Community Medicine

Summary

Slide # 7

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Vaccination

This is going to be a long journey, but it's the hardest slide so sorry for this depressing summary:")

****The doctor said no numbers are included*****

IMMUNE SYSTEM

- **Definition**: complex network of specialized organs/cells that protect bodies from destruction by foreign agents and microbial pathogens.
- **Function**: degrading and removing damaged/dead cells, and exerts a surveillance function to prevent the development and growth of malignant cells.
- **Composition**: immune cells and central/peripheral lymphoid structures.
- Immune cells move throughout the body, searching and destroying foreign substances but avoiding cells regarded as self.

TWO TYPES OF IMMUNITY

NATURAL: **Not** produced by the immune response, rather it is present at birth and appears to be present in all members of a species.

ACQUIRED: develops after birth as a result of exposure to an antigen, thereby activating the immune response. It can be active or passive, depending on whether the immune response took place in the host or a donor.

IMMUNE SYSTEM (children compared to adults)

At birth: we don't have a fully active immune system because of immaturity. Infants rely on passively transferred antibodies from the mother. This maternal antibody slowly decreases in concentration.

At 7 or 8 months: own production of antibody (when the total of maternal + infant antibody= low) and high susceptibility to infections begins.

PASSIVE IMMUNITY

- Transfer of antibody produced by one human or other animal to another
- Temporary protection

Sources

- Transplacental (most important source in infancy)
- Almost all blood or blood products
- Human antibody (Immune Globulin)

IMMUNIZATION

- The process where a person is made immune **(resistant)** to an infectious disease, typically through administrations of a vaccine. Vaccines stimulate the body's own immune system to protect the person against subsequent infection or disease.

- A proven tool for: control and elimination of life-threatening infectious diseases and prevents deaths each year from *diphtheria, tetanus, pertussis (**whooping cough**), and measles.*

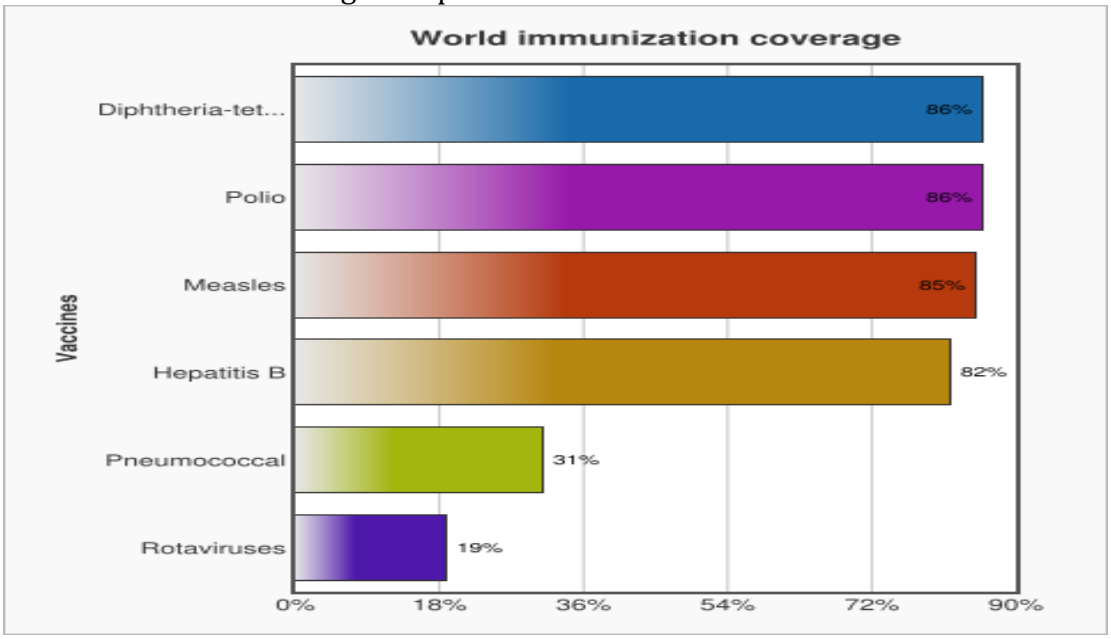
- In addition, a lot of deaths could be avoided if global vaccination coverage improves.

