

Childhood Vaccine Preventable Diseases

3.0 Contact Hours

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Childhood Vaccine Preventable Diseases

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Abstract

Clean water and vaccines are the two public health interventions that have had the greatest impact on the world's health. Infectious diseases create a great havoc especially in developing countries. The advent of vaccines and later antibiotics have reduced the impact of infectious diseases on mankind. Of these two, vaccines are meant to prevent before the disease sets in whereas antibiotics are meant to clear the infection after it starts manifesting.

Infectious diseases are still a major cause of death, disability and social and economic burden for millions around the world. More than 90 percent of the deaths from infectious diseases worldwide are caused by only a handful of diseases. Many of these diseases can be easily prevented by administration of vaccines. Vaccines are very cost effective too. Human beings have benefited from vaccines for more than two centuries. The pioneering work of Jenner and Pasteur which lead to the development of vaccines prevent millions of death world wide.

Upon completion of this course, the learner will be able to:

1. Discuss infectious diseases and their impact
2. Discuss vaccines, its invention and its history
3. Discuss the various vaccine preventable diseases
4. Discuss the vaccines available to prevent these diseases

Infectious diseases and their impact

Infectious diseases kill more people worldwide than any other single cause. The infections could be due to bacteria, viruses, fungi or protozoa. Despite medical advances that have produced hundreds of drugs that are safe and effective against bacteria, viruses, fungi and parasites, infectious diseases are still a major cause of death, disability and social and economic burden for millions around the world.

Apart from the general ecology, various other factors including social and economic factors contribute to the increased incidence of infectious disease worldwide. These include poverty, lack of access to medical care, antibiotic resistance, evolving human migration patterns, new infectious agents, and changing environmental and development activities. The factors contributing to the increased incidence of infectious diseases are mainly encountered in developing countries.

For the past 3 decades after HIV/AIDS started creating havoc, infectious diseases are not restricted to developing countries alone. HIV/AIDS are known to suppress the immune system. This leads to various opportunistic infections with a multitude of organisms. Since the early 1990s, the tuberculosis epidemic has largely been driven by the HIV/AIDS pandemic. Fueled by growing antibiotic resistance, inappropriate prescription of ineffective drugs, and poor adherence to medication, infectious diseases once believed to be under control have re-emerged as major global threats.

The morbidity and mortality due to infectious diseases are preventable and treatable. Most of these occur in developing countries. More than 75% of the deaths due to infectious diseases occur in developing countries.

Children and women are particularly vulnerable to the impact of infectious diseases. Children in developing countries lack proper nutrition, live under poor sanitary conditions and many do not have access to health care. They also live in overcrowded places. All these factors contribute to development of infectious diseases in them. The

repercussions of these infectious diseases are not limited to just morbidity and mortality, but also affect productivity, educational activities and increase health care costs.

Vaccines

Immunization represents a remarkably successful and very cost effective means of preventing infectious diseases. As a result of routine childhood immunizations, the occurrence of once contagious diseases declined markedly in the United States and other countries in the second half of the 20th century. Public health programs based on vaccination have led to global eradication of small pox, elimination of polio from the United States and possibly from the world in the near future and greater than 95% reduction of invasive Hemophilus influenza.

What is a vaccine?

Vaccine is a preparation of proteins, polysaccharides or nucleic acids of pathogens that are delivered to the immune system as single entities, as part of complex particles or by live attenuated agents or vectors, to induce specific responses that inactivate, destroy, or suppress the pathogen

What is a toxoid?

A toxoid is a modified bacterial toxin that has been made non-toxic but retains the capacity to induce the formation of antitoxin.

What is immune globulin?

Immune globulin is an antibody containing solution derived from human blood obtained by cold ethanol fractionation of large pools of plasma. It is used primarily for maintenance immunity of immunodeficient persons or for passive immunization.

What is antitoxin?

Antitoxin is an antibody derived from the serum of humans or animals after stimulation with specific antigens. It is used to provide passive immunity.

What is vaccination?

Vaccination is the administration of any vaccine or toxoids for preventing disease.

What is immunization?

Immunization is the process of inducing immunity artificially by either vaccination or administration of antibodies. Administration of vaccines is called active immunization. Administration of antibodies is called passive immunization. Immunizing agents include vaccines, toxoids, antitoxins and immune globulins. Most of these immunizing agents contain preservatives, stabilizers, antibiotics, adjuvants and a suspending fluid.

