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OCTOBER 2011 "UPDATE: IMMUNIZATIONS"



THIS MONTH
"Update
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Every few years we update information regarding immunizations & vaccines. As we head into the winter season, timing seems appropriate. Our goals in this lesson are to: describe immunity & discuss current information regarding immunizations. This lesson provides 1.25 hours (0.125 CEUs) of credit, and is intended for pharmacists in all practice settings. **The program ID # for this lesson is 707-000-11-010-H01-P. Pharmacists completing this lesson by October 31, 2014 may receive full credit.**

To obtain continuing education credit for this lesson, you must answer the questions on the quiz (70% correct required), and return the quiz. Should you score less than 70%, you will be asked to repeat the quiz. Computerized records are maintained for each participant.

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The objectives of this lesson are such that upon completion the participant will be able to:

1. Describe immunity & how it can be achieved.
2. List types of immunity.
3. Discuss vaccine-preventable childhood diseases & vaccination schedules.
4. Differentiate types of vaccines.
5. Describe safety of vaccines.

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IMMUNITY

Immunization is a process involved with administration of a substance in an individual that stimulates the immune system to produce a biological defense that prevents or fights an invasion of immugens such as viruses, bacteria and cancer cells. The response of the immune system is usually quick and has the ability to produce pathogen-specific antibodies and memory cells that assist in combating invaders. Immunization can be achieved through vaccination. A vaccine is a biological, antigenic preparation that is administered to provide immunity against certain infectious diseases or foreign molecules.

When the immune system becomes impaired, it may result in life-threatening immunodeficiency disorders such as AIDS. On the other hand, if the immune system becomes hyperactive, it may invade the normal healthy tissue in the same manner as it invades pathogens, causing autoimmune diseases such as rheumatoid arthritis, type I diabetes mellitus and lupus erythematosus. The immune system can trigger a response with an immunological memory in which a pathogen is remembered by a specific antigen. Such specificity is preserved in the body by memory cells. The hematopoietic stem cells of the bone marrow produce lymphocytes called B cells and T cells, both of which possess molecules that recognize specific targets. Memory B cells and memory T cells are responsible quick responses that occur when a foreign molecule enters the body. Once active, these cells will replicate and produce an offspring that becomes long-lived memory cells that will remember, throughout the life-time of an individual, each specific pathogen that enters the body.

Immunization can be either **passive** (short-lived) or **active** (long-term).

Passive Immunity involves the administration of pre-synthesized products such as antibodies and B cells so that the body does not need to manufacture these products itself. Passive immunity, which is artificial, is short-lasting and remains effective for a few weeks or months due to the breakdown of the introduced antibodies after which immunity ceases to exist. Antitoxins are examples of products that produce passive immunity. To boost the immune system against tetanus, an antitoxin is injected, resulting in quick neutralization of the toxin produced by the tetanus bacteria. Passive immunization is normally employed during outbreak of a disease or as an emergency treatment for toxicity. In passive immunity the body does not produce antibodies.

In **Active Immunity**, the body will produce its own antibodies and B and T cells following the administration of a foreign molecule, vaccine or the invasion by a microorganism. This type of immunity is created artificially by vaccination or can occur physiologically after infection. The purpose of a vaccine is to stimulate the immune system to develop its own immunity against specific pathogens. Active immunity is usually permanent. Thus, the difference between active and passive immunities is that passive immunity occurs when antibodies of a specific disease are injected into the body, whereas, active immunity takes place when the body itself manufactures the antibodies to combat infection. If a patient has been vaccinated against a disease or has become infected with a disease, the body will produce antibodies to kill the invading microorganisms. These antibodies will permanently remain in the body. Once the patient recovers from the infection or is successfully vaccinated, the next exposure to the infection will trigger the already present antibodies and the primed immune system to attack and destroy the microorganisms before causing the disease.

TYPES OF VACCINES

There are two major types of vaccines: **live attenuated (weakened) vaccine and inactivated (dead) vaccine.**

Live attenuated vaccine contains living, but weakened, virus or bacteria. These microorganisms are weakened in the laboratory usually by repeated culturing that result in disabling their virulence. The dose of a given virus or bacteria usually is large enough to cause an immune response, but not strong enough to cause the disease. Individuals who suffer from

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diseases such as leukemia or HIV, or are taking anticancer drugs or immunosuppressive agents, or are undergoing radiotherapy, may experience severe adverse effects. Such adverse effects may occur because the immune system might be unable to control the growth of the live attenuated microorganisms.

