Research Article

Effectivity Analysis of COVID-19 Vaccines Against Emerging Variants of SARS-CoV-2

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Abstract

SARS-CoV-2 is an mRNA virus that has plunged the whole world into serious trouble for the last two years. Due to continuous transmission, the virus mutates rapidly and new strains emerged which made vaccines less effective. The study aims to describe the impact of major vaccines on different variants of COVID-19. The successful launch of the COVID-19 vaccine raised hope for the extinction of pandemics and return to pre-quarantine life around the globe. Clinical trials revealed all major vaccines provide a short-term satisfactory level of protection against the disease but none of the vaccines is ensuring 100% safety against all variants. Efficacy drop of several vaccines has also been observed against the B.1.1.7, B.1.617, B.1.351 P.1 variants of concern. Phase 3 and phase 4 clinical trials need to be conducted on major vaccines. Chinese vaccines are expected to be most effective against the delta strain yet having no satisfactory results against SOIY.V2, B.1.1.7, and P.1

strains. While the western world has a hawk-eye on mRNA vaccines (BNT162b2 and mRNA-1273) having the highest efficacy rate (around 90-95%). Sputnik V vaccine is recently approved for use in more than 66 countries but its effectiveness against all variants of concern (VOC) is not guaranteed. The analysis revealed that overall vaccination is capable to provide 72% efficacy in terms of protection against deaths. None of the vaccines proved to be 100 % effective against all strains of COVID-19 but developed antibodies to fight better and increased chances of survival.

1. Introduction

SARS-CoV-2 is a less stable mRNA virus having more prone to mutation accumulation [1]. The chances of virus mutation increase when it is broadly circulating in a population. It results in the origination of new "variants" of the virus [2]. In late 2020, experts noted gene mutations of COVID-19 in southern England. Later on, many other countries found this mutated form (alpha B.1.1.7) of COVID-19 is up to 70% more transmissible [3]. Meanwhile, the Beta variant (B.1.351) was identified in South Africa following 20 other countries including the UK. Scientists examined B.1.351 has a 49% higher risk of critical disease, and 57% higher risks of mortality than B.1.1.7 variant. It raised an alarming situation around the globe. On 11 January 2021, experts spotted a more dangerous and contagious strain in Brazil, named gamma (P.1). Delta (B.1.617.2) variant was reported in India on Oct 2020, caused a massive surge in the cases. It was 55% more transmissible in more than 130 countries. The occurrence of new variants opens up a debate regarding the safety of a vaccine. These vaccines make antibodies against the spike protein so it's unlikely that a single new mutation in the alpha variant will make the vaccine less effective [4] In this article, we review the impact of newly arisen variants on the efficacy of vaccines.

2. Effect of Viral Vector Vaccines on Variants of COVID-19

2.1 AstraZeneca (ChADOx1 nCOV-19 vaccine)

Oxford-AstraZeneca is a worldwide science-led biopharmaceutical company that operates in over 100 countries and its innovative medicines are trusted by millions of patients. Clinical trials in UK and Brazil revealed positive high-level efficacy of AZD1222 against COVID-19. In the interim analysis of 131 COVID-19 patients, no severe cases of illness and hospitalization were observed in the patients receiving the vaccine. Statistical results revealed overall efficacy of the vaccine is 70% by two dosages in one month gap. In March 2021, the WHO advisory group (SAGE) also recommended the emergency usage of the ChADOx1 nCOV-19 vaccine [5]. University of Oxford studies revealed currently available vaccines will provide immunity against all variants of concern. Indian variants (delta &kappa) are a key contributor in the current wave of COVID 19 and have now been classified as variants of concern. It has been observed AstraZeneca's SARS-CoV-2 vaccine comprised 90% of all doses supplied in India [6]. Analytical trials demonstrate the vaccine is 92% effective against delta variant after two doses. the efficiency decreases to 17% by using a single dose [7]. Based on the sub-analysis of the phase 3 trial, UK claimed 70.4 % efficacy of COV002 vaccine against alpha variant after 14 days of the second dose [6]. For progenitor (mixed) strains, the vaccine is 23% effective in curing asymptomatic COVID 19, severe cases by a 70.4% efficacy rate [8]. Whilst for some common variants, efficacy relies on between (67•9 to 89•4) % [9]. Chief Investigator of

the Oxford Vaccine, Professor Andrew Pollard, said: "Findings show that we have effective vaccines that will save many lives. Excitingly, we've found that one of our dosing regimens may be around 90% effective. This dosing regimen plan is capable to provide vaccines to a plethora of people [6]. People all over the world having stable medical conditions and aged 18 years can get this vaccine. Those having comorbidities including cardiovascular disease, respiratory disease, obesity, and diabetes are safe to be vaccinated by AstraZeneca. Pregnant women should concern their gynecologist before getting the vaccine according to their medical reports. As many old folks are hesitant about the safety of the vaccine, but clinical trials on 57000 people revealed that it's safe for people aged above 50 [9]. Yet, preliminary reports of cases affirmed the occurrence of unusual thrombocytopenia and coagulopathy in young females after getting vaccinated by AZD1222 [10].

