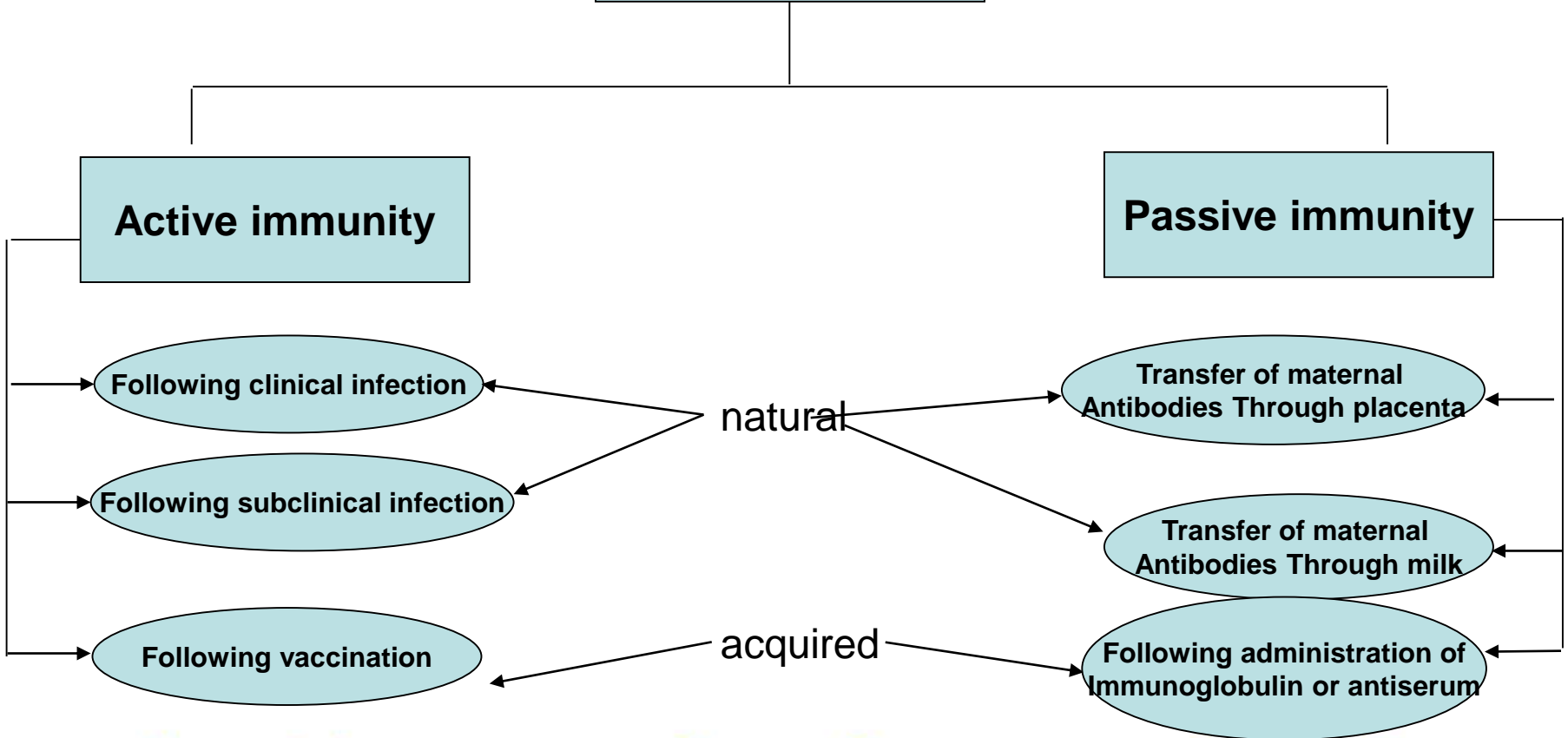


Principles of Communicable Diseases Epidemiology

LECTURE - 3

Specific defenses Immunity



Immunization

Each year, vaccines prevent more than 2.5 million child deaths globally. An additional 2 million child deaths could be prevented each year through immunization .



Why are vaccines so special?

