

Vaccines against Coronavirus Type 19: An Overview

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Vaccines are biological agents that provide immunity against certain diseases [1]. Vaccination is an effective technique for prevention of infection and control outbreak of a wide range of infectious diseases (<https://apps.who.int/iris/handle/10665/344476>). Several types of vaccines are available, including; live-attenuated, inactivated, messenger RNA (mRNA), toxoid, and viral vector, or in the form of subunit, recombinant, polysaccharide, or conjugate vaccines [2]. Weill Hallé and Raymond Turpin used BCG vaccine on human for first time at 1921 [3]. The process of developing a new vaccine is very complex and takes around 11-19 years till marketing approval [4].

Coronavirus disease-19 (COVID-19) vaccines are novel ones that have not been used on large scales in humans, and the available information have been provided by the manufacturers (<https://apps.who.int/iris/handle/10665/340301>). COVID-19 resulted in huge death numbers in a relatively short time, thus COVID-19 vaccine development was compressed in time and acquired an emergency use prior final approval, to prevent or limit virus transmission and ultimately reduce death rates [5]. As of January 2023, the World Health Organization (WHO) has granted emergency use to 11 vaccines (<https://www.who.int/publications/m/item/draft-landscape-of-covid-19-candidate-vaccines>). The main categories of COVID-19 vaccines include:

1. Messenger-RNA (mRNA) vaccine has many advantages: including potent immunogenicity, low preparation and production costs, safety, and rapid production. However, it needs special systems of storage and delivery. The mRNA vaccine technology is being used in humans for the first time. The core benefit of such a vaccine is that it allows

the cells of body to synthesize S protein, which differs from other traditional forms of vaccines. This effect diminishes the time required for building the vaccine and subsequently requires less time in comparison with the traditional vaccines. At the present time, three mRNA based vaccines are approved for use in human: PfizerBioNTech Vaccine, the Moderna vaccine and the CVnCoV vaccine of CureVac [6].

The Pfizer-BioNTech COVID-19 vaccine is approved for use in people over the age of 11 years to protect against severe acute respiratory syndrome corona virus-2 (SARS-CoV-2). This type was developed through cooperation between BioNTech and Pfizer. The vaccination needs two doses, three weeks apart, to be administered intramuscularly. Typical side effects include mild to severe discomfort at site of injection, joint and muscle pain, tiredness, headaches, and fever. Serious side effects such as allergic responses are rare. This was the first vaccine to receive approval for routine use. However, the vaccine must be kept at very low temperatures, creating distribution and storage challenges [7].

Moderna is a biotechnology company that developed Moderna COVID-19 vaccine which is injected into the muscle and needs two doses, 28-30 days apart. There is a small chance that it could induce severe allergic reactions [7].

2. Vector-based vaccines utilize replication-deficient viral vectors or attenuated backbones (bioengineered). Adenoviruses are the most commonly used viral vectors are carrying and delivering the double-strand DNA portion of SARS-CoV-2 RNA that code for the viral S-protein. The above mentioned vectors are covered by a strong coat of protein that protects the interior genetic material. As a result, these vaccines do not need to be frozen; they can be stored at refrigerator temperatures (2–8 °C) for up to 6 months. Four vector-based vaccines are currently authorized for use in human: Sputnik-V vaccine, OxfordAs

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traZeneca vaccine, AD5-nCoV (Convidecia) vaccine, and Johnson and Johnson vaccine [6].

Janssen Pharmaceutical Company of Johnson and Johnson developed COVID-19 vaccine as a vector based vaccine. Johnson was approved for use in people aged 18 years and up in February 2021, and it can be given as a single intramuscular dose [7].

3. Inactivated Vaccines of COVID-19: Scientists picked up viral variants that have the ability to multiply in the kidney cells of monkeys and disabled the viruses with chemical materials by linking to the genes and inhibiting the replicative process; it's worth mentioning that the proteins of the vaccines such as the spike S protein remain intact. Four inactivated vaccines to fight COVID-19 have been authorized for use: Sinopharm Vaccine, Sinopharm-Wuhan Vaccine, CoronaVac Vaccine and Covaxin Vaccine [6].
4. Recombinant Protein Subunit Vaccines: They use all viral proteins or parts of them rather than the genetic materials of the virus and packed in nanoparticles. They are very safe without ability to cause the COVID-19. Since such subunits are poorly immunogenic, they must be administered repeatedly. Despite the fact that the following three vaccines: ZF 2001 (RBD Dimer) vaccine, EpiVac-Corona vaccine, and Novavax vaccine are in late stages of the phase 3 clinical trials, they have been approved for use in some nations [6].
5. Virus-Like Particle (VLP) Vaccines: This type of vaccine is mostly made up of viral proteins that make up the structure of the virus. S, M, and E are manufactured viral proteins that are similar to the virus but are devoid of the viral genome. VLP vaccines require adjuvant media and repeated injection. Therefore, these vaccines depend on non-infectious virus - like-particle that are nearly similar to SARS-CoV-2 particles in morphology and structure, but devoid of infectious genetic material, thus making them very safe to produce and to handle. Virus like particle are not approved for use yet [6].

According to the WHO, all the vaccines mentioned have acceptable clinical efficacy. However, vaccination is more important in children and adolescents, pregnant women, the elderly, and patients with concurrent chronic diseases or im-

paired immunity [8]. In addition, COVID-19 vaccines as other medicines and vaccines are not free of adverse events, so benefits-risks balance need to be considered [9].

CONCLUSION

Different COVID-19 vaccines were discovered few months after the pandemic and include: Messenger-RNA, vector-based, inactivated vaccines, recombinant protein subunit, and virus-like particles, but to date the former 3 types are playing major role in vaccination globally.

ETHICAL DECLARATIONS

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Ethics Approval and Consent to Participate

The research is consistent with the Helsinki Declaration ethical standards of 1975, as revised in 2008. No formal ethical clearance was sought for conducting the study.

Consent for Publication

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Informed Consent

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