Childhood Immunization

Learning objectives
1. Define immunity, immunization, immunizing agents and know the types of active and passive immunization
2. Know the factors that affect the response to vaccinations
3. Understand the goal of immunization and know some principles in vaccinations
4. Define the types of vaccine failure
5. Recognize the adverse effects and general contraindication of vaccination
6. To be aware of false contraindication of vaccinations

Immunity
Immunity is the ability of the human body to protect itself from infectious disease.
- Natural or non-specific immunity is present from birth and includes:
  - Physical barriers (e.g. intact skin and mucous membranes)
  - Chemical barriers (e.g. gastric acid, digestive enzymes and bacteriostatic fatty acids of the skin)
  - Phagocytic cells
  - Complement system.
- Acquired immunity is generally specific to a single organism or to a group of closely related organisms. There are two basic mechanisms for acquiring immunity – active and passive.

Immunization-Definition (WHO)
- 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

History
Vaccination (Latin: vacca—cow) is so named because the first vaccine was derived from a virus affecting cows: the cowpox virus, a relatively benign virus that provides a degree of immunity to smallpox, a contagious and deadly disease.
The term was coined by Edward Jenner in 1796 and adapted by Louis Pasteur in 1885.

Active immunity
- Protection that is produced by an individual’s own immune system and is usually long-lasting.
- Active immunity can be acquired by natural disease or by vaccination.
• Vaccines generally provide immunity similar to that provided by the natural infection, but without the risk from the disease or its complications.
• Passive immunity is protection provided from the transfer of antibodies from immune individuals,
  ✓ Most common: Across the placenta
  ✓ Less often: Blood transfusion & blood products including immunoglobulin
• This protection is temporary – commonly for only a few weeks or months

**Immunizing agents**

1. **Vaccine**: A preparation of proteins, polysaccharides, or nucleic acids of pathogens that are delivered to the immune system to induce active immunization.
2. **Toxoid (detoxified toxins)**: A modified bacterial toxin that has been made nontoxic but retains the capacity to stimulate the formation of antitoxin and induce active immunization.
3. **Immune globulin**: An antibody-containing solution derived from human blood obtained by large pools of plasma and used for passive immunization (primarily for the maintenance of immunity of immunodeficient persons).
4. **Antitoxin**: An antibody derived from the serum of humans or animals after stimulation with specific antigens; used to provide passive immunity.

**Goal of Immunization**

1. Immediate goal of immunization is to prevent disease in individuals
2. Ultimate goal is to eliminate or even eradicate a communicable disease.

**Herd Immunity**

The risk of infection among susceptible individuals in a population is reduced by the presence and proximity of immune individuals "indirect protection" or a "herd effect". In this way transmission falls or stops without universal immunity.

The more children in a community that are fully immunized, the more everyone is safe.
## Types of Active Immunization

The current approaches to active immunization are the use of

1. live-attenuated infectious agents (Measles, mumps, rubella & OPV)
2. Inactivated or detoxified agents, their extracts, or specific recombinant products, include:
   - A. Inactivated whole organisms (e.g., whole-cell pertussis and hepatitis A vaccines)
   - B. Detoxified exotoxins (e.g., tetanus and diphtheria toxoids)
   - C. Purified protein antigens (e.g., acellular pertussis and hepatitis B vaccines),
   - D. Polysaccharides (e.g., capsular meningococcal vaccine)
   - E. Capsular polysaccharides conjugated to carrier proteins (e.g., Hib and pneumococcal conjugate vaccines)
   - F. Components of the organism (e.g., subunit influenza vaccine).

### Types of Active Immunization

<table>
<thead>
<tr>
<th>Bacterial</th>
<th>Live attenuated</th>
<th>BCG</th>
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<tr>
<td>Inactivated</td>
<td>Inactivated whole organism</td>
<td>Pertussis, typhoid &amp; cholera</td>
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<td>Toxoids</td>
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<td>Polysaccharides</td>
<td>Capsular meningococcal</td>
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<td></td>
<td>Purified protein antigens</td>
<td>Acellular pertussis</td>
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<td>Capsular polysaccharides conjugated to carrier proteins</td>
<td>Hib and pneumococcal conjugate vaccines</td>
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<td>Viral</td>
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<td>Inactivated</td>
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<td>Purified protein antigens</td>
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<td>Components of the organism</td>
<td>Subunit influenza vaccine</td>
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Active Immunization

Types

♦ Live attenuated
  o Virus Measles, mumps, rubella & OPV
  o Bacteria BCG

♦ Killed
  o Virus
    ▪ Whole Hepatitis A & IPV
    ▪ Purified protein antigens Hepatitis B
  o Bacteria
    ▪ Whole Pertussis
    ▪ Toxoid Tetanus & Diphtheria
    ▪ Polysaccharide Meningocccal

