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Review Article

A Report on COVID-19 Variants, COVID-19 Vaccines and the Impact of the Variants on the Efficacy of the Vaccines

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Abstract

The Coronavirus pandemic has caused negative effects across the globe; mortality and morbidity being the main impact. After WHO, termed the disease a pandemic in March 2020, they gave in health guidelines to follow to control the spread of the disease. The health industry, academia, and different governments are united to develop and test various vaccines at an unprecedented speed to combat the pandemic fully and bring the world back to its feet. Some of the vaccines developed include Pfizer, Moderna, and AstraZeneca. However, just like other viruses, the SAR-CoV-2 virus keeps changing through mutation, as various variants, different from the first one is emerging. Evidence shows that the three new variants; UK, Brazil, and South Africa are more severe in terms of transmissibility, disease severity, evading of the immune response, and reducing the ability to neutralized antibodies, compared to the original coronavirus.With such knowledge of the existence of different strains, the arises concerns on whether the already available vaccines are effective enough in preventing the new COVID-19 strains. Studies are still underdeveloped to learn more on the virologic, epidemiologic, and clinical characteristics of the ever-emerging variants. This research, through a systemic review of literature, seeks to find out whether the variants of SAR-CoV-2 have an impact on the efficacy of various vaccines developed in fighting the disease and the entire body's immune response.

Keywords: Coronavirus pandemic; COVID-19 variants; Immune response; Transmissibility, Genomic surveillance; Vaccine efficacy; Epidemiology; Diagnosis; Treatment.

Background

Humanity has faced adverse effects ever since the deadly COVID-19 pandemic struck. From the time when the first coronavirus case, the world has gone through various phases, as most activities came to a halt. In December 2019, there were cluster cases of pneumonia reported in Wuhan, China. After vivid research, the Chinese health authorities confirmed on 7th January 2020 that cases were associated with a new novel coronavirus; SAR-CoV-2. On March 11th the same year, the World Health Organization announced the outbreak of the disease naming it a world's pandemic. Currently, the total number of

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infections lies at over 120,000,000 with over 2.7 million fatality cases reported this month [1]. Wearing masks, maintaining social distance among other precautions were enforced to manage the transmission of the virus [2]. In response to this pandemic, the medical and scientific fraternity are united in their efforts toward studying and understanding the biological aspects of COVID-19 and how best to deal with it. So far, these trials have provided insights regarding how one is infected, how it affects the cells, the response of the host immune system when fighting the illness, the groups of people at risk of getting infected, and the effectiveness and efficiency of various treatments procedures.

This paper aims at adding knowledge of coronavirus, its characteristics, and how it affects the human body. It also summarizes the current knowledge about the systemic immune response to the coronavirus and possible immunotherapeutic approaches.

Epidemiology aspects of the virus

This disease is caused by a single-stranded enclosed RNA virus known as Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), a novel coronavirus [3]. There are four main genes that are associated with coid-19 including nucleocapsid (N) membrane, spike (S) protein, Small Membrane protein (SM) and glycoprotein (M) [4].The high pathogenic strain of coronavirus is known to affect the lower respiratory tract more so the lungs. The structure of the virus, apart from having the RNA genetics, contains Spike (S) and Nucleocapsid (N) proteins which play a big role in the transmission and replication of the virus. COVID-19 is transmitted from one person to another. Note that the S protein is very important with regards to recognizing and binding of the SARS-Cov-2 virus into the human body to allow its mediation and fusion into the membrane [4].

A lot of symptomatic patients show mild flu-like symptoms such as coughs, fever, etc., while a significant minority of about 20% develop acute respiratory distress syndrome (ARDS) with severe lung injury [5]. This leads to considerable morbidity and mortality. The latest research information indicates that overall symptomatic case has a 1.4% probability of fatality risk.

Systemic innate and adaptive immune responses to SARS-CoV-2

As represented in Figure 1, COVID-19's incubation period is quite long, the whole process is reported to be at least 20 days [5]. The response of specific IgM, which is the earliest antibody, starts and peaks within 1 week. As the acute phase of the disease continues, IgM also proceeds. The antibodies that develop several days after specific IgM is specific IgA after 8 days and specific IgG after 9 days. The disease stage, with the onset of symptoms, lasts for about two weeks and the convalescence follows thereafter [5].

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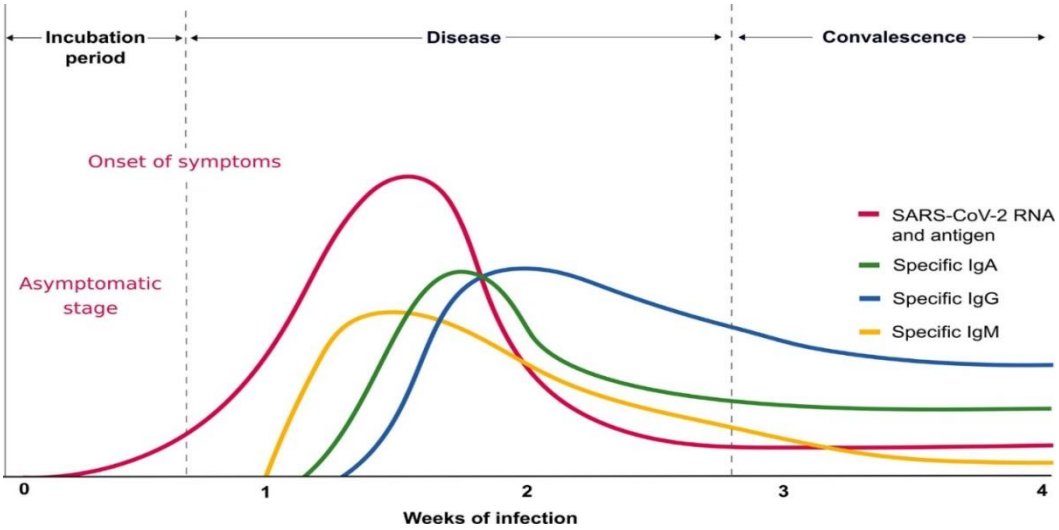
Figure 1: Immune responses to SARS-Cov-2 and mechanisms of immunopathological changes in COVID-19 [7].



