COVID-19 Vaccine Updates

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Highlights:

- **Provide an overview of (COVID-19) vaccine development strategies and safety issues.**
- **Some of the information of this review article may change rapidly.**

Abstract:

Coronavirus disease 2019 (COVID-19) has been recognized as a pandemic on January 30 /2020 by the World Health Organization. Global efforts have been exerted to prevent the spreading of the disease through political decisions together with personal behaviors, which depend on the awareness of the public and because the diseases range from mild illness to severe fatal disease and no specific treatment, only supportive treatment and because the vaccines are the most effective means of controlling infectious diseases. Scientists working to develop an effective and potent vaccine. Most scientists anticipate that, like most other vaccines, COVID-19 vaccines will not be 100% effective. Therefore, WHO is working to help ensure that any approved vaccines are as effective as possible, so they can have the greatest impact on the pandemic, with this many efforts have been directed towards the development of a vaccine against COVID-19 and most of the developing vaccine candidates have been using the S protein of the SARS-COV-2. WHO announced that the vaccines produced by Pfizer and BioNtech authorized by the US Food and Drug Administration (FDA) Moderna vaccine was authorized by the European Medicine Agency (EUA) on January 6 / 2021, all these vaccines are highly effective and safe. The goal of this review article is to assess the updates of the COVID-19 vaccines with highlights on vaccine development strategies and safety issues of these vaccines.

I– introduction:

The World health organization (WHO) declared COVID-19 a pandemic due to the progress of geographic spread. Furthermore, the WHO declared the outbreak as a Public Health Emergency of International Concern on 30 Jan 2020 [(1).] **Vaccines** are one of the greatest public health advancements of all time, resulting in the control, elimination, or near-elimination of numerous infectious diseases that were once pervasive and often fatal. The vaccine is an immuno-biological substance designed to produce specific immunity against a certain disease. Scientists also altered versions of viruses or bacteria to trigger an immune response [(2).]

Vaccines are the most effective means of controlling infectious diseases. Most scientists anticipate that, like most other vaccines, COVID-19 vaccines will not be 100% effective. Therefore, WHO is working to help ensure that any approved vaccines are as effective as possible, so they can have the greatest impact on the pandemic. With this, many efforts have been directed towards the development of a vaccine against COVID-19 and most of the developing vaccine candidates have been using the **S protein** of the SARS-COV-2 [(2).]

Immuno-therapy is considered an effective method for the prophylaxis and treatment of different diseases. This method involves triggering the immune system to elicit an immune response. The primary target for all programs of COVID-19 vaccination is a vaccine that elicits the production of **S Protein Neutralizing Antibodi**es [(2).]

II-Vaccine development strategies:

Scientists around the world are developing many potential vaccines for COVID-19 using various strategies (figure1). These vaccines are all designed to teach the body's immune system to safely recognize and block the virus that causes COVID-19[(3)]. Several different types of potential vaccines for COVID-19 are in development at the moment, including the following:

