenance care).

Comprehensive dentistry may be defined as *"Providing for the full range of dental health services for diagnosis, treatment, follow-up, and rehabilitation of patients"*.

Preventive measures aimed to minimize disease are a part of comprehensive dental care.

The term comprehensive health care was first used by the Bhore Committee in 1946. This committee meant provision of integrated preventive, curative and promotive health services from "WOMB to TOMB" to every individual residing in a defined geographic area.

According to Crandell, comprehensive dental care should be provided at three levels:

a. Individual-Refers to performing procedures appropriate for patient
b. Community-Refers to availability for public
c. Universality-All components should be incorporated like the dental, emotional and physical.

INITIAL CARE VERSUS MAINTENANCE CARE

The relation between initial care and maintenance care becomes an area of interest . As per the study conducted in 1943 at dental health services in New York, the ratio between initial care and maintenance care in terms of cost was approximating 5:1 and for chair hours 3.8:1. The two facts were obvious in their studies.

1. The high cost of initial care is a tremendous obstacle to be overcome in the initiation of a dental care program for a new group of patient.
2. Comprehensive dental care results in the significant saving of teeth in good health and function for the average patient, again work while striving for and not to be measured in terms of actual cost.

PREVENTION VERSUS TREATMENT

Attainment of comprehensive dental care for the entire population is impossible at current level of dental disease.

Only prevention can bridge the gap between dental care and dental disease. No complete preventive measure has been discovered either for dental caries or periodontal disease.

The best hope lies in a combined attack using water fluoridation, dietary improvements, oral hygiene, early correction of dental defects, and control of concomitant disease than providing comprehensive dental care.

The services which can be provided under comprehensive dental care:

1. Dental health education including motivation
2. Palliative emergency treatment at first aid level
3. Preventive services
4. Restorative services
5. Corrective services
6. Rehabilitative services

MANPOWER INVOLVED IN COMPREHENSIVE DENTAL CARE

The services can be provided by:

a. General dentists
b. Specialized dentists have a particular responsibility for those procedures unique to his specialty

c. Dental auxiliaries provide the dentists with support that enables him to increase his productivity and efficiency in the delivery of comprehensive dental care.

PREREQUISITES FOR A GOOD COMPREHENSIVE DENTAL CARE PROGRAM

1. Attitudes of a patient and a provider can be a friend, savior, servant, addresser.
2. Adequate setup can be accomplished through either solo care or group care.
3. Commitment from the providers, patients and community.

The comprehensive dental care approach is to examine all patient's dental needs and endeavor to inform them accurately about treatment options that are possible, realistic and best suit the outcome they hope to achieve. This might involve a treatment of a single tooth or the reconstruction of an entire dentition.

The approach can be broken into four stages:

Stage 1. Pain relief and/or immediate problem solving: The aim here is to alleviate or lessen the pain. The treatment offered at this stage may be provisional (For example: A temporary or sedative dressing, smoothing a sharp fractured tooth, antibiotics to reduce swelling or infection).

Stage 2. Comprehensive treatment planning: A complete examination of your current dental condition and immediate dental treatment needs. Dental radiographs (X- ray) are usually required at this stage to allow better visualization of any problems. Other special tests or records, e.g. pulp vitality tests, gum pocket depth records, plaster study models of mouth, etc. may be organized to complete our information gathering.

Stage 3. Treatment phase: All the preventive, restorative, corrective and rehabilitative services are provided at this phase.

Stage 4. Treatment review and maintenance/preventive program: Regular appointments are scheduled to review what has been achieved. Dental prevention programs should be planned out to stop or slow future dental needs.

Advantage

Comprehensive dental care result in the significant saving of teeth in good health and function, for the average patient, again worthwhile striving for and not to be measured in terms of actual cost.

RECORD MAINTENANCE

There are three primary reasons for keeping records

1. Requirements of the internal revenue system
2. Protection against malpractice and other legal consideration
3. Efficient and comprehensive practice management.

CHALLENGES AND LIMITATIONS

1. High cost of initial care is a tremendous obstacle to overcome in the initiation of a dental care program for a new group of patients
2. Limited manpower
3. Provision of total care for all population
4. Higher grades of ethical and moral responsibility.

ROLE OF PUBLIC HEALTH DENTISTS

This comprehensive service can be incorporated in the community outreach programs.

As the pattern of dental caries changes and the growing ranks of elderly keep more and more of their natural teeth, the problem of periodontal disease will assume a larger part of sum total of comprehensive dental care.

Definitions

Accretion—Accretion is a process where most of the fluoride is buried within the mineral crystallites during the period of crystal growth.

Active Immunity—It is the immunity which an individual develops as a result of infection or by specific immunization and is usually associated with presence of antibodies or cells having a specific action on the microorganism concerned with a particular infectious disease or on its toxin.

Age-specific Fertility Rate—Number of live births in a year to 1000 women in any specific age group.

Agent—A substance living or nonliving or a force tangible or intangible, the excessive presence or relative lack of which may initiate or perpetuate a disease process.

Aim—Aim is an overall statement of the reason for undertaking the study.

Allergy—An abnormally high sensitivity to certain substances, such as pollens, foods, or microorganisms.

Amphixenosis—Infections maintained in both man and lower vertebrate animals that may be transmitted in either direction.

Anthropology—It is the science of studying man/woman in terms of their physical, social and cultural characteristics.

Anthropozoonosis—Infections transmitted from man to vertebrate animals.

Arrested caries—Carious lesion which becomes arrested at any stage of caries process, due to changes in the causal factors, or increased protective factors, leading to open, self-cleansing, discolored, hard dentine lesion.

