Asian Journal of Pharmaceutical Research and Health Care, *Vol 13(1), 1-3, 2021*

ISSN (Online) : 2250-1460
DOI: 10.18311/ajprhc/2021/27078

Journey from Coronavirus Pandemic to Vaccines

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Nearly one year ago the world health organization (WHO) identified an outbreak of pneumonia cases in Wuhan, China. Later, the cause of this disease was identified to be a mysterious SARS-CoV-2 coronavirus and in a matter of time, the coronavirus disease 2019 (COVID-19) spread as a pandemic across the globe. Currently, the total confirmed cases of COVID-19 have reached over 106,301,950, with more than 2,318,094 deaths and 77,894,859 recoveries. The hard-hit countries include the united states of America (USA) with 26.7 million reported cases, followed by India (10.8 million), Brazil (9.2 million), Russia (3.9 million), and the United Kingdom (UK) (3.8 million). Practically all these countries also rank in the top 5 on the number of deaths.

Vaccines remain the most efficient tool to prevent infectious diseases and improving global health. In this pandemic, scientists around the world are racing to develop vaccines to avert the spread of COVID-19. At present, more than 170 candidate vaccines are in pre-clinical trials, and around 60 are in various phases of clinical trials (WHO). The rapid development of numerous vaccine candidates in such a short term is remarkable, considering that the usual process takes 8-15 years. There are four classes of vaccines in clinical trials: Whole virus (15), protein subunit (13), nucleic acid (20), and viral vector (15). In few vaccines, antigen (whole virus and protein subunit) is injected into the body, while in other vaccines, viral nucleic acid and protein subunit is injected to stimulate the immune response in order to produce the antigen. Among vaccine candidates that are undergoing Phase III clinical trials, few have already been approved for emergency use in countries, including China, India, Russia, UK, and the USA (Table 1).

In November 2020, Comirnaty, COVID-19 mRNA vaccine manufactured by New York-based Pfizer and the German company BioNTech became the first fully tested immunization (efficacy: 95%) approved by the US Food and Drug Administration (FDA) for emergency use[1]. In December 2020, another vaccine (mRNA-1273) made by Boston-based company Moderna also received approval by FDA for emergency use. Like Pfizer and BioNTech, the Moderna vaccine is mRNA based as well (efficacy: 94%)[2]. On 30th December, AZD1222 (also known as Covishield in India), manufactured by the University of Oxford and the British-Swedish company AstraZeneca, produced locally by Serum Institute of India, received approval from the Medicines and Healthcare products Regulatory Agency (MHRA), UK (efficacy: 62% to 90%, depending on dosage)[3]. Covishield is based on a weakened version of a chimpanzee common cold virus. Johnson & Johnson is also developing a coronavirus vaccine known as JNJ-78436735 or Ad26.COV2.S at Beth Israel Deaconess Medical Center in Boston, which showed 66% efficacy to moderate to severe COVID-19 infections in phase III trial[4]. Ad26.COV2.S vaccine is based on a replication-incompetent adenovirus serotype 26 (Ad26) vector which encodes a full-length SARS-CoV-2 spike protein (approval pending for emergency use). Recent evidence suggests that Phase III trials of vaccines based on nucleic acid coding for spike protein, delivered via adenoviruses or liposome exhibited effective immune responses[3,5-7]. China has several vaccines in phase III clinical trial, which includes CoronaVac developed by Sinovac, BBIBP-CorV by CNBG units/Sinopharm, Convidecia (Ad5-nCoV) by CanSino Biologicals, and ZF2001 by the Chinese Academy of Science[8]. Sinopharm and Sinovac vaccines are made from the inactivated virus while the CanSino vaccine is based on a replication-incompetent adenovirus vector. However, China has not released late-stage phase III data on its vaccines. In Russia, the Gamaleya Research Institute has created a vaccine with 91.6% efficacy, which is the mixture of two adenoviruses, i.e. Ad5 and Ad26, and named it sputnik V[9]. India has approved two vaccines for emergency use that are Oxford-Astrazeneca's Covishield and Covaxin[10] manufactured by the joint collaboration of Bharat Biotech and National Institute of virology based on their results from phase I and II clinical trials[11].

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Table 1. Comparison of the approved and under Phase III clinical trial vaccines

Vaccine	Developer	Country	Mode of action	Efficacy	Status
Comirnaty/ Tozinameran/ BNT162b2	Pfizer-BioNTech	USA and Germany	mRNA	95%	Approved in Bahrain, Saudi Arabia, Switzerland. Emergency use in US, E.U., other countries.
mRNA-1273	Moderna	USA	mRNA	94%	Emergency use in US, UK, E.U., others.
Sputnik V	Gamaleya	Russia	Ad26, Ad5	92%	Early use in Russia. Emergency use in other countries.
AZD1222	Oxford-AstraZeneca	U.K and Sweden	ChAdOx1	62% to 90%	Emergency use in UK, E.U., other countries.
Convidecia/ Ad5-nCoV	CanSino	China	Ad5	unknown	Limited use in China, Russia, Pakistan, Mexico, Argentina, Chile, others
JNJ-78436735/ Ad26. COV2.S	Johnson & Johnson	Belgium and USA	Ad26	66%	Approval pending
EpiVacCorona	Vector Institute	Russia	Protein	100%	Early use in Russia.
NVX-CoV2373	Novavax	USA	Protein	89.3%	Approval pending
BBIBP-CorV	Sinopharm	China	inactivated	79%	Approved in China, U.A.E., Bahrain. Emergency use in Egypt, Hungary, Jordan.
CoronaVac	Sinovac	China	inactivated	50.38%	Emergency use in China, Brazil, Turkey, indonesia others.
Sinopharm vaccine	Sinopharm-Wuhan	China	inactivated	unknown	Limited use in China, U.A.E.
Covaxin	Bharat Biotech	India	inactivated	unknown	Emergency use in India.