Inactivated (dead) vaccine contains previously virulent microorganisms that have been killed by heat or chemicals. The microorganisms are allowed to grow in a culture medium, after which they are destroyed either by heat or chemical agents, such as formalin. Unlike the live attenuated vaccines, inactivated vaccines neither multiply in the body nor cause infection, even in immunodeficient individuals. While live attenuated vaccines can stimulate the immune system following one dose, inactivated vaccine may require periodic injections in order to boost the antibody titer, which diminishes after a certain period of time.

Other Vaccines

Toxoids are inactivated toxins produced by microorganisms such as diphtheria, tetanus and botulism. The inactivation process is achieved either by chemical or heat treatments. The toxic properties of the toxin are destroyed but retain their ability to stimulate the production of antibodies that induce active immunity.

Conjugate polysaccharide vaccine is produced by covalently joining bacterial capsular polysaccharides to carrier proteins such as outer membrane proteins of the microorganism to enhance immunogenicity. Such a vaccine is used to immunize infants and children against diseases caused by Hib bacteria (*Haemophilus influenza* type b).

Polysaccharide vaccines consist of immunologic particles from the long chains of sugar molecules that are present in the outer coatings of encapsulated bacteria. This vaccine is available for immunization against pneumococcal diseases and *Haemophilus influenza* type b. Polysaccharide vaccines are less potent than conjugate polysaccharide vaccine.

VACCINE PREVENTABLE DISEASES

Hepatitis B is an infection that affects the liver. It is caused by hepatitis B virus (HBV). It spreads by contact with blood or body fluids, and may occur following sexual intercourse, sharing razors or using contaminated needles. Symptoms include: flu-like signs, nausea, vomiting, joint pain, loss of appetite and jaundice. Hepatitis B may become chronic, resulting in severe liver diseases including cancer. More than 5,700,000 people worldwide suffer from acute hepatitis resulting in more than 105,000 deaths annually.

Rotavirus, commonly known as stomach flu, is a genus of a double-stranded RNA virus and causes severe gastroenteritis in children. The virus, discovered in 1973, accounts for 50% of hospitalizations for severe diarrhea in infants and children. About 500,000 children worldwide die of the disease each year. Before the rotavirus vaccination, about 2.7 million cases of the disease occurred annually in the U.S. With each infection or following vaccination, immunity develops and subsequent infection is less severe. Adults are rarely affected. The virus is transmitted by the fecal-oral route via contact with contaminated hands, surfaces or objects.

Diphtheria is caused by *Corynebacterium diphtheriae*, a bacterial infection that affects the respiratory tract. It is a very contagious disease and can be transmitted by contact with saliva or droplets from an infected person's coughing or sneezing. The microorganism produces toxins in the blood that cause fever, swollen glands in the neck, weakness, heart enlargement, paralysis and death. Currently, over 34,000 cases and 5,000 deaths occur annually worldwide as a result of diphtheria.

Tetanus (lockjaw) is caused by a bacterium (*Clostridium tetani*) found in the soil. It usually enters the body via a wound. Once in the circulation, the bacteria produce toxins that cause serious and painful spasms and stiffness of all muscles including those of the jaw. Three out of ten people who acquire the disease die from it. Over 250,000 patients worldwide die annually from tetanus.

Pertussis (whooping cough) is caused by the bacterium (*Bordetella pertussis*) which is transmitted by direct contact with respiratory airborne droplets when one infected person coughs or sneezes. At the early stages of the infection the patient experiences symptoms similar to those of the common cold. Within one to two weeks, the disease may develop into a violent and choking cough. Babies may develop pneumonia, seizures or brain damage. Over 18 million cases and 250,000 deaths occur worldwide annually.

Haemophilus influenzae type b (Hib) is a bacterium that usually strikes children under the age of 5 years. It is responsible for 380,000 deaths and 2 to 3 million cases worldwide annually, mainly due to complications from pneumonia and meningitis. The infection is transmitted from one infected child to a healthy one by inhaling contaminated airborne droplets.

