Electronic Journal of General Medicine
2020, 17(5), em248
e-ISSN: 2516-3507
https://www.ejgm.co.uk/

Perspective Article

MODESTUM
OPEN ACCESS

The Current Update of Vaccines for SARS-CoV-2

Hoang Duc Ha [1†], Nguyen Minh Duc [2,3†*], Pham Minh Thong [4,5]

[1] Department of Radiology, Haiphong University of Medicine and Pharmacy, Hai Phong City, VIETNAM
[2] Department of Radiology, Pham Ngoc Thach University of Medicine, Ho Chi Minh City, VIETNAM
[3] Department of Radiology, Children's Hospital 2, Ho Chi Minh City, VIETNAM
[4] Department of Radiology, Hanoi Medical University, Ha Noi, VIETNAM
[5] Department of Radiology, Bach Mai Hospital, Ha Noi, VIETNAM
†These authors contributed equally to this article.
***Corresponding Author:** bsnguyenminhduc@pnt.edu.vn

Citation: Duc Ha H, Minh Duc N, Minh Thong P. The Current Update of Vaccines for SARS-CoV-2. Electron J Gen Med. 2020;17(5):em248. https://doi.org/10.29333/ejgm/8233

ARTICLE INFO

Received: 13 Apr. 2020

Accepted: 21 Apr. 2020

ABSTRACT

Late 2019 witnessed the appearance of coronavirus disease 2019 (COVID-19) outbreak triggered by a new coronavirus, Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). SARS-CoV-2 spread across China from Wuhan and has been circulated to a broader variety of countries. Seeing that COVID-19 has caused tremendous human casualties posing a global danger, an awareness of the current situation and the strategies to curtail the spread of the virus are desperately required. As the most natural way to preserve public wellbeing, preventive and therapeutic vaccinations must have essential roles. Large organizations and companies have started implementing SARS-CoV-2 preventive vaccinations. Hence, in this study, we aimed to update the vaccine evolution for SARS-CoV-2.

Keywords: COVID-19, pandemic, SARS-CoV-2, vaccines

INTRODUCTION

Cases of severe illness causing pneumonia and death were first recorded in Wuhan, Hubei, China's capital, in December 2019. Soon afterward, the number of cases increased significantly, expanding across China and across the globe. The pathogen has been identified as a novel enveloped betacoronavirus RNA, generally referred to as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (**Figure 1**), which phylogenetically closes to SARS-CoV (1-5). The coronavirus disease 2019 (COVID-19) outbreak has officially been deemed an international public health emergency by the World Health Organization (WHO) (4). Efficient human-to-human connectivity seems a precondition for the widespread dissemination of this new virus (1-5). COVID-19 has currently emerged in more than 200 countries, impacting nearly 1.8 million patients and endangering the majority of the world's population (**Figure 2**) (1-5). It is widely accepted that vaccines are the most effective method for reducing infectious illness since they are more cost-efficient than medication and decrease morbidity and death without negatively long-term consequences, thus, the production of vaccinations for SARS-CoV-2 has started at major institutions and agencies throughout the world. In this study, we aimed to introduce the vaccine status for SARS-CoV-2.

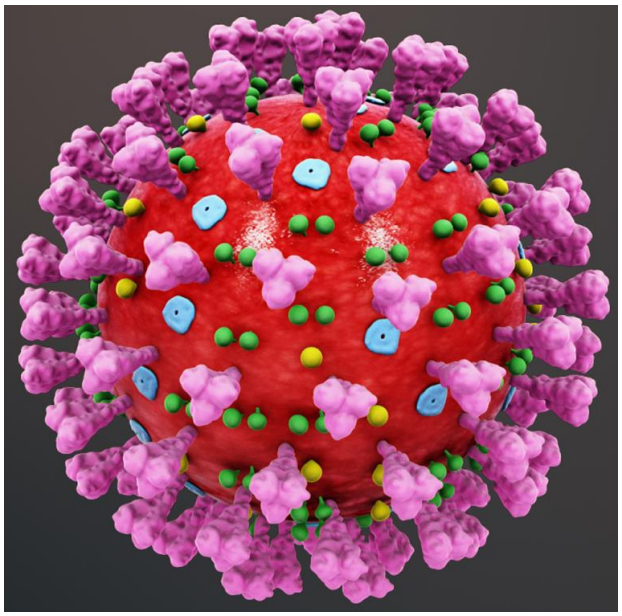

Figure 1. Severe Acute Respiratory Syndrome coronavirus 2 (6)