Assessment—A systematic or non-systematic way of gathering relevant information, analyzing and making judgment on the basis of the available information.

Association—Association is said to exist between two variables when a change in one variable parallels or coincides with a change in another.

Attack Rate—The number of cases of a disease occurring in a specified population during a specified interval.

Attributable Risk (AR)—Attributable risk is defined as the difference in the incidence rates of disease (or death) between an exposed group and nonexposed group.

Auxiliary—WHO defined an auxiliary as "a technical worker in a certain field less than full professional training".

Auxiliary Worker—WHO defines auxiliary worker as "one who has less than full professional qualifications in a particular field and is supervised by a professional worker".

Balanced Diet—It is defined as one which contains different types of food in such quantities and proportion that need for energy amino acids, vitamins, minerals, fats, carbohydrates, and other nutrients are adequately met for maintaining health, vitality and general well being and also makes small provisions for extra nutrients to withstand short duration of illness.

Basic Health Service (WHO/Unicef, 1965)—A basic health service is understood to be a network of coordinated, peripheral and intermediate health units capable of performing effectively a selected group of functions essential to the health of an area and assuring the availability of competent professional and auxiliary personnel to perform these functions.

Bias—Any systematic error in the determination of the association between exposure and disease.

Bimodality—Bimodality is the occurrence of two separate peaks in the age incidence of a disease.

Biological Environment—It is the universe of living things which surrounds man including man himself.

Biomedical Waste—Any waste which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining there to or in the production or testing of biological, and including categories like infectious waste, pathological waste, pharmaceutical waste, genotoxic waste, chemical waste, wastes containing high content of heavy metals and radioactive waste.

Biostatistics—It is the method of collecting organizing analyzing, tabulating and interpretation of data relating to living organisms and human beings.

Calculus (Greene 1967)—It is defined as a deposit of inorganic salts composed primarily of calcium carbonate and phosphate mixed with food debris, bacteria and desquamated epithelial cells.

Calibration—It is a procedure or an exercise carried out before conducting an epidemiological survey to get valid, reliable data by ensuring uniform interpretation through standardization of the procedures, measurements and instruments by proper training of all examiners, and minimizing inter and intraexaminer variations.

Cancer Prevention (WHO, 1963)—It is the elimination of or protection against factors known or believed to be involved in carcinogenesis and the treatment of precancerous condition.

Caries Activity—Caries Activity refers to the increment of active lesions (new and recurrent lesions) over a stated period of time. Caries activity is a measure of the speed of progression of a carious lesion.

Caries Susceptibility—Caries Susceptibility refers to the inherent tendency of the host and target tissue, the tooth, to be afflicted by the caries process. This is the susceptibility (or resistance) of a tooth to a caries-producing environment.

Carrier—It is defined as an infected person or animal that harbors a specific infectious agent in the absence of disease and serves as a potential source of infection for others.

Case—It is defined as a person in the population or study group identified as having the particular disease, health disorder or condition under investigation.

Case Detection—It is the presumptive identification of unrecognized disease which does not arise from a patient request, e.g. neonatal screening.

Case Fatality Rate—It is defined as the ratio of number of deaths due to a disease to the total number of cases due to the same disease.

Census—It is 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 delimited territory.

Certification—It is the process by which a nongovernmental agency or association grants recognition to an individual who has met certain predetermined qualification specified by that agency or association.

Child Mortality Rate—It is defined as "the number of deaths at ages 1 to 4 years in a given year per 1000 children in that age group at the midpoint of the year concerned".

Cohort—It is defined as a group of people who share a common characteristic or experience within a defined time period (e.g. age, occupation, exposure to a drug or vaccine, pregnancy, insured persons, etc).

Cold Chain—It is a system of storage and transport of vaccines at low temperature from the manufacturer to the actual vaccination site.

Community (Osborn & Niemeyer)—A group of people living in a contiguous geographic area, having centers of interest and functioning together in the chief concerns of life. It is a social group of individuals living in a given area and having a degree of "we" feeling.

Community Dental Health—It is that branch of dentistry which is practised in relation to population and groups, which derives from epidemiology an awareness of services required and which include the developmental of technique necessary to organize the application of these services for the benefit of the people.

Community Dentistry—It is that branch of dentistry which is practiced in relation to population and group, which derives from epidemiology an awareness of service required to organize the application of these services for the benefit of the population.

Community Health—Defined as including all the personal health and environmental services in any human community, irrespective of whether such services were public or private ones.

Community Medicine—It is that speciality which deals with populations and comprises those doctors who try to measure the needs of the people both sick and well, who plan and administer services to meet those needs and those who are engaged in research and teaching in the field.

Community Diagnosis—Generally refers to the identification and quantification of health problems in a community in terms of mortality and morbidity rates and ratios and the identification of these correlates for the purpose of defining those individuals or groups at risk or those in need of health care.

Community Organization—It is the process by which community groups identify common problems or goals, mobilize resources and in other ways develop and implement strategies for reaching the goals they have set [Minkler 1990].

Communicable Disease—An illness due to a specific infectious agent or its toxic products capable of being directly or indirectly transmitted from man to man, animal to animal or from the environment (through air, dust, soil, water, food etc), to man or animal.

Communicable Period—It is defined as the time during which an infectious agent may be transferred directly or indirectly from an infected person to another person, from and infected animal to man or from an infected person to an animal including arthropods.

Comprehensive Dental Care—Defined as "a process of providing preventive, therapeutic and maintenance care necessary for function, aesthetics and integrity of oral tissues with balanced consideration to patient's physical, social, economic and psychosomatic status".