An individual's immune system is a key player in defending the body against any disease or infection. The innate immune system protects the body from any damage by defending it against any infection from various pathogens, including viruses [6,7]. It controls the spread of the virus in the body by fighting it hence limiting organ damage at the same time speeding up recovery. The type of activated immune cell, the nature of the activation signal, and the identity of the activated immune cell receptor(s) dictate the intensity and quality of the immune response to invading pathogens. However, SAR-CoV-2 has various strategies it uses to avoid detection and defense mechanism by the innate immunity response. They do this by either inhibiting type I IFN's recognition ability, downregulation of MHC molecules hence impairing antigen presentation and T cells activation, or down streaming of PRRs through interacting with the signaling cascades [8].If the immune is unable to fight, these diseases can escape the defense placed by the immune system hence causing an acute inflammatory response known as cytokine storm [8,9].This is reported in many viral infections as studies show cytokine storm significantly contributes to the severity of infections [10]. To boost the ability of the immune to fight, medicines, vaccines, and treatment procedures that contain the mechanisms underlying immune response are taken.Although measures placed by various governments and health departments, such as wearing masks, keeping social distance, washing hands, etc., may be temporarily effective in slowing down the spread of coronavirus disease, there is a need for an ultimate control through the development of an efficient vaccine [11].

COVID-19 Vaccines

With everything slowing down or coming to a halt, scientists and health practitioners have delved into trying to find a permanent solution so that life can go back to its normal. Multi-agency efforts on research have been facilitated in pursuit of developing vaccines for immunization to prevent COVID-19 infection. These vaccines have different working mechanisms to protect individuals against the disease [12]. The research on finding a

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vaccine and improved detection for the disease have moved at an unprecedented pace for reasons such as advancement in research, increased innovative vaccine technology equipment, the human trial was done at an early stage, and lastly great unity between relevant bodies 30. There are various vaccines developed to protect people from the transmission and adverse effects of the virus [11]. Preliminary data shows support for this statement as countries are reporting a decrease in the transmission rate. For instance, Israel claims to have vaccinated almost 75% of its older population, an action that has seen a 33% decrease in the transmission rate of the virus [13]. Although, the impact of COVID-19 vaccines on the transmission of the disease has yet to be fully determined.The Strategic Advisory Group of Experts (SAGE), through evidence-based medicine, gives temporary guidance on issues to do with immunization. Priority is given to health workers and people aged above 65 years because vaccines are limited and they also face a higher risk of getting infected.

Sinovac Vaccine, EV 71

Was developed by Sinovac, a Beijing biopharmaceutical company. It works through killing viral particles that expose the immune system of the body to the virus [14]. It uses dead virus particles to induce the production of antibodies; a traditional approach that kills viral particles in comparison to Moderna and Pfizer which are mRNA vaccines that involve injections which trigger the body to make viral proteins.

Sinovac can be stored in standard refrigerators at 2-80˚C. The vaccine has undergone the three phase trials and was considered as 91.25% effective in Turkey and 65.3% effective in Indonesia. Brazil originally estimated the efficacy at 70.8% but revised to 50.4% after increasing the number of respondents. Sinovac is however still carrying out trials and its efficacy is reasonably low [14].

As shown in Figure 2, Corona Vac from Sinovac companies was tested in 2 phases of clinical trials on healthy adults between ages 18-59 and with no other medical conditions. At screening, the phase one and two participants were separated randomly, some subjected to 0-14 days vaccine cohort and others 0-28 days vaccine schedule cohort. The first 36 participants were assigned to a low dose of Corona Vac at 3μg per 0.5 mL of $Al(OH)_3$, then another 36were assigned to 6μg per 0.5 mL and the last 12 with two doses of Corona Vac or placebo. The incidence of adverse reactions for days 0-14 cohorts was 29% of the first block, 38% in the second block and 8% in the placebo group.In the phase two trials, the incidence of adverse reactions was 33%, 35% and 22% among the block one, block two and placebo group [14].

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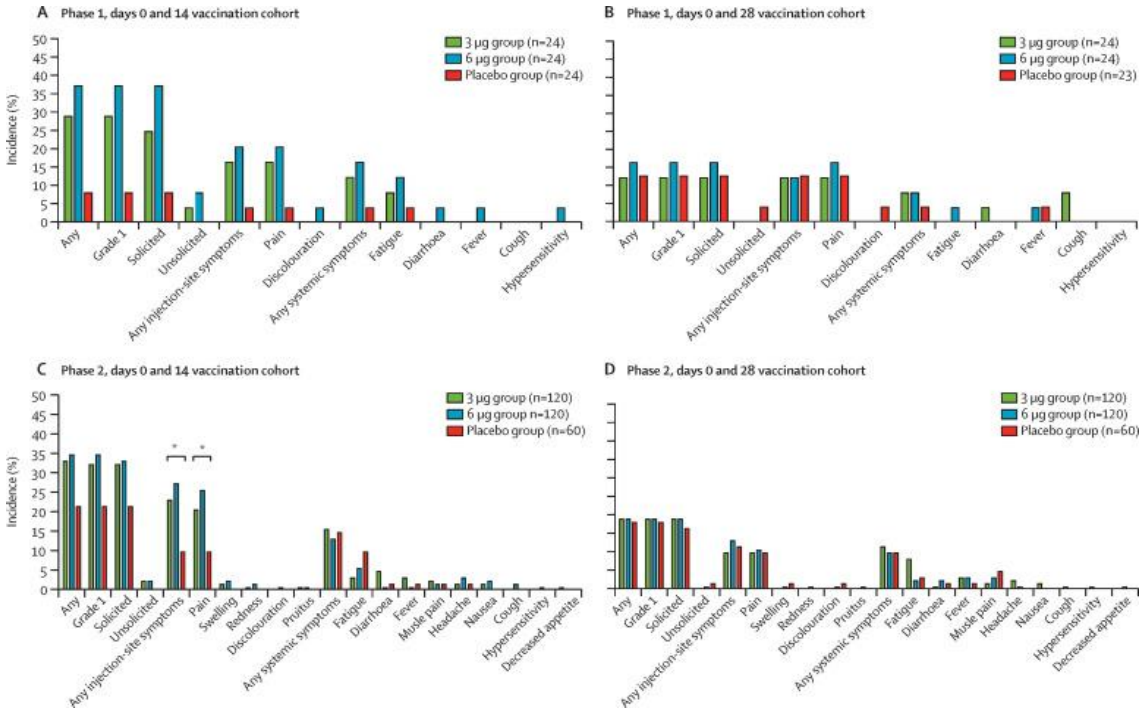
Figure 2: Incidence of adverse reactions reported within 28 days after second dose of study drug. 2A. Phase 1, days 0 – 14 vaccination cohort. 2B. Phase 1, days 0 and 28 vaccination cohort. 2C. Phase 2, days 0 and 14 vaccination cohort. 2D. Phase 2, days 0 and 28 vaccination cohort [14].