- **Global vaccination coverage**- proportion of the world's children who receive recommended vaccines- has remained steady for the past few years.

- Infants worldwide received 3 doses of diphtheria-tetanus-pertussis (DTP3) vaccine, protecting them against infectious diseases that can cause serious illness, disability, or fatal.

- One of the most cost effective health investments with proven strategies that make it accessible to even the most hard-to-reach and vulnerable populations. It has clearly defined target groups; it can be delivered effectively through outreach activities.

****DON'T MEMORIZE NUMBERS (the percentages), just know which one has higher immunization coverage compared to the other****



From this

Global Immunization Coverage

Haemophilus Influenzae:

- Type b (Hib)—causes **meningitis** and **pneumonia**
- Hib vaccine

- Global coverage with 3 doses of Hib vaccine
- Great variety between regions

Hepatitis B

- Viral infection that attacks the liver
- Its vaccine: for infants had been introduced nationwide
- Global coverage with 3 doses of Hep B vaccine

Human Papillomavirus

- Causes cervical cancer and genital warts (both men and women)
- Most common viral infection in the reproductive tract

Measles

- Highly contagious diseases caused by a virus- usually results in high fever and rash, and can lead to *blindness, encephalitis, or death.*
- *MORE* children receive 1 dose of measles vaccine and many countries had included a second dose as part of routine immunization
- LESS amount of the children receive 2 doses according to national immunization schedule

Meningitis A

- An infection that causes **severe brain damage** and is often deadly.
- Many people in African countries affected by the disease had been vaccinated.

Mumps

- Highly contagious virus
- Causes: painful swelling at the side of the face under the ears (the parotid glands), fever, headache, and muscle aches.
- Can lead to viral meningitis
- Mump vaccine was introduced nationwide

Pneumococcal Diseases

- Pneumonia
- Meningitis
- Febrile bacteremia
- Otitis media
- Sinusitis
- Bronchitis
- ***Vaccine:*** introduced in many countries and had global coverage

Polio

- Highly infectious viral disease
- Causes: irreversible paralysis
- Many infants around the world received 3 doses of polio vaccine
- Targeted for global eradication, polio had been stopped in all countries EXCEPT: Afghanistan and Pakistan.
- Polio-free countries have been infected by imported virus, and ALL countries- especially those experiencing conflict and instability, are still at risk.

Rotaviruses

- Most common cause of severe diarrheal disease in young children worldwide
- Vaccine was introduced nationwide

Rubella

- Viral disease mild in children but infection during early pregnancy may cause fetal death or congenital rubella syndrome→ can lead to defects of the brain, heart, eyes, and ears.
- Rubella was introduced nationwide

Tetanus

- Caused by a bacterium that grows in absence of O2.. Example: dirty wounds or in the umbilical cord (if it is not kept clean)→ produces a toxin which can cause serious complications or death
- Vaccine: prevents neonatal and maternal tetanus
- Many newborns were protected through immunization
- Maternal and neonatal tetanus persist as public health problems in few countries, mainly Asia and Africa

Yellow Fever

- Acute viral hemorrhagic disease transmitted by infected mosquitoes
- Yellow fever vaccine has been introduced in routine infant immunization programs in countries and territories at risk for yellow fever in Africa and the Americas

KEY CHALLENGES

- WHO identified 5 factors to achieving results in immunization coverage:
  1. Quality and use of data
  2. Community involvement
  3. Better access to immunization services for marginalized and displaced populations
  4. Strong health systems
  5. Access to vaccines in all places at all times
- Infants worldwide were not reached with routine immunization services such as DTP3 vaccine
- Many of these children live in 10 countries: Angola, Democratic Republic of the Congo, Ethiopia, India, Indonesia, Iraq, Nigeria, Pakistan, the Philippines, and Ukraine.
- Monitoring data at subnational levels: important to help counties prioritize and tailor vaccination strategies and operational plans to address immunization gaps and reach every person with lifesaving vaccines.