Concept of Disease (Webster)—A condition in which body health is impaired, a departure from a state of health and alteration of human body interrupting the performance of vital functions.

Confounding Factor—It is defined as one which is associated both with exposure and disease and is distributed unequally is study and control groups.

Consent—When two or more persons agree upon the same thing in the same sense they are said to consent – section 13 of the Indian Contract Act, 1872.

Contamination—It is defined as the presence of an infectious agent on a body surface also on or in clothes , surgical instruments, or substance including water, milk and food.

Contagious—A disease that is transmitted through contact.

Contract—Contract is defined as an agreement between two or more persons which creates an obligation to do or not to do a particular thing.

Cross-sectional Study—It is based on a single examination of a cross-section of population at one point in time, the result of which can be projected on the whole population.

Crude Death Rate—It is defined as "the number of deaths per 1000 population per year in a given community".

Cultural Anthropology—Cultural anthropology is the branch dealing with man's behavior and products.

Culture—It may be defined as a shared and organized body of customs, skill and ideas and values which is transmitted socially from one generation to another.

Defluoridation—Defluoridation is defined as a downward adjustment of fluoride ion concentration in a public drinking water supply so that the level of fluoride is maintained at the normal physiological limit of 1 ppm to prevent dental caries with minimum possibility of causing dental fluorosis.

Dental Ancillary—It is a person who is given responsibility by a dentist so that, he or she can help the dentist render dental care but who is not himself or herself qualified with a dental degree.

Dental Calculus—Dental calculus is a hard deposit that forms by mineralization of dental plaque and is usually covered by a layer of unmineralized plaque.

Dental Caries—It is defined as a progressive, irreversible microbial disease of multifactorial nature affecting the calcified tissues of the teeth, characterized by demineralization of the inorganic portion and destruction of the organic portion of the tooth.

Dental Ethics—It is the moral obligation (duties) of the dentist towards the patient, his professional colleagues and to society at large.

Dental Fluorosis—It is a hypoplasia or hypomineralization of tooth enamel or dentine produced by the chronic ingestion of excessive amounts of fluoride during the period when teeth are developing.

Dental Plaque—Dental plaque is a complex, metabolically interconnected, highly organized, bacterial ecosystem. It is a structure of vital significance as a contributing factor to the initiation of the carious lesion.

Dental Plaque—Dental plaque is defined as a highly specific variable structural entity formed by sequential colonization of microorganisms

on the tooth surface, epithelium and restorations. The natural physiologic forces that clean the oral cavity are inefficient in removing dental plaque.

Dental Plaque—Dental plaque is defined as a structured, resilient, yellow-grayish substance that adheres tenaciously to the intraoral hard surfaces, including removable and fixed restorations.

Dental Practice Management—It is defined as the process of obtaining and allocating inputs (human and economic resources by planning, organizing, staffing and directing and controlling for the purpose of outputs (dental services) desired by patients, so that practice objectives are achieved.

Dental Public Health (American Board of Dental Public Health)—It is the science and art of preventing and controlling dental disease and promoting dental health through organized community efforts.

It is that branch of dentistry or that form of dental practice which serve the community as a patient rather than the individual. It is concerned with the dental health education of the public, with research and application of the findings of research, with the administration of programmes of dental care for groups and with the prevention and control of dental disease through a community approach.

Dental Health (WHO 1970)—It is the state of complete normality and functional efficiency of the teeth and the supporting structures and also surrounding parts of the oral cavity of the various structures related to mastication and maxillofacial complex.

Dental Health Education—It has been defined as the provision of health information to people in such a way that they apply it to everyday living.

In order to standardize a comprehensive definition of health education including dental health education, several national health organizations drafted the following definition.

"A process with intellectual, psychological and social dimensions relating to activity which increases the abilities of people to make informed decisions affecting their personal, family and community well being. The process based on scientific principles, facilities learning and behavioural change in both health and consumers including children and youth".

Dentifrice—It is a mixture used to clean the tooth surface in conjunction with toothbrush.

Dentist—A dentist is a person licensed to practice dentistry under the laws of the appropriate state, province, territory or nation.

To become licensed a prospective dentist must satisfy certain requirements such as, completion of a specified period of professional education in an approved institution, demonstration of competence, evidence of satisfactory personal qualities.

Dental Hygienist—It is an operating auxiliary licensed and registered to practice dental hygiene under the laws of the appropriate state, province, territory or nation.

Dental Laboratory Technician—it is a non-operating auxiliary who fulfils the prescriptions provided by dentist regarding the extra oral construction and repair or oral appliances.

Dental Assistant—It is a non-operating auxiliary who assists the dentist or dental hygienist in treating patients but who is not legally permitted to treat independently.

Denturist—it is a term applied to those dental laboratory technicians who are permitted in some states in the Unites States, some provinces of Canada, and in some other countries to fabricate dentures directly for patients without a dentists prescription.

Dependence—It is defined as the need for assistance in bathing, dressing, eating or transmitting from bed to chair.

Diet—It is defined as the oral intake of substances that provide nutrition and energy.

Disability—Disability is any restriction or lack of ability to perform an activity in the manner or within the range considered normal for a human being.

Disability (WHO 1982)—It is any restriction or lack of ability (resulting from an impairment) to perform an activity in the manner or within the range considered normal for a human being.

Disaster—Any occurrence that causes damage, ecological disruption, loss of human life or deterioration of health and health services on a scale sufficient to warrant an extraordinary response from outside the affected community or area.

Disclosing Agent—A dye used in dentistry as a diagnostic aid, applied to the teeth to reveal the presence of dental plaque.