SAR-CoV-2 STRUCTURE AND ITS RELATIONSHIP WITH VACCINE

Per SARS-CoV-2 virion has a diameter from 50 to 200 nanometres. Like other coronaviruses, SARS-CoV-2 has four structural proteins, classified as S (spike), E (envelope), M

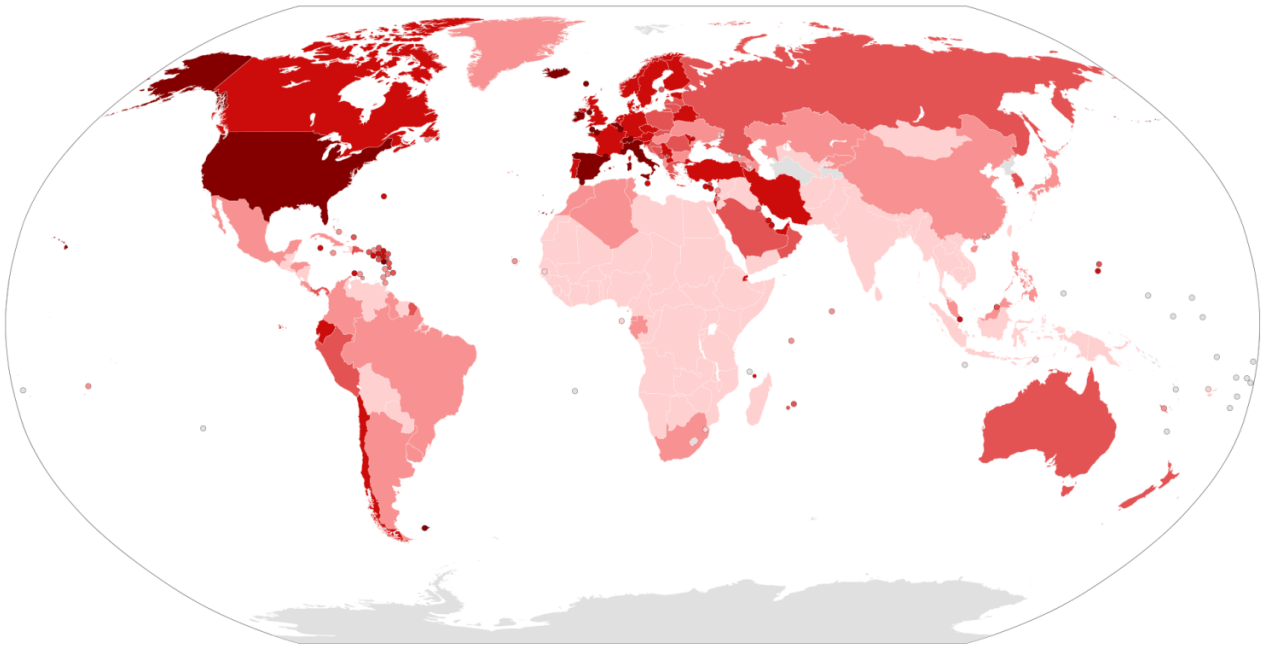

Figure 2. A global map showing the nations in which COVID-19 has been confirmed (7)

