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**Review Article**

# A DETAIL COMPREHENSIVE REVIEW ON VACCINES

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**ABSTRACT**

A vaccine is a biological preparation which enhances the immunity to a particular disease. A vaccine typically contains an agent that resembles a disease-causing microorganism and is often made from weakened or killed forms of the microbe, its toxins or one of its surface proteins. This agent stimulates the body immune system to recognize the agent as foreign, destroy it, and keep a record of it, so that the immune system can more easily recognize and destroy any of these microorganisms that it later encounters. Vaccines may be therapeutic (means vaccines against cancer are also being investigated; see cancer vaccine) or prophylactic (means to prevent or ameliorate the effects of a future infection by any natural or "wild" pathogen), The term ***vaccine*** elucidate by Edward Jenner's 1796 use of *cow pox* (Latin *variola vaccinia*, taken from the Latin *vaccīn-us*, from *vacca*, cow), to inoculate humans, providing them protection against smallpox.[1] Vaccines do not guarantee complete protection from a disease.[2] This may be due to a lowered immunity in general (diabetes, steroid, HIV infection,age) or because the host's immune system does not have a B cell capable of generating antibodies to that antigen. In this case, the infection will be less severe and heal faster.[3] Adjuvants are typically used to boost immune response. Most often aluminium adjuvants are used, but adjuvants like squalene are also used in some vaccines and more vaccines with squalene and phosphate adjuvants are being tested. Larger doses are used in some cases for older people (50–75 years)

**Keywords:** Killed, cancer vaccines, Malaria vaccine.

## INTRODUCTION

A vaccine is a biological preparation which enhances the immunity to a particular disease. A vaccine typically contains an agent that resembles a disease-causing microorganism and is often made from weakened or killed forms of the microbe, its toxins or one of its surface proteins. This agent stimulates the body immune system to recognize the agent as foreign, destroy it, and keep a record of it, so that the immune system can more easily recognize and destroy any of these microorganisms that it later encounters. Vaccines may be therapeutic (means vaccines against cancer are also being investigated; see cancer vaccine) or prophylactic (means to prevent or ameliorate the effects of a future infection by any natural or "wild" pathogen), The term vaccine elucidate by Edward Jenner's 1796 use of cow pox (Latin variola vaccinia, taken from the Latin vaccīn-us, from vacca, cow), to inoculate humans, providing them protection against smallpox.1 Vaccines do not guarantee complete protection from a disease.2 This may be due to a lowered immunity in general (diabetes, steroid, HIV infection,age) or because the host's immune system does not have a B cell capable of generating antibodies to that antigen. In this case, the infection will be less severe and heal faster.3 Adjuvants are typically used to boost immune response. Most often aluminium adjuvants are used, but adjuvants like squalene are also used in some vaccines and more vaccines with squalene and phosphate adjuvants are being tested. Larger doses are used in some cases for older people (50–75 years)

**Types of vaccine**

1. Killed

2. Attenuated
3. Toxoid
4. Subunit
5. Conjugate
6. Experimental
7. Valence

**1. Killed (inactivated) Vaccines**

Killed (inactivated) Vaccines are prepared when safe live vaccine is not available. Some vaccines contain killed, but previously virulent, micro-organisms that have been destroyed with chemicals, heat, radioactivity or antibiotics. Examples are the influenza vaccine, cholera vaccine, bubonic plague vaccine, polio vaccine, hepatitis A vaccine, etc.

**2. Attenuated**

Attenuated vaccines are viral, some are bacterial in nature. Examples include the viral diseases yellow fever, measles, rubella, and mumps and the bacterial disease typhoid. The live Mycobacterium tuberculosis vaccine developed by Calmette and Guerin is not made of a contagious strain, but contains a virulently modified strain called "BCG" used to elicit an immune response to the vaccine. The live attenuated vaccine containing strain Yersinia pestis EV is used for plague immunization.(4)

**3. Toxoid**

Toxoid vaccines are made from inactivated toxic compounds that cause illness rather than the micro-organism. Like tetanus and diphtheria. Toxoid vaccines are known for their efficacy. For example, Crotalus atrox toxoid is used to vaccinate dogs against rattlesnake bites.(5)