2.2. CanSinoBio Inc (Ad5-nCoV)

CanSinoBio is a Chinese vaccine that was developed by the team of CanSino Biologics Inc., Beijing Institute of Biotechnology of the academy of military medical sciences. Convidicea (CanSino Bio) is a genetically engineered viral vector vaccine that uses the Ad5-nCoV candidate. CanSinoBio development started in early 2020. According to the data of LANCET journal from clinical trials phase I and II (on people age 18 and older than 18), CanSinoBio induced an immune response after its single dose and do not show any severe adverse reaction [11]. CansinoBio got approved for emergency use by WHO in the world. After this, ad5-nCoV started its trial phase III in different countries includes Pakistan, Mexico, Argentina, Chile, and Russia, with 40,000 people. Talking about different strains of COVID-19, right now, alpha, beta, gamma, and delta variants are most dominant. According to the data of the China National Institute of Food and Drug Control, Ad5-CoV can induce immunity against nine different strains with a slight decrease in effectiveness against Beta (B.1351). CanSinoBio immunity against delta (B.1.617) was 0.9 to1.4 times lower than the D614G strain. Zhu Tao (cofounder of CansinoBio Inc.) said that a booster shot (after six months of a single dose of ad5-CoV) increases antibodies by eight times in the body. Based on interim data obtained from the trial phase III [12], that shows the efficacy of 65.28% at preventing symptomatic COVID-19, 28 days and 90.07% at preventing severe COVID-19 28 days after single-dose vaccination But company has not shared detailed data on its effectiveness against all strains that are causing doubt about this vaccine. That is the reason many western countries are not using Chinese vaccines [13].

2.3. Sputnik V (Gam-COVID-Vac)

Sputnik V is a Russian Covid-19 vaccine manufactured by the Gamaleya Research Institute of Epidemiology and Microbiology, Russia. Sputnik V, also known by the research name Gam-COVID-Vac, is a non-replicating viral vector vaccine made by using rAd26 and rAd5 vectors. Interim data analyses of its trial phase III held in Russia (between September 7 and November 24, 2020) show 91.6% efficacy against Covid-19 [14]. Sputnik V double dose vaccination after 21 days started in Russia, Argentina, Mexico, Serbia, and Hungary, after its approval for emergency use. Sputnik V can induce the immunity by producing neutralizing titers against variants of concern alpha (B.1.1.7) UK strain, beta (B.1.352) South Africa strain, gamma (P.1) Brazil strain, delta (B.1.617.2) India strain, and Moscow strain B.1.1.141 and B.1.1.317 with mutations within the receptor-binding domain. It is 83% effective

against delta strain [15], 3.1-,2.8- and 2.5-fold reduction in neutralizing ability against B.1.1351, B.1.671.2, and P.1 strains, respectively, were ascertained throughout the research. Still, there is a requirement for an additional study on the efficacy of Sputnik V against COVID-19 [16].

