Principles of Communicable Diseases
Epidemiology-L-3/24-25

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Objectives

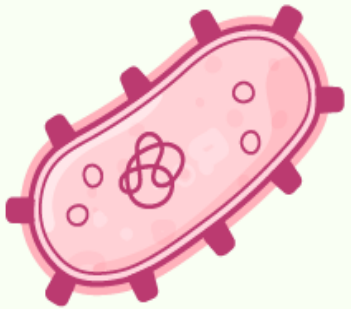
- Recognize the types of immunity and vaccines
- Recall common combination vaccines for childhood immunizations
- Describe routine vaccine schedules for common childhood diseases in Iraq
- Outline the Application of active immunization

TYPES OF IMMUNITY

ACTIVE IMMUNITY

IMMUNITY DEVELOPED AFTER THE IMMUNE SYSTEM MAKES ITS OWN ANITBODIES

NATURAL



ANTIBODIES MADE AFTER AN INFECTION

ARTIFICIAL

ANTIBODIES MADE AFTER A VACCINATION

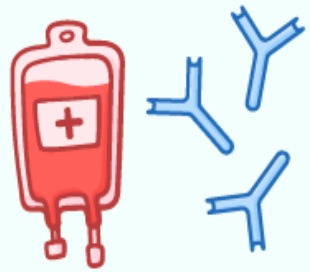
PASSIVE IMMUNITY

IMMUNITY ACQUIRED BY RECEIVING ANTIBODIES FROM ANOTHER ORGANISM

NATURAL

ANTIBODIES TRANSMITTED FROM MOTHER TO BABY

ARTIFICIAL



ANTIBODIES TRANSFUSED OR INJECTED INTO INDIVIDUAL

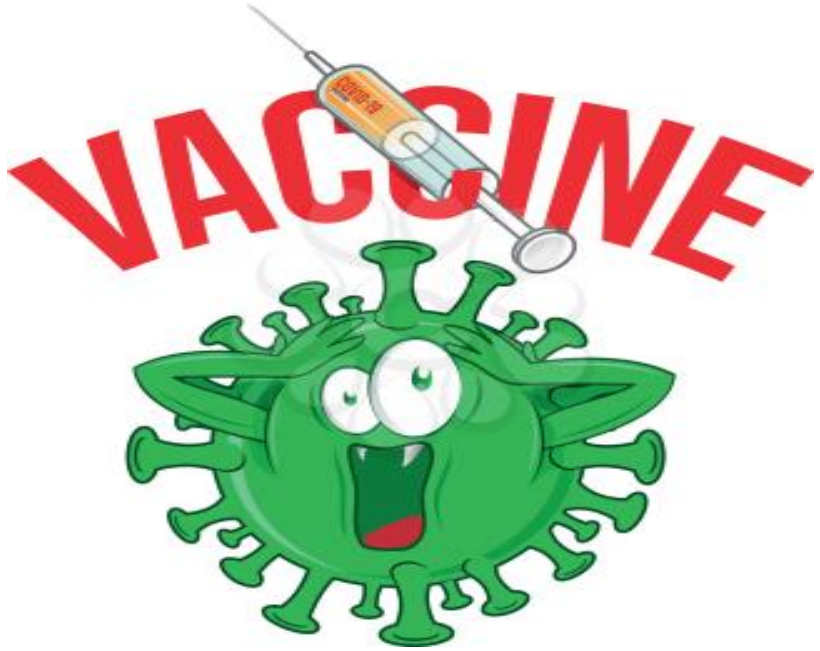
Immunization

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 vaccines are 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.

Vaccination: **The act of introducing a vaccine into the body to produce protection from a specific disease.**



Immunization: **A process by which a person becomes protected against a disease through vaccination.**

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 contains 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 .

Characteristics of Effective Vaccines

- **Safety**
- **Protection**
- **Long-lasting effects**
- **Cost Inexpensive to produce and deliver**
- **Administration easy to deliver with no side-effects**

There are several types of vaccines, including:

- **Inactivated vaccines**
- **Live-attenuated vaccines**
- **Messenger RNA (mRNA) vaccines**
- **Subunit, recombinant, polysaccharide, and conjugate vaccines**
- **Toxoid vaccines**
- **Viral vector vaccines**

1-LIVE VACCINE:

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

2- LIVE ATTENUATED VACCINE:

Live attenuated vaccines contain whole bacteria or viruses which have been “weakened”(attenuated) so that they create a protective immune response but do not cause disease in healthy people.