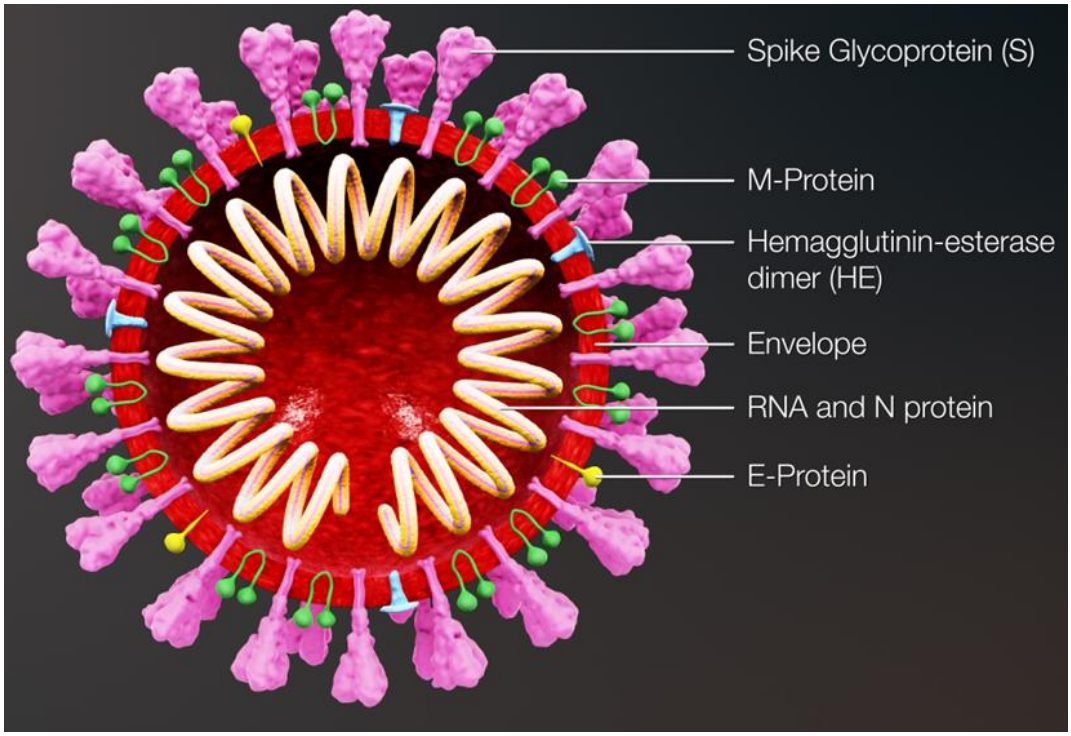

Figure 3. Detailed structure of SARS-CoV-2 (6)

(membrane), and N (nucleocapsid) proteins; the N protein comprises the RNA genome, and the S, E, and M proteins together shape the viral shell. The spike protein is responsible for helping the virus to bind and fuse with a host cell's membrane (**Figure 3**) (8-11). Theoretically, based on the structure of SARS-CoV-2, there are 3 main approaches of vaccine developments including whole virus, subunit, and nucleic acid.

Vaccines basically offer a survival course for the immune system in identifying and organizing defences against disease-causing pathogens such as bacteria or viruses. When the body recognizes such microbes they will produce antibodies that label them for death, so these antibodies continue as sentries to be identified by the same tiny marauders for potential invasions. Other vaccinations teach the immune system by merely introducing immune cells not to the pathogens themselves, but rather to the proteins that the viruses or bacteria produce; plenty of such foreign proteins will therefore identify them as unwanted.

VACCINES RELATED TO WHOLE VIRUS

Live attenuated or inactive whole-virus vaccinations serve a classic vaccination technique. Codagenix employed viral deoptimization technologies to synthesize live debilitated

vaccines, which are rationally designed. Codagenix's technology enables several vaccine candidates to be rapidly developed against SARS-CoV-2, beginning with just the digital sequence of the viral genome. The SARS-CoV-2 genome was already available to the public only a couple of days after the viruses were initially isolated (12). Johnson & Johnson utilized Janssen's AdVac ® adenoviral vector, similar to their Ebola vaccine platform, and developed it in their PER.C6 ® cell line technology. Their innate immunogenicity and capacity to activate toll-like receptors (TLRs) such as 3, 7, 8, and 9 are a big benefit of entire virus vaccines (13). In addition, ChAdOx1 nCoV-19, studied at the University of Oxford, is a safe adenovirus as it was engineered to not develop in the human body and genetically modified to produce a protein like S protein of SARS-CoV-2 virus. The adenovirus produces spike proteins after it has been introduced into the body and this is the SAR-CoV-2 surface antigen. The body will respond against potential SAR-CoV-2 to the production of new anti-SARS-CoV-2 antibodies (14).