**4. Subunit**

Protein subunit – rather than introducing an inactivated or attenuated micro-organism to an immune system (which would constitute a "whole-agent" vaccine)[6] Examples include the subunit vaccine against Hepatitis B virus that is composed of only the surface proteins of the virus (previously extracted from the blood serum of chronically infected patients, but now produced by recombination of the viral genes into yeast), the virus-like particle (VLP) vaccine against human papillo mavirus (HPV) that is composed of the viral major capsid protein, and the hemagglutinin and neuraminidase subunits of the influenza virus. Subunit vaccine is being used for plague immunization.

**5. Conjugate[7]**

Conjugate – certain bacteria have polysaccharide outer coats that are poorly immunogenic. By linking these outer coats to proteins (e.g. toxins), the immune system can be led to recognize the polysaccharide as if it were a protein antigen. This approach is used in the Haemophilus influenza type B vaccine.

**6. Valence**

Valence may be monovalent (also called univalent) or multivalent (also called polyvalent).A monovalent vaccine is designed to immunize against a single antigen or single microorganism8 A multivalent or polyvalent vaccine is designed to immunize against two or more strains of the same microorganism, or against two or more microorganisms.9The valence of a multivalent vaccine may be denoted with a Greek or Latin prefix (e.g., tetravalent or quadrivalent). In certain cases a monovalent vaccine may be preferable for rapidly developing a strong immune response.

**Excipients used in the formulatation of vaccine [10-12]**

| EXCIPIENTS | USES |
|---|---|
| Antibiotics | It is used in vaccines to protect bacterial growth during production and storage. |
| protein | It is used in influenza and yellow fever vaccines as they are prepared using chicken eggs. |
| Formaldehyde | It used to inactivate bacterial products for toxoid vaccines. Formaldehyde is also used to inactivate unwanted viruses and kill bacteria. |
| Aluminum | Salts or gels are added as adjuvant, they allow for a lower vaccine dosage. |
| Thimerosal | It contain more than one dose to prevent contamination and growth of potentially harmful bacteria. |

**Vaccine Classification**

1. Cancer vaccines
2. Malaria vaccine
3. Human papillomavirus and HPV vaccines
4. BCG Vaccine
5. Hepatitis A vaccine
6. Varicella (Chickenpox)
7. Cholera Vaccine
8. Rotavirus Vaccine
9. Typhoid Vaccine
10. Tetanus Vaccine
11. Swin flue

**1. Cancer vaccines**

Globally there are currently 10 million new cases of cancer per annum (around 2000 figures), but the WHO has predicted this figure to be 15 million per year by 202013. Although there are more than 100 different forms of cancer, more than 80 percent of cases involve just 14 types of cancers: Prostate, Liver, Breast, Lung, Stomach, Colon, Bladder, Skin, Ovary, Kidney, Brain, Leukemia, Pancreas &Testes[14]

**Types of Cancer Vaccines[15]**

Preventive/Prophylactic vaccines – These are the vaccine which prevent cancer from developing in healthy people.

Treatment/Therapeutic vaccines – It existing cancer by strengthening the body's natural defences against the cancer.

Specific Cancer Vaccines – As the name indicates they treat specific type of cancers. Different vaccines are needed to treat different types of cancers.

**Universal Cancer Vaccines –** They fight cancer cells regardless of cancer type. Basic idea on which Cancer Vaccine works: The vaccine, which contains tumor cells or antigens, stimulates the patient's immune system, which produces special cells that kill cancer cells and prevent relapses of the cancer.