Disease—Definition by Webster: A Condition in which body's health is impaired, a departure from a state of health and alteration of the human body interrupting the performance of vital functions.

Simplest Definition: It is just the Opposite of Health.

Disease Agent—It is defined as a substance living, or nonliving or a force, tangible or intangible the excessive presence or relative lack of which may initiate or perpetuate a disease process.

Disease Control—The term disease control described (ongoing) operations aimed at reducing

- The incidence of disease
- The duration of disease and consequently the risk of transmission.
- The effects of infection including both the physical and psychological complications and
- The financial burden to the community.

Disinfection—It is defined as the killing of infectious agents outside the body by direct exposure to chemical or physical agents.

Double Blind Study—The study which is so planned that neither the doctor nor the participant is aware of the group allocation and the treatment received.

Early Diagnosis—The detection of disturbances of homeostatic and compensatory mechanism while biochemical morphological and functional changes are still reversible.

Ecology—It is the science of mutual relationship between living organisms and their environment.

Ecology of Health—It is the study of the relationship between variations in man's environment and his state of health.

Effectiveness Evaluation—Effectiveness evaluation refers to whether program results meet predetermined objectives.

Effectiveness—Effectiveness is defined as the ratio between the achievement of the program activity and the desired level which, during the planning process, the planners had proposed would result from the program. – WHO 1974.

Efficiency Evaluation—Efficiency evaluation relates the results obtained from a specific program to the resources expended to maintain the program.

Efficiency—Efficiency is defined as the result that might be achieved through expenditure of a specific amount of resources and the result that might be achieved through a minimum of expenditure. – WHO 1974.

Endemic—It refers to the constant presence of a disease or infectious agent, within a given geographic area or without importation from outside, may also refer to the usual or expected frequency of the disease within such area or population group.

Environment—It can be defined as the sum total of all conditions and influences that effect the development and life of an organism.

Environmental Sanitation (WHO)—Controls for all those factors in man's physical environment which exercise or may exercise a deleterious effect on his physical development, health and survival.

Enzootic—An endemic occurring in animals.

Epidemic—The unusual occurrence in a community or region of disease, specific health-related behavior or other health related events clearly in excess of expected occurrence.

Epidemiologist—An epidemiologist is any person who researches into the occurrence of disease or disability in groups of people.

Epidemiology—Epidemiology is defined as the study of the distribution and determinants of health related states or events in specified populations, and the application of this study to the control of health problems. (John M. Last 1988)

Maxcy-Rosenau: Epidemiology is that field of medical science which is concerned with the relationship of various factors and conditions which determine the frequencies and distributions of an infectious process, a disease or a physiological state in a human community.

Paul JR: Defines epidemiology as that which is concerned with the circumstance under which disease occur, where disease tend to flourish and where they do not. Such circumstance may be microbiological or toxicological. They may be based on genetic, social or environmental factors, even religious or political factors may come under scrutiny provided they are found to have come bearing upon disease prevalence.

WH Frost: Defines epidemiology as "the science which considers the occurrence, distribution and types of diseases of mankind, in distinct epochs of time at varying points on the earth's surface and secondly, will render characteristics of the individual, and to the external conditions surrounding him and determining his manner of life.

American Epidemiological Society: Defined epidemiology "as the science which concerns itself with the natural history of disease as it is expressed in groups of persons related by some common factors of age, sex, race, location or occupation as distinct from development of disease in individuals.

Epizootic—An outbreak of disease in an animal population (often with the implication that it may also affect human populations).

Epornithic—An outbreak (epidemic) of disease in a bird population.

Eradication—It is the termination of all transmission of infection by extermination of the infectious agent through surveillance and containment.

Erythroplakia—Erythroplakia is defined as a red lesion of the oral mucosa that cannot be characterized as any other definable lesion.

Ethics—It is defined as the science of morals, of moral principals of right and wrong, specifying rules of right behavior. Ethics broadly are the unwritten laws of the profession embodying an expected standard of behavior. It is the science of moral duty.

Evaluation—It is a process of making judgements about selected objectives and events by comparing them with specified value standards for the purpose of deciding alternative course of action.

Evaluation of Family Planning—Process of making judgments about selected objectives and events by comparing them with specified value standards for the purpose of deciding alternative course of action.

Exotic—Diseases which are imported into a country in which they do not otherwise occur.

Expectation of Life—It is the average number of years that will be lived by those born alive into a population if the current age-specific mortality rates persist.

Express Contract—Express contract is an actual agreement of the parties, the terms of which are openly uttered or declared at the time of making it, being stated in distinct and explicit language, either orally (oral agreement) or in writing (written agreement).

Expressed Need—Expressed need (Demands for Health care) arises out of attempts by members of the public to seek attention for their perceived needs.

External Environment of Men—It is defined as "all that which is external to the individual human –host.

Family—It is a group of individuals who are biologically related and living together and eating in a common kitchen. It is a primary unit of society.

Family Planning—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 the social development of a country".

Felt Need—Felt need (Perceived need) is the requirement of or care as determined by the patient or the public.

Fissures—Fissures are long clefts between cusps or ridges.

Folkways—Folkways are the patterns of conventional behavior in a society, norms that apply to everyday matters.

Food Additives—Non-nutritious substances, which are added intentionally to food, generally in small quantity, to improve its appearance, flavor, texture or storage properties.

Food Fortification—It is a process whereby the nutrients are added to foods in relatively small quantities to maintain or improve the quality of the diet of a group, a community or a population.

Foodborne Disease—A disease usually either infectious or toxic in nature caused by agents that enter the body through the ingestion of food.