VACCINES RELATED TO NUCLEIC ACID

The idea of DNA immunization began with positive tests in mice demonstrating defensive immunity to influenza in 1993 but these findings have not converted into comparable findings in humans for decades. More recently, experimental modifications and formulations have enhanced the efficiency of nucleic acid in humans, with the hope that this strategy may potentially contribute to the first human nucleic acid vaccine approved. Several big pharmaceutical firms have developed applications for the SARS-CoV-2 nucleic acid vaccine. Inovio Pharmaceuticals, for example, is producing a DNA vaccine, while others are pursuing RNA vaccine networks, such as Moderna Therapeutics and Curevac. Inovio Pharmaceuticals launched preclinical studies against SARS-CoV-2 for the DNA vaccine which stimulates T-cells by delivering DNA plasmids containing the SARS-CoV-2 spikes (15). In contrast, after being introduced the genetic material like mRNA encodes a protein from the virus into the body, the immune cells in the lymph nodes receive these mRNAs as a blueprint to generate the appropriate protein. This protein is recognised as an antigen by the body and will generate antibodies to destroy it (16,17).

VACCINES RELATED TO SUBUNIT

For SARS coronaviruses, subunit vaccines depend on an immune reaction to the S-spike protein to avoid its docking with the host angiotensin-converting enzyme 2 (ACE2) receptor (18). A collaboration led by the Texas Children's Hospital Center for Vaccine Research at Baylor College of Medicine has currently produced and evaluated a subunit vaccine composed solely of the SARS-CoV-2 S-protein receptor-binding domain (RBD) (19). Furthermore, the University of Queensland synthesizes virus surface proteins, allowing them possible to submit to the immune system (20). Clover Biopharmaceuticals produces a subunit vaccine composed of a SARS-CoV-2 S-protein trimerized employing Trimer-Tag ® technology (21). In addition, Novavax created immunogenic, virus-like nanoparticles based on S-protein recombinant expression (22) meanwhile Vaxart purposes to produce vaccine candidates based on the reported SARS-CoV-2 genome and test them for their potential to elicit both mucosal and systemic immune responses in preclinical models. The mucosal immune responses should be of special concern, as coronavirus is mainly a respiratory tract infection (23).

CONCLUSION

Each of these vaccines can entail additional processing measures and standardized toxicology tests before sending a regulation package to national regulatory agencies and may begin clinical development. All procedures have advantages and disadvantages. Nevertheless, in the present pandemic and into the future, developing vaccines without having the enough time to consider thoroughly the health hazards might cause unwarranted drawbacks.

ACKNOWLEDGEMENTS

We are very thankful to all health care workers who are on the front lines of the pandemic.

REFERENCES

1. Li Q, Guan X, Wu P, et al. Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus-Infected Pneumonia. N Engl J Med. 2020;26;382(13):1199-207. https://doi.org/10.1056/NEJMoa2001316 PMid:31995857
2. Cakir Z, Savas HB. A Mathematical Modelling Approach in the Spread of the Novel 2019 Coronavirus SARS-CoV-2 (COVID-19) Pandemic. Electron J Gen Med. 2020;17(4):em205. https://doi.org/10.29333/ejgm/7861
3. Gondauri D, Mikautadze E, Batiashvili M. Research on COVID-19 Virus Spreading Statistics based on the Examples of the Cases from Different Countries. Electron J Gen Med. 2020;17(4):em209. https://doi.org/10.29333/ejgm/7869
4. World Health Organization. Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19). Available at: https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf (Accessed 14 April 2020).
5. Minh Duc N, Duc Ha H, Anh Tuan T, Lien Bang MT, Hong Duc P, Minh Thong P. From First COVID-19 Case to Current Outbreak: A Vietnamese Report. Electron J Gen Med. 2020;17(4):em208. https://doi.org/10.29333/ejgm/7867
6. 3D medical animation coronavirus structure. Available at: https://www.scientificanimations.com/coronavirus-symptoms-and-prevention-explained-through-medical-animation/ (Accessed 20 April 2020).
7. Dunant R. COVID-19 Outbreak World Map per Capita. Available at https://en.wikipedia.org/wiki/2019%E2%80%9320_coronavirus_pandemic#/media/File:COVID-19_Outbreak_World_Map_per_Capita.svg (Accessed 20 April 2020).
8. Abdulamir AS, Hafidh RR. The Possible Immunological Pathways for the Variable Immunopathogenesis of COVID—19 Infections among Healthy Adults, Elderly and Children. Electron J Gen Med. 2020;17(4):em202. https://doi.org/10.29333/ejgm/7850