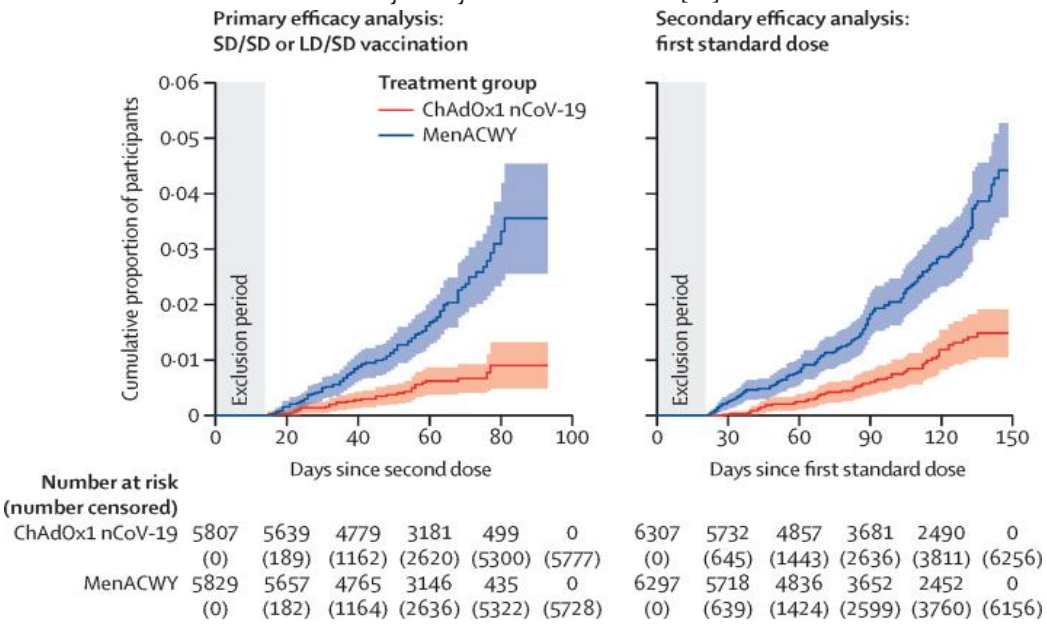


AstraZeneca vaccine

It was developed and manufactured at University of oxford. The research name is AZD 1222 (ChAdOx1) [15]. The vaccine is administered through intramuscular injection with the commended dosage of two injections (0.5 ml each) given at an interval of 8 to 12 weeks between each injection (15-17). The body is then expected to be able to recognize and therefore develop a form of the protected response to the spike protein. This will help in stopping the entry of SARS-Cov-2 virus into the cells [12].The fact that AZD1222' has a 63.09% efficacy for fighting against COVID-19 infection, creates the need to find long-term protection after one is given a single shot [16,17]. Nonetheless, there is no data or evidence to show that this vaccine prevents infection or transmission of the disease.

As shown in Figure 3, data was obtained from four ongoing blinded, random, control trials using above 18-year-olds. AstraZeneca (ChAdOx1 nCoV-19) and meningococcal was randomly assigned to the participants. The ChAdOx1 nCoV-19 group received two doses containing 5 × 1010 viral particles (standard dose; SD/SD cohort) and the other group received a low dose then a standard dose. Participants who received two doses had a vaccine efficacy of 62.1% and those with a lower dose then a standard dose had a vaccine efficacy of 90% [18]. The more the days between doses in the primary efficacy analysis, the higher the cumulative proportion of participants in both the primary and secondary efficacy analysis [18].

Figure 3: The Kaplan-Meier cumulative incidence of primary symptomatic COVID-19 after two doses and one dose respectively of AstraZeneca. 3A. Primary efficacy analysis after second dose. 3B. Secondary efficacy analysis after first dose [18].



The European Medicines Agency has reviewed the vaccine to ensure it is safe for use, efficient, and of high quality. Apart from EMA, the vaccine meets the requirements of WHO and SAGE. This was after a global clinical procedure that was involving over 20,000 participants was carried out and the findings and evaluations concluded the vaccine safe for use [19]. Since the vaccine is limited, countries are advised to follow the WHO Prioritization RoadMap to administer the vaccine to those that need it more. The vaccine is therefore recommended for people with a higher risk of severe COVID-19 due to having comorbidities such as respiratory illnesses, diabetes, obesity, etc[17, 20]. Although pregnant women are at an increased risk of getting the disease, there is little information to access the vaccine safety on them [21]. The vaccine on the other hand is not recommended for people with a severe allergic reaction to any component used in the manufacturing of the dose. Besides, it is not advisable for persons under the age of 18 years.

Moderna (Mrna-1273) vaccine

The vaccine, like its name, was developed by Moderna. The recommended dosage to be given to individuals above 18 years is scheduled into two doses (0.5 ml each) that are to be administered through intramuscular injections into the deltoid muscle [22]. The interval between the two schedules is 28 days.The vaccine has shown the efficacy of 94.1% after a two months' follow-up since it was first administered [23]. Unlike the AstraZeneca vaccine, this one does not need booster doses since the two schedules are a complete dose.

According to WHO statistics, the potential benefits of this vaccine outlie potential risks. Just like the previous vaccine, countries should follow the WHO Prioritization RoadMap to give priority to the groups that are at a higher risk of infection.