Passive Immunization

1. Human Immune Serum Globulin
   n Specific
     • IM Hepatitis B (HBIG) & Tetanus (TIG)
     • IV CMV (CMV-IG) & RSV (RSV-IG)

   n Non-specific
     • IM Immune serum globulin (ISG)
       » Hepatitis A
       » Measles
     • IV Intravenous immune globulin (IGIV)
       » Antibody deficiency disorders
       » ITP
       » Kawasaki syndrome

2. Specific equine antibodies (IM)
   - Botulism antitoxin
   - Diphtheria antitoxin
   - Tetanus antitoxin
   - Snake & spider anti-venom

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Factors that affect the response to vaccinations

1. **Chemical** and **physical** state of the antigen

2. the **mode** of administration

3. **Host** factors (e.g., age, nutrition, gender, and pre-existing antibody)

4. Presence of high concentrations of **maternal antibody** in the first few months of life and the relative immaturity of the immune response impair the initial immune response to some vaccines

5. **Route** of administration
   - Parentally administered vaccines may not induce mucosal secretory IgA, whereas vaccines given orally are likely to do so.
   - The immunogenicity of some vaccines is reduced when not given by the proper route. For example, subcutaneous hepatitis B vaccine.

Rights of vaccine Administration

- the right patient
- the right vaccine
- the right time*
- the right dosage
- the right route, needle length, and technique
- the right site; and
- the right documentation
- *(includes administering at the correct age, the appropriate interval, and before vaccine or diluent expires)*

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Vaccine failure

♦ No vaccine offers 100% protection and a small proportion of individuals get infected despite vaccination.
♦ Vaccines can fail in two main ways – primary or secondary vaccine failures:

Vaccine failure

Primary failure

Occurs when an individual fails to make an initial immunological response to the vaccine.

- Infection can therefore occur at any point after vaccination.
- e.g. is the 5–10% of children who do not respond to the measles component of the first dose of MMR. The risk of measles in such children is reduced by *offering an additional dose of vaccine, usually before school entry.*

Secondary failure

Occurs when an individual responds initially but then protection decrease over time.

- Individuals who acquire infection despite vaccination may have a modified, milder form of disease and are less likely to suffer serious complications than those who have never been vaccinated.

  ➢ An example is pertussis vaccine, when protection against whooping cough after three doses is initially high but declines as a child gets older. *A fourth (booster) dose is given to improve protection during the school years.*

Goal of Immunization

♦ The immediate goal of immunization is to prevent disease in individuals, but the ultimate goal is to eliminate or even eradicate a communicable disease.
♦ Herd immunity exists if the number of people in a community who have active immunity against an infection exceeds a level. Above which; susceptible individuals are unlikely to contact someone with the infection.
♦ In this way transmission falls or stops without universal immunity.

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Principles in Vaccination

I. Live vaccines, unless given simultaneously, should not be given within a month of each other.
   ➢ Recent oral polio vaccine (OPV), however, does not contraindicate giving measles/mumps/rubella (MMR) at the appropriate time.

II. Vaccines should not be given within 3 months of receiving a gamma globulin product

III. Premature infants should be kept on the same schedule as full-term infants; split doses of vaccine are unnecessary.

IV. Lapsed immunizations do not require reinstitution of an entire vaccine series; immunizations should be given as though the proper interval has elapsed

V. Children whose vaccination status is uncertain should be considered unimmunized and should be given appropriate vaccines.

VI. There are no contraindications to simultaneous administration of multiple vaccines, which are routinely recommended for infants and children.

Adverse events after vaccination

♦ Vaccine components can cause allergic reactions in some recipients, the most common extraneous allergen is egg protein from vaccines prepared in embryonated eggs, such as measles, mumps, influenza, and yellow fever vaccines.
♦ Reactions may be local or systemic, including anaphylaxis and urticaria.
♦ Local or systemic reactions result from too frequent administration of some vaccines, such as tetanus toxoids or rabies, and are probably caused by antigen-antibody complexes.

General Contraindications

1. Serious allergic reaction (e.g., anaphylaxis) after a previous vaccine dose
2. Serious allergic reaction (e.g., anaphylaxis) to a vaccine component
3. Moderate or severe illnesses with or without a fever (more than 38 C )
False contraindications to vaccination

✓ Mild acute illness with low grade fever or mild diarrhea
✓ Mild to moderate local reaction (soreness, redness, swelling) after a dose of an injectable antigen
✓ Current antimicrobial therapy
✓ Prematurity
✓ Breast feeding
✓ Pregnancy of mother or household contact
✓ Malnutrition
✓ A history of penicillin or other non specific allergy
✓ Family history of convulsion in a child considered for pertussis or measles vaccination

Thanks