**2. Malaria vaccine**

The methods adopted by parasites to thrive and colonize living organisms are truly fascinating. Along with basic features such as fecundity and resistant cyst structures, the parasites exhibit a fine-tuning of modifications in response to the attack by the host immune system. While the host fights the parasites through its armory of immune as well as certain behavioral responses, the parasites appear to use the host immune responses towards quorum sensing, limiting their own number, but surviving. The human malaria parasite, Plasmodium falciparum, which appears to have an ancient origin and has evolved in parallel with humans.[16]

**3. Human papillomavirus and HPV vaccines**

Cervical cancer, the most common cancer affecting women in developing countries, is caused by persistent infection with "high-risk" genotypes of human papillomaviruses (HPV).17 The most common oncogenic HPV genotypes are 16 and 18, causing approximately 70% of all cervical cancers. Types 6 and 11 do not contribute to the incidence of high-grade dysplasia's or cervical cancer, but do cause laryngeal papillomas and most genital warts. HPV is highly transmissible, with peak incidence soon after the onset of sexual activity. In phase III trials, the vaccine prevented 100% of moderate and severe precancerous cervical lesions associated with types [16].

**4. BCG Vaccine**

Bacillus Calmette–Guerin (historically Vaccine Bilie de Calmette et Guerin commonly referred to as Bacilli de Calmette et Guerin or BCG) is a vaccine against tuberculosis that is prepared from a strain of the attenuated live bovine tuberculosis bacillus, Mycobacterium bovis, that has lost its virulence in humans by being specially subculture in a culture medium, usually Middle brook 7H9. Because the living bacilli evolve to make the best use of the available nutrients, they become less well adapted to their traditional environment, human blood, and can no longer induce the disease when introduced into a human host. Still, they are similar enough to their wild ancestors to provide some degree of immunity against human tuberculosis.

**5. Hepatitis A vaccine**

A vaccine for Hepatitis A has been developed from formalin-inactivated, cell cultured derived virus. The first successful vaccine against it was invented by Maurice Hilleman at Merck.18 The vaccine protects against the virus in more than 95% of cases and provides protection from the virus for at least fifteen years.[19] There are two types of vaccines: one type contains inactivated hepatitis A virus, the other contains a live but attenuated virus. Both types stimulate active immunity against a future infection. Within the US, the vaccine was first phased in around 1996 for children living in

 

high-risk areas. In 1999, it was spread to areas with elevating levels of infection. In the US today, the vaccine is strongly recommended for all children 12 to 23 months of age in an attempt to eradicate the virus nationwide. Although the original FDA license for Havrix by GlaxoSmithKline is dated in 1995, it has been in use in Europe since 1993.

**6. Varicella (Chickenpox) [21]**

Varicella (Chickenpox) was, until recently, one of the most common of childhood diseases. Before there was a vaccine, almost everyone got it. Chickenpox is caused by the varicella zoster virus (VZV). VZV is a DNA virus and is a member of the herpes virus group. VZV persists in sensory nerve ganglia. Primary infection with VZV results in chickenpox. Herpes zoster (shingles) is the result of recurrent infection. The virus is believed to have a short survival time in the environment. Its most recognizable feature is an itchy rash all over the body. It also causes fever and drowsiness. It is spread from person to person through the air, by coughing, sneezing or breathing, and can also be spread by contact with fluid from the blisters Chickenpox is usually mild, but it occasionally causes serious problems. The blisters can become infected, and some children get encephalitis. Among infants less than 1 year old who get the disease, about 1 in 250,000 die. For older children, about 1 in 100,000 dies. If a woman gets chickenpox just before or after giving birth, her baby can get very sick, and about 1 in 3 of these babies will die if not treated quickly. About 1 child in 500 who gets chickenpox is hospitalized.

**7. Cholera Vaccine**

Cholera is caused by a bacterium, vibrio cholera, which produces a toxin that affects the intestines. The infection is often mild or without symptoms, but sometimes it can be severe. The severity of the disease is mainly correlated to the risk of severe dehydration, which can lead to death in a few hours. Treatment thus relies on a rehydration adapted to the patient's condition. A person may get cholera by drinking water or eating food contaminated with the cholera bacterium. In an epidemic, the source of the contamination is usually the feces of an infected person. The disease can spread rapidly in areas with inadequate treatment of sewage and drinking water.