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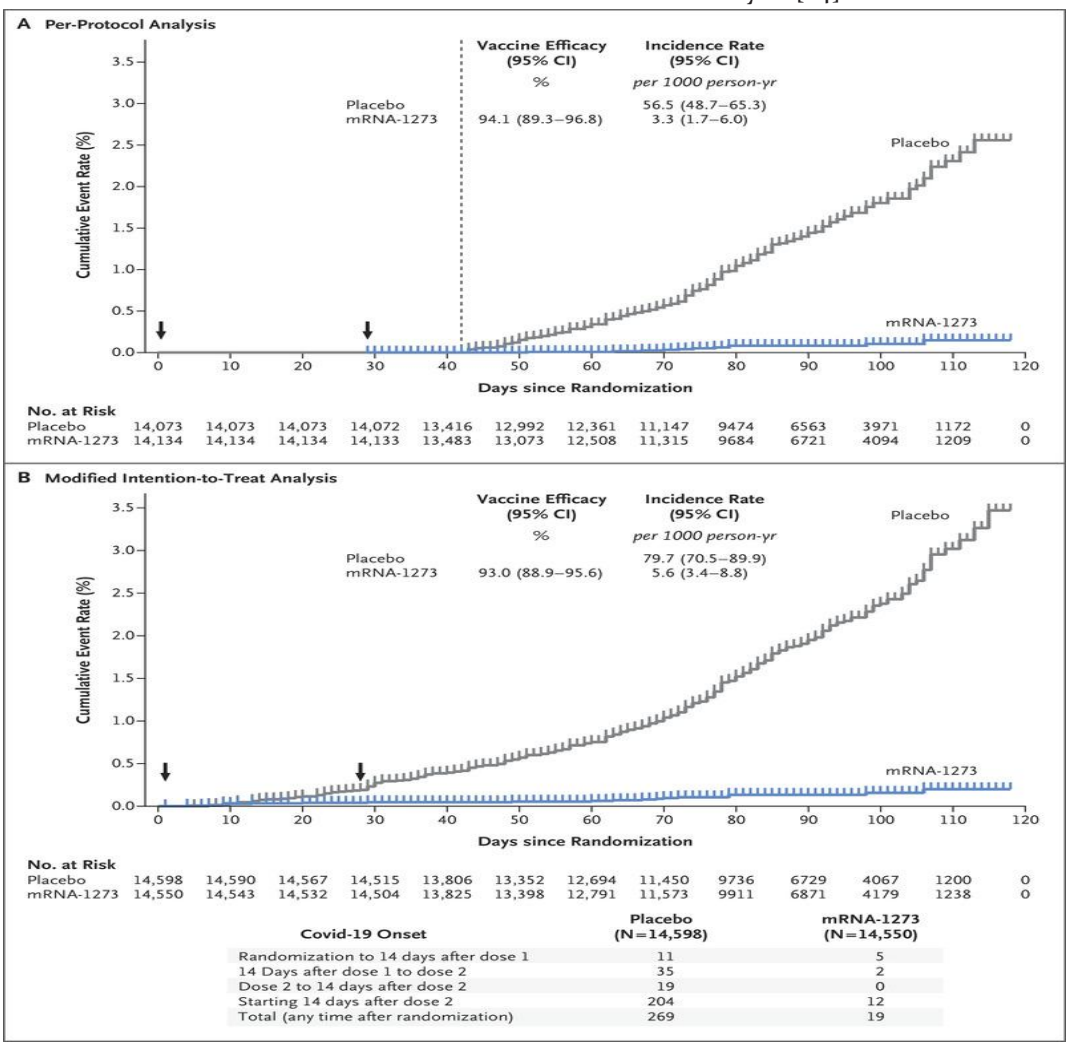
196 COVID-19 cases were diagnosed, at a confidence interval of 95%, 11 cases were in the vaccine group and 185 in the placebo group. mRNA-1273 vaccine was determined to have 94.1% efficacy for preventing symptomatic infection of SARS-Cov-2 in comparison to the placebo group as seen in Figure 4A. 2 weeks after the first dose 225 cases with placebo and 11 cases with mRNA-1273 evidenced a 95.2% efficacy. For the seropositive SARS-Cov-2, 187 cases with placebo and 12 cases with m-RNA-1273, a volunteer with RNA-1273 was given placebo, a vaccine efficacy of 93.6% was obtained. Between 1st day and seventh week, 7 cases of COVID-19 were identified in m-RNA-1273 group and 65 cases in placebo group as shown in Figure 4B [22].

Figure4: Efficacy and safety of the mRNA-1273 SARS-Cov-2 Vaccine. A represents Pre-protocol analysis and B shows Modified Intention to Treat Analysis [24].



Researchers say there are no safety issues associated with this vaccine because only local and systemic reactions are experienced.The antibody lasts up to four months after immunization and it wasapproved the U.S.Food and Drugs Administration (FDA) [12].

However, this vaccine should not be administered to specific groups; individuals with a history of anaphylaxis towards any component of the vaccine or any other vaccine, acute febrile illness.

Pfizer vaccine (BNT162b2)

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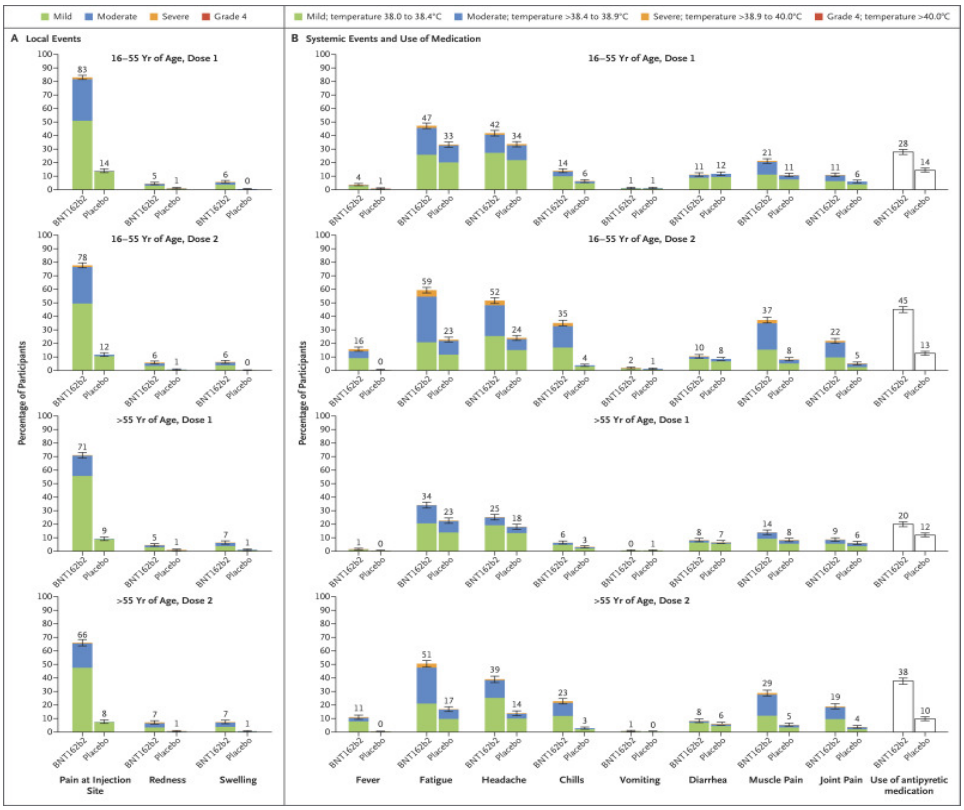
Pfizer has an active ingredient mod RNA that encodes the spike of SARS-Cov-2, the lipid hexane-6,1-diyl and salts such as potassium chloride, potassium phosphate and finally sucrose. Thirty-nine cases in BNT162b2 group and 82 cases in placebo group were observed between the first and second doses. The vaccine efficacy was determined at 52% at 95% confidence interval. Early protection was noticed from as early as 12 days after the first dose.

