

Review on Covid-19 vaccines and vaccination report

ABSTRACT

A biological material intentionally prepared by scientists to provide active acquired immunity against a specific infectious disease is called a vaccine. It is engineered with either a portion of the pathogen that is harmless, or a whole pathogen but which has been killed or rendered harmless in the laboratory through radiation, chemical, or high temperature. The idea is to cause the body's immune system to recognize the pathogen and to build immunity against it, should the body be exposed to it at any time. Categories of vaccines exist such as; prophylactics (which acts by preventing the effect of future infection by either natural or wild pathogen), and/or therapeutic (developed to fight a disease that has already occurred). This review is focused at understudying the various types of vaccines approved by the World Health Organization (WHO), their mechanism of actions and the outcomes of these vaccines (benefits and adverse effects). The vaccines approved by WHO include: the Oxford AstraZeneca, Pfizer BioNTech, Sputnik V, Sinopharm, Sinovac, Moderna and Convidecia each having its mode of action. Few mild adverse reactions have been noted so far from the administration of the vaccine and they include: pain at the site of injection, fever, dizziness, headache, and body aches which lasted from few hours of receiving the vaccines to about 24 hours. Some severe adverse reactions have also been observed. The benefits of taking the vaccine however far exceed these adverse effects. Finally, this study went further to examine the effectiveness of these vaccines against the Alpha, Gamma, Beta, and Delta variants of COVID-19 and was found to be able to offer immunity against them.

INTRODUCTION

A vaccine is a biological material intentionally prepared by scientists to provide active acquired immunity against a specific infectious disease (Iowa Admin Code, 2019). It is engineered using an agent which looks like the disease causing microorganism, its toxin, or one of its surface proteins but which is weakened or killed. The idea is to stimulate immune response from the body against the real microbe should the body be eventually exposed to the disease. The body's immune system gets to recognize the disease, fight and destroy the pathogen. Categories of vaccines exist such as; prophylactics (which acts by preventing the effect of future infection by either natural or wild pathogen), and/or therapeutic (developed to fight a disease that has already occurred) (Melief *et al.*, 2015; Brotherton, 2015; Bol *et al.*, 2016; Frazer, 2014). Covid-19 vaccine therefore is a vaccine developed to provide acquired immunity against SARS-Cov-2 (severe acute respiratory syndrome), the virus responsible for the causation of coronavirus disease (COVID-19). According to Subbarao (2021), the COVID-19 vaccine is targeted at preventing symptomatic, often severe cases of Covid-19 infection. The vaccines have been widely applauded for the part in lowering the spread, degree of impact from infection, and even death caused by COVID-19 (Vergano, 2021).

7. 34 billion doses of vaccine is said to have been administered all over the world as of the 10th of November 2021, according to the official reports from National Public Health Agencies (Richie, *et al.*, 2020). The implementation of phased distribution plans have been carried out by most countries, to give priority to those at higher risk of complications such as the elderly, and also those that stand the chance of higher risk of exposure and transmission such as the healthcare workers (Beaumont, 2020, Erunke, *et al.*, 2021). Plotkin and his colleague in their study noted that single dose interim use is working towards extending vaccination to as many people as possible while the availability of vaccines improves (Plotkin *et al.*, 2021; Epperly, 2021; Wang, 2021). AstraZeneca targets the production 3 billion doses, Pfizer BioNTech anticipates 2.5 billion doses, while Sputnik V, Sinopharm, Sinovac, and Janssen targets 1 billion doses each. Buntz report shows the target of Moderna and Convidecia to be 600 and 500 million doses respectively (Buntz, 2021). By the end of December 2020, a study by Mullard (2020) revealed that more than 10 billion vaccine doses had been preordered by countries all over the world, with about half of the doses being purchased by high income countries (Mullard, 2020; So *et al.* 2020). A report from the National Primary Health Care Development Agency shows that vaccination began on 5th March 2021 in Nigeria, with 5,118,422 million people having been vaccinated so far with the first dose of COVID-19 and 2,359,781 people given their second dose (NPHCDA, 2021).