In 1977, only 5 percent of the world's children were vaccinated. Today, that figure has climbed to 75 percent and more than 3 million lives have been saved each year. In 1978, WHO declared that small pox had been eradicated from the world. It is the first disease to be eradicated.

Vaccination started as early as the 18th century. In 1798, Edward Jenner began to carry out inoculations against smallpox, the first systematic effort to control a disease through immunization. In 1885, Louis Pasteur developed the first vaccine to protect humans against rabies. Toxoids against diphtheria and tetanus were introduced in the early 1900s; the bacillus Calmette-Guérin vaccine (against tuberculosis) in 1927; the Salk polio vaccine in 1955; and vaccines against measles and mumps in the 1960s.

Vaccine Preventable diseases

In 2002, WHO estimated that 1.4 million deaths among children under 5 years were due to diseases that could have been prevented by routine vaccination. This represents 14% of the global total mortality in children under 5 years of age.

Since the introduction of the small pox vaccine by Jenner 200 years ago, many infectious diseases have been controlled by vaccines. The list of vaccine preventable

diseases has been increasing gradually since the inception of the immunization program.

The following is the list of the various childhood vaccine preventable diseases:

- Measles
- Mumps
- Rubella
- Poliomyelitis
- Diphtheria
- Pertussis
- Tetanus
- Hepatitis B
- Hemophilus influenza b

Measles

Measles is an acute viral infection characterized by a final stage with a maculopapular rash erupting successively over the neck and face, body, arms and legs and accompanied by a high fever. It is also called rubeola. Measles is endemic throughout the world. In the past, epidemics tended to occur irregularly, appearing in the spring in large cities at 2-4 years interval as new groups of susceptible children were exposed.



Measles is very contagious. The Measles virus normally grows in the cells that line the back of the throat and the cells that line the lungs. Measles transmission typically occurs through coughing and sneezing. Measles has three clinical stages:

- Incubation stage – This lasts for 10-12 days.
- Prodromal stage- This stage is characterized by development of rashes inside the mouth called the Koplik spots.
- Final stage – This is characterized by rashes all over the body and a high grade fever

It is the complications of measles that results in the death of the child. The complications are quite serious and include:

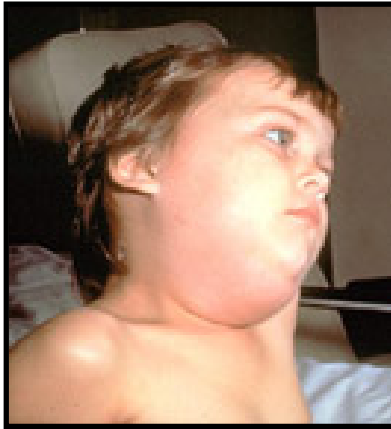
- Pneumonia - The most common cause of death
- Diarrhea
- Otitis media
- Encephalitis
- Blindness

General nutritional support and the treatment of dehydration with oral rehydration solution are necessary. Antibiotics should be prescribed for treating eye and ear infections and pneumonia. All children in developing countries diagnosed with measles should receive two doses of vitamin A supplements given 24 hours apart. This can help prevent eye damage and blindness. Moreover, vitamin A supplementation has been shown to reduce the number of deaths from measles by 50%.

In 2006, it was estimated that there were 242,000 measles deaths globally: this translates to about 663 deaths every day or 27 deaths every hour. With the advent of measles vaccine, the incidence has come down drastically. Overall, global measles mortality decreased by 68% between 2000 and 2006. The largest gains occurred in Africa where measles cases and deaths fell by 91%.

Mumps

Mumps is an acute viral infection characterized by painful enlargement of the salivary glands, chiefly the parotid glands. It is transmitted by direct contact, airborne droplets, fomites contamination by saliva and possibly by urine. Epidemics occur in all seasons, but are slightly more frequent in late winter and spring. It most often affects children between five and nine years old. But the mumps virus can infect adults as well.



The incubation period is 14 -24 days. About 40% of the infections are subclinical. The clinical features include head ache, fever, salivary gland enlargement, muscle aches, loss of appetite. The complication includes:

- Encephalitis/meningitis
- Orchitis
- Oophoritis
- Mastitis
- Arthritis
- Pancreatitis
- Thyroiditis
- Myocarditis
- Deafness

There is no specific treatment for mumps. Treatment is entirely supportive with antipyretics and bed rest.