GLOBAL VACCINE ACTION PLAN (GVAP)

- Endorsed by the Member States of the World Health Assembly

- A framework to prevent millions of deaths by 2020 through more easy access to existing vaccines for people in all communities.

- ***Goal:***
  a. To strengthen routine immunization to meet vaccination coverage targets
  b. Accelerate control of vaccine-preventable diseases with polio eradication as the first milestone
  c. Introduce new and improved vaccines and spur research and development for the next generation of vaccines

- **3 key steps for closing the immunization gap:**
  * Integrating immunization with other health services, such as postnatal care
  * Strengthening health systems so that vaccines continue to be given even in times of crisis
  *Ensuring that everyone can access vaccines and afford to pay for them

Herd Immunity

- ***In case 1***: few people are immune to an infectious disease (e.g. 10%) →the incidence of acute infections in susceptible hosts is relatively high.
- ***In case 2:*** where the level of immune persons is (e.g. 50%) → the incidence of acute infections in susceptible hosts is sporadic and relatively low
- ***In case 3:*** where the level of immunity is high (e.g. 90%)→ the incidence of new cases in susceptible hosts is very low.

Vaccination

- Purpose: administration of a substance to a person with the purpose of preventing a disease
- Traditionally composed of a killed or weakened microorganism
- Works by creating a type of immune response that enables the memory cells to later respond to a similar organism before it can cause the diseases
- Only 34 vaccines made (know this number just in case)

ERA OF VACCINATION (story time)

The story of how smallpox got eradicated:

English physician Edward Jenner: observed that milkmaids stricken with a viral disease called cowpox were rarely victims of a similar disease, called smallpox. Jenner took a few drops of fluid from a pustule of a woman who had cowpox and injected the fluid into a healthy young boy who had never had cowpox or smallpox. Six weeks later, Jenner injected the boy with fluid from a smallpox pustule, but the boy remained free of the dreaded smallpox. In those days, a million people died from smallpox each year in Europe alone, (mainly children). Those who survived were often left with blindness, deep scars, and deformities. Later on, Jenner started on a course that would ease the suffering of people around the world for centuries to come. Many years later, an updated version of Jenner vaccine leads to the total eradication of smallpox.

Since Jenner, vaccines developed for more then 20 infectious diseases:

Date of intro of 1st generation of vaccines for use in humans:

- **smallpox**
- **rabies**
- **plague**
- **diphtheria**
- **Pertussis**
- **TB (BCG)**
- **Tetanus**
- **Yellow Fever**

After World War II: (1950s-1980s)

- **Injectable Polio Vaccine (IPV)**
- **Oral Polio Vaccine (OPV)**
- **Measles**
- **Rubella**
- **Hepatitis B**

Types of Vaccines:

- The way in which the body responds to a vaccine depends on the type of vaccine being administered. There are several different types of vaccine available and with new technology there will be more.
- The more similar a vaccine is to the natural disease, the better the immune response to the vaccine**.**

Classifcation of Vaccines

- There are two basic types of vaccines: live attenuated and inactivated.
- Their characteristics determine how the vaccine is used .

Live attenuated vaccines

- **Result:** The resulting vaccine organism retains the ability to replicate (grow) and produce immunity, but usually does not cause illness.

- Include live viruses and bacteria.

