INTRODUCTION — Vaccines are one of the most effective ways to prevent serious illness in children and adults. Vaccine programs in the United States have been quite successful in reducing the number of children affected by many highly contagious diseases, including measles, rubella, mumps, diphtheria, and polio.

The following is a discussion of how immunizations work, common side effects, reasons to avoid a particular vaccine, and common concerns about vaccines. Separate articles discuss individual vaccines for children and adults. (See "Patient information: Vaccines for infants and children age 0 to 6 years (Beyond the Basics)" and "Patient information: Vaccines for children age 7 to 18 years (Beyond the Basics)" and "Patient information: Adult vaccines (Beyond the Basics)".).

HOW DO VACCINES WORK? — The immune system functions to protect the body against illness and infection. When an organism (bacterium or virus) is foreign to the body, the immune system detects the organism and responds by creating proteins called antibodies. Antibodies fight the infection and help the person to recover.

Antibodies also work to prevent a person from becoming ill in the future. If a person is exposed to the organism again, the immune system recognizes it and rapidly produces more of the antibodies required to destroy the organism. This response protects the individual from developing the disease, ideally for life. For example, a person who had chickenpox as a child is unlikely to develop it again, even if he or she is in close contact with a person who is infected.

Vaccines work by stimulating the immune system to produce antibodies. However, unlike bacteria and viruses, vaccines do not cause the person to become ill in order to develop these antibodies. There are two main types of vaccines: active and passive.

Active vaccines — Active vaccines use a weakened form of the harmful bacteria or virus to stimulate the immune system. Examples of active vaccines include vaccines that are used to prevent polio, measles, mumps, rubella (German measles), pertussis, etc.

Some bacteria (eg, diphtheria, tetanus) cause illness because they produce harmful substances called toxins. Vaccines that help the immune system protect the body from toxins are called toxoids. Toxoids are made from weakened forms of the bacterial toxins.

Passive vaccines — Passive vaccines provide temporary immunity using antibodies obtained from a large pool of donors; this type of preparation is known as immune serum globulin. Passive vaccines offer short-term protection to children or adults who have been exposed to a specific organism.

One example of a passive vaccine is hepatitis B immune globulin (HBIG). HBIG is given to newborns whose mothers test positive for hepatitis B surface antigen (HBsAg). HBIG provides temporary protection to the newborn against infection with hepatitis B.
Vaccines protect children and adults — Many parents are concerned about the risks of vaccines. However, vaccines have a long record of being a safe and effective way of preventing disease. In most cases, the benefits of vaccinating a child are far greater than any potential risks.

Diseases such as diphtheria and measles were common at one time in the United States, but are no longer a significant threat because of vaccination programs. However, these illnesses are still common in developing countries throughout the world. Because it is easy to travel from one country to another, it is very possible for someone with a vaccine-preventable disease to enter the United States and transmit the disease to any child or adult who has not been vaccinated. Vaccination helps to reduce a child's, family's, and even an entire community's chances of becoming ill by decreasing the number of people who could get sick and then transmit the infection to others. This process of protection is sometimes referred to as "herd immunity".

An example of a successful vaccination effort is the smallpox program. Before a vaccine was available, smallpox killed millions of people every year. Up until the early 1970s, smallpox disease was a worldwide threat to life. Use of the smallpox vaccine in large populations of people prior to the 1970s led to complete eradication of the disease. Because of this, the smallpox vaccination is no longer administered for routine protection.

How are vaccines given? — In children, most immunizations are given in the form of a shot. Vaccines are also given in other ways, such as in a liquid taken by mouth (eg, rotavirus) or as a nasal spray (eg, one form of the influenza vaccine).

Paying for vaccines — Vaccines are available for every child in the United States, even for those who do not have health insurance. If a child does not have health insurance and the parents are unable to pay for vaccines, a program called Vaccines for Children is available. This program helps to cover the costs of vaccines given at private doctor's offices, clinics, hospitals, community health clinics, and in some schools.

VACCINE SIDE EFFECTS — Most vaccines and toxoids are safe and cause few if any serious side effects. Very rarely, serious side effects do occur. Children who develop unusual reactions such as rashes involving much of the body surface, difficulty breathing, excessively high fevers, seizures or loss of consciousness within a short time after receiving a vaccine should be evaluated by a healthcare provider.