- ❑ **Vaccines promote health:** unlike many other health interventions, they help healthy people stay healthy, removing a major obstacle to human development.
- ❑ **Vaccines have an extensive reach:** they protect individuals, communities, and entire populations.
- ❑ **Vaccines have rapid impact:** the impact of most vaccines on communities and populations is almost immediate.

For example, between 2000 and 2008, vaccination reduced global deaths from measles by 78% (from 750 000 deaths to 164 000 deaths per year)

- **Immunization:** is the process whereby a person is made immune or resistant to an infectious disease, typically by the administration of a vaccine. Vaccines stimulate the body's own immune system to protect the person against subsequent infection or disease.
- **Immunization procedure called **vaccination** and the immunizing agent called **vaccine**.**

IMMUNIZING AGENTS

The immunizing agents may be classified as **vaccine, immunoglobulin** and **antisera**.

Vaccines

A vaccine is a biological preparation that improves immunity to a particular disease .

A vaccine typically contain an agent that resembles a disease –causing microorganism , and is often made from weakened or killed forms of the microbe or its toxins.

The agent stimulates the body's immune system . Vaccines can be prophylactic or therapeutic .

Characteristics of Effective Vaccines

➤ **Safety**

➤ **Protection**

➤ **Long-lasting effects**

Cost Inexpensive to produce and deliver

➤ **Administration easy to deliver
with no side-effects**

TYPES OF VACCINES

Live attenuated (LAV)

- Tuberculosis (BCG)
- Oral polio vaccine (OPV)
- Measles
- Rotavirus
- Yellow fever

Inactivated (killed antigen)

- Whole-cell pertussis (wP)
- Inactivated polio virus (IPV)

Subunit (purified antigen)

- Acellular pertussis (aP),
- *Haemophilus influenzae* type B (Hib),
- Pneumococcal (PCV-7, PCV-10, PCV-13)
- Hepatitis B (HepB)

Toxoid (inactivated toxins)

- Tetanus toxoid (TT),
- Diphtheria toxoid

TYPES OF VACCINES

1-LIVE VACCINE:

Only small pox vaccine is no more in uses at present.



A young [Bangladeshi](#) girl infected with smallpox (1973).
Due to the development of the smallpox [vaccine](#), the disease was officially eradicated in 1979.

2- LIVE ATTENUATED VACCINE:

a virulent vaccine, virulent pathogenic organisms can not be used as such, but so treated to become attenuated and a virulent, but remain antigenic.

Available live attenuated vaccines are:

BCG Use for prevention of TB

OPV (oral polio vaccine) (Sabin)

Measles

MMR(measles, mumps, rubella)

Rubella

Rotavirus vaccine

A rotavirus vaccine protects children from rotaviruses, which are the leading cause of severe diarrhea among infants and young children.

Rota virus vaccine is a live, oral pentavalent vaccine that contains five rotaviruses.



For administering Rotarix®, click here



In general, live attenuated vaccines are more potent immunizing agents than killed vaccines, the reasons being :

(I) live organisms multiply in the host and the resulting antigenic dose is larger than what is injected.

(ii) live vaccines have all the major and minor antigenic components.

(iii) live vaccines occupy certain tissues of the body, as for example, intestinal mucosa by the oral polio vaccine.

(iv) There may be other mechanisms such as the persistence of latent virus.

Such vaccines produce a durable immunity , but not always as long as that of natural infection.

Live attenuated vaccines should not be administered to persons with immune deficiency diseases or to persons whose immune response may be suppressed because of leukemia, lymphoma or malignancy or because of therapy with corticosteroids, alkylating agents, anti - metabolic agents, or radiation.

Pregnancy is another Contraindication.

When two live vaccines are required they should be given either simultaneously at different sites or with an interval of at least 3 weeks.

In the case of live vaccines, immunization is generally achieved with a single dose.

The exception is polio vaccine which needs three or more doses to be given at spaced intervals to produce effective immunity.

3-INACTIVATED VACCINES (killed vaccine)

live attenuated vaccines can not be prepared for some infectious diseases, where killed organisms are used.

Though inactivated (by heat& chemicals), they are antigenic and stimulate immune response.

TAB (ENTERICA), Pertussis, cholera, Salk (parenteral) for polio, hepatitis A and rabies vaccine.

They tend to provide a shorter length of protection than live vaccines, and are more likely to require boosters to create long-term immunity.