As illustrated in Figure 5, local and systemic reactions and use of medication was tested using data collected from 8,183 participants for 7 days after vaccination. Local reactions are shown in A. Pain at injection site was assessed basing on severity. Redness and swelling were also measured based on severity. Systemic events and medication use are shown in 5B. Additional scales of measurement were fatigue, headache, chills, muscle and joint pain, vomiting and diarrhoea. Under local reactions, pain at the injection site was a key feature affecting both the below and above 55-year-olds irrespective of the dosage in those with BNT162b2. The participants in the placebo group however felt less pain at the injection site. Irrespective of age or type of dosage, in systemic reactions, fatigue was highest and vomiting lowest. Those with BNT162b2 had higher rates than those with placebo [25].

Figure 5: The local and systemic reactions reported within 7 days after injection of BNT162b2 or placebo according to age group [25].



An observational study from Israel shows that Pfizer is 26% effective at preventing infection V on people who have not been infected before, which is then boosted to 92% by the second shot [26]. 2 shots, 21 days apart. The vaccine is administered through an injection on the upper hand. To be given to people above 16 years. Those

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with severe allergic reactions to any ingredient used in the manufacture of the vaccine or may experience an allergy after the first shot are advised not to take the vaccine [26]. Clinical trials showed mild or moderate side effect that occurs within 7 days after getting the shot, with only a few getting severe side effects to the point of hospitalization or death [27]. These include tiredness, swelling, muscle pain, nausea, etc.

COVID-19 variants/ strains

Just like any other virus, the SARS-CoV-2 changes constantly due to mutations [28,29]. These changes cause variations of the virus, which occur over time. While some variants appear and disappear, while others emerge and persist.

There are multiple variants of COVID -19 reported so far globally. Out of these, three new strains are raising concern due to their epidemiological, pathogenic, or immunological properties that cause them to spread faster [26,28,30].Quicker spreading of the virus means an increased number of COVID-19 cases. For that reason, health care resources are at risk, with more potential deaths if the variants are not controlled.

The three strains include; UK -1.1.7, Brazil P.1, and South Africa B 1.351. Epidemiological evidence has it that these mutations spread faster than viruses without the mutation [28,29]. All three strains share one mutation; D614G which gives the strains the ability to spread quicker than the predominant variants [32].

UK strain B.1.1.7

It was first detected in the UK. This strain has 23 mutations. Some of the mutations are in the spike-like S protein that the virus uses to attach itself to a human cell. There are at least three known mutations that influence viral activity. Mutation N501Y enhances the capacity of the virus to bind to ACE2 while mutation P681H occupies the region next to the furin cleavage site in spike, which enhances a virus's ability to infect and transmit [33]. On the other hand, in relation to its antigenicity, deletion ΔH69/ΔV70 in spike is attributed to immune escape and increase in vitro viral infectivity [33]. This is the deadliest strain, as it spread faster and has an increased death risk, although further research is needed to ascertain this. The transmissibility of B.1.1.7 is estimated at 43-90% higher than that of other variants in England [33]. A paper analysing 12 studies on B.1.1.7 mortality rate discovered that the virulence was 71% as per LSHTM, 70% as per University of Exeter, 65% according to Public Health England and 36% as per Imperial College [34].

Brazil strain P.1

This variant of SAR-CoV-2 was first found in Brazil travellers during a routine test at a Japanese airport. It has 17 unique mutations, with 3 found in the S protein [35]. The specific protein substitutions include K417N/T, E484K, N501Y and D614G. Brazil Strain P.1 is 140-160% more transmissible than ancestral strain [36]. As at March 2021, the virulence of Brazilian P.1 was estimated due to its ability to result in more than 2,000 deaths in Brazil daily [37]. In relation to its antigenicity, Brazilian Strain P.1 can evade protective immunity by 25-61%, caused by previous infection from another variant. Other current

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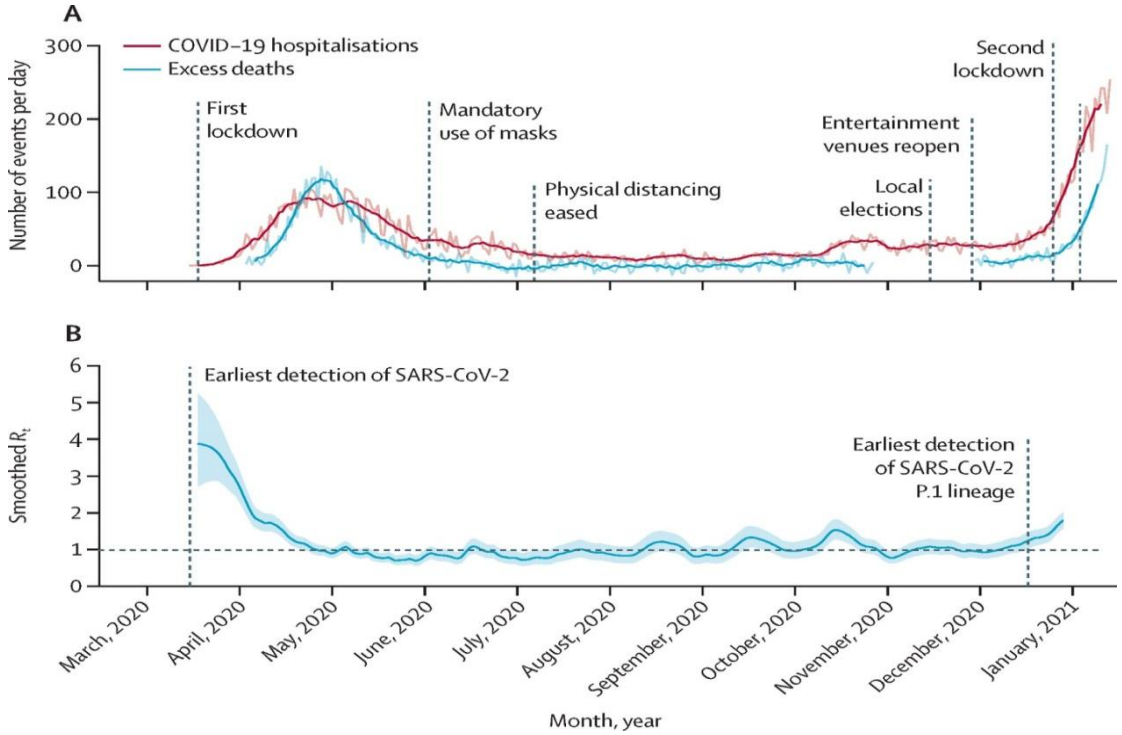
vaccines are also less effective against it. It contains additional mutations that affect its ability to be recognized by antibodies hence interrupting the immune response process [35].

