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Short Communication:
Moderna (mRNA Vaccine) for COVID-19: A Leap in Vaccine World

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ABSTRACT

In December 2019, Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) appeared and spread worldwide, triggering a pandemic of respiratory illness. So, there was an urgent need for vaccines worldwide. The mRNA-based vaccines are undergoing an accelerated phase of development during this pandemic. WHO has issued interim guidelines for administering the Moderna mRNA-1273 vaccine against COVID-19 based on advice given by the Strategic Advisory Group of Experts on Immunization (SAGE). The significant future directions for study would be comparing and elucidating the immune processes triggered by mRNA vaccine platforms, developing existing methods focused on these mechanisms, and introducing new clinical trials of these vaccines against additional disease targets.

This study aims to reveal the important role and contribution of the Moderna mRNA-1273 vaccine to COVID-19 vaccinology.

Moderna mRNA-1273 vaccine could be the keystone of modern vaccinology in the context of the COVID-19 pandemic.

Introduction

In December 2019, Severe Acute Respiratory Syndrome Coronavirus 2 (SARS- CoV-2) appeared and spread worldwide, triggering a pandemic of respiratory illness [1]. Although the ruling bodies worldwide have laid down many guidelines to control the pandemic, like wearing masks, social distancing, the COVID-19 disease remained uncontrollable for some time.

As there was an urgent need for vaccines worldwide, a race started among 120 manufacturers to produce vaccines [2]. A broad array of approaches to SARS-CoV-2 vaccines was suggested, including the conventional approaches like live-attenuated, inactivated, protein/adju-

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vant, as well as other approaches like viral vectors and using nucleic acids. As per the New York Times coronavirus vaccine tracker, 94 vaccines were listed in clinical trials on humans while 31 vaccines are in the final phases of testing and 77 vaccines were in the preclinical stage [3].

History of mRNA vaccines

In 1993, mRNA encapsulated inside liposomes was subcutaneously inoculated. It encoded nucleoproteins for the influenza virus [4]. After this success, mRNA vaccine development started its journey by intradermal injections of naked mRNA encoding various protein substitutes of virus antigenic particles [5]. The mRNA vaccines have already been studied for diseases like flu, Zika, Rabies, and Cytomegalovirus (CMV). As more and more data were collected on SARS-CoV-2 immunopathogenesis, researchers began the trial on the option of mRNA vaccines for COVID-19.

Mode of action

The vaccine's mechanism of action is stimulating a primary immune response so that when the person has been exposed, the secondary immune response will initiate based on memory cells. For this reason, the traditional vaccines use live attenuated, killed organisms, part of the virus, i.e., protein or fragment of it. But, inoculating mRNA is the mode used in a new generation of mRNA vaccines.

There are 3 significant types of RNA vaccines, namely non-amplifying mRNA molecules (mRNA), base-modified non-amplifying mRNA molecules (bmRNA), and self-amplifying mRNA (saRNA or replicons) that has the self-replicative activity of RNA virus. Self-replicating mRNA has several benefits over non-replicating one. For one thing, in the self-replicating mechanism, the dose of RNA required for vaccine manufacture is very low. It is maintained by the auto replication process, making it cost-effective. Also, at times of pandemic when there is an urgent need for vaccines, they are easy to produce at a much faster pace. Thus, a greater population could be vaccinated in a short period [6].

Moderna (mRNA 1273) vaccine

Moderna mRNA1273 vaccine, which uses a self-replicating mechanism, was the first to launch in clinical trials by the National Institute of Allergy and Infectious Diseases on 17 March 2020 [7]. As soon as mRNA encoded with lipid molecule is injected intramuscularly in the deltoid muscle, the cells are instructed to translate it into a special protein name 'spike protein,' which is the surface marker protein of SARS-CoV-2. This spike protein is expressed over the cell surface and is recognized by our immune system as foreign. Thus an immune response is developed, producing antibodies to fight against future viral infection.