The only absolute contraindication to their administration is a severe local or general reaction to a previous dose.

4-Cellular fractions: prepared from extracted cellular fractions, e.g., meningococcal vaccine from polysaccharide of the cell wall, They are available for:

meningococcal, pneumococcal, & homophiles influenza vaccine (Hib)
Hepatitis B poly peptide vaccine (new).

Polysaccharide vaccine prevents disease, but cant prevent carrier state

5-SURFACE - ANTIGEN VACCINE (subunit) : protein subunit –rather than introducing an inactivated or attenuated microorganism to immune system, a fragment of it can create an immune response.

Examples include the subunit vaccine against *Hepatitis B virus* that is composed of only the surface proteins of the virus ; two forms were prepared for HBV :

- *Plasma- derived hepatitis B vaccine, made of Hbs Ag, prepared from healthy Hbs Ag carriers.**
- Yeast – recombinant hepatitis B vaccine; Hbs Ag needed to prepare the vaccine is produced by recombinant DNA in yeast cell, it is the vaccine used at present.**
- Virus –like particle (VLP) vaccine against human papilloma virus (HPV).**

TOXOIDS

Some bacterial diseases are not directly caused by a bacterium itself, but by a toxin produced by the bacterium.

They are detoxicated exotoxins preparations which stimulate formation of humoral antitoxin immunity.

Diphtheria toxoids & tetanus toxoids are widely used for active immunization, each by itself or in combinations (DPT& DT) ,Pertussis toxoids (less reaction), Cholera toxoid ;oral , against cholera exotoxin, which is the major pathogenic factor of cholera vibrios.

Combination Vaccines

Combination vaccines take two or more vaccines that could be given individually and put them into one shot.

Combination vaccines defines as “a product whose components can be equally divided into independently available routine vaccines.”

What are some examples of combination vaccines?

DPT

MMR

DT

DTaP-Hib-polio

DTaP-hepatitis B- IPV

DTP-HB-Hib -IPV

Advantages of combination vaccines

1. Fewer injections
2. Reduced trauma to the infant
3. Higher rates of compliance with complex vaccination schedules^[3,4]
4. Better vaccine coverage^[5]
5. Timely vaccination – vaccination schedule completed on time^[5]
6. Reduced administration costs
7. Lower storage space requirements
8. Allows incorporation of new vaccines into immunization schedules^[7]

SYSTEMS OF ACTIVE IMMUNIZATION

Primary (first time) immunization & booster immunization or revaccination, are to maintain protective immune level, if necessary.

1-Primary immunization : giving either single dose or more than one dose with proper spacing in between doses, according to nature of vaccine.

One- dose primary immunization stimulates formation of protective immunity either:

- ❑ Producing a form of innocent infection; certain viral vaccines.**
- ❑ Forming a focus of infection, at site of inoculation, that stimulates the immune response, and continues for so long as the focus exists, BCG.**

Single dose vaccine: MEASLES, MUMPS, RUBELLA, MMR, BCG, PLAGUE.

Multiple -dose primary immunization: for efficiently protective immune response, in toxoids & certain vaccines , it is necessary to fulfill :

- Giving a suitable NO. Of doses, usually (3), sometimes 2, and occasionally 4, according to preparation, but for rabies vaccine more doses are given.**
- Proper spacing of doses, varies may be 4 weeks (TAB, CHOLERA), 8weeks (DPT, OPV,). Less spacing than the optimum lowers the immune response, but longer spacing would not affect the response.**

Multiple dose vaccine/ toxoids: DPT, DT, OPV, HB VACCINE, TAB, CHOLERA VACCINE.

2. Booster immunization as long as an individual or particular group is exposed to the risk of infection, it is necessary to give a booster dose after a suitable interval, to maintain a satisfactory level of immunity.

Protective period of full primary & booster immunization:

- **short period of some months; cholera & plague vaccines which are protective for about 6M.**
- **3- 5 years: DPT, Tetanus toxoids**
- **5 or more years : BCG**
- **Solid, life time immunity: Measles, MMR, Mumps no booster doses are needed).**

What are the factors determining effectiveness of active immunization in prevention of a particular infectious disease in the community?