VACCINES APPROVED BY WHO

There are 8 vaccines approved by the World Health Organization (WHO) for Covid-19 vaccination and they include; Moderna (mRNA-1273) approved for use in 76 countries and 32 trials in 8 countries; Pfizer/BioNTech (BNT162b2) approved for in 103 countries and 42 trials in 21 countries; Janssen (Johnson & Johnson-Ad26.COV2.S) approved in 75 countries and 14 trials in 18 countries; Oxford AstraZeneca (AZD1222) approved for use in 124 countries and 47 trials in 23 countries; Serum institute of India Covishield (Oxford/AstraZeneca formulation) approved for use in 46 countries and 2 trials in 1 country; Bharat Biotech (Covaxin) approved for use in 9 countries and 7 trials in 1 country; Sinopharm (Beijing)-BBIBP-CorV (Vero Cells) approved for use in 68 countries and 15 trials in 10 countries; and Sinovac (CoronaVac) approved for use in 42 countries and 24 trials in 8 countries (COVID19 Vaccine tracker, 2021). Of all these vaccines, the Moderna and Pfizer/BioNTech are mRNA based; Janssen and Oxford/AstrZeneca under the category of non replicating viral vector, while Bharat Biotech and Sinopharm are under inactivated vaccine type.

In Nigeria, the Moderna, Pfizer/BioNTech, Gamaleya Sputnik V, Janssen (Johnson & Johnson), Oxford AstraZeneca, Covashield, and Sinopharm have been approved for use as of the date of the writing of this publication (Covid19 Vaccine Tracker, 2021). There is also no vaccine clinical trial in Nigeria as of this date. So far, only the Oxford AstraZeneca and Moderna have been

deployed. According to the vaccination plan, the health workers and supporting staff, frontline workers and first responders are captured in the phase one of those to be vaccinated and is in progress. The phase two priority is focused on persons within the age of 60 years and above and those between the brackets of 50-59 years old. The latter is also in progress. The phase three and four plan comprises of persons within 18-49 years old and the rest of the population eligible within the same age bracket (NPHCDA, 2021; Erunke, 2021). The statistics of those who have received the first dose of the vaccine stands at 2, 360, 781, while the unvaccinated population stands at 195, 881, 578 million people. The total number of vaccinated population stands at 2,757,641 as of 8th of October 2021 (NPHCDA, 2021). Based on this statistics, the percentage of the unvaccinated population is 97.45% against 1.18% of the population that have received the first dose and 1.37% for the fully vaccinated persons.

VACCINES MODE OF ACTION

According to gavi.org, there are four main categories of Covid-19 namely: whole virus, protein subunit, viral vector and nucleic acid (RNA and DNA). Some function by carrying antigen into the body system, whereas, others work by using the body cells to make the viral antigen.

Viral Vector

An example of the vaccines which falls under this category of COVID-19 vaccine is the Johnson & Johnson and the Oxford AstraZeneca (Covid19 vaccine tracker). They function by issuing genetic instructions to cells to produce antigens. They differ from the mRNA vaccines in that harmless viruses are employed, which are different from the one targeted by the vaccine to give these set of instructions to the cells. An example of this viral vector is the common cold adenovirus virus. The body immune system on sensing the vector, instructs the cells to make large amount of antigens against it and all similar pathogens the body may be exposed to in the future. *Gavi.Org* in their report noted that this has the advantage of triggering stronger immune response.

Protein Subunit

In this class we have the Pfizer-BioNTech. The protein subunit vaccines only include part of the virus that can best trigger immune response, but are incapable of causing the disease in itself (Mayo, 2021). This reduces the risk of side effects that may arise from taking the vaccine. This fragment could be proteins or polysaccharide from the pathogen, which have been properly studied to identify its ability to best produce immune response from the body. This type of vaccine has some disadvantages in that the immune responses they trigger may be weaker when compared to other types of vaccines because the antigens used to trigger the immune response may not have pathogen-associated molecular patterns which are common to a category of

pathogen, usually read by the body immune system as danger signals. As a result of this absence, the immune response from the body may be weak. To mitigate this shortfall, agents that stimulate immune response are delivered alongside the vaccine or vice versa (Gavi, 2021).

Whole Virus

An example of vaccines in this class includes the Bharat Biotech Covaxin, Sinopharm, and the Sinovac CoronaVac (Covid19 Vaccine Tracker, 2021). They are comprised of the inactivated and live-attenuated forms of the virus. The inactivated vaccines are made up of the copies of the virus that their genetic materials have been killed by heat, radiation, or chemicals, but can still trigger immune system, while the live-attenuated vaccines are those in which the viruses have been weakened such that they are able to replicate, but unable to cause any disease. The live-attenuated has some disadvantages in that those with low immune systems may be at risk and it also requires cold storage, as a result places without cold storage facilities and inadequate power supply may not be able to properly store the vaccine (gavi.org, 2021; Covid19 Vaccine tracker, 2021). They are however known to produce stronger responses.