- Live vaccines are derived from "wild," or disease-causing, virus or bacteria. These wild viruses/bacteria are attenuated (or weakened), in a lab, usually by repeated culturing. For example, the measles vaccine used today was isolated from a child with measles disease back then. Almost 10 years of serial passage on tissue culture media was required to transform the wild virus into vaccine virus.

- A relatively small dose (usually 1 dose if not taken orally) of virus /bacteria is given, which replicates in the body and creates enough virus/bacteria to stimulate an immune response.

- Anything that either damages the live organism in the vial (e.g., heat, light), or interferes with replication of the organism in the body (circulating antibody) can cause the vaccine to be ineffective.

- Although they replicate, they usually do not cause disease, such as may occur with the natural ("wild") organism. When a live attenuated vaccine does cause "disease," it is usually much milder than the natural disease, and is referred to as an adverse reaction.

- The immune response to a live attenuated vaccine is virtually identical to that produced by a natural infection. The immune system does not differentiate between an infection with a weakened vaccine virus and an infection with a wild virus.

- May cause severe or fatal reactions as a result of uncontrolled replication (growth) of the vaccine virus. This only occurs in persons with immunodeficiency (e.g., from leukemia, treatment with certain drugs, or HIV infection)

- Could theoretically revert back to its original pathogenic (disease-causing) form. This is known to happen only with live (oral) polio vaccine.

- Active immunity from a live attenuated vaccine may not develop due to interference from circulating antibody to the vaccine virus. Antibody from any source (e.g., Transplacental, transfusion) can interfere with growth of the vaccine organism and lead to a poor response or no response to the vaccine (also known as vaccine failure). Measles vaccine virus seems to be most sensitive to circulating antibody. Polio and rotavirus vaccine viruses are least affected.

- They must be handled and stored carefully. Currently available live attenuated viral vaccines include measles, mumps, rubella, varicella, yellow fever, influenza (intranasal), oral polio vaccine, BCG, and oral typhoid vaccine.

Characteristics

- Able to replicate in the host
- Attenuated (weakened) so they do not cause disease

Advantages

- Induce a broad immune response (cellular and humoral)
- Low doses of vaccine are normally sufficient
- Long-lasting protection are often induced

Disadvantages

- May cause adverse reactions
- May be transmitted from person to person

Inactivated Vaccines

- Composed of either whole viruses or bacteria, or fractions
- Fractional vaccines= protein based or polysaccharide-based
- Protein based—include toxoids (inactivated bacterial toxin), and subunit or subvirion products
- Most polysaccharide-based are made of pure cell wall polysaccharide from bacteria
- Conjugate polysaccharide vaccines are when the polysaccharide is chemically linked to a protein. This link makes the polysaccharide very potent.
- Produced by: culture media→ inactivating it with heat/ chemicals (formalin). In the case of fractional vaccines, the organism is further treated to purify only those parts to be included in the vaccine (the polysaccharide capsule of pneumococcus.)
- Not alive and can't replicate
- Cannot cause disease from infection, even in an immune-deficient person
- ALWAYS require multiple ~~diseases~~ doses
- Produce protective immunity, but only "primes" the immune system
- Immune response: mostly humoral, little to no cellular immunity results
- Antibody titers against inactivated antigens diminish with time. As a result, some inactivated vaccines may require periodic supplemental doses to increase "boost" antibody titers.

- Only for WHOLE inactivated viral vaccines: influenza, polio, rabies, and hepatitis A, pertussis, typhoid, cholera, and plague.
- Only for FRACTIONAL vaccines: subunits of hepatitis B, influenza, acellular pertussis, and toxoids (diphtheria, tetanus)

Polysaccharide Vaccines

- **Special type** of inactivated subunit vaccine
- Composed of long chains of sugar molecules that make up the surface capsule of certain bacteria.
- Pure polysaccharide vaccines: pneumococcal, meningococcal, and Salmonella typhi
- Immune response: typically t-cell INDEPENDENT = able to stimulate B-cells with no help of the T-cells
- T-cell INDEPENDENT antigens (polysach. vaccines) are not immunogenic in children under 2 years old
- Young children do not respond consistently to polysaccharide antigens (because of immaturity of immune system)
- EXCEPTION: polysaccharide vaccines do NOT have a "booster" response with multiple doses unlike the inactivated protein vaccines that DO cause a booster response.
- This is not seen with polysaccharide antigens. Antibody induced with polysaccharide vaccines has less functional activity than that induced by protein antigens. This is because the predominant antibody produced in response to most polysaccharide vaccines is IgM, and little IgG is produced.