**8. Rotavirus Vaccine**

Rotavirus is a double-stranded RNA virus belongs to family Reoviridae. It is recognized as the most common cause of severe gastroenteritis in infants and young children. The virus enters the body through the mouth. Viral replication occurs in the villous epithelium of the small intestine. Infection may result in decreased intestinal absorption of sodium, glucose, and water, and decreased levels of intestinal lactase, alkaline phosphates, and sucrase activity, and may lead to isotonic diarrhea. The incubation period for rotavirus diarrhea is 1–3 days. The clinical manifestations of infection vary and depend on whether it is the first infection or reinfection. Infection may be asymptomatic, may cause self-limited watery diarrhea, or may result in severe dehydrating diarrhea with fever and vomiting. The clinical features and stool characteristics of rotavirus diarrhea are nonspecific, and similar illness may be caused by other pathogens. As a result, confirmation of a diarrheal illness as rotavirus requires laboratory testing. Rotavirus infection in infants and young children can lead to severe diarrhea, dehydration, electrolyte imbalance, and metabolic acidosis. Immune deficient children may have more severe or persistent disease and may have evidence of abnormalities in multiple organ systems, particularly the kidney and liver.

**9. Typhoid Vaccine**

Typhoid fever is an infectious illness caused by a bacterium, Salmonella typhi. It is caused spread by eating or drinking contaminated food or water. Since the bacterium is present in feces, the infection can occur in any country but it more commonly occurs in places or countries with poor personal or public hygiene. The main signs of the illness include headache, pains in the stomach, constipation or diarrhea and a fever that may last for one or two weeks. Patients normally get better after about four weeks, but relapses can occur. 'Typherix' will only prevent disease caused by the bacterium Salmonella typhi and not against salmonella bacteria that can cause food poisoning or gastroenteritis.

**Symptoms**

1. 7 to 14-day incubation period, typical signs, including diffuse abdominal pain, possibly high fever, anorexia, and very often diarrhea, progressively appear.
2. Daytime drowsiness and night time insomnia are characteristic signs.

3. Possible complications include gastrointestinal hemorrhage and perforation, heart failure, and encephalitis.

**10. Tetanus Vaccine**

Tetanus disease is caused by exotoxin produced by the bacteria Clostridium tetani. It is characterized by generalized rigidity and convulsive spasms of skeletal muscles. The muscle stiffness usually involves the jaw (lockjaw) and neck and then becomes generalized. Tetanus (lockjaw) differs from other vaccine-preventable diseases in that it is not contagious. It does not spread from person to person. The organism is sensitive to heat and cannot survive in the presence of oxygen. The spores of Clostridium tetani bacteria are usually found in soil, intestines and feces of horses, sheep, cattle, dogs, cats, rats, guinea pigs, and chickens, dust, and manure, and they enter the body through breaks in the skin. Children usually become infected through deep puncture wounds or cuts, like those made by nails or knives. These are usually a headache, crankiness, and spasms of the jaw muscles.

**11. Swin Flue**

Vaccines have been developed to protect against the virus that causes swine flu. There are two different brands of vaccine – Pandemrix and Celvapan. Many people given the Pandemrix vaccine will only need one dose. People who have the Celvapan vaccine will need two doses three weeks apart.

**Needle free injection (vaccine) and its route of addministration.[21]**

The use of vaccine is totally based on the clinical trials and practical experience and theoretical considerations. There are five routes used in the administration of vaccines clinical trials,

**Oral (PO) Route**

Oral vaccines should be administered prior to administering injections or performing other procedures that might cause discomfort. Administer the liquid slowly down one side of the inside of the cheek (between the cheek and gum) toward the back of the infant's mouth. Care should be taken not to go far enough back to initiate the gag reflex. Never administer or spray (squirt) the vaccine directly into the throat. Example Rotavirus vaccines (RV1/Rotarix, RV5/RotaTeq) and oral typhoid (TY21a/Vivotif).

**Intranasal (NAS) Route**

A plastic clip on the plunger divides the dose into two equal parts. The patient should be seated in an upright position with head tilted back. Instruct the patient to breathe normally. The provider should gently place a hand behind the patient's head. The tip of the nasal sprayer should be inserted slightly into the naris. Half of the contents of the sprayer (0.1 mL) are sprayed into the nostril. The dose-divider clip is then removed and the procedure is repeated in the other naris.

