

A mini-review on the different types of covid-19 vaccines in use

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Abstract

Novel Coronavirus (Covid-19) is an infectious disease caused by Severe Acute Respiratory Syndrome Corona Virus 2 (SARS-CoV-2). It is a new strain that is identified newly in humans, which was originated in China in 2019. This virus spread from an infected person's mouth or nose upon coughing, sneezing, speaking, or breathing. This is an ongoing global pandemic which increases day by day. The only solution to decrease the fatality caused by COVID-19 is vaccination. Vaccines are of different types. Vaccines get differed depending on the approach in designing them. Inactivated, live attenuated, and viral vector vaccines are made up of the whole microbe approach. Subunit vaccines are made up of the subunit approach. Nucleic acid vaccines are made up of nucleic acids. The present review has attempted to reveal the different types of vaccines used against COVID-19.

Keywords: COVID-19; SARS-CoV-2; Vaccines; Nucleic Acids; Infectious

1. Background

A vaccine is a biological preparation that activates the immune system in the body. The body can produce antibodies upon exposure to a pathogen. The pathogen can be a bacterium, virus, parasite, or fungus which is capable of causing the disease. The disorders caused by these pathogens are termed as infectious diseases. There are physical barriers like skin, mucous, cilia to prevent the pathogen being entering the body. But once after if the pathogen gets entered into the body, the immune system triggers, and the pathogen is attacked or destroyed or overcome. The pathogen is made up of several subparts which are unique to a specific pathogen. The subpart of the pathogen which produces antibodies is called the antigen. When the body is exposed to an antigen for the first time the immune system produces specific antibodies specific to that antigen. Meanwhile, the body turns to a disease state [1].

Once the antigen-specific antibodies are produced, they work with the rest of the immune system to destroy the pathogen and stop the disease. Once the body's immune system produces antibodies specific to the antigen, it also produces antibody-producing memory cells that remain alive even after the pathogen is defeated by antibodies. If the person is exposed to the same pathogen again, the body's immune system can identify and prevent being diseased [1].

Vaccines are the safest way to protect against infectious diseases. Once a person is vaccinated, they have the ability to fight off the disease when they are exposed to the pathogen. Vaccines are made out of killed, greatly weakened, or broken-down parts of a pathogen as the active ingredient. When these vaccines are injected into fatty cells or muscles, they are not strong enough to produce signs and symptoms of the disease. But they have a strong capacity to trigger the immune system and to produce antibodies against them [2].

COVID-19 virus is an infectious disease caused by a virus named SARS-CoV-2 which was originated in China in 2019. This disease has rapidly spread around the world in more than 200 countries and confirmed more than 4.5 million

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deaths. Coronaviruses are relatively large viruses containing single-stranded RNA encapsulated within a membrane envelope. The membrane envelope contains glycoprotein spikes which give a crown-like appearance to the virus. SARS-CoV-2, the severe acute respiratory disorders attack the lower respiratory system and cause viral pneumonia. But may also affect other organs and systems like the gastro-intestinal system, liver, and kidney leading to one or multiple organ failures. Viral pneumonia is caused by the infection of the lungs by viruses. The virus usually sticks on the upper part of the respiratory system. When they go down the respiratory system to the lungs, it infects the air sacs of the lungs, and they get filled up with fluids [3]. The novel Coronavirus is more contagious and transmissible which is also designated with four variants as alpha, beta, delta and gamma.

1.1. History of vaccines against coronaviruses

Coronavirus which was characterized in human was identified in 1965, which was firstly identified in the respiratory tract of a human with common cold [4]. It has a larger RNA molecule enclosed by a protein envelope which consists of outer glycoproteins which are known as spike proteins. These spike proteins contain receptor-binding domain (RBD) which is capable of binding to the host cell through angiotensin-converting enzyme 2 (ACE-2). History reveals that there were many troubles in vaccine development against the coronavirus [1]. Earlier coronavirus vaccines had shown immunogenic against animal models but were unable to exhibit the effective prevention against the disease. Further, it was observed that with the vaccine unlike natural immunity against corona virus does not induce lifelong immunity and reinfection was possible. There had some safety concerns like vaccine-associated disease progression with some previously used corona vaccines. Two mice which were treated with these early vaccines were diagnosed with lung eosinophilic infiltration which was not seen in unvaccinated mice [5,6,7,8].