Formative Evaluation—Formative evaluation is an examination of the activities of a program, as they are taking place.

Foetal Death—Death prior to the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of pregnancy.

Four-handed Dentistry—Four-handed dentistry is the art of seating both the dentist and the dental assistant in such a way that both are within easy reach of the patient's mouth.

F-ratio—A ratio of the variance between the group means over the variance within the groups; determines if the observed difference among the sample means is significant, statistics that result from ANOVA.

Functional Relationship—It is a relationship probably based on a complex system of interactions rather than being directly causal.

Geriatric Dentistry—American Association of Dental School (AADS) defines it that branch of dentistry that deals with the special knowledge, attitudes and technical skills required in the provision of oral health care to older adults. The term older adults has no specific chronological boundary.

Gerodontology—It is defined as the multi disciplinary study of the process of ageing in the oro-facial area and its relations to the surroundings.

Gingivitis—Gingivitis is a disease characterized by inflammation restricted to the gingival soft tissues, with no loss of alveolar bone or apical migration of the periodontal ligament along the root surface.

Goal—It is the ultimate desired state towards which objectives and resources are directed. Unlike objectives and targets, goals are not constrained by time or resource, nor are they necessarily attainable.

Group—Group is defined as a gathering of two or more people who have a common interest.

Group Practice—Group practice is defined as that type of dental practice in which dentists, sometimes in association with the members

of other health professions agree formally between themselves on certain central arrangements designed to provide efficient dental health service ADA (1969).

Guinea Pig Effect—It is thought to occur when subjects respond to data collection instruments itself; causing them to assume uncharacteristic behavior.

Rather it refers to adults who are affected by physical, social, psychological, physiological and biological changes associated with ageing with or without concomitant disease.

Habit—It is an acquired tendency to respond in an identical way to a situation or stimulus.

Handicap—A disadvantage for a given individual resulting from an impairment or a disability that limits or prevents the fulfillment of a role that is normal for that individual.

Handicapped Person—It is an individual child or adult who has been prevented by reason of his handicap from full participation in his normal activities for age.

Hazard—Any phenomenon that has the potential to cause disruption or damage to people and their environment.

Health—Definition by World Health Organization (WHO): A State of complete Physical, Mental and Social well-being and not merely the absence of disease or infirmity.

Oldest definition of Health: Absence of Disease

Definition by Webster: The condition of being sound in Body, Mind and Spirit, especially freedom from Physical Disease and Pain.

Health Education—WHO 1969: To persuade people, to adopt and sustain healthy life practices; to use judiciously and wisely health services available to them and to take their own decisions both individually and collectively to improve their status and environment.

By National Conference on Preventive Medicine- USA- Is defined as the process which informs, motivates and helps people to adopt and maintain healthy practices and lifestyles, advocates environmental changes as needed to facilitate the goal and conducts professional training and research to the same end.

Health Appraisal—Has been defined as the process of determining the total status of the child through such means as histories, teachers and nurse observators, screening tests and medical, dental and psychological examinations.

Health Behavior—Any activity undertaken by an individual, regardless of actual or perceived health status, for the purpose of promoting, protecting or maintaining health, whether or not such behavior is objectively effective towards that end. – WHO Health Promotion Glossary, 1986.

Health Care Waste—Health care waste is defined as all the waste generated by health care establishments, research facilities and laboratories.

Health Communication—Health communication is defined as a key strategy to inform the public about health concerns and to maintain important health issues on the public agenda. The use of the mass and multimedia and other technological innovations to disseminate useful health information to the public, increases awareness of specific aspects of individual and collective health as well as importance of health in development. – WHO Health Promotion Glossary, 1998.

Health Information System (WHO 1973)—It is defined as a mechanism for the collection, processing, analysis and transmission of information required for organizing and operating health services and also for research and training.

Health Literacy—Health literacy represents the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health. – WHO Health Promotion Glossary, 1998.

Health Maintenance Organization—A Health Maintenance Organization (HMO) is defined as a legal entity which provides a prescribed range of health services to each individual who has enrolled in the organization, in return for a prepaid, fixed and uniform payments.

Health Manpower Planning—The process of estimation of the number of persons and the kind of knowledge, skills and attitudes they need to achieve predetermined health targets and ultimately health status objectives.

Health Needs (WHO 1971)—Are defined as deficiencies in health that call for preventive curatives, control and eradication measures.

Health for all—Defined as "the organized application of local, state, national and international resources to achieve health for all, i.e. attainment by all people of the world by the year 2000 of a level of health that will permit them to lead a socially and economically productive life".

Health Development (WHO)—It is defined as the process of continuous progressive improvement of the health status of a population.

Health Care (Last)—It is defined as a multitude of services rendered to individuals, families or communities by the agents of the health services or professions, for the purposes of promoting, maintaining, monitoring or restoring health.

Health Indicators—They are defined as variables which helps to measure changes .

Health Team (WHO)—It is defined as a group of persons who share a common health goal and common objectives, determined by community needs and towards the achievement of which each member of the team contributes in accordance with his competence and skills and respecting the functions of the other.

Health Services Research (WHO)—It is defined as the systematic study of the means by which biomedical and other relevant knowledge is brought to bear on the health of individuals and communities under a given set of conditions.

Health Promotion (WHO)—It is a process of enabling individuals to improve their health through personal choice and social responsibility.

Health Planning—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 proposed program.

Health Promoting School—A health promoting school can be characterized as a school constantly strengthening its capacity as a health setting for living, learning and working. – WHO TRS 870.