Conjugate Vaccines

- It was discovered that the problems with polysaccharide vaccines could be overcome through a process called *conjugation*. Conjugation changes the immune response from T-cell *independen*t to T-cell *dependent,* leading to increased immunogenicity in infants and antibody booster response to multiple doses of vaccine.
- The first conjugated polysaccharide vaccine was for Haemophilus Influenzae type b (Hib)
- Also now available are conjugate vaccines: pneumococcal disease and meningococcal disease.

Recombinant Vaccines

- Vaccine antigens may also be produced by *genetic engineering technology*. These products = referred to as recombinant vaccines. There are f**our genetically-engineered vaccines** are currently available:
- *Hepatitis B* vaccines are produced by insertion of a segment of the hepatitis B virus gene into the gene of a yeast cell. The modified yeast cell produces pure hepatitis B surface antigen when it grows.
- *Human papillomavirus vaccines* are produced by inserting genes for a viral coat protein into either yeast (as the hepatitis B vaccines) or into insect cell lines. Viral-like particles are produced and these induce a protective immune response.
- *Live typhoid vaccine (Ty21a)* is Salmonella typhi bacteria that has been genetically modified to not cause illness.

- *Live attenuated influenza vaccine (LAIV)* has been engineered to replicate effectively in the mucosa of the nasopharynx but not in the lungs.

General Principles of the action of vaccines

- Most vaccines are injected directly into muscle tissue. Briefly the following occurs:
- Vaccine antigen disassociates from adjuvant (i.e. aluminum hydroxide)
- Cells of the non-specific immune system (i.e. macrophages and dendritic cells) recognize the antigen as foreign and engulf it→ then chop the antigen into smaller fragments→display these on their cell surfaces.
- The dendritic cells move through the lymphatic system to a local lymph node where specific T cells and B cells which recognizes the fragments of antigen generate a specific immune response.
- Other components in the vaccine such as the adjuvant and preservative, if present, are absorbed into the blood where they circulate and are excreted in the stools and urine.
- Live viral vaccines multiply several times in the relevant tissues as per natural infection, however these viruses are attenuated so they cannot multiply as much as a the normal infectious virus.
- Different vaccines stimulate the immune system in different ways. Some provide a broader response than others. Vaccines influence the context of the immune response by the nature of the antigens, the amount of antigens, route of administration as well as adjuvants present.

*****Route of Administration*****

Oral	OPV ***Oral polio vaccine***
Intradermal	BCG, ****Bacille Calmette-Guérin (Tuberculosis) Vaccine*** Rabies
Subcutaneous	MMR **Measles, Mumps, Rubella*, IPV *Inactivated* ***polio vaccine,*** Pneumoccocal, Influenza
Intramuscular	DPT, DT Tetanus, Hepatitis A, HepatitisB, Pneumococcal, Rabies, Hib, Influenza

*****Site of Administration*****

Intradermal	Over the insertion of left deltoid muscle
Subcutaneous	Anterolateral aspect of the thigh or the upper arm
Intramuscular	Anterolateral aspect of the thigh in infants and deltoid muscle in older children or adult.

Q) Who should not be vaccinated?