In Brazil, the various COVID-19 restrictions have had varying effects on the number of cases and deaths reported per day and in turn the Rt as shown in Figure 6 below. After the first lockdown in March, the COVID -19 cases and excess deaths rose steadily to peak at 100 events per day in April 2020, the mandatory wearing of masks resulted in a decrease in both COVID -19 cases and excess deaths between May and November. The relaxation of COVID-19 regulations saw the curve fall first before starting to rise again in December 2020 approaching January 2021 as shown in Figure 6A. Similarly, as represented by Figure 6B, the effective reproduction number, Rt dropped steadily from mid-March 2020 to start rising in January 2021 when SAS-Cov-2 P1 lineage was first detected as in Figure 6B [38].

Figure 6: The resurgence of COVID-19 in Manaus, Brazil, despite high seroprevalence. A. COVID-19 hospitalizations and excess deaths over time in Manaus, Brazil. B. Effective reproduction number, Rt, over time in Manaus, Brazil, 2020-2021. Rt was calculated using EpiFilter method [38].



South Africa B.1.351

This strain emerged independently from the rest in South Africa. It shares some mutation with the UK variant, with multiple mutations found on the S protein [39]. There are a high number of re-infection cases by this strain in places that there were earlier waves of the original virus [40] hence high transmissibility of between 50-70% more than original SARS-Cov-2 [41]. This means that those who have already recovered from COVID-19 are also at risk of getting re-infected if they are exposed to this strain. It is also considered as 50% more virulent [41]. It has high antigenicity since one of its mutations key mutation - called E484K - that may help

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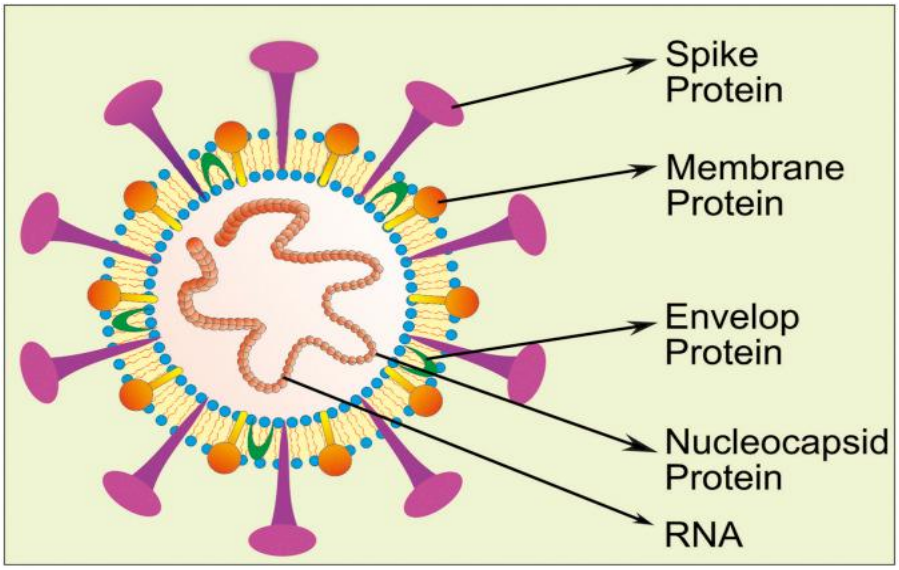
the virus evade parts of the immune system, that makes it hard for antibodies to fight it hence evading the immune response [42].

The mutations in the three variants are enabled by the error-prone polymerase in RNA viruses.Based on the antibody a vaccine was cultured with, the SARS-CoV-2 virus may adopt one or more mutations among E417, N501Y and EW484N in a bid to evade the antibodies [43]. D614G spike protein mutation, on the other hand, has been indicated to increase the infectivity, transmissibility and case fatality rate of the variants.

The ORF1a protein is involved in the replication process of the virus. The next is ORF1b protein which relates to the encoded non-structural protein and lastly is the spike protein which changes shape and interacts with a protein on the surface of the human cell. In addition, as shown in Figure 7 below, there is a membrane protein and envelope protein which are the major structural components of the SARS-Cov-2. The nucleocapsid protein is a viral genome which surrounds a helical nucleocapsid. The RNA is the positive single stranded genome of approximately 30kb in length [43].

Figure 7: The schematic representation of the SARS-CoV-2 virus [43].



In terms of infection surges, experts have been unable to single out whether the rise is due to increased transmissibility or ineffective infection control measures.Hypothetically, the higher the ability of a variant to bind closely to ACE2 receptors, the higher its infection and transmission capability. All the mutations mentioned have the capacity to adjust ACE2/RFD affinity which may increase transmissibility. Further, they possess the potential to affect the virus' neutralisation by antibodies produced by the COVID -19 vaccines.

A US interagency government group that is focused on the characterization of emerging COVID-19 strains classified SARS-CoV-2 variants into three classes; variant of interest, variants of concern, and variant of high consequence [44]. The 3 variants in this study fall under variants of concern because of having common features. Evidence shows that these strains, compared to other classifications have

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features like high transmissibility, they cause more severe disease hence higher hospitalization and death rates, reduced neutralization by antibodies that were formed during vaccination or previous infection, and lastly, less effectiveness in terms of diagnosis, treatment or vaccination.