1.2. Emergence of Severe Acute Respiratory Syndrome (SARS) coronavirus

The SARS coronavirus is the new form of coronavirus which was emerged in China in late 2002. It was spread in 29 countries reporting 770 deaths. These viruses are reported to be easily grown in tissue culture making it easy to identify the genome structure of the virus concluding that the human SARS coronavirus was different from the SARS coronavirus in animals. It is still in trouble of identifying how these viruses spread in the human population [4,9].

Studies have identified that coronaviruses have caused mild respiratory diseases prior to the SARS-CoV outbreak. Recent studies reveal that this was the cause for 15-30% of the deaths related to respiratory tract infections per year. SARS- CoV was controlled in 2003[4]. In 2012 a mutated human coronavirus was identified in the Middle East which is called as Middle East Respiratory Syndrome CoV (MERS- CoV). It has caused higher pathogenic. However, that was controlled in 2013 [10].

1.3. Pandemic COVID-19 outbreak

The novel coronavirus named COVID-19 was originated in 2019 and is declared a global health emergency. The novel coronavirus is termed as SARS- CoV-2. As of 3rd September 2021 World Health Organization (WHO) database confirms 4,539,723 deaths and 218,946,836 confirmed cases globally [11]. However, these numbers are changing every second. The most affected country is the United States confirming 2,112,810 deaths [12]. Most of the countries control this pandemic with the implementation of curfew from time to time. The COVID-19 pandemic has severely effect on the sociological, economical, and psychological state globally. Elderly people as well as people suffering from long-term illnesses are more prone to get severe with the COVID-19. The most critical complication in COVID-19 is the development of severe acute respiratory disease which requires oxygen therapy and intensive care. It is clearly identified that this is transmitted from human to human [13].

The physical remedies to get rid of the virus are wearing masks, maintaining social distancing, and frequent use of hand sanitizer or washing hands. However, once the virus is entered into the human respiratory system it starts to grow in the body, diseasing the body.

1.4. COVID-19 and vaccination

COVID-19 has become a world health burden, and there are no antiviral treatments. The most effective treatment to control the complications with COVID-19 infection is the vaccination which increases the immunization [14]. Researchers are trying to accelerate the research studies to produce new vaccines with advanced technology. The best way to protect the population from critical COVID-19 is the vaccination, which creates herd immunity. Herd immunity is known as the immunity that develops when a large portion of the community becomes immune through vaccination [15]. There are many vaccines for COVID-19. Out of that most are under Phase III clinical trial while only one vaccine is accepted by the United States Food and Drug Administration Authority (US-FDA) recently.

1.5. Types of vaccines

Different types of vaccines perform in different ways to offer protection. With all types, the body produces memory cells that will remember the way to fight the particular virus upon exposure in the future. Typically, it takes few weeks after vaccination to produce these memory cells. The time is way from vaccine to vaccine. Currently there are three types of COVID-19 vaccines produced as;

- Protein subunit vaccines
- Whole virus vaccines
- Nucleic acid vaccines

1.5.1. Protein subunit vaccines

The spike proteins (S Proteins) in the SARS-CoV-2 virus play a vital role in host cell binding and fusion. These purified parts are harmless and stimulate the immune system to produce antibodies against the COVID-19 virus. These vaccines are incapable of causing the disease, hence considered to be used safely. Protein subunit vaccines are manufactured using recombinant technology which does not require to grow in virulent organisms. The key advantage of using these subunit vaccines is their strong stability which can transport and store at regular refrigerator temperatures. These vaccine types do not trigger the immune system strongly with one dose. Hence it requires adjuvant doses or booster doses. [16,17,18].