Pneumococcal disease is a lung infection caused by *Streptococcus pneumoniae* which also can cause sinus infections, meningitis, bacteremia and sepsis. Pneumococcal disease can be fatal and may result in hearing loss and brain damage. It spreads through coughing or sneezing from an infected person.

Inactivated poliovirus (Poliomyelitis or infantile paralysis) is a very contagious acute viral infection that is transmitted primarily via the fecal-oral route. The virus may enter the central nervous system, thereby destroying the motor neurons, leading to muscle weakness and paralysis. Symptoms usually include: fever, sore throat, weakness and pain. About 1% of cases cause paralysis. Due to vaccination programs worldwide, only a few hundred cases (about 1,700) occur every year.

Influenza is a highly contagious disease of the respiratory tract. It spreads via inhalation of cough or sneeze droplets of an infected person. Symptoms include: fever, chills, dry cough, sore throat, headache, running nose and muscular aches. This infection is seasonal and affects 3 to 5 million people annually, causing 250,000-500,000 deaths.

Measles (Rubeola) is a very communicable infection caused by a paramyxovirus. It is transmitted through inhalation of infected airborne respiratory droplets. The main symptom is the emergence of a skin rash (Koplik's spots). Other symptoms include: fever, cough and red watering eyes. Approximately 27 million cases a year are reported worldwide.

Mumps is an acute, contagious infectious disease caused by a paramyxovirus and characterized by painful inflammation and swelling of the salivary glands, especially the parotids. Other symptoms include: fever and muscular aches. It usually affects children 5 to 15 years of age. It is transmitted via inhalation of infected airborne nasal droplets. About 544,000 cases of mumps occur worldwide annually.

Rubella (German measles) is a contagious, acute viral disease caused by an RNA virus. It is less contagious than Rubeola (regular measles), and the symptoms are milder. Other than the appearance of a skin rash, the patient experiences flu-like symptoms. Rubella may cause serious complications if a woman is infected during pregnancy, especially during the first trimester, because the fetus may become infected with potential for fetal damage.

Varicella (Chickenpox) is a very contagious viral infection caused by varicella zoster. It is characterized by eruption of skin blisters accompanied by intense itching, headache and fever. It is transmitted via inhalation of airborne droplets from an infected person or via direct contact. Blisters may leave permanent scars.

Hepatitis A: This infectious disease is caused by Hepatitis A virus (HAV) which spreads via the fecal-oral route. The virus enters the mouth from contact with objects, foods or drinks contaminated by feces of an infected person. Symptoms include: fever, fatigue, anorexia, nausea, abdominal distress, dark urine and jaundice. Over one and a half million people are infected annually worldwide.

Meningococci (meningococcal) disease is caused by *Neisseria meningitis*. Children up to 5 years of age and adults between the ages of 15 to 25 are most vulnerable. The microorganisms usually affect the membrane covering the brain as well as the fluid of the spinal cord. About 340,000 deaths occur worldwide as a result of this infection.

Human Papillomavirus (HPV) is a viral infection that may affect adults, but mostly patients in their teens and early 20s. It is considered a cause of cervical cancer in women and genital warts in men. The disease is contracted during sexual contact. About half a million cases occur every year worldwide, resulting in a quarter of a million deaths.

CHILDHOOD IMMUNIZATION

New born babies and toddlers are constantly in contact with their parents, siblings, adults and other children. This exposure to diseases may result in infections that are preventable through immunizations. These have decreased greatly the occurrences of childhood infectious diseases such as tetanus, diphtheria, mumps, measles, pertussis, polio and chickenpox. All of these vaccine-preventable diseases are at their lowest levels ever. Newborns have no exposure to the environment and, therefore, they have not developed any immunity on their own. They are vulnerable to infectious. However,

the mother provides passive protection to the fetus by supplying antibodies directly via the placenta, especially during the last five weeks of pregnancy. Consequently, at birth the newborn has enough immune system elements to provide protection until the body can produce its own antibodies. This natural protection may last for a few months. Since the natural protection is not permanent, vaccinations against infectious childhood diseases are vital.