Table 1: COVID -19 variants, their locations, spike protein substitutions, transmissibility, virulence and antigenicity.

Name	Location of first detection	Spike protein substitutions	Transmissibility	Virulence	Antigenicity
B.1.1.7	United Kingdom [34]	N501Y A570D D614G P681H [33]	Estimated at 43-90% higher than that of other variants in England [33]	A paper analysing 12 studies on B.1.1.7 mortality rate discovered that the virulence was 71% as per LSHTM, 70% as per University of Exeter, 65% according to Public Health England and 36% as per Imperial College [34]	deletion ΔH69/ΔV70 in spike is attributed to immune escape and increase in vitro viral infectivity [33]
P.1	Japan/Brazil [37]	K417N/T E484K N501Y D614G [35]	Brazil Strain P.1 has a transmissibility ranging between 140%-160%. [36]	As at March 2021, the virulence of Brazilian P.1 was estimated at more than 2,000 deaths in Brazil daily [37].	In relation to its antigenicity, Brazilian Strain P.1 can evade protective immunity by 25-61%, caused by previous infection from another variant [35].
B.1.351	South Africa [40]	K417 E484K N501Y D614G [39]	High transmissibility of between 50-70% more than original SARS-Cov-2 [41].	It is also considered as 50% more virulent than SARS-Cov-2 [41].	It has high antigenicity since one of its mutations key mutation - called E484K - that may help the virus evade parts of the immune system, that makes it hard for antibodies to fight it hence evading the immune response [42].

The ability of COVID-19 variants to resist vaccines

Many countries have initiated a vaccine program that seeks to drive more people into getting shots vaccine shots to curb the spread of the virus that still threatens the whole world [43]. In as much as the governments have invested in funding these campaigns, the program faces challenges posed by the further evolution

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and spread of new variants. The emergence of variants has raised many questions that remain unanswered, as concerns revolve around their resistance to the vaccines [46]. These questions include; How widely spread are the variants? Does COVID-19 cause the new variants different from the other available variants? If so, do they spread more easily? Do they cause milder or severe disease? Does a patient suffer from COVID-19 caused by these strains respond to medication prescribed for treatment? Lastly, do the variants affect the efficacy and effectiveness of existing tests, vaccines, and therapies? [47]. The last question is more concerning since a large population of people has been vaccinated worldwide.This may cause an immune pressure that may either favour or accelerate the emergence of other variants.

When a person takes a vaccine, they expect to have a higher chance of being protected from the illness since vaccines boost the body's immunity. With the occurrence of the new COVID-19 variants, there is a concern that these strains may be resistant to vaccines [44,48,49]. The variants have developed a significant number of mutations in the S-protein which allow them to escape undetected or evade immunity induced by both vaccine or innate immune response. Lately, there have been cases of countries suspending the use of some of the vaccines, for instance, Australia suspended AstraZeneca after some of those who were injected developed blood clot while other died [50]. After doing various clinical trials, scientists are now concerned that the South African variant might be more resistant to the top three vaccines.

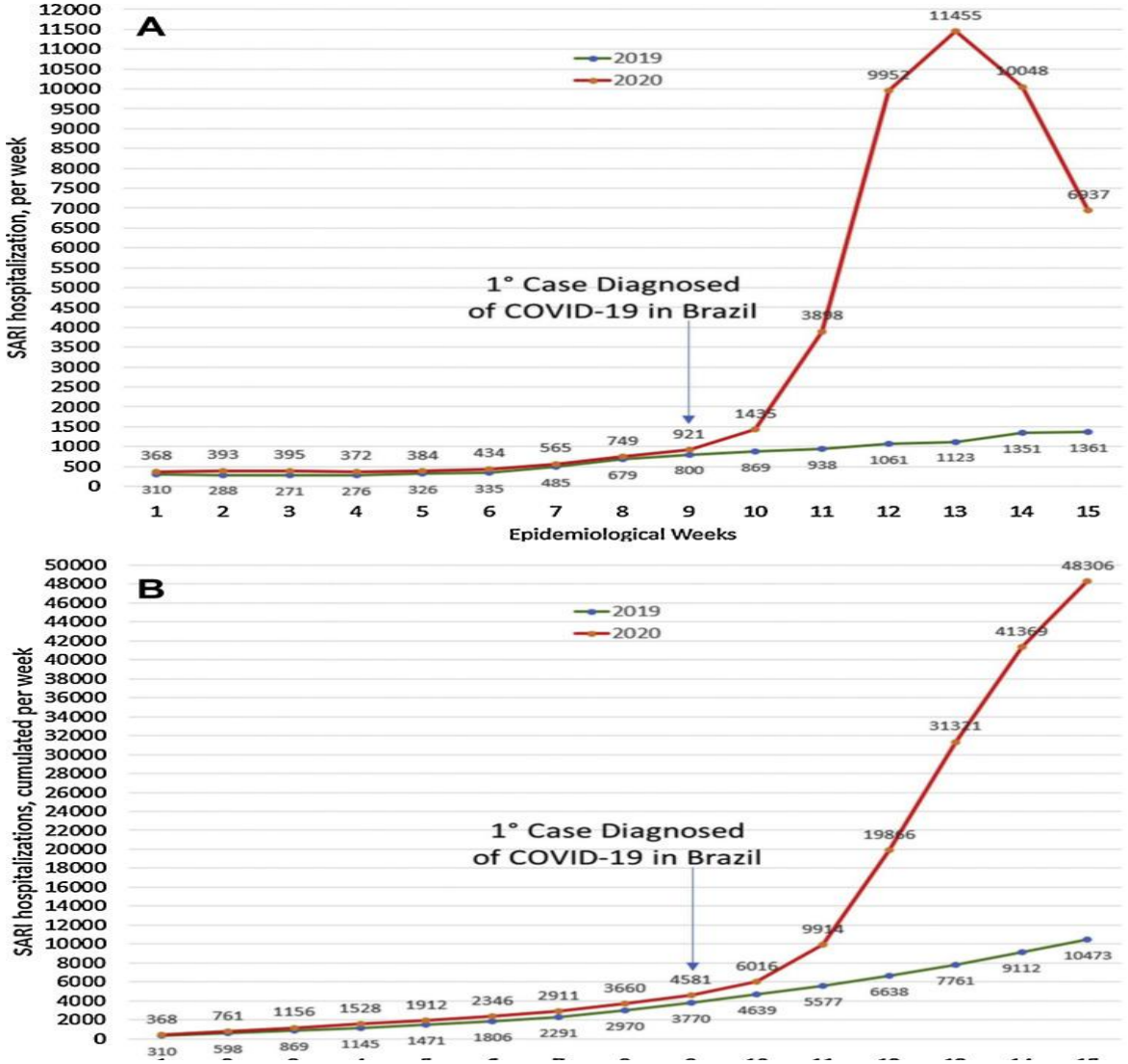
UK Strain and Impact on Vaccine Efficacy