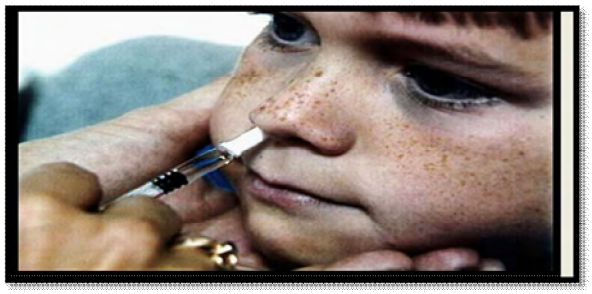

**Figure no 1. Intranasal (NAS) Route**

**Subcutaneous Route.**

Subcutaneous injections are administered into the fatty tissue found below the dermis and above muscle tissue. It is that recommended subcutaneous sites for vaccine administration are the thigh (for infants younger than 12 months of age) and the upper outer triceps of the arm (for persons 12 months of age and older). If necessary, the upper outer triceps area can be used to administer subcutaneous injections to infants. Needle Gauge & Length - 5/8-inch, 23- to 25-gauge needle.

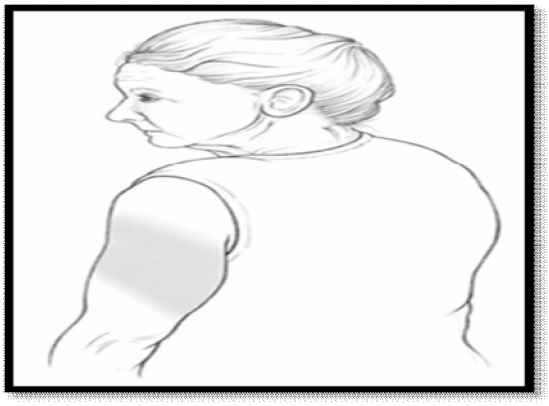

**Figure no 2. Subcutaneous route**

**Intramuscular (IM) Route:**

Intramuscular injections are administered into muscle tissue below the dermis and subcutaneous tissue. There are only two routinely recommended IM sites for administration of vaccines, the vastus lateralis muscle (anterolateral thigh) and the deltoid muscle (upper arm). Injection at these sites reduces the chance of involving neural or vascular structures. The site depends on the age of the individual and the degree of muscle development. Needle Gauge - 22- to 25-gauge needle.

**Intradermal (ID) Route**

Fluzone Intradermal is the only U.S.-licensed vaccine that is administered by the intradermal route. It is approved only for use in persons 18 through 64 years of age. This Fluzone formulation is not the same as intramuscular formulations of inactivated influenza vaccine (TIV). Needle Gauge and Length A manufacturer prefilled microinjection syringe is used to administer a 0.1 mL dose into the dermal layer of the skin. The syringe contains a 30-gauge, 1.5 milliliter micro needle.

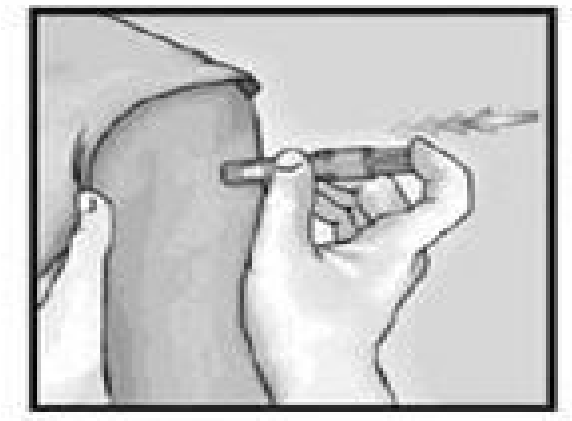

**Figure no 3. Intradermal (ID) Route**

**Some doubts regarding vaccination**

1. Why all vaccines 100% effective
2. Why are there so many vaccines
3. Is natural immunity better than vaccine acquired immunity
4. Why do some vaccines require booster
5. Can babies' immune systems handle so many vaccines
6. Is the polio vaccine linked to HIV
7. Why is there a new flu vaccine every year

**Why all vaccines 100% effective**

Vaccines are designed to generate an immune response that will protect the vaccinated individual during future exposures to the disease. Individual immune systems, however, are different enough that in some cases, a person's immune system will not generate an adequate response. As a result, he or she will not be effectively protected after immunization. After receiving the second dose of the MMR vaccine (measles, mumps and rubella) or the standalone measles vaccine, 99.7% of vaccinated individuals are immune to measles. The inactivated polio vaccine offers 99% effectiveness after three doses. The varicella (chickenpox) vaccine is between 85% and 90% effective in preventing all varicella infections, but 100% effective in preventing moderate and severe chicken pox.