In 1968, before the introduction of the mumps vaccine, the number of cases of mumps that was reported in the United States was 152,609. It has gone down to 683 cases in 1997. Also, maternal antibodies are protective in infants in the first 6 months of age.

Rubella

Rubella is also known as German measles or three day measles. It is an acute viral infection characterized by mild constitutional symptoms, a rash similar to measles, fever and enlargement and tenderness of lymph nodes in the neck. Rubella in early pregnancy can cause either abortion or congenital rubella syndrome. Congenital rubella causes serious birth defects.



Humans are the only hosts of rubella. It spreads either by oral droplet or transplacentally to the fetus causing congenital infection. The incubation period is 14-21 days. About two thirds of the cases are subclinical. The clinical features include mild fever, tender lymph nodes in the neck and skin rashes that last for about three days. Babies affected by congenital rubella syndrome have features including the following:

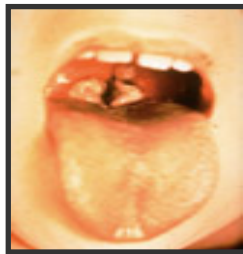
- Intra uterine growth retardation
- Cataracts
- Deafness
- Patent ductus arteriosus
- Microphthalmia
- Myocarditis
- Mental retardation

There is no specific treatment for rubella. Treatment is entirely supportive. Antipyretics are given for fever.

Before the introduction of rubella vaccine in 1969, pandemics of rubella occurred every 6-9 years with most of the cases occurring in spring. The peak incidence of rubella used to occur in children 5-14 years of age. Now after vaccination, most of the cases occur in susceptible teenagers and young adults.

Diphtheria

Diphtheria is an acute infection caused by the bacteria *Corynebacterium diphtheriae*. It is transmitted from person to person through close physical and respiratory contact. It can cause infection of the nasopharynx, which may lead to breathing difficulties and death. Risk factors include crowded environments, poor hygiene, and lack of immunization. In 2006 about 4000 cases were reported.



The incubation period is 2-4 days. Most of the clinical manifestations are due to the production of a toxin by the bacteria. This toxin spreads through the blood to different parts of the body causing the various symptoms.

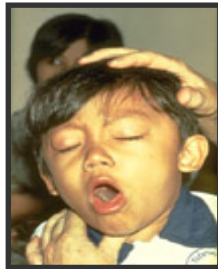
- Respiratory tract diphtheria – This is characterized by high grade fever with rhinitis, pharyngitis and laryngitis with involvement of the local lymph nodes. The most characteristic feature is membrane formation in these places which bleeds on removal. Enlarged lymph nodes cause a bull neck appearance.
- Cutaneous diphtheria – This is characterized by superficial non healing ulcers with a membrane formation.
- Toxic cardiomyopathy – This occurs in about 25% of the patients with diphtheria. It is responsible for 60% of the deaths. This is due to the inflammation of the cardiac muscle. This usually occurs 2-3 weeks after the throat infection.

- Toxic neuropathy – This occurs 2-3 weeks after the throat infection. This may result in the paralysis of the soft palate, pharynx, larynx and eye muscles. Symptoms include nasal twang, regurgitation, breathlessness, and squint.
- Infections at other sites – These include otitis, conjunctivitis, vulvovaginitis and septicemia.

Specific antitoxin is the mainstay of therapy and should be administered on the basis of clinical diagnosis. It neutralizes the free toxins. Antimicrobial therapy should be given to halt toxin production, treat local infection and prevent the transmission of infection. The organism is susceptible to various antibiotics like penicillin and erythromycin,

Pertussis

Pertussis is also called as whooping cough. It is caused by the bacteria *Bordetella pertussis*. It is a disease characterized by uncontrollable coughing. The name whooping cough comes from the noise that is produced by breathing after the coughing spell. It is a highly contagious disease. It spreads by coughing and sneezing.



The incubation period is 3-12 days. There are three phases of pertussis. These include:

- Catarrhal stage – This is characterized by low grade fever, sneezing, lacrimation and conjunctival suffusion.
- Paroxysmal stage – This is characterized by paroxysms of cough
- Convalescent stage – This is the end stage with reduction in the symptoms

The complications of pertussis include:

- Pneumonia
- Seizures
- Encephalopathy
- Death

The goals of therapy include limiting the number of paroxysms, to observe the severity of cough to provide assistance when necessary and to maximize nutrition, rest and recovery without sequelae. An antimicrobial agent like erythromycin is given to prevent the spread of infection. Other symptomatic treatment includes giving salbutamol and corticosteroids.

