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### **Discuss on immunization and prevention**

#### **Immunization**

Immunization is the process of stimulating an individual's immune system to recognize and combat pathogens, such as bacteria or viruses. The main tool for immunization is vaccination, which involves introducing a harmless part or a weakened form of a pathogen (antigen) into the body. This triggers an immune response, helping the body "learn" to recognize and fight the pathogen in the future.

#### **How vaccines work**

Vaccines work by introducing a component of a pathogen to the immune system. The body recognizes this component as foreign, and the immune system responds by producing antibodies. These antibodies are proteins that bind to and neutralize the pathogen. Additionally, the immune system generates memory cells that "remember" the pathogen, allowing the body to mount a faster and stronger defense if it encounters the pathogen again.

#### **Types of vaccines**

There are different types of vaccines:

1. Live Attenuated Vaccines: These contain a weakened form of the virus or bacteria (e.g., measles, mumps, rubella, and yellow fever vaccines). They typically offer long-lasting immunity but may not be suitable for people with weakened immune systems.
2. Inactivated or Killed Vaccines: These contain viruses or bacteria that have been killed or inactivated so they cannot cause disease (e.g., polio and hepatitis A vaccines).
3. Subunit, Recombinant, or Conjugate Vaccines: These contain parts of the pathogen, such as proteins or sugars, that are important for immune recognition (e.g., HPV vaccine, Haemophilus influenzae type b (Hib) vaccine).
4. Messenger RNA (mRNA) Vaccines: These vaccines, such as the Pfizer-BioNTech and Moderna COVID-19 vaccines, contain genetic material (mRNA) that instructs cells to produce a protein that triggers an immune response.

## **Benefits of Immunization**

1. Prevention of Disease: Vaccines can prevent the occurrence of various infectious diseases, some of which can be deadly or cause long-term disability (e.g., polio, tetanus, and hepatitis B).
2. Herd Immunity: When a large proportion of a population is immunized, the spread of disease is minimized. This protects vulnerable individuals who cannot be vaccinated, such as those with weakened immune systems or allergies to vaccine components.
3. Elimination and Eradication: Immunization has led to the global eradication of smallpox and has drastically reduced the incidence of diseases like polio. The goal of global vaccination campaigns is to eliminate certain diseases from the population entirely, which can be achieved through widespread vaccination programs.
4. Cost-Effectiveness: Vaccination is one of the most cost-effective public health interventions. The economic benefits of preventing disease outweigh the costs of vaccination in terms of healthcare savings, lost productivity, and other societal costs.

### Benefits and Global Impact

Immunization is one of the most successful public health interventions, saving millions of lives annually and preventing diseases like smallpox (eradicated), polio, measles, and tetanus. It provides individual protection and contributes to herd immunity, which protects vulnerable people who cannot be vaccinated. The benefits far outweigh the risks, as serious side effects are extremely rare compared to the complications of the diseases they prevent.

### Programs and Schedules

Vaccination is guided by national and international schedules, such as those promoted by the WHO's Essential Programme on Immunization (EPI), which aim to ensure universal access to critical vaccines throughout a person's life, often requiring multiple doses (boosters) for long-lasting protection.

Routine Immunisation Schedule					
Minimum target age of child	Type of vaccine	Dosage	Route of administration	Site	Diseases prevented
At birth	BCG	0.05ml	Intra dermal	left upper arm	
	OPV 0	2 drops	Oral	Mouth	Tuberculosis, polio, Hepatitis B
	Hep B@ birth	0.5ml	Intramuscular	Anterolateral aspect of right thigh	
6 weeks	Pentavalent (DPT/Hep B and Hib)1	0.5ml	Intramuscular	Anterolateral aspect of left thigh	(Diphtheria+Pertussis +Tetanus+Hepatitis)
	Pneumococcal Conjugate Vaccine 1	0.5ml	Intramuscular	Anterolateral aspect of right thigh	pneumonia and meningitis.
	OPV 1	2 drops	oral	Mouth	polio
	IPV 1	0.5ml	Intramuscular	Anterolateral aspect of right thigh (2.5cm apart from PCV)	polio
	Rotavirus vaccine 1	5 drops	oral	Mouth	diarrhea
10 weeks	Pentavalent (DPT/Hep B and Hib) 2	0.5ml	Intramuscular	Anterolateral aspect of left thigh	(Diphtheria+Pertussis +Tetanus+Hepatitis)
	Pneumococcal Conjugate Vaccine 2	0.5ml	Intramuscular	Anterolateral aspect of right thigh	pneumonia and meningitis.
	OPV 2	2 drops	oral	Mouth	polio
	Rotavirus vaccine 2	5 drops	oral	Mouth	diarrhea,
	Pentavalent (DPT/Hep B and Hib) 3	0.5ml	Intramuscular	Anterolateral aspect of left thigh	(Diphtheria+Pertussis +Tetanus+Hepatitis)
14 weeks	Pneumococcal Conjugate Vaccine 3	0.5ml	Intramuscular	Anterolateral aspect of right thigh	pneumonia and meningitis.
	OPV 3	2 drops	oral	Mouth	polio
	Rotavirus vaccine 3	5 drops	oral	Mouth	diarrhea,
	IPV 2	0.5ml	Intramuscular	Anterolateral aspect of right thigh (2.5cm apart from PCV)	Polio
	Malaria Vaccine	0.5ml	Intramuscular	Anterolateral aspect of right thigh	Malaria
5 months	Vitamin A 1st dose	100000 IU	Oral	Mouth	Nutritional supplement
6 months	Malaria Vaccine	0.5ml	Intramuscular	Anterolateral aspect of right thigh	Malaria
7 months	Malaria Vaccine	0.5ml	Intramuscular	Anterolateral aspect of right thigh	Malaria
9 months	Measles 1st dose (MCV1)	0.5ml	Subcutaneous	Left upper arm	measles
	Yellow fever	0.5ml	Subcutaneous	Right upper arm	Yellow fever
	Meningitis Vaccine	0.5ml	Intra Muscular	Anterolateral aspect of left thigh	Meningitis
	Vitamin A 2nd dose	200,000 IU	Oral	Mouth	Nutritional supplement
15 months	Measles 2nd dose (MCV 2)	0.5ml	Subcutaneous	Left upper arm	Measles
	Malaria Vaccine	0.5ml	Intramuscular	Anterolateral aspect of right thigh	Malaria
9 years	HPV	0.5ml	Intramuscular	Deltoid muscle (left upper arm)	Human papilloma virus

