Understanding Vaccines

HOW DO VACCINES WORK?

Vaccines work by stimulating the body's immune system. In the normal course of a disease, a pathogen (a disease-causing agent like a bacteria or virus) invades the body, causing illness. The immune system detects the presence of the pathogen and subsequently begins to produce antibodies that are specifically designed to fight it. These antibodies then become a permanent part of the immune system, remaining even after the pathogen has been eliminated; this is why a person who contracts measles never does so again. The body maintains what is known as an immunologic memory of that particular virus. If it invades again, the immune system recognizes it and kills it before it can cause disease.

Vaccination mimics this process by introducing a weakened or inactivated form of a particular virus or bacteria into the body, thus exposing the immune system to the pathogen. Although the pathogen is too weak to make a person sick, the body "thinks" that it is being invaded by an organism, and the immune system produces antibodies and other immune-system components to kill it. It is these immune-system components that prevent the full-strength form of the pathogen from successfully attacking in the future. Vaccines are prepared in several different ways, but for each type the goal is the same—to create an immunologic memory without causing illness.

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WHAT ARE THE DIFFERENT TYPES OF VACCINE?

- *Live weakened vaccines*: Some vaccines—such as those for measles, mumps, and rubella—use live viruses that have been weakened (attenuated).
- *Inactivated vaccines*: Other vaccines use killed (inactivated) bacteria or viruses. The inactivated polio vaccine is made this way (although there is a live attenuated form of polio vaccine as well).
- *Toxoid vaccines*: Some types of bacteria cause disease by producing toxins that enter the bloodstream. Toxoid vaccines, such as those for diphtheria and tetanus, use bacterial toxin that has been rendered harmless to provide immunity.
- *Subunit vaccines*: Subunit vaccines are made by using only a component of the virus or bacteria. The hepatitis and *Haemophilus influenzae* type b vaccines are made this way.
- *Virus-like particle vaccines*: Virus-like particle vaccines are made using proteins that are derived from a particular virus. Although these particles resemble the virus they come from, they cannot replicate and thus cannot cause infection. The human papillomavirus (HPV) vaccine is made in this way, as are hepatitis B vaccines.
- *Conjugate vaccines*: Conjugate vaccines are created by joining a subunit vaccine to a carrier protein, which enhances the immune response of the vaccine. Pneumococcal vaccines are made this way.

Vaccines are typically administered through injection into the muscle or under the skin, although some are given orally (such as the live attenuated polio and rotavirus vaccines). Research is currently under way to develop improved jet injectors, which can deliver a vaccine under the skin without using a needle. This method holds significant promise for preventing infection from dirty needles.

IS NATURAL IMMUNITY BETTER THAN VACCINE-INDUCED IMMUNITY?

Gaining natural immunity to a disease involves considerable risk. Diseases that otherwise are vaccine preventable can kill or cause permanent disability, such as paralysis from polio, deafness from meningitis, liver cancer from hepatitis B, or brain damage and blindness from measles. Immunity from a vaccine offers protection similar to that acquired by natural infection. In fact, the new HPV vaccines produce a more robust immunity than natural infection.

In addition, if enough people are vaccinated against a particular disease, then the disease cannot spread within their community; this is referred to as community or herd immunity. By reducing or eliminating circulation of a disease, herd immunity can help protect people who, for health reasons, cannot be vaccinated, but it will not protect them if they are exposed to disease.

Like any medical intervention, vaccines are not without risk, but for the vast majority of people, the benefits of vaccination far outweigh the risks. Some people choose not to vaccinate their children for personal or religious reasons. In the developed world, these children are largely protected by herd immunity. However, if a significant amount of people do not become vaccinated, then herd immunity declines and rare diseases can become common again. Routine immunization is still the safest, most effective, and cost-efficient way to prevent the spread of deadly diseases.

IS PREVENTION PREFERABLE TO TREATMENT?

Treatment is a vital component of health care and is equally important in the fight against disease. Prevention alone cannot protect everyone, but it is often significantly easier, less expensive, more effective, and safer to prevent a disease than to treat it once it has developed. A vaccine to prevent polio, for example, costs less than a quarter. However, once polio has infected and crippled a person, the cost of his treatment and the effects of paralysis on his future productivity can add up to tens of thousands of dollars over the course of his life.

PATH is working to close gaps in access to lifesaving vaccines. By strengthening health systems, expanding access to new vaccines, accelerating research and development, and creating innovative technology solutions, PATH is working to make safe and effective vaccines affordable and available to those most in need.

RESOURCES

US Centers for Disease Control and Prevention: http://www.cdc.gov/vaccines/vac-gen/imz-basics.htm

US National Institute of Allergy and Infectious Disease: http://www.niaid.nih.gov/topics/vaccines/Pages/Default.aspx

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