During the pre-vaccine era of 1922-1948, pertussis was the leading cause of death due to communicable disease among children under 14 years of age. Wide spread use of vaccines led to a greater than 99% decline in the cases.

Tetanus

Tetanus commonly called as lockjaw is an acute spastic paralytic illness caused by tetanus toxin. Tetanus toxin is a neurotoxin produced by the bacteria *Clostridium tetani*. This is a spore forming bacteria commonly found in the soil, dust and the alimentary tracts of various animals. Tetanus spores can survive boiling but not autoclaving. But the vegetative cells are killed by antibiotics, heat and standard disinfection. The most common form is the neonatal tetanus which occurs if the mother is not immunized against tetanus.



Tetanus other than neonatal tetanus is acquired by injury and contamination of the wound. The incubation period is 2-14 days. Tetanus can be localized or generalized and the latter is common. The various clinical features include:

- Trismus or lockjaw
- Stiffness of the body
- Dysphagia
- Stridor
- Seizures
- Headache
- Restlessness

When the paralysis extends to the abdominal, lumbar, pelvic and thigh muscles, the patient may assume an arched posture called opisthotonus. The smallest disturbance by light, sound or touch may trigger a tetanic spasm. Complications include aspiration pneumonia, pneumothorax, rhabdomyolysis, cardiac arrhythmias and unstable blood pressure and temperature.

Treatment includes eradication of the organism with antimicrobial agents like penicillin, neutralization of the toxins with immune globulins, surgical debridement of the wound and symptomatic treatment of the complications. Seizures are controlled with anti-epileptics.

Tetanus occurs worldwide and it is endemic in 90 developing countries. The most common type is the neonatal tetanus. Its incidence has decreased drastically since the advent of vaccines.

Poliomyelitis

Poliomyelitis is a viral infection that affects the nerves resulting in paralysis. The use of the polio vaccine has eliminated the virus in many countries like the United States. The virus spreads by direct person-to-person contact, by contact with infected mucus or phlegm from the nose or mouth, or by contact with infected feces. There are three types

of polio viruses – type 1, 2 and 3. Polioviruses spread very easily in areas with poor hygiene



Polio virus infection may follow one of several courses:

- Inapparent infection which occurs in 90-95% of cases
- Abortive poliomyelitis – This is characterized by fever, headache, vomiting, sore throat, constipation and diffuse abdominal pain.
- Non-paralytic poliomyelitis – The symptoms are the same as above in addition to soreness and stiffness of the posterior muscles of neck, trunk and limbs.
- Paralytic poliomyelitis – The symptoms are the same as above along with weakness of one or more muscle groups either skeletal or cranial

The principles of treatment include allaying fear, to minimize ensuing skeletal deformities and to prepare the child for prolonged treatment that might be necessary for permanent disability that may occur. Abortive and non-paralytic polio are treated with analgesics, sedatives, nutritious diet and bed rest. Paralytic polio requires hospitalization. Treatment is mainly supportive.

The use of poliovirus vaccine has been eliminated since 1979 for the wild polio virus in the United States. The last case of wild poliovirus in the Americas occurred in Peru in 1991. In 1994, the World Health Organization declared that polio had been eradicated from the Western hemisphere.

Hepatitis B

Hepatitis B infection infects the liver. It is responsible for deadly medical problems like cirrhosis of liver and hepatocellular carcinoma. The virus is acquired by perinatal transmission from mother to the infant, by transfusion of contaminated blood products, by sharing infected needles, by sexual contact and close household contact.



The incubation period is 45-160 days. It affects the liver and can cause the following diseases:

- Acute hepatitis – This is characterized by fever, joint pain, abdominal pain, loss of appetite and also jaundice in some cases
- Chronic hepatitis – This is usually asymptomatic with non-specific symptoms
- Cirrhosis – In this the liver is destroyed and replaced by fibrous tissue and disorganized regenerating tissue. It produces complications like portal hypertension. This can cause varices with bleeding, ascites and encephalopathy
- Hepatocellular carcinoma – Hepatitis B can cause liver cancer either directly or through the development of cirrhosis.

If the hepatitis B infection is acquired during early childhood, the chances of it becoming a chronic infection are more. If it is acquired during adulthood, the chances of it becoming chronic are less. It is the chronic infection that results in all the various manifestations.

Treatment is with antiviral agents and interferons. Antiviral agents include lamivudine, adefovir and entecavir. Interferon can be standard interferon or pegylated interferon.