\*HPV Vaccine for all 9 year old girls

## Challenges in Immunization

1. Vaccine Hesitancy: One of the main challenges to immunization is vaccine hesitancy, which is often driven by misinformation, fear, and distrust in medical systems. This has led to outbreaks of diseases that were previously under control, such as measles and whooping cough.
2. Global Inequities: There is a significant disparity in vaccine access between high-income and low-income countries. Many developing nations face challenges in acquiring vaccines, leading to higher rates of preventable diseases.
3. Logistical Challenges: Some vaccines require cold-chain storage (keeping vaccines at low temperatures), which can be difficult to maintain in remote or resource-limited areas.

## **Prevention**

### **Disease Prevention: Broader Strategies to Combat Infection**

Prevention strategies extend beyond vaccines and encompass a range of practices, policies, and behaviors designed to reduce the risk of infection and promote public health.

**A. Primary Prevention:** Primary prevention focuses on preventing disease before it occurs. It includes strategies that reduce exposure to risk factors and protect the body from potential threats.

- i. Vaccination: As discussed, immunization is a key form of primary prevention.
- ii. Health Education: Educating the public about health practices such as handwashing, safe food handling, and safe sex can prevent the spread of many diseases.
- iii. Vector Control: Measures to control disease vectors, such as mosquitoes (which spread malaria, dengue, Zika, etc.), include insecticides, bed nets, and eliminating breeding sites (e.g., standing water).
- iv. Sanitation and Clean Water: Ensuring access to clean water and proper sanitation helps prevent diseases caused by contaminated water (e.g., cholera, dysentery).
  
- v. Nutrition: Proper nutrition supports the immune system, reducing vulnerability to infections. Micronutrient supplementation (e.g., vitamin A for children) has been shown to reduce the risk of some infections.

### **B. Secondary Prevention**

Secondary prevention aims to detect and treat diseases early, before they cause significant harm. It involves screening for diseases and conditions that may not yet show symptoms.

- i. Screening Programs: Regular screening for diseases like cancer (e.g., mammograms, colonoscopies) or infections like HIV, hepatitis B, and tuberculosis helps detect conditions early when they are easier to treat.
- ii. Early Treatment: Treating infections or conditions at an early stage can prevent complications and reduce the spread of infectious agents.

### **C. Tertiary Prevention**

Tertiary prevention focuses on managing and reducing the impact of diseases that cannot be cured or eliminated. This level of prevention involves interventions aimed at minimizing the effects of a disease or injury and improving the quality of life for those affected.

i. Rehabilitation: After a disease or injury, rehabilitation programs help patients recover function and maintain independence. This may include physical therapy, psychological support, or community services.

ii. Palliative Care: In cases where a disease is incurable, palliative care aims to alleviate symptoms, manage pain, and provide emotional and psychological support for patients and families.

### **Combining Immunization and Prevention: A Comprehensive Public Health Approach**

A well-rounded public health strategy combines both immunization and broader prevention efforts to achieve optimal health outcomes. For example:

1. HIV/AIDS Prevention: Along with vaccination strategies for diseases like hepatitis B (which can be transmitted through similar routes), prevention of HIV transmission focuses on safe sex practices, needle exchange programs, education, and antiretroviral treatments.

2. Influenza: The flu vaccine is a critical tool in preventing influenza, but other preventive measures, such as hand hygiene, wearing masks, and avoiding close contact during peak flu season, also help reduce transmission.

3. Antimicrobial Resistance (AMR): Vaccines play a role in reducing the use of antibiotics for preventable diseases, which can help combat antimicrobial resistance, a growing threat to global health.

4. Global Health Initiatives: Organizations like the World Health Organization (WHO) and UNICEF work to integrate immunization into broader health initiatives, ensuring that vaccines reach the most vulnerable populations in low- and middle-income countries. Programs such as Gavi, the Vaccine Alliance, aim to improve vaccine access worldwide.

### **Future Directions in Immunization and Prevention**

1. Next-Generation Vaccines: The development of vaccines is continually evolving. New technologies such as mRNA vaccines, universal flu vaccines, and vaccines for diseases like malaria and HIV show promise in expanding our ability to prevent infections.

2. Personalized Prevention: Advances in genetics and personalized medicine may lead to tailored prevention strategies, including vaccines and treatments based on individual risk profiles.

3. Global Coordination: Strengthening global cooperation, sharing resources, and improving vaccine distribution systems are essential to achieving global health equity.

4. Addressing Vaccine Hesitancy: Efforts to educate the public and build trust in vaccines are

crucial in overcoming barriers to immunization.

## **Conclusion**

Immunization and prevention are cornerstone strategies in global health, essential for reducing the burden of infectious diseases and improving health outcomes. Vaccination saves millions of lives every year, while prevention strategies at the individual, community, and global levels help mitigate the risk of disease transmission and promote healthier environments. As science advances, the hope is that new vaccines, prevention strategies, and global collaborations will continue to reduce the prevalence of infectious diseases, particularly in underserved populations.