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Review on Vaccine against Viruses – Current Technology



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ABSTRACT

Vaccines stimulate the body's immune system to protect the person against subsequent infection or disease, Vaccination is one of the most effective ways to prevent diseases. A vaccine helps the body's immune system to recognize and fight pathogens like viruses or bacteria, which then keeps us safe from the diseases they cause. Vaccines protect against more than 25 debilitating or life-threatening diseases, including measles, polio, tetanus, diphtheria, meningitis, influenza, tetanus, typhoid, and cervical cancer. Types of vaccine i) Live-attenuated vaccines, ii) Inactivated vaccines, iii) Subunit, recombinant, polysaccharide, and conjugate vaccines, iv) Toxoid vaccines. When most people hear the word "virus," they think of disease-causing (pathogenic) viruses such as the common cold, influenza, chickenpox, human immunodeficiency virus (HIV), and others. Viruses can affect many areas in the body, including the reproductive, respiratory, and gastrointestinal systems. It helps to understand the virus adaptation conditions, It helps to understand the virus life cycle between mammals (Egg: Bats to Humans), to increase the immunization rates.

INTRODUCTION:

Immunization is the process whereby a person is made immune or resistant to an infectious disease, typically by the administration of a vaccine. Vaccines stimulate the body's immune system to protect the person against subsequent infection or disease. A Vaccine is a substance that helps protect against certain diseases.^[1] Vaccines contain a dead or weakened version of a microbe. It helps your immune system recognize and destroy the living microbe during a future infection. Vaccination is one of the most effective ways to prevent diseases. A vaccine helps the body's immune system to recognize and fight pathogens like viruses or bacteria, which then keeps us safe from the diseases they cause.^[2] Vaccines protect against more than 25 debilitating or life-threatening diseases, including measles, polio, tetanus, diphtheria, meningitis, influenza, tetanus, typhoid, and cervical cancer.^[3]

Types of vaccine

- Live-attenuated vaccines
- Inactivated vaccines
- Subunit, recombinant, polysaccharide, and conjugate vaccines
- Toxoid vaccines

Live-Attenuated Vaccines

- Measles, mumps, rubella (MMR combined vaccine)
- Rotavirus
- Smallpox
- Chickenpox
- Yellow fever

Inactivated vaccine

- Hepatitis A
- Flu(Shot only)

- Polio(Shot only)

Subunit recombinant, Polysaccharide, and conjugate vaccines

Hib (Haemophilus influenza type b) disease

- Hepatitis B
- HPV (Human papillomavirus)
- Whooping cough (part of the DTaP combined vaccine)
- Pneumococcal disease
- Meningococcal disease
- Shingles

Toxoid vaccines

- Diphtheria
- Tetanus^[4]



VIRUS: Viruses are small particles of genetic material (either DNA or RNA) that are surrounded by a protein coat. Some viruses also have a fatty "envelope" covering. They are incapable of reproducing on their own. Viruses depend on the organisms they infect (hosts) for their very survival. Viruses get a bad rap, but they also perform many important functions for humans, plants, animals, and the environment. For example, some viruses protect the host against other infections. Viruses also participate in the process of evolution by transferring genes among different species. When most people hear the word "virus," they think of disease-causing (pathogenic) viruses such as the common cold, influenza, chickenpox, human immunodeficiency virus (HIV), and others. Viruses can affect many areas in the body, including the reproductive, respiratory, and gastrointestinal systems. ^[5]

Viral Infection:

A viral infection is a proliferation of a harmful virus inside the body. Viruses cannot reproduce without the assistance of a host. Viruses infect a host by introducing their genetic material into the cells and hijacking the cell's internal machinery to make more virus

particles. With an active viral infection, a virus makes copies of itself and bursts the host cell (killing it) to set the newly-formed virus particles free. The virus makes more copies of it, releases new virus particles, and kills more host cells. ^[6]

- Smallpox
- Measles, mumps, rubella, chickenpox, and shingles, Hepatitis
- Herpes and cold sores, Polio, Rabies
- Ebola and hanta fever, Dengue Fever, Zika, and Epstein-Barr
- HIV, the virus that causes AIDS & Severe acute respiratory syndrome (SARS)

Discovery of viruses ^[7]