For most modern vaccines this “weakening” is achieved through genetic modification of the pathogen either as a naturally occurring phenomenon or as a modification specifically introduced by scientists.

Live vaccines tend to create a strong and lasting immune response

- 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 attenuated vaccines, immunization is generally achieved with a single dose.

Available live attenuated vaccines are

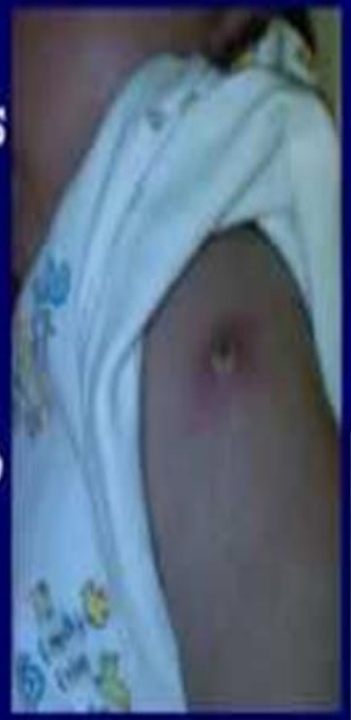
BCG **Use for prevention of TB. ID injection in left deltoid**

OPV (oral polio vaccine) (Sabin)

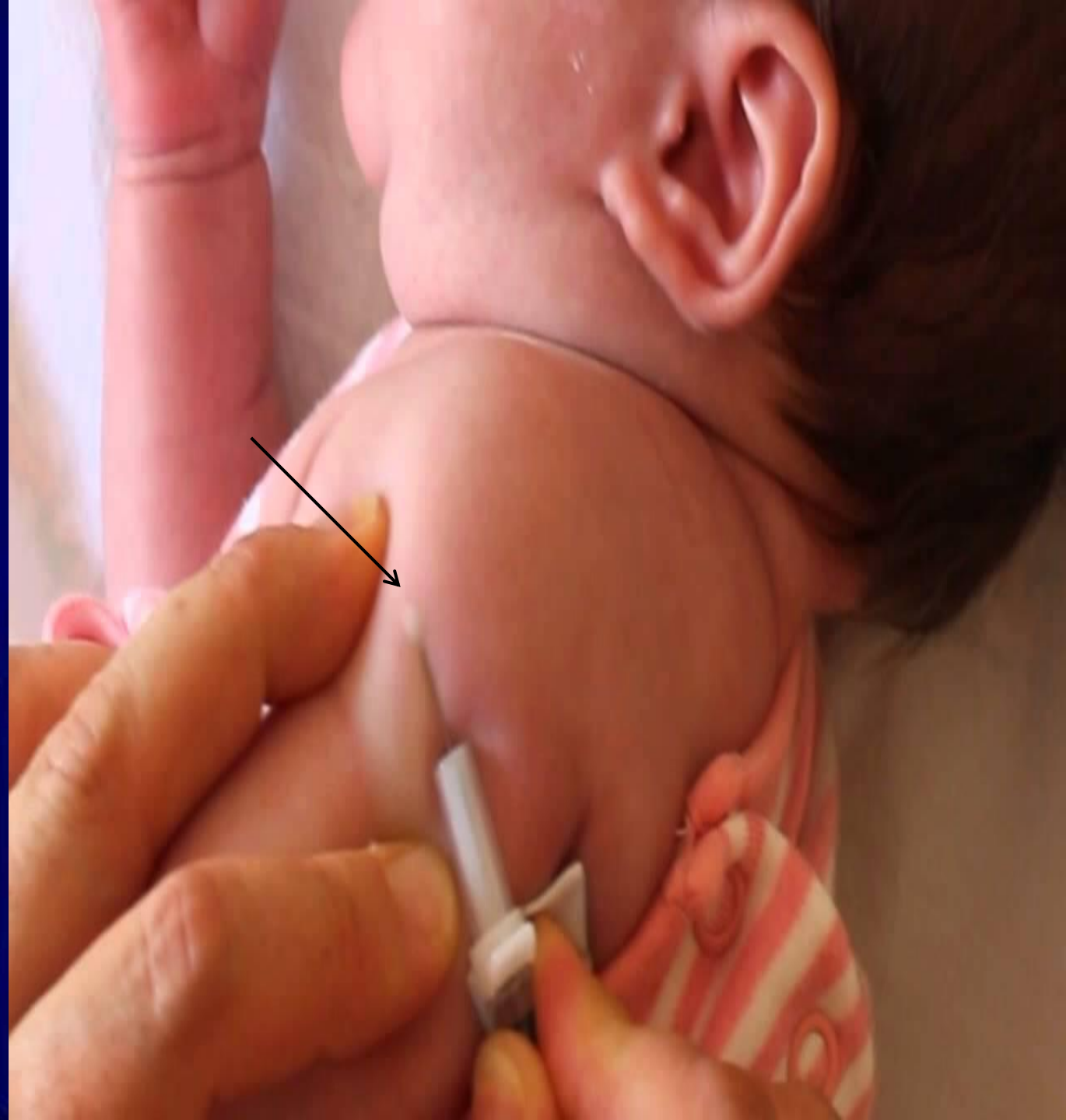
- OPV live attenuated , 2 drops

NORMAL BCG REACTIONS

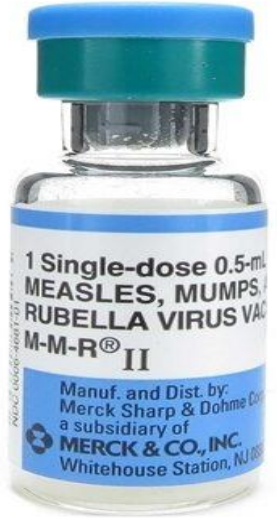
- < 5 mm of erythematous induration,
- bluish-red pustule @ 2 - 3 wks
- Ulceration, drainage, crust formation @ 4 - 6 wks
- healing 10 - 12 wks,
- small scar



- Non suppurative adenopathy



- ✓ **Measles**
- ✓ **MMR (measles, mumps, rubella)**
- ✓ **Rubella**



- **0.5 ml**
- **Subcutaneous -arm**

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.

3-INACTIVATED VACCINES (killed vaccine)

Inactivated vaccines contain whole bacteria or viruses, which have been killed or have been changed, so that they cannot replicate. Because inactivated vaccines do not contain any live bacteria or viruses, they cannot cause the diseases against which they protect, even in people with severely weakened immune systems.

Types include:

Viral: - Injected polio vaccine (Salk vaccine)
-Hepatitis A vaccine
-Rabies vaccine
-Most influenza vaccines
-Some COVID-19 vaccines

Bacterial:

Injected typhoid vaccine
Cholera vaccine
Plague vaccine
Whole-cell Pertussis vaccine

Advantages and disadvantages

Advantages

- **Inactivated pathogens are more stable than live pathogens. Increased stability facilitates the storage and transport of inactivated vaccines.**

- **Unlike live attenuated vaccines, inactivated vaccines cannot revert to a virulent form and cause disease.**