Source: WHO, Vaccine manufacturing firms/companies websites

Altogether, remarkable progress has been made with the effective production of several vaccines in all these countries. Despite this success, there are various challenges in front of researchers, clinicians, and policy makers to ensure the accessibility of vaccines to the general public and strengthening confidence towards existing vaccines by providing their accountability, transparency, and efficacy. Furthermore, the race in vaccine development has created a disparity in allocation and access to vaccines between economically rich and poor countries. India is one of the first countries, who has started shipping the first doses of Covishield vaccines to its neighboring mid- and lower-income countries like Bangladesh, Nepal, Bhutan, Maldives, and Afghanistan as a gift, which is being widely appreciated as a part of "vaccine diplomacy." To ensure the procurement and equitable distribution of COVID-19 vaccines worldwide, COVID-19 Vaccines Global Access (COVAX) facility has been established by WHO in collaboration with the Coalition for Epidemic Preparedness Innovations (CEPI) and Gavi, the Vaccine Alliance. Although, the cascade of health-related and economic damages caused by the coronavirus pandemic will probably remain for years, but we hope with great confidence that global initiatives of vaccine development and procurement between nations will provide the fastest recovery and will eradicate this pandemic from the world.

1. References

1. Callaway E, Ledford H, Viglione G, Watson T, Witze A. COVID and 2020: An extraordinary year for science. Nature. 2020; 588: 550-552.
2. Baden LR, El Sahly HM, Essink B, et al. Efficacy and Safety of the mRNA-1273 SARS-CoV-2 Vaccine. N Engl J Med. 2020; 384:403-416.
3. Selectscience.net. 2021. AZD1222 vaccine met efficacy endpoint in preventing COVID-19. [online] Available at: https://www.selectscience.net/industry-news/astrazeneca-covid-19-vaccine-azd1222-met-primary-efficacy-endpoint/?artID=53242 [Accessed 24 January 2021].
4. Sadoff, J., Le Gars, M., Shukarev, G., Heerwegh, D., Truyers, C., de Groot, A., Stoop, J., Tete, S., Van Damme, W., Leroux-Roels, I., Berghmans, P., Kimmel, M., Van Damme, P., de Hoon, J., Smith, W., Stephenson, K., De Rosa, S., Cohen, K., McElrath, M., Cormier, E., Scheper, G., Barouch, D., Hendriks, J., Struyf, F., Douoguih, M., Van Hoof, J. and Schuitemaker, H., 2021. Interim Results of a Phase 1–2a Trial of Ad26.COV2.S Covid-19 Vaccine. N Engl J Med.
5. Pfizer.com. 2021. Pfizer and BioNTech Conclude Phase 3 Study of COVID-19 Vaccine Candidate, Meeting All Primary Efficacy Endpoints | Pfizer. [online] Available at: https://www.pfizer.com/news/press-release/press-release-detail/pfizer-and-biontech-conclude-phase-3-study-covid-19-vaccine [Accessed 31 January 2021].
6. Moderna, Inc. 2021. Moderna's COVID-19 Vaccine Candidate Meets its Primary Efficacy Endpoint in the First Interim Analysis of the Phase 3 COVE Study | Moderna, Inc.. [online] Available at: https://investors.modernatx.com/news-releases/news-release-details/modernas-covid-19-vaccine-candidate-meets-its-primary-efficacy/ [Accessed 1 February 2021].
7. En.wikipedia.org. 2021. Sputnik V COVID-19 vaccine. [online] Available at: https://en.wikipedia.org/wiki/Sputnik_V_COVID-19_vaccine [Accessed 11 February 2021].
8. Mallapaty, S., 2021. China COVID vaccine reports mixed results — what does that mean for the pandemic?. [online] https://www.nature.com. Available at: https://www.nature.com/articles/d41586-021-00094-z [Accessed 2 February 2021].
9. Voysey M, Clemens SAC, Madhi SA, et al. Safety and efficacy of the ChAdOx1 nCoV-19 vaccine (AZD1222) against SARS-CoV-2: an interim analysis of four randomised controlled trials in Brazil, South Africa, and the UK. Lancet. 2021; 397: 99-111.
10. Ella R, Vadrevu KM, Jogdand H, et al. Safety and immunogenicity of an inactivated SARS-CoV-2 vaccine, BBV152: a double-blind, randomised, phase 1 trial. Lancet Infect Dis 2021 pp. 1-10.
11. Poland GA, Ovsyannikova IG, Kennedy RB. SARS-CoV-2 immunity: review and applications to phase 3 vaccine candidates. Lancet. 2020; 396: 1595-1606.