**Why are there so many vaccines?**

The U.S. childhood vaccination schedule for children between birth and six years of age recommends immunizations for 14 different diseases. Some parents worry that this number seems high, particularly since some of the diseases being vaccinated against are now extremely rare in the United States. The United States has seen mumps outbreaks in recent years since vaccination rates have dropped, with severe complications and hospitalizations required for some patients. And before the introduction of the Hib (Haemophilus Influenzae Type b) vaccine, Hib meningitis affected more than 12,000 American children annually, killing 600 and leaving many others with seizures, deafness, and developmental disabilities. After introduction of the vaccine, the number of deaths from Hib dropped to fewer than 10 per year.

**Is natural immunity better than vaccine acquired immunity?**

The risks of natural infection, however, outweigh the risks of immunization for every recommended vaccine. For example, wild measles infection causes encephalitis (inflammation of the brain) for one in 1,000 infected individuals. Overall, measles infection kills two of every 1,000 infected individuals. In contrast, the combination MMR (measles, mumps and rubella) vaccine results in a severe allergic reaction only once in every million vaccinated individuals, while preventing measles infection. The benefits of vaccine-acquired immunity extraordinarily outweigh the serious risks of natural infection.

| Vaccine Name | Route | Schedule For Routine Vaccination And Other Guidelines | Schedule | Contraindications And Precautions |
|---|---|---|---|---|
| DTaP, DT (Diphtheria, tetanus | IM | Give to children at ages 2m, 4m, 6m, 15–18m, 4,6yrs. If possible, use the same DTaP product for all doses. | 2 and #3 may be given 4wks after previous dose. #4 may be given 6m after #3. If #4 is given before 4th birthday, wait at least 6m for #5 (age 4–6yrs). | For DTaP/Tdap only: encephalopathy not attributable to an identifiable cause, within 7d after DTP/DTaP/Tdap. |
| Hepatitis B (HepB) | IM | Vaccinate all children age 0- 18yrs. | If mother is HBsAg-positive: give the newborn HBIG + dose #1 within 12hrs of birth; complete series at age 6m or, if using Convax, at age 12–15m. If mother's HBsAg status is unknown: give the newborn dose #1 within 12hrs of birth. If low birth weight (less than 2000 grams), also give HBIG within 12hrs. For infants weighing 2000 grams or more whose mother is subsequently found to be HBsAg positive, give the infant HBIG ASAP (no later than 7d of birth) and follow HepB immunization schedule for infants born to HBsAg-positive mothers. | **Contraindication** Previous anaphylaxis to this vaccine or to any of its components. **Precautions** Moderate or severe acute illness. For infants who weigh less than 2000 grams. |
| Tdap, Td (Tetanus, diphtheria | IM | For children and teens lacking previous Tdap: give Tdap routinely at age 11–12yrs and vaccinate older teens on a catch-up basis; then boost every 10yrs with Td. | Children as young as age 7yrs and teens who are unvaccinated or behind schedule should complete a primary Td series (spaced at 0, 1–2m, and 6–12m intervals); substitute Tdap for any dose in the series, preferably as dose #1.Tdap should be given regardless of interval since previous Td. | **Contraindications.** For DTaP/Tdap only: encephalopathy not attributable to an identifiable cause, within 7d after DTP/DTaP/Tdap. **Precautions** acute illness. |
| Influenza | IM | Vaccinate all children and teens age 6m through 18yrs. LAIV may be given to healthy, non-pregnant people age 2–49yrs.Give 2 doses, spaced 4wks apart, to children age 6m through 8yrs who 1) are first-time vaccines or 2) who meet any of the additional guidance in the current year's ACIP influenza vaccine recommendations | If LAIV and either MMR, Var, and/or yellow fever vaccine are not given on the same day, space them at least 28d apart. | **Contraindications** Previous anaphylaxis to this vaccine, to any of its components, including egg protein. For LAIV only: age younger than 2yrs; pregnancy; chronic pulmonary (including asthma), cardiovascular (except hypertension), renal, hepatic, neurological/neuromuscular, hematologic, or metabolic **Precautions** Moderate or severe acute illness. |
| Varicella | SC | Give dose #1 at age 12–15m. Give dose #2 at age 4–6yrs. Dose #2 of Var or MMRV may be given earlier if at least 3m since dose #1. If the 2nd dose was given at least 4wks after 1st dose, it can be accepted as valid. Give a 2nd dose to all older children/teens with history of only 1 dose. | If younger than age 13yrs, space dose #1 and #2 at least 3m apart. If age 13yrs and older, space at least 4wks apart. May use as postexposure prophylaxis if given within 5d. If Var and either MMR, LAIV, and/or yellow fever vaccine are not given on the same day, space them at | Contraindications Previous anaphylaxis to this vaccine or to any of its components. Pregnancy or possibility of pregnancy within 4wks Precautions Moderate or severe acute illness. |