  For example, there have been rare instances of the live attenuated form of poliovirus present in the oral polio vaccine (OPV) becoming virulent, leading to the inactivated polio vaccine (IPV) replacing OPV in many countries with controlled wild-type polio transmission

- **Unlike live attenuated vaccines, inactivated vaccines do not replicate and are not contraindicated for immunocompromised individuals.**

Disadvantages

- Inactivated vaccines have a reduced ability to produce a strong immune response for long-lasting immunity when compared to live attenuated vaccines.

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

4 - Sub unit vaccines

Subunit vaccines are made from a piece of a pathogen, not the whole organism, so they do not contain any live pathogens.

Use specific pieces of the germ—like its protein, sugar, or capsid (a casing around the germ).
Because these vaccines use only specific pieces of the germ, they give a very strong immune response that's targeted to key parts of the germ.

Subunit vaccines can be further categorized into:

- **Protein-based subunit vaccines**
- **Polysaccharide vaccines**
- **Conjugate subunit vaccines**

- **They can also be used on almost everyone who needs them, including people with weakened immune systems and long-term health problems.**

- **One limitation of these vaccines is that need to give booster shots to get ongoing protection against diseases.**

❖Protein-based subunit vaccines

- **Protein based subunit vaccines present an antigen to the immune system without viral particles, using a specific, isolated protein of the pathogen.**
- **A weakness of this technique is that isolated proteins, if denatured, may bind to different antibodies than the protein of the pathogen.**
- **Commonly used protein-based subunit vaccines are the following:**

❑**Acellular pertussis (aP) vaccines contain inactivated pertussis toxin (protein) and may contain one or more other bacterial components.**

The pertussis toxin is detoxified either by treatment with a chemical or by using molecular genetic techniques.