The UK variant contains the E484K mutation in the S-protein which is said to neutralize anti-body resistance [51,52]. A pseudo-virus experiment carried on 15 people at the University of Cambridge showed that sera of 10 of the 15 people, who had received both doses of a vaccine, was less effective on B 1.1.7 compared to the other versions of the virus [44]. Another trial on 256 participants injected with the AstraZeneca/Oxford vaccine found out that the vaccine had similar efficacy against the B.1.1.7 and non-B.1.1.7 lineages. However, the vaccine was found to elicit nine-fold lower antibodies against the variant compared with the original strain. On the other hand, the B.1.1.7 variant did not have a significant impact on the efficacy of the Moderna vaccine in comparison with the original strain [53].

Brazilian Strain and Impact on Vaccine Efficacy

As shown in Figure 8 before the Brazilian strain, the rates of respiratory infections were at an average level of approximately 500 hospitalizations per week. After the first COVID-19 case in Brazil, the rate however rose at n extremely high rate with the highest rate between weeks 11 and 13 where the hospitalizations reached its peak. 8A shows the hospitalizations per week while 8B shows the hospitalization rates cumulatively per week [54].

Figure 8: The hospitalizations due to Severe Acute Respiratory Infections (SARI), during the first 15 epidemiological weeks of 2019 and 2020. (A) New number per week. (B) Cumulative per week [54].



A research team from Oxford University after a series of experiments has concluded that Pfizer-BioNTech and AstraZeneca vaccines are effective in protecting against the Brazilian strain [55]. The study that involved the use of blood samples from people with natural antibodies and after recovering from COVID-19 suggested that P.1 might be less resistant to immune response and vaccines compared to the other two new strains. A separate study has established that Pfizer-BioNTech and AstraZeneca/Oxford vaccines have a three-fold lower virus neutralisation by the antibodies generated by the vaccines against the P.1 variant compared with the original strain [50]. However, the level of protection is still high despite early fears of the variant's potential to reduce vaccine efficacy.

South African Strain and Impact on Vaccine Efficacy

Data from recent trials of vaccines done in South Africa indicated a decline in efficacy of AstraZeneca/Oxford, Novavax and Johnson and Johnson's vaccines on B 1.351 than in trials conducted in countries where the B.1.351 variant was non-dominant. The reduction in efficacy is attributed to the vaccines' reduced sera neutralisation and antibodies binding affinity towards the variant.

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Laboratory evidence on AstraZeneca/Oxford vaccine indicated a 74% efficacy on the B.1.351 variant compared to 84% efficacy on the non-variant strain.Studies have established that Pfizer and Moderna vaccines have a strong but slightly reduced effectiveness against the B.1.351 variant. The studies collected 10 and 12 blood samples from people that had received Pfizer vaccine, 28 days after they had received the second doses.Pfizer vaccine had a 10.3-fold lower efficacy in neutralising the B.1.351 variant, compared to its efficacy against the original Covid-19 strain [18]. Currently, there is little knowledge to know whether SAR-CoV-2 variants are impacting the effectiveness and efficiency of already developing vaccines. WHO together with health departments globally are working hand in hand to collect and analyse data on COVID-19 variant and how they affect the behaviour of the virus and vaccine in general? Besides, if there is any impact, vaccine developers and manufacturers are underway in making adjustments to the vaccines that will keep up with the mutations. Vaccine manufactures are making booster shots to improve vaccine protection against these variations [56].

Another alternative may be to find a way of merging two or more kinds of vaccines to make a stronger version that could fight this disease. Although the swiftness in research gives hope, there are still concerns because new strains of the virus keep emerging and that means the vaccine will have to be adjusted every time.

The herd immunity and Covid -19

The herd immunity model was founded to offer vaccines against specific viral infections such as polio and small pox. Human beings are the reservoirs of these infections.Therefore, the model works by providing immunity to some individuals in the community. In a naïve population that is considered to be susceptible to infection, a form of immunity to a section of the community can be offered. This means only a part of the community will be susceptible and the pathogen will not spread successfully, thereby resulting in a decline in the rates of infection prevalence. There are various emergent issues concerning SARS-Cov-2 and herd immunity. The virus remains a novel pathogen whose features have not been fully understood and therefore this model has not been fully effective in managing COVID-19. Also researches on the effects of antibodies towards the virus have not had positive results [57].

Lessons learnt from COVID-19

It is very necessary to note that delaying dealing with the vaccine can be costly. The use of digitalized technological systems to battle the virus are very key [58].

Conclusion

The world is struggling to rise again after being hit by one of the most tragic pandemics ever witnessed. COVID-19, a severe acute respiratory syndrome, has led to the collapse of the economy at the same time impacting the world's health sector. With the virus comes a high rate of transmission, increased hospitalization, and death cases. Scientists, health departments, and various governments are working hand in hand to ensure that this disease is controlled. This seemed under control when various vaccines such as Moderna, Pfizer, AstraZeneca among many

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others, were developed to protect people from the disease. These vaccines showed a higher percentage of efficacy. With the rapid rate of research and development of better vaccine and treatment procedures, there was the hope of curbing the disease. Unfortunately, this hope came to a halt when the virus started mutating, leading to many variants for instance P.1, B.1.1.7, and B.1.351. Evidence shows that these variants are more deadly than the original coronavirus due to the increased transmissibility, ability to evade the immune response, and reduced neutralizing by antibodies. Currently, there is a concern that these strains may impact the efficacy of already developed vaccines. Scientists are working hard to study these new variants to learn anything about them. There is a need to also have a coordinated way of studying and evaluating the SARS-CoV-2 variants and their impact on the success of vaccines.

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