3. Effect of Inactivated Viral Vector Vaccines on Variants of COVID-19

3.1. Sinopharm (BBIB-CorV)

Sinopharm BBIB-CorV is the first Chinese vaccine authorized by WHO for emergency use., developed by the Beijing Institute of Biological Products (BBIBP) [17]. In December 2020, Sinopharm claimed its first vaccine is 79% effective against symptomatic covid 19 and hospitalization. Meanwhile, China gave emergency approval, millions of Chinese get vaccinated. UAE, Bahrain, Jordan, Egypt, and Peru trialed the jab immediately. UAE claimed 86% efficacy based on phase 3 trial data, while Brazil declares the dose has a 50-90% efficacy rate [18]. In May 2021, WHO granted emergency approval to this non-western vaccine and assured its validity. WHO highly recommends BBIB-CorV for adults ranging 18-60 in a two-dose schedule with a gap of 3-4 weeks. Researchers in Sri Lanka claim this inactivated viral vaccine proved to be most effective against delta strain of covid 19. According to their research, 95% of individuals who received two doses of Sinopharm vaccine have developed antibodies similar to the naturally affected covid 19 patients [19]. Professor Christine Carrington from West Indies reported, "The Sinopharm vaccine is expected to be protective against the Delta variant and also another variant [20]. Moreover, it proved to be safe and well-tolerated in most cases. Minor Side effects included dizziness, vomiting, fatigue, fever, nausea. The most acceptable feature of the vaccine is its capacity to be stored at optimal refrigerator temperature. Yet, none of the Chinese drugmakers has to clear the detailed efficacy data. Experts warn piecemeal data has undermined the success of the Chinese vaccine. Based on the shreds of evidence, the England journal of medicine has shown that Sinopharm can only prevent clinical COVID 19. However, failed in preventing severe infection. the efficacy of the vaccine was also noticed to be decreased by 1.6 fold in the case of the SOIY.V2 variant and failed to cure B.1.1.7 and P.1 variant [21].

3.2. SinoVac/CoronaVac

Sinovac is an inactivated vaccine is prepared by The Beijing-based biopharmaceutical company in China. This is approved by the World Health Organization (WHO) for intensive conditions, which is already used in China and 80 countries around the world. The main advantage of inactivated virus vaccine is that it can be stored at 2-8 degrees Celsius in a standard refrigerator. It means that the Sino vac vaccine is more useful for underdeveloped countries which haven't facilities to store a large amount of vaccine at low temperatures [22]. In Chile delta variant is most transmissible than previous variants. So, 70% of Chileans are vaccinated mostly with SinoVac. More than 1 million people have been infected with the coronavirus in Indonesia. The Indonesian government is trying to slow the spread of coronavirus by campaigning for the Sinovac vaccine. These types of campaigns are most effective for vaccination as well as to prevent a COVID-19 pandemic. The campaign results showed a significant effect on people's behavior in receiving the SinoVac vaccine [23]. In Thailand, people were completely vaccinated with Sinovac but hundreds of medical workers caught Covid-19, so Thailand has changed

its vaccine policy to mix China's Sinovac with AstraZeneca to get sufficient effect. Some countries are planning to switch different COVID-19 vaccines for second doses or to increases the efficacy. The WHO said studies showed that the Sinovac vaccine 51% prevented people from symptomatic diseases and also prevented 100% from severe covid-19 and hospitalization. The efficacy of this vaccine could not be estimated for the over 60 age group because only a few adults of this age group were enrolled in clinical trials.

According to a study published in the New England Journal of Medicine showing results from Chile, Sinovac efficacy rate of 65.9% against Covid-19, 87.5% is effective at preventing hospitalization and 86.3% effective at preventing death. However, there are little data about its efficacy against the Delta variant. Based on studies trying to model immune protection from the virus, Prof Cowling estimates that the inactivated virus vaccines against the delta variants could be as much as 20% less than compared to the original strain. An alpha variant is first identified in the UK and the double doses of vaccine are 71%-91% effective [24]. Beta variant first identifies in South Africa, which differs from the original virus. Research has shown that the efficacy of the vaccine against beta variant is 70% lower than wild type variant. Professor Jinn Dong-Yan, a virologist from the University of Hong Kong, told the BBC it is "expected" that the Chinese vaccine's efficacy will slow down against the variants including Delta. He also said that "Sinovac is good vaccine" and people do not access vaccine of higher efficacy should still receive their injections. But they should follow preventive measures such as social distancing, wearing masks [25].

4. Effect of mRNA vaccines on variants of COVID-19

4.1. Pfizer (BNT162b2)

Pfizer–Biotech is a collaboration between Pfizer and BioNTech. The COVID-19 vaccine, branded as Comirnaty [26] is an mRNA-based COVID-19 vaccine produced by BioNTech, a German biotechnology company. It is approved for use in people aged twelve and older in some areas, and sixteen and older in others [27] to protect against COVID-19. SARS CoV-2 has caused about 170 million illnesses and 3.5 million deaths since its discovery. In phase III studies including 43,538 people, with 170 confirmed instances of COVID-19 in the first 28 days [28]. Two doses spaced 3–4 weeks apart were 94–95 % effective against symptomatic, laboratory-confirmed SARS-CoV-2 in Randomized-Controlled Trials (RCT) of both products. It also seems unlikely that a single dose can give permanent protection, as data suggests immunity only lasts 12–18 months [29]. In December 2020, Pfizer received approval in Canada. Clinical and authentic results showed that the mRNA-based vaccination was 95 percent effective against the original SARS-CoV-2 and the Alpha (B.1.1.7) variant. Several SARS-CoV-2 variants have been developed and been characterized by the World Health Organization (WHO) since December 2020. Alpha (B.1.1.7) was discovered first in the United Kingdom (UK), Beta (B.1.351) was discovered first in South Africa, and Gamma (P.1) was discovered first in Brazil. In April 2021, the Delta (B.1.617.2) variation was discovered in India and categorized on May 11 of the same year. effectiveness of the Comirnaty vaccine was recently shown to be 75% against any documented infection with the Beta variant and 97.4% against the severe, critical, or fatal disease [30]. The Delta VOC is also induced by the