- Hepatitis B vaccines are composed of the hepatitis B virus surface antigen (HBsAg), a protein produced by hepatitis B virus.

Earlier vaccine products were produced using purified plasma of infected individuals.

This production method has been replaced by recombinant technology that can produce HBsAg without requiring human plasma increasing the safety of the vaccine by excluding the risk from potential contamination of human plasma

Advantages and disadvantages of protein subunit vaccines

- **Well-established technology**
- **Suitable for people with compromised immune systems**
- **No live components, so no risk of the vaccine triggering disease**
- **Relatively stable**
- **Relatively complex to manufacture**
- **Adjuvants and booster shots may be required**
- **Determining the best antigen combination takes time**

❖Polysaccharide Vaccine

- **Some bacteria when infecting humans are often protected by a polysaccharide (sugar) capsule that helps the organism escape the human defense systems especially in infants and young children.**

Polysaccharide vaccines create a response against the molecules in the pathogen's capsule.

These molecules are small, and often not very immunogenic.

As a consequence they tend to:

1. Not be effective in infants and young children (under 18–24 months)

2. Induce only short-term immunity (slow immune response, slow rise of antibody levels, no immune memory).

Examples of polysaccharide vaccines include Meningococcal disease caused by Neisseria meningitidis groups A, C, W135 and Y, as well as Pneumococcal disease.

❑ Conjugate Vaccines

Conjugate subunit vaccines also create a response against the molecules in the pathogen's capsule.
In comparison to plain polysaccharide vaccines, they benefit from a technology that binds the polysaccharide to a carrier protein that can induce a long-term protective response even in infants.

Various protein carriers are used for conjugation, including diphtheria and tetanus toxoid.
Conjugate subunit vaccines, can therefore prevent common bacterial infections for which plain polysaccharide vaccines are either ineffective in those most at risk (infants) or provide only short-term protection (everyone else).

- **PCV (children's pneumococcal vaccine)**
- **Hib vaccine**

5- Virus Like Particles

Virus-like particles (VLPs) are molecules that closely resemble viruses, but are non-infectious because they contain no viral genetic material.

A few VLP-based vaccines are currently used worldwide:

- **Hepatitis B vaccine**
- **HPV vaccine**

6-Nucleic Acid Vaccines

❖ Messenger RNA vaccines—also called mRNA vaccines

mRNA vaccines make proteins in order to trigger an immune response.

- **mRNA vaccines have several benefits compared to other types of vaccines, including shorter manufacturing times and, because they do not contain a live virus, no risk of causing disease in the person getting vaccinated.**

- **There are two RNA vaccines authorized for emergency use at present. The Pfizer BioNTech and the Moderna COVID-19 vaccines are both RNA vaccines.**

❖ DNA vaccines

There are currently no licensed DNA vaccines, but there are many in development.

7-Viral Vectored Vaccines

As with nucleic acid vaccines, viral vectored vaccines are a newer technology, using harmless viruses to deliver the genetic code of target vaccine antigens to cells of the body, so that they can produce protein antigens to stimulate an immune response.

Viral vector vaccines modify another virus and use it as a vector to deliver protection from the intended virus. Some of the viruses used as vectors include adenovirus, influenza, measles virus and vesicular stomatitis virus (VSV).

Recent uses of viral vector technology have been in Ebola virus and COVID-19, and studies into its use for Zika, flu and HIV are ongoing.

The Oxford-AstraZeneca COVID-19 vaccine

8-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.

Toxoids can actually be considered killed or inactivated vaccines, but are sometimes given their own category to highlight that they contain an inactivated toxin, not an inactivated form of bacteria.