To report an unusual reaction after a vaccine, you can contact the national Vaccine Adverse Event Reporting System (VAERS, telephone number 1-800-822-7967). Parents who are concerned about a particular vaccine should discuss their concerns with their child's healthcare provider.

Mild side effects — Vaccines and toxoids can occasionally cause mild side effects, including:

- A low-grade fever
- A red and tender area at the site of an injection

Moderate side effects — Occasionally, children can develop a combination of fever, skin rash, swollen lymph nodes, and/or joint pain after vaccination. These reactions, called serum sickness-like reactions, can be uncomfortable, although they are rarely dangerous and resolve without treatment in days to weeks.

Severe side effects — Severe side effects of vaccines are rare, but may include a severe neurologic reaction (eg, seizures) or severe allergic reactions (eg, anaphylaxis). Allergic reactions usually occur within minutes to hours of receiving the vaccine. If this occurs in the doctor's or nurse's office, emergency care can be given immediately. If a severe reaction occurs away from the doctor's or nurse's office, the parent/guardian should call emergency medical services, available in most areas of the United States by dialing 911.
Reasons to avoid vaccination — A particular vaccine may not be recommended for children with a serious allergic reaction to the following:

- Eggs or egg protein, since some vaccines are prepared with embryonic chicken eggs or cultures (eg, influenza vaccines, yellow fever vaccines). A mild allergic reaction to eggs does **not** mean that the vaccine should be avoided.
- The antibiotic medications neomycin or streptomycin (some vaccines contain trace amounts of neomycin)
- Gelatin
- A specific vaccine administered in the past

In some cases, parents may not know their child is allergic to one of these components until the vaccine is given and the child develops a reaction.

In addition, live virus vaccines (eg, the measles, mumps, and rubella vaccine) are generally not recommended for children with a weakened immune system since there is an increased risk of infection as a result of the vaccine. However, there may be exceptions to this recommendation.

Administration of the measles-mumps-rubella and varicella vaccines should be delayed in children who have recently received a blood transfusion or blood products (eg, immunoglobulin preparations) since these products can make the vaccine less effective.

Conditions that do not affect vaccination — The following conditions do not require delaying or avoiding vaccines:

- Current or recent mild illness
- Current or recent antibiotic therapy
- Previous mild to moderate tenderness, redness, or swelling at the site of injection or fever less than 104.9°F (40.5°C) after a previous vaccination
- A personal history of allergies, except those listed above
- A family history of adverse reactions to vaccines

Are vaccines safe for my child? — There have been concerns about the safety of vaccines for children.

One concern was related to a particular preservative (thimerosal) that was previously used in a number of different vaccines. The concern centered around the possibility of any relationship between the administration of certain vaccines and autism. Thimerosal is a derivative of mercury that was previously used as a preservative in most vaccines. As the number of vaccinations given to infants increased, there was concern that this preservative could lead to potentially unsafe levels of mercury levels in some infants. As a result, several expert groups recommended in 1999 that all standard childhood vaccines be produced without thimerosal. The recommendation was a precautionary change and was **not** based upon known harm from thimerosal. Thimerosal-free forms of all of the childhood vaccines are available in the United States. A large number of studies throughout the world have failed to show any cause and effect relationship between autism and those vaccines that contained thimerosal.

A second concern was in regards to a possible relationship between certain vaccines and the development of autism. Despite this concern, there is no scientific evidence that receiving these vaccines causes or increases the risk of developing autism.

Studies that had previously raised the possibility of a relationship had significant weaknesses in their design. A number of the studies were based on a small number of children and relied upon the memory of parents or pediatricians to recall when behavioral signs/symptoms related to autism began. Most studies did not include a control group to compare children who were vaccinated with those who were not vaccinated to determine if there was a cause and effect relationship. At least some cases of autism are most likely attributable to gene abnormalities.
For more information about any potential link between vaccines and autism, visit the Centers for Disease Control and Prevention.

**VACCINE RECOMMENDATIONS** — To prevent a child from getting any of the diseases for which vaccine protection is available, children should begin receiving vaccines within the first few months of life. This allows the child to be protected from common childhood illnesses as well as illnesses that can develop during adulthood.