1-Vaccine or toxoids:

- * **Protective (immunologic) value.**
- * **How handled since prepared until used, including the cold chain.**
- * **For organisms characterized by frequent antigenic changes – influenza vaccine must be prepared from the prevailing organisms of outbreak or epidemic.**

2-Process of immunization: requirements of primary & booster immunization, or revaccination, including doses, spacing & route of administration must be fulfilled.

3-Vaccination coverage:

Vaccination coverage is the percent of at risk or susceptible individuals, or population who have been fully immunized against particular diseases by vaccines or toxoids.

To be significantly effective in prevention of disease on mass or community level at least a satisfactory proportion (75% or more) of the at risk population must be immunized.

Why an actively immunized individual may get disease when exposed to infection?

1-Causes related to the vaccine/ toxoids & process of immunization : inactivation of live attenuated vaccine used; not using updated vaccine of antigenic ally changing organisms, moderate protective value of vaccine

2- Host factors:

- * Unsatisfactory or impaired immune response .**
- * Serum antibody level at time of immunization; the higher the level, less immune response to active immunization & vice versa.**

Age & dose	Vaccine
After birth(1 st week)	BCG, OPV (0 dose) , HBV (within 24hr)
2 Months 1 st dose	(السداسي)[DPT, Hib , HBV,IPV]& Rota virus & OPV , pneumococcal
4Months 2 nd dose	[DPT, Hib , HBV,IPV]& Rota virus &OPV السداسي, pneumococcal
6Months 3 rd dose	[D PT, Hib , HBV, IPV], Rota virus , OPV pneumococcal
9Months	Measles vaccine + vit A (100 ,000IU)
15 Months{1 st dose}	MMR
18 Months	[DPT , Hib,HBV], OPV { <u>1ST booster dose</u> }+ vit A (200,000IU)
4- 6 Years	(DPT,Hib,HBV), OPV (<u>2ND booster dose</u>), MMR(<u>2nd dose</u>)

HAZARDS OF IMMUNIZATION

No immune response is entirely free from the risk of adverse reactions or remote sequel.

The adverse reactions that may occur may be grouped under the following heads:

- 1. Reactions inherent to inoculation**
- 2. Reactions due to faulty techniques**
- 3. Reactions due to hypersensitivity**
- 4. Neurological involvement**
- 5. Inflammatory reactions**
- 6. Others**

Ways of achieving satisfactory immunization coverage

- ✓ **Efficient immunization service; urban and rural**
- ✓ **Health awareness and cooperation of the public**
- ✓ **Periodic mass immunization campaigns, to cover those who missed regular immunizations**
- ✓ **Outreach programs in rural and migrant areas, and home visits**

Application of active immunization

- ❑ **Infants and children expanded immunization program (schedule)**
 - ❑ **Active immunization for adult females**(MMR vaccine is given in adolescence girls, Tetanus toxoid in pregnancy)
 - ❑ **Vaccination for special occupations**
 - ❑ **Vaccination for special life styles**
 - ❑ **Vaccination for special environmental situations**
- All should receive hepatitis B vaccine**

- ❑ **Vaccinations for special health status persons**

- ❑ **Vaccinations in travel**

- ❑ **Vaccines against bioterrorism : Anthrax**

**Small pox
plague**

□ **Vaccination for special occupations**

- ✚ **Health care workers: hepatitis B, influenza, MMR, polio**
- ✚ **Public safety personnel (police, fire fighters) and staff of institutions for the developmentally disabled: hepatitis B, influenza**
- ✚ **Vets and animal handlers: rabies, plague and anthrax**
- ✚ **Sewage workers: DT, hepatitis A, polio, TAB**
- ✚ **Food handlers: TAB**
- ✚ **Military troops and camp dwellers: pneumococcal, meningococcal, influenza, BCG (for non reactors), tetanus.**

❑ **Vaccinations for special health status persons.**

- **Immuno-compromised persons (Leukemia, lymphoma, HIV, malignancy...)**
- **Hemodialysis and transplantation should receive the following vaccines according to their situation:**
- **HBV, Influenza, Pneumococcal vaccines**

❑ **Vaccinations in travel:** Haj for instance necessities meningococcal vaccination from all over the world , TAB, YF from places like south Africa, and cholera from places like India.