- **Allergy**
- **Fever**
- **HIV infection**
- **Immunodeficiency**
- **Neurological Disorder**
- **Prematurity**
- **Reactions to previous vaccine**
- **Simultaneous administration of vaccines**
- **Thrombocytopenia**

Allergy:

Allergic Reactions to Egg-related antigens

1. Yellow fever and influenza vaccines do contain egg proteins and rarely induce immediate allergic reactions. Skin testing is recommended before administration with an history of allergic to egg
2. MMR- even those with severe hypersensitivity are at low risk of anaphylaxis.

Vaccination in pregnancy:

- Risk to a developing fetus from vaccination of the mother during pregnancy is mostly theoretical
- Only smallpox vaccine has ever been shown to injure a fetus
- The benefits of vaccinating usually outweigh potential risks

- **Inactivated vaccines**

Routine (influenza)
Vaccinate if indicated (Hep B, Td, mening, rabies)
Vaccinate if benefit outweighs risk (all other)
Live vaccine – do not administer
Exception is yellow fever vaccine

- **For *pregnant woman* all of the following vaccines are contraindicated: Influenza (LAIV), MMR, Varicella, and Zoster**

Exception: Human Papillomavirus – NOT recommended.

Vaccine Cold Chain

- **Maintaining proper vaccine temperatures during storage and handling to preserve potency**
- **The success of efforts against vaccine-preventable diseases is attributable in part to proper storage and handling of vaccines.**
- **Exposure of vaccines to temperatures outside the recommended ranges can affect potency adversely, thereby reducing protection from vaccine-preventable diseases**

Vaccination Schedule Preschool in Jordan

Age → type of vaccine

1st contact→ BCG
2 months → DaPT1 IPV1+Hib+1HepB1
3 months → DaPT2 IPV2+Hib2+HepB2+OPV
4 months→ DaPT3 IPV3 + Hib3+ HepB3+ OPV
9 months → Measles + OPV
12 months → MMR1
18 months→ DPT (booster1) + OPV + MMR2

School Immunization Schedule:

School children who were completely vaccinated

- 1st class ------ OPV + Td+ checked for MMR (2 doses)
- 10th class ----- Td+ checked for MMR (2 doses)
- Validate the primary vaccination (preschool program)
- Vaccinate the unvaccinated children according to national program

TT vaccination

1st pregnancy:
- At first contact 1st TT dose
- After one month from the 1st dose 2nd TT

2nd pregnancy:
- 3rd dose

3rd pregnancy:
- 4th dose

4th pregnancy:
- 5th dose

Vaccination for extra groups:

*Influenza vaccine (pilgrims, health personnel, & high risk groups)

*Meningitis vaccine (pilgrims, contacts, &high risk groups)

*HBV to health workers & prisoners

*Typhoid vaccine for the high-risk areas

FOCUS A LOT ON THESE LAST TWO CHARTS!!!!

Types of Vaccines

Vaccine	Type of vaccine	Disease	Storage temp.
BCG	Live attenuated Bacteria	Tuberculosis	2 to 8 ^{O}C
OPV (Oral Polio)	Live attenuated Virus	Poliomyelitis	Can be freezed
DPT	-D & T (Fractional (Toxoid) -Pertussis (Inactivated whole bacteria)	_Diphtheria & Tetanus _ Pertussis	2 to 8 ^{O}C Damaged by freezing
Measles	Live attenuated Virus	Measles	2 to 8 ^{O}C Can be freezed

Vaccines Types

Vaccine	Type of vaccine	Disease	Storage temp.
MMR	Live attenuate Virus (Measles +Mumps+ Rubella)	Measles -Mumps -Rubella	2 to 8 ^{O}C Can be freezed
HBV	Recombinant (HBSAg)	Hepatitis B	2 to 8 ^{O}C Damaged by freezing
Hib	Fractional(Conjugate Polysaccharide)	Haemophilus Influenza B	2 to 8^{O}C
IPV	Inactivated polio virus	Poliomyelitis	2 to 8 ^{O}C Damaged by freezing

GOOD LUCK ☺