Lesson 2: Vaccines

Lecture Notes

Underlined words are included on the "Vocabulary Words" list for this lesson.

Vaccine: Deliberate stimulation of adaptive immunity so that the immune system will develop immunologic memory to a pathogen.

Vaccines are the most effective means of controlling infectious diseases. They not only work to protect individuals who get them, they also protect others. This happens because people who have been vaccinated are contagious for a shorter period of time or not at all. This effect is known as herd immunity or community immunity.

A. How Do Vaccines Work?

When a person is sick, the immune system makes antibodies that have the ability to remember the pathogen. With subsequent exposure to the pathogen, the immune system quickly responds by producing white blood cells to fight the infection, which results in no or only minor symptoms of disease. This adaptive immune system response occurs because the immune system is capable of immunologic memory.

Vaccines work the same way except they cause immunity to a pathogen without causing the symptoms and complications of disease.

B. How Are Vaccines Made?

Vaccines use altered versions of viruses or bacteria to trigger an immune response without causing any symptoms of disease. There are four basic ways vaccines are made.

1. Weaken the virus: Viruses require cells to reproduce themselves. If they are grown repeatedly in cells other than those they are used to, they change and are no longer able to grow well in the original cells. This is known as cell culture adaptation. Examples of vaccines that are made this way include measles, mumps, rubella, chickenpox, shingles and rotavirus.
2. Inactivate the virus: The virus is killed so that it cannot replicate. Examples include polio shot, hepatitis A, influenza shot and rabies.
3. Use part of the virus: A piece of the virus is used to make the vaccine. Examples are HPV and hepatitis B.

B. How Are Vaccines Made? *continued*

4. Use part of the bacteria:

a. Toxoid vaccines: Some bacteria produce poisons, called toxins, which cause illness. When the toxins are treated with a chemical, the toxins are no longer able to cause disease. Inactivated toxins are called toxoids. Examples include diphtheria, tetanus and pertussis.

b. Polysaccharide vaccines: Some bacteria are covered with a sugar coating called a polysaccharide. In some cases, the polysaccharides used in vaccines are attached to a helper protein to make the vaccine. Examples include Hib, pneumococcal and meningococcal.

C. How Are Vaccines Determined to Work and Be Safe?

When researchers think they have a vaccine that may work, it needs to be tested in people. There are several phases of testing that must be done before a vaccine can be administered to the population.

1. **Phase I** studies are performed using fewer than 100 volunteers, usually adults, and are designed to answer the questions: *Is the vaccine safe?* and *Does it induce an immune response?*

2. **Phase II** studies are performed using a few hundred volunteers of the type of people who are likely to use the vaccine.

3. **Phase III** studies are performed using more than 5,000 volunteers across a large geographical area so that different types of people are studied.

4. If the vaccine is determined to be safe and effective, all data is submitted to the U.S. Food and Drug Administration (FDA) to be evaluated for proper scientific techniques and consistent results. The FDA may then grant a license, which means the company can make and sell the vaccine.

5. The Advisory Committee on Immunization Practices (ACIP) is a group of scientists and doctors who advise the Centers for Disease Control and Prevention (CDC). This group recommends who should receive the vaccine and how it should be administered. A recommendation is based on best health practices.

6. The final recommendation is a group decision between the CDC, the American Academy of Pediatrics and the American Academy of Family Physicians.

7. Requirements: The government of each state decides whether people in that state will be required to get the vaccine; for example, before a child enters school. These decisions are influenced by economics and politics and may not be the best health decision. This is the case with the HPV vaccine. It has been shown to be safe and effective, but it currently is not required in any state.

8. **Phase IV** studies can include data from selected health departments or health maintenance groups. Vaccines continue to be monitored for safety even after they are being used. Sometimes very rare side effects are found after the vaccine has been given to large numbers of people. The CDC also monitors reports to a system called the Vaccine Adverse Event Reporting System (VAERS). If a problem is suggested by these reports, the CDC establishes specific studies to evaluate the concern. If the vaccine is found to be unsafe, it is removed from the market.

D. Which Diseases Do Vaccines Prevent and Who Receives Them?

Infants and Children (0 through 6 years of age)

1. Hepatitis B: This is usually the first vaccine given as it is recommended for newborns.
2. Rotavirus: This is the only orally administered vaccine.
3. Diphtheria, Tetanus and Pertussis*
4. *Haemophilus influenzae* type b
5. Pneumococcus
6. Polio: While an oral version was used previously in this country, the version developed by Jonas Salk and given as a shot is now the only one used in the United States.
7. Influenza: Influenza vaccine, also known as flu vaccine, is administered yearly.
8. Measles, Mumps and Rubella*
9. Varicella: Also known as chickenpox.
10. Hepatitis A: Can be transmitted through contaminated food. In 2003, a large outbreak originated at a ChiChi's restaurant in Pennsylvania because of contaminated green onions.
11. Meningococcus: for certain groups of high-risk children

*Diphtheria, tetanus and pertussis (DTaP) and measles, mumps and rubella (MMR) are what are known as combination vaccines. DTaP is a combination of diphtheria, tetanus and pertussis vaccines given in a series of five doses at 2 months, 4 months, 6 months, 15 to 18 months and then at 4 to 6 years of age. MMR is a combination of measles, mumps and rubella vaccines given as a series of two doses at 12 to 15 months of age and at 4 to 6 years of age.

View the recommended immunization schedule for infants and children aged 0 through 6 years: www.cdc.gov/vaccines

Children and Teens (7 through 18 years of age)

1. Tetanus, Diphtheria and Pertussis*
2. Human Papillomavirus
3. Meningococcus
4. Influenza: Also known as flu, given yearly.

*Adolescents 11 and 12 years of age need tetanus, diphtheria and pertussis (Tdap) because immunity to diphtheria, tetanus and pertussis is not lifelong; therefore, additional vaccines are needed. Tdap contains lesser amounts of diphtheria and pertussis and causes fewer side effects in adolescents and adults than DTaP.

D. Which Diseases Do Vaccines Prevent and Who Receives Them? *continued*

Adolescents and teens should "catch up" on certain vaccines they may have missed, such as:

1. Hepatitis A
2. Hepatitis B
3. Inactivated Poliovirus
4. Measles, Mumps and Rubella
5. Varicella: Also known as chickenpox

View the recommended immunization schedule for children and teens aged 7 through 18 years: www.cdc.gov/vaccines

Adults

Most adults don't realize when they, too, need vaccines.

Those times include:

- Certain ages
- Pregnancy
- Travel
- Occupational
- Certain medical conditions

Adult vaccines

1. Td/Tdap: Substitute one-time dose of Tdap for Td booster, then Td booster every 10 years.
2. Human Papillomavirus: Recommended for all previously unvaccinated women through age 26.
3. Varicella
4. Shingles or Herpes Zoster: Administered to people age 60 or older.
5. MMR: Measles, mumps and rubella
6. Influenza: Known as flu, administered yearly. Elderly people not in good health are susceptible to dying from complications of influenza, such as pneumonia.
7. Pneumococcal: People with recent bouts of influenza are more susceptible to dying from this opportunistic pathogen.
8. Hepatitis A
9. Hepatitis B
10. Meningococcus

View the recommended immunization schedule for adults: www.cdc.gov/vaccines