- i. 1892 – Dmitri Ivanovsky observed that agent of tobacco mosaic disease passes through porcelain filters that retain bacteria.
- ii. 1898 – Marcus Beijerinck makes the same observation; concludes that the pathogen must be a distinctive agent.
- iii. 1898 – Friedrich Loeffler and Paul Frosch (former students of Koch) find that causative agent of foot-and-mouth disease is filterable (the first animal virus).
- iv. 1901 – Yellow fever virus – Walter Reed (the first human virus)
- v. 1903 – Rabies virus (Remlinger, Riffat-Bay)
- vi. 1906 – Variola virus (Negri)
- vii. 1908 – Poliovirus (Karl Landsteiner and E. Popper); chicken leukemia virus (Ellerman, Bang)
- viii. 1911 – Rous sarcoma virus (Peyton Rous)
- ix. 1915 – Bacteriophages -Frederik Twort, Felix D'Herelle
- x. 1931 – Swine influenza virus (Shope)

ZIKA VIRUS (ARTHROPOD-BORNE VIRUS):

Zika virus disease is caused by a virus transmitted primarily by *Aedes* mosquitoes, which bite during the day. Symptoms, are generally mild and include fever, rash, conjunctivitis, muscle and joint pain, malaise, or headache. Symptoms typically last for 2–7 days. Most people with Zika virus infection do not develop symptoms. Zika virus infection during pregnancy can cause infants to be born with microcephaly and other congenital malformations, known as congenital Zika syndrome. Infection with Zika virus is also associated with other complications of pregnancy including preterm birth and miscarriage. ^[8]

The spread of zika virus:

Zika virus is spread to people through mosquito bites or from sexual contact with an individual who is infected with the Zika virus. The species of mosquito that carries the Zika virus is not known to be established in Rhode Island at any time of the year. In Rhode Island, the Zika virus is considered to be travel-acquired. This means that confirmed cases will be because that person contracted the virus in another area and then returned to Rhode Island. ^[9]

Prevention

- Pregnant women who have plans to travel to an area with the active, mosquito-borne transmission of the Zika virus should not travel.
- Men who travel to an affected area and have a pregnant sexual partner should use a condom during sex or abstain from sex for the duration of the pregnancy.
- Anyone who travels to an area with the active, mosquito-borne transmission of Zika virus should use an EPA-approved bug spray with at least 20% DEET to help prevent mosquito bites.

Vaccine

- A DNA-based vaccine developed by scientists at NIAID's Vaccine Research Centre (VRC). The strategy is similar to the VRC's investigational flavivirus vaccine for West Nile virus infection. The DNA-based Zika vaccine candidate entered a Phase 1 clinical trial at NIAID in August 2016. A second Phase 1 trial testing an optimized vaccine design launched in December 2016. Results indicate the optimized vaccine is safe and able to induce a neutralizing antibody response against the Zika virus. In March 2017, NIAID launched a

Phase 2 clinical trial of the candidate, which is enrolling healthy adult and adolescent participants in areas of confirmed or potential active mosquito-transmitted Zika infection. The trial, called VRC 705, further evaluates the safety and immunogenicity of the vaccine and will assess the optimal dose for administration. It also will attempt to determine if the vaccine can effectively prevent disease caused by Zika infection.^[10]

INFLUENZA

Types of Influenza

- **Influenza Type A** viruses can infect people, as well as birds, pigs, horses, and other animals. There are different strains (or subtypes) of influenza type A viruses, two of which circulate among humans: H1N1 and H3N2. These two subtypes are included in the seasonal flu vaccine each year.
- **Influenza Type B** viruses are usually found only in humans. Influenza B viruses can cause illness among humans, but in general, are associated with less severe infection than influenza A viruses.
- **Influenza Type C** viruses cause mild illness in humans. Influenza C cases occur much less frequently than A and B and are not included in the seasonal flu vaccine.^[11]

Process of Influenza Affects our Body

- The flu affects the whole body—including your nose, throat, and lungs—and can lead to serious complications in those with chronic illness.
- Many people who become sick with the flu say it is like being hit by a truck. Flu symptoms, such as high fever, cough, and muscle aches, usually come on suddenly and are more severe than colds. Not only does having the flu impact your daily activities, but it also leads to missed days from work and school.
- Complications can include pneumonia, ear or sinus infections, dehydration, and worsening of chronic medical conditions, such as congestive heart failure, asthma, or diabetes.^[12]

Typical symptoms in adults can include:

- Sore throat

- Runny nose
- Cough
- Fatigue (tiredness)
- General aches and pains
- Nose, throat, and lung congestion.