Health Protection—The provision of conditions for normal mental and physical functioning of the human being individually and in the group. It includes the promotion of health, prevention of sickness and curative and restorative medicine in all its aspects.

Holoendemic—A high level of infection beginning early in life and affecting most of the child population, leading to a state of equilibrium such that the adult population shows evidence of the disease much less commonly than do the children.

Host—A person or other animal including birds and arthropods, that affords subsistence or lodgment to an infectious agent under natural conditions.

Hospital (WHO–1963)—A hospital is a residential establishment which provides short–term and long–term medical care consisting of

observational, diagnostic, therapeutic and rehabilitative services for persons suffering or suspected to be suffering from a disease or injury and for parturients, it may or may not also provide services for ambulatory patients on an out patient basis.

Housing—All places in which a group of people reside and pursue their life goals; the size of the settlement may vary from a single family to millions of people.

Hygiene—It is defined as the science of health and embraces all factors which contribute to healthful living.

Hyperendemic—It expresses that the disease is constantly present at a high incidence and/or low prevalence rate, and affects all age groups equally.

Hypothesis—It is a supposition arrived at from observing or reflection.

Iatrogenic—Any untoward or adverse consequence of a preventive, diagnostic or therapeutic procedure that causes impairment, handicap, disability or death resulting from a physician's professional activity or from other professionals.

Immunity—It is possessing specific protective antibodies or cellular immunity as a result of previous infection or immunization.

Incidence—Incidence rate is defined as the number of new cases occurring in a defined population during a specified period of time.

Incremental Dental Care—It is defined as a periodical dental care so spaced that increments of dental diseases are treated at the earliest time, consistent with a proper diagnosis and operating efficiency in such a way that there is no accumulation of dental needs.

Incubation Period—The time interval between invasion by an infectious agent and appearance of first sign or symptom of the disease in question.

Infection—The entry and development or multiplication of an infectious agent in the body of a man or animal.

Infectious Disease—A clinically manifest disease of man or animals resulting from an infection.

Internal Environment of Man—It pertains to each and every component part, every tissue, organ and organ system and their harmonious functioning within the system.

Infant Mortality Rate—The ratio of infant deaths registered in a given year to the total number of live births registered in the same year; usually expressed as a rate per 1000 live births.

Impairment—Any loss or abnormality of psychological or anatomical structure or function.

Incineration—A high temperature dry oxidation process that reduces organic and combustible waste to inorganic incombustible matter and results in a very significant reduction of waste-volume and weight.

Incremental Dental Care—Defined as the treatment of the children at the earliest at which they are available and providing maintenance care through periodic treatments. The treatment is provided by taking the youngest available group in the first year and then carrying it forward in subsequent years as far as the funds permit, each year adding a new class of children at the next earliest age, until an entire child population is being served to as high an age as available resources permit.

Index (Russell)—An index has been defined as a numerical value describing the relative status of a population on a graduated scale with definite upper and lower limits, which is designed to permit and facilitate comparison with other populations classified by the same criteria and methods.

Infection—The entry and development or multiplication of an infectious agent in the body of man or animals.

Infectivity—It is defined as the ability of an infectious agent to invade and multiply on a host.

Intervention—Can be defined as any attempt to intervene or interrupt the usual sequence in the development of disease in man.

Interceptive Orthodontics—It is the phase of the science and art of orthodontics employed to recognize and eliminate potential irregularities and malpositions in the developing dento–facial complex.

Isolation—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.

Jurisprudence—It is the philosophy of law, or the science that treats the principles of law and legal relations.

Latent Period—It is the period from disease initiation to disease detection.

Level of Living—As per United Nations documents level of living consists of nine components: health, food consumption, education, occupation and working conditions, housing, social security, clothing, recreation and leisure, and human rights.

Licensure—It is the process by which an agency of government grants permission to those meeting predetermined qualifications to engage in a given occupation and use a particular title or by which it grants permission to perform specified function.

Longitudinal Study—It is defined as study in which the same individuals are examined on repeated occasions and changes within a group are recorded in lapse of time.

Macro-environment—Is defined as all that which is external to the individual human host, living and non living and with which he is in constant interaction.

Malnutrition—It is a pathological state resulting from a relative or absolute deficiency of excess of one or more essential nutrients.

Manpower—It is defined as individuals with a kind of knowledge, skills and attitude needed to achieve predetermined health targets and ultimately health status objectives.

Matching—It is defined as the process by which we select the controls in such a way that they are similar to cases with regard to pertinent selected variables which are known to influence the outcome of disease and which if not adequately matched for comparability could distort or confound the results.

Materia Alba—It is a deposit composed of aggregate of micro organisms, leukocytes and dead exfoliated epithelial cells randomly organized and loosely adhered to surfaces of teeth, plaque and gingiva.

Maternal Death—Deaths associated with complication of pregnancy, child birth and puerperium.

Mental Dimension—A state of balance between the individual and surrounding world, in a state of harmony between oneself and other; coexistence between reality of the self and that of other people and that of environment.

Modes of Intervention—It is defined as any attempt to intervene or interrupt the usual sequence in the development of disease in man.

Monitoring—The performance and analysis of routine measurements aimed at detecting changes in the environment or health status of population"

Morbidity—It is defined as any departure subjective or objective from a state of physiological well being.

Mortality Rate—The number of deaths due to a disease in a general population in a community (that is not just among cases)

Motives—Emotional emerging forces which bring certain features of belief to the forefront of consciousness, make personal and immediate changes and push the person towards acting upon them.

National Health Policy—It is an expression of goals for improving the health situation, the priorities among these goals and the main directions for attaining them.