The vaccine is immunogenic, and with increasing dose, increasing antibody titers are administered; however, serious adverse effects were noted in a subcategory of patients with higher doses (250 μg) with the incidence rising after the second vaccination [8]. The recommended schedule and dosage of the Moderna RNA-1273 vaccine comprises two doses (100 μg, 0.5 mL each) 28 days apart with an extendable interval of 42 days if needed. The Moderna mRNA vaccine has received a conditional marketing authorization valid throughout the European Union on 6 January 2021 [9]. In a clinical trial on 30000 participants, a 94.1% reduction in symptomatic COVID-19 cases was observed in those who received the Moderna vaccine versus placebo (11 vs 185). Also, there was a 90.9% efficacy in at-risk individuals, including those with chronic lung disease, heart disease, obesity, liver disease, diabetes, or HIV infection [9].

Side effects of moderna mRNA-1273 vaccine

The side effects of Moderna mRNA-1273 vaccines are broadly divided into three categories: common, serious, and rare side effects. The common side effects are chills, headache, tiredness, and injection site reactions (pain, flushed skin, and swelling). The severe side effects are breathing difficulties, confusion, light-headedness, fainting, and rapid heartbeat. The rare adverse effects are myocarditis and pericarditis.

Concerning issues in relation to mRNA vaccines [10]

Although using mRNA as an option for the vaccine has many benefits over others, researchers are still concerned over some issues. Firstly, RNA is more sensitive than DNA to enzymes; thus, various additives are to be searched to find the best ones for increasing the shelf-life of mRNA vaccines. Another approach may be freeze-drying the vaccine for storage. Secondly, switching from two shots to a single shot will be very beneficial in this pandemic scenario serving the population worldwide.

Interim guidelines of the Center for Disease Control (CDC) and prevention for Moderna vaccine have been laid down, which recommends people older than 18 years receive this vaccine. Various clinical trials have demonstrated the safety and efficacy of mRNA vaccines

in people with underlying medical conditions. Based on existing knowledge so far, it has been postulated that mRNA vaccines do not pose any threat to pregnancy and in lactating mothers and neonates, as this vaccine does not contain a live virus. The only known contraindication to this vaccine is an anaphylactic reaction. Hence a person with a history of allergic reaction to the previous dose of the same vaccine or its components like Poly-Ethylene Glycol (PEG) should strictly not receive this mRNA vaccine [11].

Recently, WHO has issued interim guidelines for administering Moderna mRNA-1273 vaccine against COVID-19, based on advice from the Strategic Advisory Group of Experts on Immunization [12, 13]. For undergoing vaccination, a previous history of hypersensitivity to any other vaccine or an injectable therapy is not a contraindication. Instead, precautions should be taken during and after vaccination. The list of precautionary entities does not include food allergies, contact allergies, allergic rhinitis, asthma, and insect venom allergies. There is no contraindication whatsoever for eggs, gelatin, or latex allergy. A healthcare expert should do a complete assessment of wellbeing, including allergic disorders for such individuals, and if the benefits outweigh the risks, the vaccine should be administered. A minimum observation period of 30 minutes should be considered after the vaccination. A person must be afebrile at the time of vaccination, as pyrexia is an absolute contraindication for vaccination.

With the new phase of vaccination, the population eligible for vaccination are older people and those with comorbidities like cardiac diseases, chronic lung diseases, liver diseases, HIV infection, and morbidly obese as per the supportive data from phase 2/3 of the clinical trial. A group of the population for which limited or no data is available are pregnant women, adolescents, lactating mothers, extremely frail older people above the age of 95, persons with an autoimmune condition, people with a history of SARS-CoV-2 infection, and patients who have undergone plasma therapy [12].

Conclusion

mRNA-based vaccines have undergone an accelerated phase of development during this pandemic. Significant future directions for study would be comparing and elucidating the immune processes triggered by mRNA vaccine platforms, developing existing methods focused on these mechanisms, and introducing the mRNA-based vaccine in clinical trials against additional disease targets.