Most people recover within a few days, but in some people with existing medical conditions more serious infections can occur such as pneumonia or inflammation of the lungs, resulting in a much longer illness. ^[13]

Vaccine for FLU

An epitope-based vaccine against influenza ^[14]

The currently available vaccines against influenza are viral strain-specific and, hence, their efficacy is limited when the circulating strain is not the one included in them. We review herewith some of the more recently developed influenza vaccines and further describe our data on the design of epitope-based broad-spectrum vaccines for human use. This vaccine is comprised of recombinant flagella that act as a carrier and adjuvant, expressing conserved epitopes of influenza proteins. These epitopes are common to the vast majority of influenza virus strains regardless of their antigenic drifts and shifts. The vaccine, activating both the humoral and cellular arms of the immune response, induces long-lasting protection against many strains of the influenza virus. Consequently, it is expected to protect against future strains as well.

POLIOMYELITIS

Symptoms

Most people who get infected with poliovirus (about 72 out of 100) **will not have any visible symptoms.**

About **1 out of 4 people** with poliovirus infection **symptoms** may include:

- Sore throat

- Fever
- Tiredness
- Nausea
- Headache
- Stomach pain. These symptoms usually last 2 to 5 days, then go away on their own.^[15,16]

A smaller proportion of people with poliovirus infection will develop other, more serious symptoms that affect the brain and spinal cord:

- **Paresthesia** (feeling of pins and needles in the legs)
- **Meningitis** (infection of the covering of the spinal cord and/or brain) occurs in about 1 out of 25 people with poliovirus infection.
- **Paralysis** (can't move parts of the body) or weakness in the arms, legs, or both, occurs in about 1 out of 200 people with poliovirus infection.

Paralysis is the most severe symptom associated with polio because it can lead to permanent disability and death. Between 2 and 10 out of 100 people who have paralysis from poliovirus infection die, because the virus affects the muscles that help them breathe.^[17, 18]

Even children who seem to fully recover can develop new muscle pain, weakness, or paralysis as adults, 15 to 40 years later. This is called post-polio syndrome.

Note that “poliomyelitis” (or “polio” for short) is defined as a paralytic disease. So only people with the paralytic infection are considered to have the disease.^[19]

- **Poliovirus is very contagious and spreads through person-to-person contact.**
- **It lives in an infected person's throat and intestines.**

Poliovirus only infects people.

- It enters the body through the mouth and spreads through
- Contact with the feces (poop) of an infected person.
- Droplets from a sneeze or cough of an infected person (less common).

- You have feces on your hands, and you touch your mouth.
- You put in your mouth objects like toys that are contaminated with feces.

An infected person may spread the virus to others immediately before and up to 2 weeks after symptoms appear. [20, 21]

- The virus can live in an infected person's feces for many weeks. It can contaminate food and water in unsanitary conditions.
- People who don't have symptoms can still pass the virus to others and make them sick.

Diagnostic Methods [22]

Poliovirus can be detected in specimens from the throat, feces (stool), and occasionally cerebrospinal fluid (CSF) by isolating the virus in cell culture or by detecting the virus by polymerase chain reaction (PCR).Centres for Disease Control and Prevention laboratories conduct testing for poliovirus, including:

- Culture
- Intratypic differentiation
- Genome sequencing
- Serology

MEASLES (RUBEOLA)

Signs and Symptoms [23, 24]

Measles symptoms appear 7 to 14 days after contact with the virus and typically include high fever, cough, running nose, and watery eye. The measles rash appears 3 to 5 days after the first symptoms, 7 – 14 days after a measles infection: symptoms are shown

- High fever (may spike to more than 104°),
- Cough,
- Runny nose (coryza), and
- Red, watery eyes (conjunctivitis).

- Small raised bumps may also appear on top of the flat red spots.
- The spots may become joined together as they spread from the head to the rest of the body.
- When the rash appears, a person's fever may spike to more than 104° Fahrenheit.

Treatment

No specific antiviral treatment exists for the measles virus.