National Pathfinder Survey—It is a collection of data incorporating sufficient examination sites to cover all important subgroups of the population that may have differing disease level or treatment needs, and at least three of the age groups are index ages, for the planning and monitoring of the services.

Neonatal Mortality Rate—It is the number of neonatal deaths in a given year per 1000 live births in that year.

Nosocomial Infection—Nosocomial infection (hospital acquired) is an infection originating in a patient while in a hospital or other health care facility.

Nutrition—The science of food and its relationship to health. It is concerned primarily with the part played by the nutrients in body growth development and maintainance.

Odds Ratio (OR)—It is a measure of the strength of association between the risk factor and outcome.

Opportunistic Infection—This is infection by an organism that takes the opportunity provided by the host defense to infect the host and hence cause the disease.

Oral Health Survey (WHO)—It is defined as survey to collect the basic information about oral disease status and treatment needs that is needed for planning or monitoring oral health care programs.

Outbreak—The sudden, unexpected pronounced increase in the occurrence of disease usually focally in the limited section of the patient.

Pandemic—An epidemic usually affecting large proportion of the population occurring over a wide geographic area such as a section of nation, the entire nation, continent or the world.

Physician (WHO)—A physician is a "person who, having been regularly admitted to a medical school, duly recognized in the country in which it is located, has successfully completed in the prescribed courses of studies in medicine and has acquired the requisite qualification to be legally licensed to practice medicine (comprising prevention, diagnosis, treatment and rehabilitation) using independent judgment to promote community and individual health".

Physical Environent—It is applied to non living things and physical factors (eg. air, water, soil, housing, climate etc) with which man is in constant interaction.

Plan (Planning)—(By EC Banfield) It is a Decision about a course of action.

It is a systemic approach to defining the problem, setting priorities developing specific goals and objectives and determining alternative methods and strategies for implementation.

Pollution—It is distinct from contamination and implies the presence of offensive but not necessarily infectious matter in the environment.

Preventive Medicine—It is defined as meaning not only the organized activities of the community to prevent occurrence as well as progression of disease and disability, mental and physical, but also the timely application of all means to promote the health of individuals and of the community as a whole, including prophylaxis, health education and similar work done by a good doctor in looking after individuals and families.

Preventive Dentistry—Procedure employed in practice of dentistry and community dental health programmes which prevent occurrence of oral disease and oral abnormalities.

Primary or Definitive Hosts—They are hosts in which the parasite attains maturity or passes its sexual stage.

Primary Prevention—Action taken prior to the onset of disease which removes the possibility that a disease will ever occur.

Prevalence—Refers specifically to all current cases(old and new) existing at a given point in time, or over a period of time in a given population.

Point Prevalence—It is defined as the number of all current cases (old and new) of a disease at one point in time in relation to a defined population.

Period Prevalence—It is defined as the frequency of all current cases(old and new) existing during a defined period of time, expressed in relation to a population.

Profession—Defined as "a calling requiring specialized knowledge and often long and intensive academic preparation" and "the whole body of persons engaged in a calling".

Professionalism—It is the conduct, aims or qualities that characterize or mark a profession or professional person.

Positive Health (WHO)—Implies that a person should be able to express as completely as possible the potentialities of his genetic heritage.

Prosodemic—Pertaining to infections that maintain themselves in human populations by a variety of mechanisms of transmission.

Plaque—Plaque is a specific but highly variable structural entity resulting from colonization of microorganisms on tooth surfaces, restorations and other parts of oral cavity which consists of salivary components like mucin, desquamated epithelial cells, debris and microorganisms all embedded in a gelatinous extra cellular matrix.

Plaque Control—Plaque control is the removal of microbial plaque and the prevention of its accumulation on the teeth and adjacent gingival tissues. Besides, its also deals with the prevention of calculus formation.

Pit and Fissure Sealant—Defined as a cement or resin material which is introduced into unprepared occlusal pits and fissures of caries susceptible teeth forming a mechanical and physical protective layer against the action of acid producing bacteria and their substrates.

Postneonatal Mortality Rate—The ratio of post neonatal deaths in a given year to the total number of live births in the same year; usually expressed as a rate per 1000.

Precancerous Lesion—Precancerous lesion is defined as morphologically altered tissue in which cancer is more likely to develop than in its apparently normal counterpart.

Precancerous Condition—Precancerous condition is a generalized state associated with a significantly increased risk of cancer.

Primordial Prevention—Primordial prevention is the prevention of the emergence or development of risk factors in countries or population groups in which they have not yet appeared.

Prevalence—The total number of all individuals who have an attribute or disease at a particular time divided by the population at risk of having the attribute or disease at this point in time or midway through the period.

Psychological Environment—It includes a complex of psychological factors which are defined as "those factors affecting personal health, health care and community well being that stem from the psychological makeup of individuals and the structure and functions of social groups.

Public Health (Defined by Winslow in 1920)—Defined as the science and art of preventing disease, prolonging life and promoting health and efficiency through organized community efforts for the sanitation of the environment, the control of communicable infections, the education of the individual in personal hygiene, the organization of medical and nursing services for early diagnosis and preventing treatment of disease, and the development of social machinery to ensure for every individual a standard of living adequate for the maintenance of health, so organizing these benefits as to enable every citizen to realize his birth right of health and longevity.

Quality of Life (WHO)—As the condition of life resulting from the combination of the effects of the complete range of factors such as those determining health, happiness (including comfort in the physical environment and a satisfying occupation) education, social and intellectual attainments, freedom of action, justice and freedom of expression.

Quarantine—The limitation of freedom of movement of such well persons or domestic animals exposed to communicable disease for a period of time not longer than the longest usual incubation period of disease, in such manner as to prevent effective contact with that not so exposed.