DNA and recombinant vector vaccines

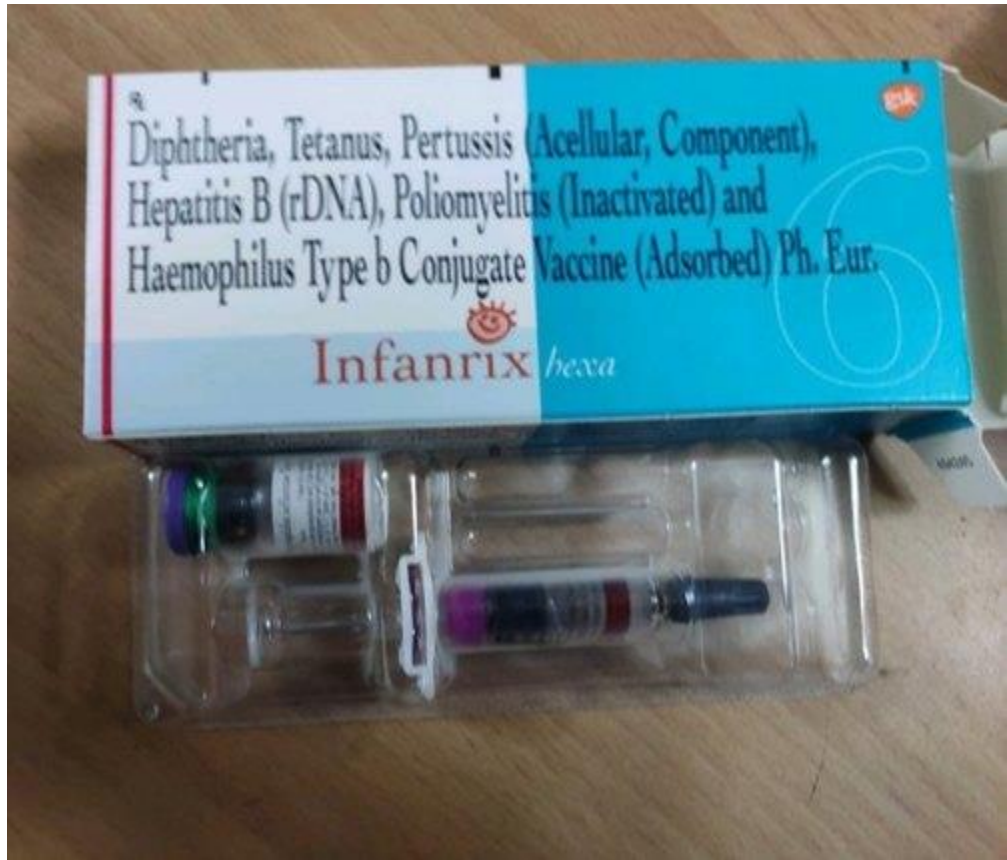
DNA and recombinant vector vaccines (also known as platform-based vaccines) are two new types of vaccines currently under development.

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.”

Some examples of combination
DPT
MMR
DT
DTaP-Hib-polio
DTaP-hepatitis B- IPV
DTP-HB-Hib –IPV



This approach has been used for over 50 years in many vaccines such as DT wP and MMR.

Combination products simplify vaccine administration and allow for the introduction of new vaccines without requiring additional health clinic visit and injections.

Potential advantages of combination vaccines include:

- **Reducing the cost of stocking and administering separate vaccines**
- **Reducing the cost of extra health care visits**
- **Improving timeliness of vaccination (some parents and health-care providers object to administering more than two or three injectable vaccines during a single visit because of a child's fear of needles and pain, and because of concerns regarding safety)**
- **Facilitating the addition of new vaccines into immunization programme**

SCHEDUALE of ACTIVE IMMUNIZATION in IRAQ (CHILDREN)

Age &dose	Vaccine
After birth(1st week	BCG, OPV (0 dose) , HBV-1 (within 24hr)
2 Months 1st dose	(الخماسي)[Panta -1] (DwPT+ Hib , HBV)& Rota virus & OPV-1+ Pneumococcal(PCV13-1)
4Months 2nd dose	Panta-2 [DwPT, Hib , HBV] , IPV-1 Rota virus-2 OPV-2+ Pneumococcal (PCV13-2)
6Months 3rd dose	[D wPT, Hib , HBV] . IPV-2, OPV-3 + Pneumococcal(PCV13-3)
9Months	Measles vaccine + vit A (100.000 IU)
12 Months	MMR
18 Months	[DwPT +Hib] الرباعيTetra (1st booster dose) MMR , OPV 1st booster , vit A (200.000IU)
4- 6 Years	DwPT الثلاثي (2ND booster dose), OPV, Vit A(200.000IU)

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, lifetime immunity: Measles, MMR, Mumps.**

What are the factors determining effectiveness of active immunization 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: it is the percent of individuals of at risk group or population, who has been fully immunized. For satisfactory benefit of a given vaccine, coverage must be not less than 80- 85%.

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.**

Application of active immunization

- **Infants and children expanded immunization program EPI (schedule)**

- **Active immunization for adult females(MMR vaccine is given in adolescence girls, or rubella vaccine .Tetanus toxoid in pregnancy**

❑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.**

ANY QUESTION?

References:

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