Many diseases prevented by vaccines are more serious in young children. Infants and children frequently seen by their healthcare provider during the first year of life are more likely to receive all of the recommended vaccines. In most states, specific vaccines are required before the child can attend school. This policy is designed to not only protect the individual child but to prevent the spread of certain contagious diseases to other children attending the school. Vaccine requirements tend to vary from state to state.

In the United States, certain vaccines are recommended for children between birth and 6 years. The recommended schedule is available through the Centers for Disease Control and Prevention (CDC). Using combination vaccines can help to reduce the number of shots needed at each visit. (See "Patient information: Vaccines for infants and children age 0 to 6 years (Beyond the Basics)."

The timing of vaccines is important; some vaccines are most effective when given to children at a particular age or in combination with other vaccines. A personal, customized vaccine schedule is available through the CDC. The schedule may be helpful in reminding parents when their child is due for vaccines.

The CDC has also developed a catch-up immunization scheduler to help parents of children younger than six years determine which vaccines have been missed and when the vaccines should be scheduled for administration.

**WHERE TO GET MORE INFORMATION** — Your child’s healthcare provider is the best source of information for questions and concerns related to your child’s medical problem.

This article will be updated as needed on our web site (www.uptodate.com/patients). Related topics for patients, as well as selected articles written for healthcare professionals, are also available. Some of the most relevant are listed below.

Patient level information — UpToDate offers two types of patient education materials.

**The Basics** — The Basics patient education pieces answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials.

Patient information: Vaccines (The Basics)
Patient information: Vaccines for babies and children age 0 to 6 years (The Basics)
Patient information: Vaccines for children age 7 to 18 years (The Basics)
Patient information: Vaccines for travel (The Basics)
Patient information: Mumps (The Basics)
Patient information: Rubella (The Basics)
Patient information: Tetanus (The Basics)
Patient information: Poliomyelitis (The Basics)
Patient information: Measles (The Basics)
Patient information: Tdap vaccine (The Basics)

**Beyond the Basics** — Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are best for patients who want in-depth information and are comfortable with some medical jargon.
Professional level information — Professional level articles are designed to keep doctors and other health professionals up-to-date on the latest medical findings. These articles are thorough, long, and complex, and they contain multiple references to the research on which they are based. Professional level articles are best for people who are comfortable with a lot of medical terminology and who want to read the same materials their doctors are reading.

Allergic reactions to vaccines
Clinical trials of human papillomavirus vaccines
Epidemiology, clinical manifestations, diagnosis and management of mumps
Hepatitis A virus vaccination and postexposure prophylaxis
Hepatitis B virus vaccination
Meningococcal vaccines
Pneumococcal (Streptococcus pneumoniae) conjugate vaccines in children
Poliovirus vaccination
Prevention of varicella-zoster virus infection: Chickenpox
Recommendations for the use of human papillomavirus vaccines
Rubella
Seasonal influenza vaccination in children
Standard immunizations for children and adolescents
Treatment of varicella-zoster virus infection: Chickenpox
Vaccinia virus as the smallpox vaccine

The following organizations also provide reliable health information.

- National Library of Medicine
  (www.nlm.nih.gov/medlineplus/healthtopics.html)
- National Institute of Allergy and Infectious Diseases
  (www.niaid.nih.gov/)
- Centers for Disease Control and Prevention (CDC) National Immunization Program
  Toll-free: (800) 311-3435
  (www.cdc.gov/vaccines/)
- National Foundation for Infectious Diseases
  Tel: (301) 656-0003
  (www.nfid.org)
- The Children’s Hospital of Philadelphia Vaccine Education Center
  (www.chop.edu/service/vaccine-education-center/home.html)
- Vaccinate Your Baby
  (www.vaccinateyourbaby.com)
REFERENCES

ACIP Childhood/Adolescent Immunization Work Group, Akinsanya-Beysolow I, Jenkins R, et al.
1 Advisory Committee on Immunization Practices (ACIP) recommended immunization schedule for

Feikin DR, Lezotte DC, Hamman RF, et al. Individual and community risks of measles and pertussis
associated with personal exemptions to immunization. JAMA 2000; 284:3145.

Centers for Disease Control and Prevention (CDC). Summary of the joint statement on thimerosal in
vaccines. American Academy of Family Physicians, American Academy of Pediatrics, Advisory
49:622, 631.


5 Offit PA, Moser CA. Vaccines and Your Child: Separating Fact from Fiction, Columbia University