Ethical Considerations

Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

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Authors' contributions

All authors contributed equally in preparing and critically revising the manuscript.

Conflict of interest

The authors declared no conflict of interest.

References

[1] Helmy YA, Fawzy M, Elaswad A, Sobieh A, Kenney SP, Shehata AA. The COVID-19 pandemic: A comprehensive review of taxonomy, genetics, epidemiology, diagnosis, treatment, and control. J Clin Med. 2020; 9(4):1225. [DOI:10.3390/jcm9041225] [PMID] [PMCID]

[2] Pandey A, Belbase P, Parajuli A. COVID-19 vaccine development to vaccination. J Nepal Health Res Counc. 2021; 18(4):807-9. [DOI:10.33314/jnhrc.v18i4.3351] [PMID]

[3] Zimmer C, Corum J, Wee SL, Kristoffersen M. Coronavirus vaccine tracker [Internet]. 2021 [Updated 2022 January 28]. Available from: https://www.nytimes.com/interactive/2020/science/coronavirus-vaccine-tracker.html

[4] Martinon F, Krishnan S, Lenzen G, Magné R, Gomard E, Guillet JG, et al. Induction of virus-specific cytotoxic T lymphocytes in vivo by liposome-entrapped mRNA. Eur J Immunol. 1993; 23(7):1719-22. [DOI:10.1002/eji.1830230749] [PMID]

[5] Hoerr I, Obst R, Rammensee HG, Jung G. In vivo application of RNA leads to induction of specific cytotoxic T lymphocytes and antibodies. Eur J Immunol. 2000; 30(1):1-7. [DOI:10.1002/1521-4141(200001)30:1<1::AID-IMMU1>3.0.CO;2-%23] [PMID]

[6] Blakney AK, Ip Sh, Geall AJ. An update on self-amplifying mRNA vaccine development. Vaccines. 2021; 9(2):97. [DOI:10.3390/vaccines9020097] [PMID] [PMCID]

[7] National Institutes of Health (NIH). Clinical trial of investigational vaccine for COVID-19 begins [Internet]. 2020 [Updated 2020 March 16]. Available from: https://www.nih.gov/news-events/news-releases/nih-clinical-trial-investnins

[8] Jackson LA, Anderson EJ, Rouphael NG, Roberts PC, Makhene M, Coler RN, et al. An mRNA vaccine against SARS-CoV-2:

Preliminary report. N Engl J Med. 2020; 383(20):1920-31. [DOI:10.1056/NEJMoa2022483] [PMID] [PMCID]

[9] European Medicines Agency (EMA). Recommends COVID-19 vaccine Moderna for authorization in the EU [Internet]. 2021 [Updated 2021 January 6]. Available from: https://www.ema.europa.eu/en/news/ema-recommends-covid-19-vaccin-eu

[10] The Conversation. 4 things about mRNA COVID vaccines researchers still want to find out [Internet]. 2021 [Updated 2021 February 4]. Available from: https://theconversation.com/4-things-about-mrna-covid-vaccines-researchers-st160

[11] Centre for Disease Control and Prevention (CDC). Interim Clinical Considerations for Use of COVID-19 Vaccines Currently Approved or Authorized in the United States. Assessed from: https://www.cdc.gov/vaccines/covid-19/clinical-considerations/covid-19-vaccines-us.html

[12] World Health Organization (WHO). Interim recommendations for use of the Moderna mRNA-1273 vaccine against COVID-19 [Internet]. 2021 [Updated 2021 December 7]. Available from: https://www.who.int/publications/i/item/inter-covid-19

[13] World Health Organization (WHO). Extraordinary meeting of the Strategic Advisory Group of Experts on immunization (SAGE) - 21 January 2021 [Internet]. 2021 [Updated 2021 January 21]. Available from: https://www.who.int/news-room/events/detail/2021/01/21/default-calendar/-2021