Comirnaty vaccine, which results in a significant antibody response. The highly transmissible Delta variety, first identified in India in October of last year, is on track to overtake the Alpha variant as Canada's dominant strain this summer.

4.2. Moderna (mRNA-1273)

mRNA-1273 protein could be a supermolecule nanoparticle–epitomized mRNA-based protection that encodes the prefusion settled full-length spike macromolecule of the SARS-CoV-2, the infection that causes COVID-19 [31]. The mRNA-1273 immunogen has been reported to own 94.1% effectiveness at preventing symptomatic COVID-19. when the primary dose of the messenger RNA immunogen showed negligible effectiveness for two weeks and when the second dose within the third and fourth week directly enlarged. Against b.1.1.7 infection the immunogen was 88. 1% effective (95% CI;83.7-91.5%) ≥14 days when the primary dose however before the ordinal and was 100 percent (95%ci;91.8-100%) ≥14 days when ordinal dose. Analogous effectiveness against B.1.351 infection was 61. 3% when the primary dose (95% CI: 56. 5–65.5%) and 96.4% when the second dose (95% CI: 91. 9–98.7%). Effectiveness against any severe, essential, or fatal COVID-19 malady because of any SARS-CoV-2 infection (predominantly B.1.1.7 and B.1.351) was eighty-one. 6% (95% CI: 71.0–88.8%) and 95.7% (95% CI: 73. 4–99.9%) when the primary and second dose, severally. The mRNA-1273 immunogen is very effective against B.1.1.7 and B.1.351 infections, whether or not symptomatic or well and any COVID-19 hospitalization and death, even when one dose. Corresponding effectiveness measures for mRNA-1273 were seventy-nine.0% (95% CI: 58.9-90.1%) and 84.8% (95% CI: 75.9-90.8%), severally. Effectiveness against any severe, critical, or fatal COVID-19 malady because of Delta was a hundred.0% (95% CI: 41.2-100.0%) for mRNA-1273, ≥14 days when the second dose [32]. SAGE suggests that an insusceptible person ought to be determined a minimum of fifteen minutes when obtaining the primary dose if he observes any reasonably allergic reaction. The WHO stated that the Moderna immunogen persists immunity. However, it does not apprehend the length until [33].

4.3. NovaVax (NVX-CoV2373)

Scientific name NVX-CoV2373 under the brand name covovax [34]. This protein-based vaccine is applied to people above 18 to below 85. A baculovirus with a gene expressing full-length SARS-CoV-2 spike glycoprotein (prototype Wuhan-Hu-1 sequence) stable in the perfusion confirmation is used to make the vaccine. The NVX-CoV2373 vaccine was prescribed in two-dose routine 21 days apart in phase 1–2 trial involving healthy adults. phase 2a–b trial of NVX-CoV2373 in Africa during a period of primary circulation of the B.1.351 variant virus [35]. According to new information from clinical studies, the SARS-CoV-2 vaccine developed by the US biotechnology company Novavax is 95.6 % effective against the original variation of SARS-CoV-2 and also gives protection against the newer variants B.1.1.7 (85.6 %) and B.1.351 (60 %). The variant, which has mutations in the SARS-CoV-2 spike protein-the immune system's principal target against Coronaviruses and the source for most vaccines, including Novavax's-currently accounts for more than 90% of COVID-19 cases in South Africa [36].

5. Conclusion

Vaccines are crucial weapons to fight against the battle of pandemics. None of the vaccines proved to

be 100% effective against all strains of COVID-19 but developed antibodies to fight better and increased chances of survival. Phase 3 and phase 4 clinical trials are necessary to improve the vaccination process but at the same time, we should use the available tools. We shouldn't resist the vaccination process because of our concerns regarding emerging strains.

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