1.5.2. Whole virus vaccines

Whole virus vaccines are inactivated or weakened form of the SARS-CoV-2 virus which trigger the immune system.

Vector vaccines

Viral vector vaccines are a modified form of a virus which releases the genetic instructions to make proteins against the virus. The virus used as a vector is chemically weakened so that it cannot cause the disease. The COVID-19 vector vaccines contain genetic instructions to produce spike proteins present on the surface of the SARS-CoV-2 which plays a vital role in causing the disease. Once the vaccine is injected, it uses the cell machinery and commences to produce a harmless piece of the virus. Those are S proteins that are unique to cause COVID-19. The immune system recognizes these as antigens /foreign bodies and starts the production of antibodies against this to fight. So if the body is exposed to the virus again, the immune system is ready with memory cells to fight. This vaccine is a harmless version of a virus, and the genetic material does not interfere with the person's DNA. Hence, these vector vaccines are found to be effective and safe to us [19, 20, 21].

Inactivated vaccines

Inactivated vaccines are prepared using the killed virus. Killing is done using chemicals, heat, or radiation. This requires a special laboratory facility to grow the virus safely. Viruses require living cells to grow. Inactivated vaccines are relatively low-cost since they are easy to produce. Studies confirm that the vaccines are safe and tolerable [22,23].

Live- attenuated vaccines

Live attenuated vaccines are the vaccines which contain weakened SARS-CoV-2 virus. This can grow in the living cells once injected but does not cause the disease. There are pros as well as cons to these vaccines. These vaccines induce target stimulation of mucosal and cellular immunity which is an advantage. But this also can excrete through feces, which can then transmit to an unvaccinated person. This requires good quality maintenance in production [23,24].

1.5.3. Nucleic acid vaccines

Nucleic acid vaccines are produced using a part of genetic material which provides instructions to produce specific proteins. Nucleic acids are of two types as Deoxyribonucleic acid (DNA) and Ribonucleic acid (RNA). Both of these give instructions to produce proteins. DNA vaccines use a part of DNA that encodes antigen. It is inserted into a bacterial plasmid. Bacterial plasmids are circular DNA which stores the genetic material that is essential for survival. Plasmids are capable of self-replication independently. This allows the antigen genetic material to translate to proteins by host cell machinery. Hence, these are used in genetic engineering intensively [24].

MRNA vaccines encode the genetic material of the antigen in a mRNA which acts as a template to translate and produce proteins. Then the immune system gets activated against these proteins and produces antibodies to fight against them. The nucleic acid vaccines are a new approach in developing vaccines. Before the COVID-19 pandemic, none of the nucleic

acid vaccines were fully approved by the relevant authorities to be used in the human population. Nucleic acid vaccines have to store in extremely low storage temperatures. Nucleic acid vaccines require high technology [25,26].

2. Discussion

COVID-19 has become a global problem in numerous ways, which is challenging from time to time with varying the virus via mutations. The researchers are struggling to produce vaccines which compatible with to prevent newer variants. Several different vaccines are produced and most of them are still under Phase 3 clinical trials, which can also be used in an emergency. At present, only one vaccine which is an mRNA vaccine is approved by the USA- Food and Drug administration authority.

3. Conclusion

The acceleration of vaccine development is done at a greater speed for the first time. Therefore, the advances in vaccine development are required in order to prepare the best quality and safe vaccines. The nucleic acid vaccines are the most effective, safe, and most expensive vaccines out of all. Hence, it requires extreme temperatures like -70°C , resulting in disturbance in maintaining cold chain management to Asian and Middle East countries. Further studies have to conduct to evaluate heat-stable vaccines. All countries have to get together to give their maximum effort to protect the world from the COVID-19 pandemic.

Compliance with ethical standards

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Disclosure of conflict of interest

Ms. AGK Neranja and Ms. SU Kankanamge contributed in writing the manuscript. All authors read and approved the manuscript.

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