Nucleic Acid

These vaccines that function by instructing the body cells to make proteins that trigger immune responses in the body against Covid-19 virus (CDC, 2021). They give these instructions using genetic materials such as either the DNA or RNA of the host. The advantage of nucleic acid vaccines is that they are not only cheap to make, but also bring about stronger immune responses, since they are made within the body cells and systems (gavi.org, 2021). The disadvantage however is they have to be stored under very cold temperature (-70°C or lower) and no vaccine in this category has been approved yet for human use so far (Gavi.org, 2021). Vaccine in this category include the Moderna.

BENEFITS OF COVID-19 VACCINES

While experts continue to study the COVID-19 vaccines, some benefits abound from receiving the vaccines against COVID. One of such benefits is the reduction of the risk to infection. According to muhealth.org, once the vaccines have been taken, they trigger immune responses such that the body begins to make antibodies against the virus, which reduces the chance of getting the disease (muhealth.org, 2021). The vaccines also limit the risk of developing fatal symptoms (Baptist health, 2021). Vaccination lowers the risk of transmitting COVID-19 pathogen to others in cases where the vaccine recipient has been previously infected. COVID-19 vaccines have been shown to help in the protection of unborn babies and/or newborns. (muhealth.org, 2021). According to this report, it was shown that expectant mothers who received the vaccines develop immunity against the virus which then passed on to their babies via the placenta. In the cases of newborns, it is suggested that breastfeeding mothers can pass the immunity from the vaccine to the newborns via the breast milk. Studies on the effectiveness of

the vaccines revealed that clinical trials for Pfizer-BioNTech and Moderna showed that they were 100% active in offering protection against infection and illness, while the Johnson & Johnson's effectiveness against illness stood at 85% (muhealth.org, 2021).

ADVERSE EFFECT OF THE VACCINES

As should be expected from a vaccine, COVID-19 vaccination also gave rise to some side effects ranging from serious adverse to non-serious adverse effects which could occur from the moment of receiving the vaccine to about three days (Laila *et al.*, 2021; WHO, 2021). Most of the cases of the non-serious side effects were mild to moderate and happened within 24 hours of vaccination to few days after receiving the vaccine and they include: pain at the site of injection, fatigue, fever, headache, epigastric pain, shortness of breath, and body aches. Cases of chills and diarrhea have also been reported (WHO, 2021). This adverse effect varies based on the type of vaccine. Laila and colleague reported that none of the events led to hospitalization, or needed extra treatments while who.int noted that they can go away on their own within few days. Less common side effects such as anaphylaxis are also possible but are considered to extremely rare (WHO, 2021). Serious side effect such as cardiac arrest was reported in the work of Laila and colleague, which they said occurred following the administration of COVID-19 vaccine. Other severe outcomes that were reported include thrombotic events: CVST in some patients (2), and pulmonary embolism in some other patients (Laila *et al.*, 2021). However, WHO casualty result noted that there is insufficient specific proof that the effect was caused by the vaccine. Side effect which occurs after receiving the vaccine shows that the vaccine is working because your body's response to the vaccine is what gives rise to the adverse effects (WHO, 2021).

In Nigeria, more than 10,000 persons have reported side effects due to COVID-19 vaccination and this adverse effect ranges from pain to swelling at the injection site. Others includes abdominal pain, dizziness and other non-serious side effects already discussed above (premiumtimes, 2021).

EFFECTIVENESS OF THE VACCINE AGAINST NEW VIRUS STRAINS

Some of the new strains of coronavirus that have been identified by scientists includes: the Alpha (B.1.1.7) which was first identified in the United Kingdom in late 2020. It was reported that this strain spreads easily than the original and may be associated with increased risk of death from infection. The other strain identified was the Gamma (P.1) in Brazil. It was detected in January this year 2021. Study on this strain revealed that it contains more mutations than the Alpha strain which may make it resistant to a vaccine or antibodies. The Beta and Delta variants were also identified at about late 2020 and both share similar threat with Gamma variant, with the Delta variant being the most transmissible of them all and also having the ability to cause severe illness than them all (umms.org, 2021). A report both by muhealth.org and baptisthealth.com shows that

the vaccines are highly effective against COVID-19 variants (baptisthealth.com, 2021; muhealth.org, 2021).

CONCLUSION

Finally, this study reveals that the benefit of COVID-19 vaccination far outweighs the temporary adverse effects it comes with. However, despite this report, the population of vaccinated individuals especially in Nigeria is below 2% compared to the unvaccinated group which is above 98%. This therefore calls for more research in this area to understand the cause for the gap between vaccinated and unvaccinated groups. More research is also needed in area of what can be done to minimize both the mild and severe adverse reactions especially in those who have a history of serious illnesses.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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