Children from birth through six years of age are typically immunized against the following: tetanus, rubella, polio, pertussis, mumps, measles, diphtheria, chickenpox, Haemophilus influenzae type b, hepatitis A & B, rotavirus, pneumococci, influenza and meningococci. To achieve the intended protection from infection, children should receive their immunizations once their immune system is able to react to vaccines and produce antibodies. A booster injection may be required to achieve full immunity. Due to the large number of administered vaccines and subsequent boosters, parents' compliance with childhood vaccination is not always adequate. To combat noncompliance, notification systems have been initiated to alert parents as to vaccination time. Furthermore, the production of a number of combination injections such as pneumococcal conjugate vaccine and MMR (measles, mumps, and rubella) vaccines has reduced the number of visits to the pediatrician's office. The decrease in number of cases of these diseases has led some parents erroneously to believe these diseases have been eradicated, or that they are not serious. This misconception may lead to noncompliance. Combination vaccines are as safe and effective as administering one vaccine at a time. It has been shown that when immunization rate declines, the diseases re-emerge and the number of cases increases. The following is the recommended immunization schedule in the United States:

At birth: All newborns need to be given a dose of monovalent Hepatitis B vaccine (Hep B) prior to hospital discharge. A second dose should be repeated at age of one or two months. Infants who did not receive immunization upon hospital discharge should be given doses at 0,1, and 6 months of age.

At two months through 6 years of age: Babies and children should receive the following: Rotavirus vaccine (RV), Hepatitis B vaccine (HepB), Diphtheria, Tetanus toxoids and a cellular Pertussis Vaccine (DTaP), Haemophilus influenza type b conjugate vaccine (Hib), Pneumococcal conjugate vaccine (PCV), Inactivated Poliovirus vaccine (IPV), Influenza vaccine, Measles, Mumps, and Rubella vaccine (MMR), Varicella vaccine (Chickenpox), Hepatitis A vaccine (Hep A), and meningococcal conjugate vaccine [quadrivalent (MCV₄)]. The first dose of rotavirus vaccine should be administered at age 6 through 14 weeks. The maximum age for administering DTaP, Hib, IPV, and PCV is 6 weeks. The minimum age for vaccination with pneumococcal polysaccharide (PPSV) is 2 years. Administration of an additional dose of IPV is needed at age 4 through 6 years if 4 or more doses are given prior to age 4 years. Normally the final dose of IPV is administered on or after the age of 4 years and at least 6 months following the previous dose. The minimum age for administering influenza vaccine is 6 months for trivalent inactivated influenza vaccine (TIV), and 2 years for live, attenuated influenza vaccine (LAIV). The LAIV should not be given to children aged 2 years through 4 who suffer from respiratory problems or who have had wheezing in the past 12 months. The minimum age for administering MMR is 12 months. The second dose may be administered before age 4 years provided that at least 4 weeks have elapsed since the first dose. The minimum age for vaccination with varicella vaccine is 12 months. The second dose may be given before age of 4 years provided that 3 months have elapsed since the first dose. The minimum age for the administration of HepA is 12 months provided that the 2 doses are given at least 6 months apart. This vaccine may be administered to children aged 23 months or older, who are at increased risk of infection. The MCV₄ should not be administered before the age of 2 years. The doses should be administered at least 8 weeks apart to children aged 2 through 10 years with persistent complement deficiency and one dose every 5 years thereafter.

Immunization Schedule. Birth through 6 Years of age

	Birth	1-2	2-4	4-6	6-12	12-15	15-18	18-19-23	2-3	4-6
Hepatitis B	✓	✓	✓	✓	✓	✓	✓	✓		
Rotavirus			✓	✓	✓	✓	✓	✓		
Diphtheria, Tetanus, Pertussis			✓	✓	✓	✓	✓	✓		✓
Haemophilus influenza Type B			✓	✓	✓	✓	✓			
Pneumococcal			✓	✓	✓	✓	✓		✓	✓
Inactivated Poliovirus			✓	✓	✓	✓	✓	✓		✓
Influenza					Yearly					
Measles, Mumps, Rubella						✓	✓			✓
Varicella						✓	✓			✓
Hepatitis A						✓	✓	✓	High Risk Patients	High Risk Patients
Meningo-coccal									High Risk Patients	High Risk Patients