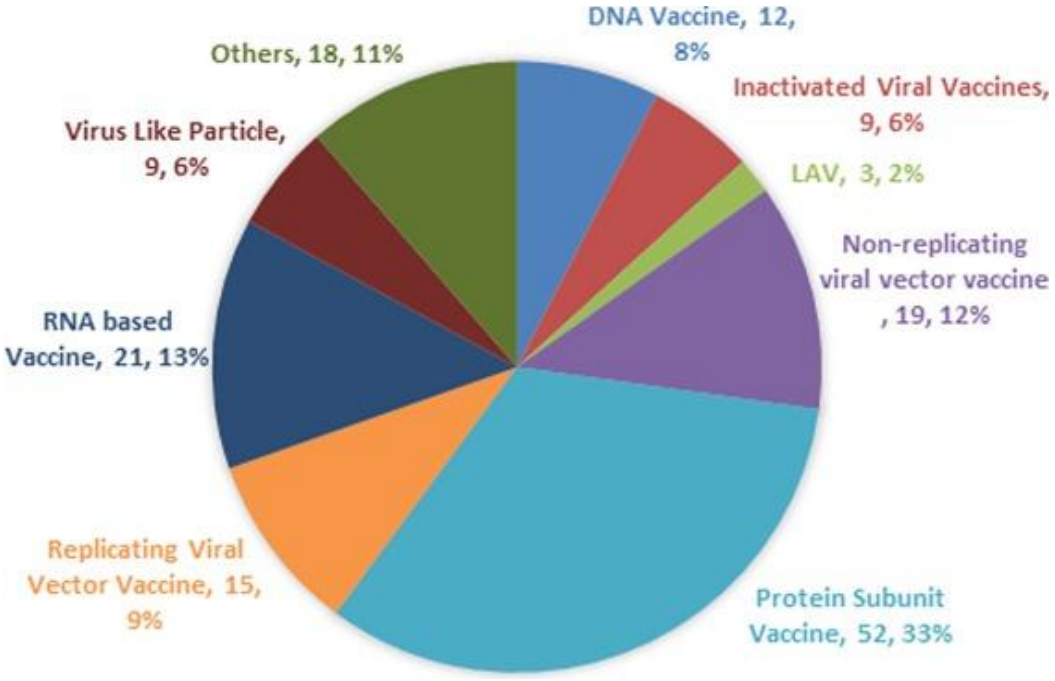

Figure (1): Vaccine Development Strategies.

Source: Simhan Preet Kaur and Vandana Gupta. 2020.

A- Protein Subunit Vaccine:

Which use harmless fragments of proteins or protein shells that mimic the COVID-19 virus to safely generate an immune response. This vaccine **is based on Synthetic Peptides or Recombinant Antigenic Proteins.** It exhibits low immunogenicity, therefore, requires an adjuvant to potentiate the immune response to the vaccine. The **S protein** is the most suitable antigen to induce antibody production [(3).]

1- **NVX-CoV2373 (NovaVax, inc. /EmergentBioSolutions):** This is a **Nano**-particle based vaccine that is based on the recombinant expression of the stable pre-fusion Corona Virus S protein. The company plans to use the Matrix M adjuvant [(2).]
2- Molecular clamp stabilized spike protein vaccine candidate: It's being developed by the **University of Queensland in collaboration** with GSK and Dynavax[(2).]
3- **Pitt- CoVacc(University of Pittsburgh):** It is a micro-needle array (MNA) based recombinant SARS-COV-2 vaccine (MNA-SARS-COV-2 vaccine). The statistically significant titers of antibodies elicited at early stages, even before boosting promise the feasibility of the vaccine [(3).]

B- Viral Vectored Vaccines:

Scientists use a virus that has been **genetically engineered** so that it cannot cause disease **but produces coronavirus proteins to safely generate an immune response**. This type of vaccine is highly specific in developing the genes to the target cells, is highly efficient in gene transduction, and efficiently induces an immune response. These vaccines elicit long term and high level of antigenic protein expression and have the potential for prophylaxis. They trigger cytotoxic **T Cells** that lead to the elimination of infected cells[(3).]

ChAdOx -1(Oxford University)

Interim data suggests 70% protection, but the researchers say the figure may be as high as 90% by tweaking the dose**.** Protection was **90%** in an analysis of around 3,000 people on the trial who were given a half-sized first dose and a full-sized second dose.ChAdOx -1 (oxford)vaccine by Astrazenecacompany efficacyis90% [(3)].

Ad5-nCoV (CanSino Biologics inc./Beijing (Institute of Biotechnology)

This is a recombinant replication-defective adenovirus type 5 vector that expresses the recombinant spike protein of the SARS-COV-2. Clinical trials have established seroconversion with a four-fold increase in serum titer of S protein-specific neutralizing antibody within 14 days. Also, there will be a follow up for 3-6 months post-vaccination for evaluation [(3).]

C-mRNA Vaccines: This is an emerging non-infectious and non-integrating platform with almost no risks of insertional mutagenesis. It has empowered a rapid vaccine development program due to its flexibility and ability to mimic antigenic structure and expression [(3).]

1- mRNA-1273 (Moderna Tx Inc.)

This is a vaccine developed from synthetic **mRNA** encapsulated in a lipid nanoparticle that codes for full-length pre-fusion stabilized spike protein ofSARS-COV-2. It has the potential to elicit a highly S protein-specific antiviral response. It is also relatively safe and was rapidly approved by the food and drug administration (**FDA)** to conduct phase II trials. The vaccine efficacy is 94%[(3).]

2- BNT162b1 (BioNTech/FosunPharma/Pfizer)

A codon-optimized mRNA vaccine encodes for a trimerized SARS-COV-2**RBD**. It portrays increased immunogenicity due to the addition of T4 fibrin-derived fold on trimerization domain to RBD antigen. The phase I and II clinical trials have revealed an increase in antibody production but data analysis did not evaluate safety [(3).]

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D- DNA Vaccines: In this type of vaccine scientists use a cutting-edge approach that uses genetically engineered DNA to generate a protein that itself safely prompts an immune response [(3).]