Range—It is the simple measure of dispersion, the difference between smallest and largest values in data.

Random Sampling—It is a sampling procedure in which every element in the population has an equal and independent chance of being selected.

Recommended Daily Intake—The amounts of nutrients sufficient for the maintenance of health in nearly all people

Registration—It is defined as an attribute or exposure that is significantly associated with the development of a disease.

Rehabilitation (WHO)—It is defined as the combined and coordinated use of medical, social, educational and vocational measures for training and retraining the individual to the highest possible level of functional ability.

Relative Risk—It is the ratio of the incidence of disease among exposed and incidence among non exposed.

Reservoir—It is defined as any person, animal, arthropod, plant, soil, or substance (or combination of these) in which an infectious agent 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.

Risk Factor—It is defined as a determinant that can be modified by intervention thereby reducing the possibility of occurrence of disease or other specified outcomes.

Risk Ratio—It is defined as the ratio between the incidence of disease among exposed persons and incidence among non exposed.

Sample—It is the representative part of a whole group of people or population to be studied.

Screening—It is defined as the use of presumptive methods to identify unrecognized health risk factors or asymptomatic disease in persons determined by prior studies to be potentially at elevated risk and able to benefit from interventions performed before overt symptoms develop. WHO, 1994.

Secondary Attack Rate—It is defined as the number of exposed persons developing the disease within the range of the incubation period, following exposure to the primary case.

Secondary Prevention—It can be defined as action which halts the progress of a disease at its incipient stage and prevents complications.

Self Care in Health—It is defined as those health generating activities that are undertaken by the persons themselves.

Segregation—It is the separation for special consideration, control of observation of some part of group of persons from the others to facilitate control of communicable diseases.

Sentinal Surveillance—It is a method for identifying the missing cases and thereby supplementing the notified cases required.

Sewage—The waste water from a community, containing solid and liquid excreta, derived from houses, street and yard washings, factories and industries

Social Dimension—Quantity and quality of an individual, interpersonal ties and the extent of involvement with the community.

Social Integration—It is defined as the active participation of disabled and handicapped people in the mainstream of community life.

Sociology—It is the science concerned with the organization or structure of social groups.

Society—A group of individuals who have organized themselves and follow a given way of life.

Society—Is a system of uses and procedures of authority and mutual aid of many groups coupled with divisions of control of human behaviour and liberty.

Source—The person, animal, object or substance from which an infectious agent passes or is disseminated to the host.

Spectrum of Disease:Spectrum of disease is 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.

Sporadic—The word sporadic means scattered about. The cases occur haphazardly from time to time and generally infrequently, the cases are so few and widely distributed in space and time that they show little or no connection with each other, nor a recognizable common source of infection.

Standard of Living—Refers to the usual scale of our expenditure, the goods we consume and the services we enjoy. It includes the level of education, employment, status, food, dress, house, amusement and comforts of modern living.

Standard Deviation—It is the square root of the square deviation from the mean and dividing by the number of observation.

Statistics—It is the method of collecting, organizing, analyzing and interpreting of data.

Sterilization—It is a process by which an article, surface or medium is freed of all microorganisms either in vegetative or spore state.

Surveillance—The continuous scrutiny of the factors that determine the occurrence and distribution of the disease and other conditions of ill health.

Survey—The method of collection of data, analyzing and evaluating the data in order to determine the amount of disease problems in a community and also identify cases that have not been identified.

Survey—Survey is an non experimental type of research that attempts to gather information about the status quo for a large number of cases by describing present conditions without directly analyzing their causes.

Taboo—Taboo is a strong social prohibition (or ban) aganist words, objects,action or discussions that are considered undesirable or offensive by a group, culture, society, or community.

Tertiary Prevention—All measures available to reduce or limit impairments and disabilities, minimize suffering caused by existing departures from good health and to promote the patients adjustments to irremediable conditions.

Tooth Mortality—Number of lost teeth divided by total number of teeth possible in the group.

Tooth Fatality—Number of missing teeth divided by decay missing filled teeth.

Transport Host—It is defined as a carrier in which the organism remains alive but does not undergo development.

Utilization of Services—The proportion of people in need of a service who actually receive it in a given period, usually a year.

Vaccine—Vaccine is an immunobiological substance designed to produce specific protection against a given disease.

Vector—The term vector is commonly used to describe arthropods which transmit infectious agents from human to human or from animal to human.

Vehicle—A medium through which an infectious agent is conveyed to man, most commonly used with reference to drinking water or food.

Virulence—It is defined as the proportion of clinical cases resulting in severe clinical manifestations (including sequelae).

Vital Statistics—It is defined as the facts related to vital events, systematically collected and numerically compiled.

Water Fluoridation—It is defined as an upward adjustment of fluoride ion concentration in a public drinking water supply so that the level of fluoride is maintained at the normal physiological level of 1 ppm to prevent dental caries with minimum possibility of causing dental fluorosis.

Water Defluoridation—It is defined as a downward adjustment of fluoride ion concentration in a public drinking water supply so that the level of fluoride is maintained at the normal physiologic limit of 1 ppm to prevent dental caries with minimum possibility of causing dental fluorosis.

Water Fluoridation—Is defined as the upward adjustment of concentration of fluoride ion in a public water supply in such a way that the concentration of fluoride ion in the water may be consistently maintained at one part per million (ppm) by weight to prevent dental caries with minimum possibility of causing dental fluorosis.

Zoonosis—An infection or infectious disease transmissible under natural condition from vertebrate animals to man.

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