Young Adult Vaccination

Adult vaccinations are needed as much as those for children. Vaccine-preventable diseases such as influenza, pneumococcal diseases and tetanus or their complications cause up to 60,000 deaths each year. It should be kept in mind that vaccine-preventable diseases that are usually mild in children can be serious and fatal in adults. Complications from mumps and chickenpox among adults are much more serious than in children. Rubella, if it occurred during pregnancy, may cause birth defects, miscarriages and stillbirths. Adult immunization is necessary when: 1) adults were never immunized as children, 2) newer vaccines were not available during the childhood years, and 3) immunity against certain vaccine-preventable diseases such as tetanus begins to fade over time. Adult vaccination against certain diseases depends on age, health conditions that place them at high risk for serious diseases, and previous immunizations. The following are vaccines recommended for adults:

1. **Tetanus-Diphtheria (Td)** booster is recommended for adults every 10 years. Two new vaccines, that include a cellular pertussis vaccine, are recommended for use in adolescents and adults.
2. **Measles-Mumps-Rubella (MMR)** vaccine for persons who never contracted the diseases or never received MMR vaccine.
3. **Meningococcal conjugate vaccine (MCV₄)** is recommended for persons 11-12 and 15 years of age and others who are at increased risk of the disease.
4. **Influenza vaccine** is recommended annually for those with underlying medical conditions.
5. **Varicella vaccine** is recommended for persons 13 years of age and older without evidence of immunity.
6. **Hepatitis A vaccine.**
7. **Human papilloma virus** which is transmitted through sexual contact.

Middle-aged and Elderly Vaccinations

Morbidity and mortality of vaccine-preventable diseases is common among the elderly due to low vaccination rate and impairment of immune response due to aging. For example, pneumonia, influenza and their complications are the fifth leading cause of death among older adults. Tetanus is fatal in at least 32% of persons over 80 years of age. Effectiveness of tetanus toxoid is limited to 10 years, and it is relatively uncommon for the very old to maintain vaccination schedules.

Certain vaccines are recommended routinely, while others are recommended in certain situations. This depends on age, lifestyle, high-risk conditions, previous immunization and type and location of travel around the world. It is recommended that an elderly patient consult with a health provider who will give advice regarding specific immunization needs. The following are suggested:

1. **Influenza** (Trivalent Inactivated Influenza Vaccine, TIV). Usually given every year, either in fall or winter, to persons, especially those with respiratory, cardiac, hepatic or kidney problems. Intranasal vaccine is not recommended for persons 50 years or older.
2. **Pneumococcal polysaccharide (PPSV)** vaccine for people 65 years of age and older.
3. **Varicella vaccine** to be given if there is no evidence of immunity such as previous infection of the virus.
4. **Herpes zoster (Shingles)**: This vaccine is not recommended for individuals below the age of 60.
5. **Hepatitis B vaccine**.
6. **Other vaccines**: In spite of physical limitations due to age, retired persons like to travel especially to countries with warm climates. It has been estimated that 5 to 8% of travellers in tropical areas are elderly. Thus, the health aspect of a journey should be planned in accordance with the country and its common diseases. Immunization against diseases of fecal hazard such as typhoid fever and hepatitis A, as well as others such as yellow fever, should be considered.

VACCINE SAFETY

Like any medication, adverse reactions may occur following the administering of vaccines. For the most part they are safe and effective. The reactions may be **local**, **systemic** or **allergic** in nature.

Local reactions such as pain, swelling, and erythema at the site of injection are commonly encountered. These usually happen following the use of inactivated vaccines, especially those that contain adjuvants.

Systemic adverse reactions consist of fever, muscle pain, headache, weakness, rash and anorexia. These are more common following vaccination with live attenuated vaccines that contain living microorganisms. The systemic symptoms are usually mild and occur after a certain incubation period characteristic of the natural disease.