9. Wu C, Liu Y, Yang Y, Zhang P, et al. Analysis of therapeutic targets for SARS-CoV-2 and discovery of potential drugs by computational methods. Acta Pharm Sin B. 2020. https://doi.org/10.1016/j.apsb.2020.02.008 PMCid:PMC7102550
10. Wrapp D, Wang N, Corbett KS, Goldsmith JA, et al. Cryo-EM structure of the 2019-nCoV spike in the prefusion conformation. Science. 2020;367(6483):1260-3. https://doi.org/10.1126/science.abb2507 PMID:32075877 PMCid:PMC7164637
11. Aljofan M, Gaipov A. Chloroquine and COVID-19: A Light at the End of the Tunnel, or is it Another Train?. Electron J Gen Med. 2020;17(4):em207. https://doi.org/10.29333/ejgm/7863
12. BioSpace. Codagenix and Serum Institute of India Initiate Co-Development of a Scalable, Live-Attenuated Vaccine Against the 2019 Novel Coronavirus, COVID-19. Available at: https://www.biospace.com/article/releases/codagenix-and-serum-institute-of-india-initiate-co-development-of-a-scalable-live-attenuated-vaccine-against-the-2019-novel-coronavirus-covid-19/ (Accessed 14 April 2020).
13. Our Efforts to Develop a Vaccine and Identify Therapies for COVID-19. Available at: https://www.jnj.com/coronavirus/prevention-and-treatment (Accessed 14 April 2020).
14. A Study of a Candidate COVID-19 vaccine (COV001). Available at: https://www.clinicaltrials.gov/ct2/show/NCT04324606 (Accessed 14 April 2020).
15. Inovio Pharmaceuticals. Inovio Collaborating With Beijing Advaccine To Advance INO-4800 Vaccine Against New Coronavirus In China. Available at: http://ir.inovio.com/news-and-media/news/press-release-details/2020/Inovio-Collaborating-With-Beijing-Advaccine-To-Advance-INO-4800-Vaccine-Against-New-Coronavirus-In-China/default.aspx (Accessed 14 April 2020).
16. Inside the Company That's Hot-wiring Vaccine Research in the Race to Combat the Coronavirus. Available at: https://time.com/5775784/coronavirus-vaccine-research (Accessed 14 April 2020).
17. Smith J. CureVac bids to develop first mRNA coronavirus vaccine. 2020. Available at: https://www.labiotech.eu/medical/curevac-coronavirus-outbreak-cepi (Accessed 14 April 2020).
18. Jiang S, Bottazzi ME, Du L, Lustigman S, et al. Roadmap to developing a recombinant coronavirus S protein receptor-binding domain vaccine for severe acute respiratory syndrome. Expert Rev Vaccines. 2012;11(12):1405-13. https://doi.org/10.1586/erv.12.126 PMid:23252385 PMCid: PMC3586247
19. Mukherjee S. The first coronavirus drug candidate is set for testing in China. Fortune. 2020. Available at: https://fortune.com/2020/02/03/coronavirus-vaccine-testing-in-china/ (Accessed 14 April 2020).
20. Hennessy J. Australia's been asked to make a coronavirus vaccine at 'unprecedented speed'. Science Alert. 2020. Available at: https://www.sciencealert.com/australian-scientists-asked-to-make-coronavirus-vaccine-at-unprecedented-speed (Accessed 14 April 2020).
21. Clover Biopharmaceuticals. Clover initiates development of recombinant subunit-trimer vaccine for Wuhan coronavirus (2019-nCoV). Available at: https://pipelinereview.com/index.php/2020012873644/Vaccines/Clover-Initiates-Development-of-Recombinant-Subunit-Trimer-Vaccine-for-Wuhan-Coronavirus-2019-nCoV.html (Accessed 14 April 2020).
22. Pharmaceutical Technology N. Coronavirus: Vir Biotechnology and Novavax announce vaccine plans. Available at: https://www.pharmaceutical-technology.com/news/coronavirus-vir-biotechnology-novavax-vaccine (Accessed 14 April 2020).
23. Vaxart. PipelineReview.com Vaxart Announces Initiation of Coronavirus Vaccine Program. 2020. Available at: https://pipelinereview.com/index.php/2020020273689/Vaccines/Vaxart-Announces-Initiation-of-Coronavirus-Vaccine-Program.html (Accessed 14 April 2020).