An estimated 400 million persons are carriers of the hepatitis virus worldwide. Transmission by blood products has decreased due to routine screening of blood before transfusion. Perinatal transmission can be prevented by screening the mother and early vaccination in the infant.

Hemophilus Influenza b

Hemophilus influenza b is a bacterium that can cause serious infections in children less than 5 years of age. It is a gram negative bacterium spread by airborne droplets due to coughing and sneezing. It can cause fetal infections involving the brain, lungs and blood.

Humans are the only natural host of this organism. It is a constituent of the normal respiratory flora in 60-90% of normal children. The exact incubation period is not clearly known. The clinical manifestations depend on the site involved. The various disease manifestations include:

- Meningitis
- Cellulitis
- Epiglottitis
- Pneumonia
- Suppurative arthritis
- Pericarditis
- Septicemia
- Otitis media

The treatment includes antimicrobial therapy with antibiotics for which the organisms are susceptible. These include chloramphenicol, cephalosporin and amoxicillin with clavulanate.

Before the advent of effective conjugate vaccines, H.influenza was a major cause of certain invasive diseases in children. Serotype b accounted for more than 95% of the

cases. More than 90% occurred in children less than 5 years of age. After the advent of vaccines, the incidence has decreased from 34 to 0.4 per 100000 children.

Vaccination Against Preventable Diseases

Immunization is one of the greatest medical success stories in human history and has saved millions of lives in the 20th century. Many serious childhood diseases are preventable by using vaccines. Since the introduction of these vaccines, diseases such as polio, measles, mumps, rubella, diphtheria, pertussis and meningitis caused by haemophilus influenza type b have declined by 95 to 100%. Immunizations not only save life but also prevent the spread of infection.

The vaccines available against the above discussed vaccine preventable diseases could be killed vaccines or live attenuated vaccines or toxoids. The following schedule is based on the Universal Immunization Program.

Measles, Mumps & Rubella (MMR)

The measles vaccine is usually given as a measles, mumps and rubella vaccine combination (MMR). It is given as a subcutaneous injection. It is recommended at 12-15 months of age. But it may be given for measles post-exposure and outbreak prophylaxis as early as 6 months of age. A second immunization of MMR is recommended routinely at 4-6 years of age. Children who have not previously received the second dose should be immunized by 11-12 years of age. The Measles vaccine is a live attenuated vaccine.

The Mumps vaccine is a live attenuated vaccine. It is given with the combination vaccine MMR. It is also available as a monovalent mumps vaccine. Women should avoid becoming pregnant for 30 days after a monovalent mumps vaccination.

Rubella is a live attenuated vaccine. It is given with the combination vaccine MMR during the period mentioned above. It is especially important for girls to have immunity to rubella before they reach child bearing age.

Diphtheria, tetanus and pertussis (DTP)

Diphtheria is given as a combination triple valent vaccine along with tetanus and pertussis. The diphtheria component is a toxoid prepared by formaldehyde treatment of the diphtheria toxin. The DTP vaccine is given as an intramuscular injection. It is given at 2 months, 4 months and 6 months of age. The booster is given at 18 months and 5 years of age.

The Pertussis component can be whole cell or acellular. The whole cell component produces central nervous system damage in a few children. This complication can be avoided by giving DTP_a which contains the acellular pertussis vaccine.

Tetanus is available as a toxoid and it is given as part of DTP. Monovalent toxoid is also available which is given after injury or even after dog bites. The Tetanus toxoid as a monovalent vaccine should be given at 10 years and 16 years of age.

Poliomyelitis

The Polio vaccine is available as both oral polio drops and inactivated polio vaccine given as an injection. Oral polio is given 2 drops at birth, 2 months, 4 months and 6 months of age. The booster doses are given at 18 months and 5 years. IPV can be given at 2 months, 4 months, 6 months and 18 months.

Hepatitis B vaccine

The Hepatitis B vaccine is a sub unit vaccine manufactured by genetic engineering against the Hb_sAg antigen. Three doses are to be given at 6 weeks, 10 weeks and 6 months. If the mother is positive for hepatitis B, the first dose is to be given immediately after birth and the next dose after one month and the third dose at 6 months.

Hemophilus influenza b vaccine

Hemophilus influenza b vaccine is a conjugate vaccine. Four different vaccines are available – HbOC, PRP-OMP, PRP-T and PRP-D. The vaccine is given at 2 months, 4 months and 6 months of age and a booster dose is given at 18 months.

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