Allergic reactions may be caused by the antigen itself, or some component of the vaccine such as preservatives, cell culture materials, or chemicals used to inhibit bacterial and viral multiplication. Vaccines propagated in embryonic eggs may cause hypersensitivity reactions including anaphylaxis, especially if large quantities of egg protein remain in the final product (e.g., yellow fever and influenza vaccines). Such vaccines are contraindicated in individuals who show allergic symptoms following the ingestion of eggs or egg products.

Vaccination with live attenuated vaccines during pregnancy should be avoided in order not to expose the fetus to infection. Inactivated vaccines may only be given, with caution, to expecting mothers, since the vaccines contain microorganisms. Individuals who are immunodeficient should not be given live attenuated vaccine, since there is no adequate defense mechanism that prevents the microorganisms, especially viruses, from serious growth.

Individuals with cancer, HIV, or who are receiving immunosuppressive agents or radiotherapy should not receive live attenuated vaccine. Inactivated vaccines may be given to immunosuppressed persons.

VACCINE EFFECTIVENESS

Vaccines may fail to provide complete protection in cases where:

- The patient's immune system does not have an adequate level of B cells to produce antibodies to the vaccine, or
- If the immunity has been diminished due to the intake of anti-inflammatory agents, or
- The presence of diseases such as HIV.

To enhance the immune response, adjuvants are included in the vaccine formulation. Aluminum adjuvants are commonly used, but squalae and phosphate adjuvants may be employed. Efficacy of a vaccine depends on:

- The disease,
- The strain of the vaccine,
- Compliance of the timetable to vaccination,
- Ability of the immune system to produce antibodies, and
- Genetic predispositions.

Even if the vaccine did not provide complete protection and the person becomes ill, usually the result is much milder than without vaccination.

Summary

The objective of immunization is to enhance the ability of the immune system of the body to produce specific antibodies against a specific disease. Immunity occurs following a natural infection or vaccine administration. Most of vaccine-preventable diseases are now at their lowest level in history. Immunization is intended for children, young adults, middle-aged adults and the elderly. These are the safest and most economical tools of modern medicine that could be long lasting, and even life-long.

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LESSON EVALUATION

Please fill out this section as a means of evaluating this lesson. The information will aid us in improving future efforts. Either circle the appropriate evaluation answer, or rate the item from 1 to 7 (1 is the lowest rating; 7 is the highest).

1. Does the program meet the learning objectives?

Describe immunity & how it can be achieved

Yes No

List types of immunity

Yes No

Discuss vaccine-preventable childhood diseases & vaccination schedules

Yes No

Differentiate types of vaccines

Yes No

Describe safety of vaccines

Yes No

2. Was the program independent & non-commercial

Yes No

Poor

Average

Excellent

3. Relevance of topic

1 2

3

4 5

6 7

4. What did you like most about this lesson? _____

5. What did you like least about this lesson? _____

Please Select the Most Correct Answer(s)

1. Hyperactivity of the immune system may cause autoimmune diseases.

A. True

B. False

2. Live attenuated vaccines contain:

A. Toxin produced by microorganisms

B. Conjugated polysaccharide elements

C. Living but weakened microorganisms

D. Microorganisms that have been killed

3. Rotavirus causes:

A. Lockjaw

B. Hepatitis

C. Whooping cough

D. Gastroenteritis

4. Chickenpox is also:

A. Herpes zoster

B. Varicella

C. Rubella

D. Hib

5. Which of these vaccines is recommended to be given every year to the elderly?

A. Varicella

B. Herpes zoster

C. Influenza

D. Typhoid fever

6. This vaccine needs to be given to

newborns before leaving hospital.

A. Hib

B. Mumps

C. Tetanus

D. Hepatitis B

7. Tetanus booster should be given:

A. Every 10 years

B. After each injury

C. Only during childhood

D. Every 5 years

8. Infant natural immunity may last for a few months after birth.

A. True B. False

9. Live attenuated vaccines should not be given to:

A. Patients 50 years & older

B. Women

C. Patients between age 10 & 15

D. HIV patients

10. Which one of these may cause a vaccine to fail?

A. Inadequate level of B cells

B. Age

C. Gender

D. Presence of cardiac disease

Contributing Author

Farid Sadik, Dean Emeritus
University of South Carolina
College of Pharmacy
Columbia, SC

Executive Editor

William J. Feinberg,
BS Pharm, MBA



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