**Why do some vaccines require booster**

It's not completely understood why the length of acquired immunity varies with different vaccines. Some offer lifelong immunity with only one dose, while others require boosters in order to maintain immunity. Recent research has suggested that the persistence of immunity against a particular disease may depend on the speed with which that disease typically progresses through the body. If a disease progresses very rapidly, the immune system's memory response (that is, the "watchdog antibodies" generated after a previous infection or vaccination) may not be able to respond quickly enough to prevent infection—unless they've been "reminded" about the disease fairly recently and are already watching for it. Boosters serve as a "reminder" to your immune system.

**Can babies' immune systems handle so many vaccines?**

Yes. Studies demonstrate that infants' immune systems can handle receiving many vaccines at once—more than the number currently recommended. The immunization schedule is

based on infants' ability to generate immune responses, as well as when they are at risk of certain illnesses. For example, the immunity passed from mother to child at birth is only temporary, and typically does not include immunity against polio, hepatitis B, Haemophilus Influenzae Type b, and other diseases that can be prevented by vaccination.

**Is the polio vaccine linked to HIV**

In the 1990s, certain critics began to blame the testing of a live, weakened polio vaccine in Africa in the 1950s for the spread of acquired immune deficiency syndrome (AIDS). Those behind the accusation argued that chimpanzee cells were used to create the vaccine, and that those cells had been contaminated with a virus that sometimes affects chimps: simian immunodeficiency virus, or SIV. When the vaccine was given to children in Africa, they argued, SIV mutated to become human immunodeficiency virus, or HIV, which causes AIDS. The accusations, however, were demonstrably false for a variety of reasons. Most notably, the weakened polio vaccine was not made with chimpanzee cells, but with monkey cells. The vaccine was later tested using a technique that can detect viral DNA (the PCR technique, or polymerase chain reaction); it did not contain SIV or HIV. Researchers at the University of Birmingham in Alabama demonstrated in 2006 that while HIV was in fact a derivative of SIV, chimpanzees in Cameroon that had been infected with SIV in the 1930s were the most likely source of the AIDS epidemic—decades before the weakened polio vaccine was tested in Africa.

**Why is there a new flu vaccine every year?**

Unlike most vaccines, which contain the most common strains of a given pathogen (if more than one exists) and are rarely changed, the seasonal flu vaccine changes frequently, though one or more of the flu strains in the vaccine may be retained from one year to the next. This is because the strains of influenza viruses that circulate are constantly changing. Each year, researchers choose viruses for the vaccine based on which ones are likely to be circulating over the course of the coming flu season, thus providing protection against the most prevalent strains. So when you get a seasonal flu vaccine, you're usually not getting another "dose" of the same flu vaccine you were given before. Instead, you're usually getting protection against a whole new batch of flu viruses.

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