Severe complications from measles can be reduced through supportive care that ensures good nutrition, adequate fluid intake, and treatment of dehydration with WHO-recommended oral rehydration solution. This solution replaces fluids and other essential elements that are lost through diarrhea or vomiting. Antibiotics should be prescribed to treat eye and ear infections, and pneumonia. ^[25]

All children diagnosed with measles should receive two doses of vitamin A supplements, given 24 hours apart. This treatment restores low vitamin A levels during measles that occur even in well-nourished children and can help prevent eye damage and blindness. Vitamin A supplements have also been shown to reduce the number of measles deaths. ^[26]

Prevention

Prevent measles with MMR vaccine (Measles, Mumps, and Rubella)

Measles can be prevented with the MMR vaccine. The vaccine protects against three diseases: measles, mumps, and rubella. MMR vaccine is given later than some other childhood vaccines because antibodies transferred from the mother to the baby can provide some protection from disease and make the MMR vaccine less effective until about 1 year of age.

MRV vaccine may be given to children 12 months through 12 years of age, usually:

- First dose at 12 through 15 months of age
- Second dose at 4 through 6 years of age^[27,28]

MUMPS

Complications from mumps are rare but can be serious if left untreated. Mumps mostly affects the parotid glands. However, it can also cause inflammation in other areas of the body, including the brain and reproductive organs. Orchitis is inflammation of the testicles that may be due to mumps. orchitis pain by placing cold packs on the testicles several times per day. The doctor may recommend prescription-strength painkillers if necessary. In rare cases, orchitis can cause sterility. [29, 30]

Prevention

Mumps can be prevented with the MMR vaccine. The vaccine protects against three diseases: measles, mumps, and rubella. MMR vaccine is given later than some other childhood vaccines because antibodies transferred from the mother to the baby can provide some protection from disease and make the MMR vaccine less effective until about 1 year of age.

Vaccination can prevent mumps. Most infants and children receive a vaccine for measles, mumps, and rubella (MMR) at the same time. The first MMR shot is generally given between the ages of 12 and 15 months at a routine well-child visit. A second vaccination is necessary for school-aged children between 4 and 6 years old. With two doses, the mumps vaccine is approximately 88 percent effective. The rate of effectiveness of only one dose is about 78 percent. [31]

RUBELLA (GERMAN MEASLES)

Symptoms

Rubella is usually mild in children; sometimes it doesn't cause any symptoms.

A pink or red-spotted rash is often the first sign of infection. It starts on the face and then spread down to the rest of the body. The rash lasts about 3 days. This is why rubella is sometimes called "3-days measles" along with

- A mild fever-from 99 to 100 F
- Swollen and picky-coloured eyes (conjunctivitis)
- Headache
- A swollen gland behind the ears and on the neck

- Stuffy, runny nose
- Cough
- Sore joints(more common in young women)^[32]

VACCINE

- The MMR vaccine, introduced in the United States in 1971, helps prevent measles, mumps, and rubella (German measles). This vaccine was a huge development in the battle to prevent these dangerous diseases.
- Rubella can be prevented with the MMR vaccine. The vaccine protects against three diseases: measles, mumps, and rubella. MMR vaccine is given later than some other childhood vaccines because antibodies transferred from the mother to the baby can provide some protection from disease and make the MMR vaccine less effective until about 1 year of age.
- . The first MMR shot is generally given between the ages of 12 and 15 months at a routine well-child visit. A second vaccination is necessary for school-aged children between 4 and 6 years old. With two doses, the mumps vaccine is approximately 88 percent effective. The rate of effectiveness of only one dose is about 78 percent.^[33]

YELLOW FEVER

Symptoms

Yellow fever develops quickly, with symptoms occurring three to six days after exposure. The initial symptoms of the infection are similar to those of the influenza virus. They include:

- Headaches
- Muscle aches
- Joint aches
- Chills
- Fever

Acute Phase^[34]

This phase usually lasts for three to four days. Common symptoms include:

- Headaches
- Muscle aches
- Joint aches
- A fever
- Flushing
- A loss of appetite
- Shivers
- Backaches

SUMMARY:

By this submission, researchers can get the idea about the development of a new method for immunization developments. The challenges in vaccine production revolve around difficulties in recognizing essential antigens that display little variation and which cause defensive immunity as pathogens show a great antigenic variation or several strains. In the olden method vaccine, we face more struggles to produce the vaccine and people don't get awareness about the viruses but in the modern century, everyone gets the knowledge & awareness about the viruses and vaccine development. Through The current pandemic of COVID-19, everyone in the world knows the danger of the virus and importance of the vaccine development.

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