E- Live Attenuated Vaccines: DelNS1-SAR-COV2-RBD **(University of Hong Kong)**

It is influenza based vaccine strain with a deletion in the NS1 gene and it is reorganized to **express the RBD domain of**SARA COV-2 S protein on its surface. It is cultivated in the chick embryo and/or Madin Darby Canine Kidney (MDCK) Cells [(3).]

Table (1): How vaccines compare.

Name of Vaccine	Pfizer & BioNtech COVID-19 Vaccine	(MMR) Vaccine Measles, Mumps, Rubella vaccine	Flu Vaccine Influenza Vaccine
Type	RNA-virus genetic code	Live attenuated vaccine	Inactivated virus
Doses	Two injections 21 days apart	Two injections at least 28 days apart	Annual injection
How effective	90%	97% against measles and rubella, 88% against mumps	40% -60%
Storage	-80℃	2 ℃-8℃	2 ℃- 8℃

Source: CDC, Pfizer, and BioNTech)**.**

III- Safety Issues:

Clinical trial shows that a COVID-19 vaccine is relatively safe and effective. A series of independent reviews of the efficacy and safety evidence is required including regulatory review and approval in the country where the vaccine is manufactured before WHO considers a vaccine product for prequalification. Part of this process also involves a review of all the safety evidence by the Global Advisory Committee on Vaccine Safety [(2)].

Pfizer and BioNTech announced that their COVID-19 vaccine candidates had 95% efficacy in clinical trials. It was soon followed by similar announcements by Russian Sputnik and Moderna vaccines. Unfortunately, the release of the trial results was via press leaving many scientific uncertainties and the availability of safety data is limited [(4)].

The vaccines must be proven safe and effective in large (phase III) clinical trials. It is also not clear yet how many doses of a COVID-19 vaccine will be needed. Most COVID-19 vaccine being tested now is using two dose regimens. It is too early to know if COVID-19 vaccines will provide long-term protection [(4)].

The US (FDA) announced there will be an advisory committee meeting on December 10th to discuss the request for emergency use of authorization (EUA) of the COVID-19 vaccine from Pfizer. The WHO general director remarked in September-2020 that initially when supply is a limited priority is to vaccinate high-risk -groups in all countries rather than all people in some countries [(5,7)].

The first vaccines for the prevention of coronavirus disease 2019 (COVID-19) in the United States were authorized for emergency use by the Food and Drug Administration (FDA) and recommended by the Advisory Committee on Immunization Practices (ACIP) in December 2020. However, demand for COVID-19 vaccines is expected to exceed supply during the first months of the national COVID-19 vaccination program [(8)].

ACIP advises CDC on population groups and circumstances for vaccine use. On December 1, ACIP recommended that health care personnel and residents of long-term care facilities be offered COVID-19 vaccination first, in phase 1a of the vaccination program [(8)].

On December 20 / 2020 Advisory Committee on Immunization Practices updated interim vaccine allocation recommendations. In Phase 1b, the COVID-19 vaccine should be offered to persons aged

≥75 years and non–health care frontline essential workers, and in Phase 1c, to persons aged 65–74 years, persons aged 16–64 years with high-risk medical conditions, and essential workers not included in Phase 1b [8].

COVID-19 Vaccine Moderna is now authorized across Europe. This follows the granting of a conditional marketing authorization by the European Commission on 6 January 2021. EMA has recommended granting conditional marketing authorization for COVID-19 vaccine Moderna to prevent Coronavirus disease (COVID-19) in people from 18 years of age. This is the second COVID-19 vaccine that EMA has recommended for authorization after the Pfizer BioNtech vaccine [9].

IV- Conclusion

COVID-19 is caused by SARS-COV-2, the causative agent of a potentially fatal disease that is of great global public health concern. Therefore, increasing the awareness of preventive measures helps to mitigate the impact of the epidemic and to delay the epidemic peak thus, preventing the overwhelming of the health care system until the vaccine is available for all people worldwide. To conduct life until the epidemic is revealed by discovering the effective and safe COVID -19 vaccine by the scientists especially m RNA vaccines produced by Pfizer and BioNtech as well Moderna companies all vaccines are highly effective and safe. Also, WHO announced that up to the mid of the next year 2021, the vaccines are accessible in many counties for only the high-risk group such as the elderly and health workers and patients with comorbidities such as (diabetes, hypertension, heart disease, cardiovascular disease, cancer, or any chronic illness and not available for all people worldwide. Therefore, increasing the awareness of preventive measures are still advised by WHO until the availability of COVID -19 vaccines worldwide for all people**.**

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