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Research Paper

Comparing Efficacy of mRNA and AstraZeneca vaccines against SARS-CoV-2variants of concern

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Abstract: Since upsurge of coronavirus pandemic in December 2019, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the number of confirmed cases has increased more than 308 million worldwide, with nearly 5 million deaths. Vaccines are best way to control covid-19 pandemic as suggested by researchers all over world. Current COVID-19 vaccines were based on the SARS-CoV-2 spike protein, which virus used to bind and infected host cells. But the emerging "variants of concern" seemed to be more transmissible or deadlier than the wild-type SARS-CoV-2,containedmutations in the spike protein, questioning vaccine efficacy concerns. Multiple vaccines Pfizer-BioNTech, Moderna Sinopharm, Sinovac, Oxford-AstraZeneca, Sputnik V, Novavax have been granted authorization for vaccination against covid -19 in different countries. Despite authorization having been granted for multiple vaccines, as the ongoing global outbreaks demonstrated, the pandemic is far from over. This review discussed mutations in spike proteins and compared effectiveness of mRNA and AstraZeneca against variants of concern. Vaccine effectiveness was increased ≥7 days after the second dose against Alpha for all three vaccines: mRNA-1273=92% (95% CI, 88–95%), Pfizer=89% (95% CI, 87–90%), and AstraZeneca=91% (95% CI, 62–98%). Efficacies for double dose mRNA vaccines are 84%, 88%, and 77% respectively against both Beta and Gamma variants together in multivariate analysis. Efficacy reported for greater for Beta compared to Gamma variant. Vaccine effectiveness of the two-dose regimen of AstraZeneca after 14 days of the second dose is 77.9% (95% CI, 69.2–84.2) against Covid-19, 87.6% (95% CI, 78.2–92.9) against hospitalization, and 93.6% (95% CI, 81.9–97.7) against death for Gamma variant. The effectiveness of two doses Of Pfizer and AstraZeneca was documented 88.0% (95% CI, 85.3 to 90.1) and 67.0% (95% CI, 61.3 to 71.8) against the Delta variant. There was no effect against Omicron from 15 weeks after AstraZeneca two dose regimens, while VE after Pfizer two dose regimen was 88.0% (95%CI: 65.9 to 95.8%) 2-9 weeks after dose 2,

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dropping to between 34 and 37% from 15 weeks post-dose regimen.

Keywords: Vaccine efficacy,SARS-CoV-2,AstraZeneca,Pfizer.

Introduction:
Covid 19 variants repeatedly caused havoc across the world. The current COVID-19 pandemic has urged the scientific community internationally to find answers in terms of therapeutics and vaccines to control SARS-CoV-2. emerging variants. Newly emerged SARS-CoV-2 Variants Alpha, Beta, Gamma, Delta, Delta plus, and now omicron have urged researchers across the world to develop therapeutics and vaccines to control it. A successful COVID-19 vaccine will require clinical trials of efficacy and adverse reactivity as the target vaccine population include high-risk individuals over the age of 60, particularly those having incurable, persistent diseases, frontline healthcare workers, and those involved in essential industries (Kaur and Gupta, 2020). Various vaccines are developed based on different delivery methods- virus vector vaccines, protein subunit vaccines, genetic vaccines, and monoclonal antibodies for passive immunization which are under evaluation for SARS-CoV-2 variants.COVID-19 Vaccines are highly efficacious at preventing symptomatic disease, as shown by clinical trials (Polack et. ai.,2020, Voysey *et. al.*, 2021, Baden *et. al.*, 2021) and real-world evidence
Over the past few months, several COVID-19 vaccines have been approved for general or emergency use worldwide. Pfizer-BioNTechBNT162b2 and Moderna are the COVID-19 RNA vaccine consisting of mRNA ingredients made in a lab that code for SARS-CoV-2 virus most immunogenic component Spike protein (S). Once mRNA enters the body it instructs the cells to produce antigens – such as the spike protein present in coronavirus – which are then detected by immune cells, triggering a response by the body's lymphocytes. The killer T-cells destroy coronavirus infected cells, while the B-cells activated by helper T-cells, start antibody production. Whoever is exposed to the COVID-19 coronavirus in the future would have an immune system that recognizes and remembers it, and protects infection. Sputnik V and AstraZeneca-Oxford vaccine introduce chimpanzee common cold viral vectorChAdOx1 to deliver genetic code for the antigen. Once the body's cells catch coronavirus, immune cells are instructed to produce a large number of antigens, which in turn trigger an immune response. The Johnson & Johnson vaccine uses a modified and disabled adenovirus to deliver the instructions (https://www.healthcareitnews.com/news/emea/four-types-covid-19-vaccine-snapshot)
The rationale for writing this review is to gather all the information regarding the efficacy of the major COVID-19 vaccine.

Materials and Methods:
This review is based on databases of PubMed, New Journal England Medicine, Lancet, medRxiv, bioRxiv, for vaccine-related literature as of 16 December 2021.

Results:
SARS-CoV-2 variants of concern (VOCs: Alpha (B.1.1.7), first documented in the United Kingdom; Beta (B.1.351), first documented in South Africa; Gamma (P.1), first documented in Japan/Brazil; and Delta (B.1.617.2), first documented in India, omicron first documented in South Africa have emerged with mutations that alter the receptor-binding domain (RBD) of the spike protein and this may impact on vaccine effectiveness (notably the N501Y mutation occurring in Alpha, Beta and Gamma variants, the E484K and E417T/N mutations in Beta and Gamma,

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and the L452R mutation in Delta) (Khateeb and Zhang, 2021) E484A, N501Y, S477N, and K417N in omicron.

Efficacy of COVID-19 Vaccines against Variants of Concern

Vaccines rely on the Spike protein of the virus to form neutralizing antibodies that adhere to the receptor-binding domain of S protein and protect the body from infection.

Vaccine Efficacy against B.1.1.7 Variant

B.1.1.7 variant is more transmissible and increased hospitalizations, mortality rates, and burden to the health care systems. this variant may have reduced neutralization by monoclonal antibody therapies, convalescent sera, and post-vaccination sera.

Data collected from Ontario Canada showed that vaccine effectiveness ≥14 days against after the first dose for Alpha variant was higher for mRNA-1273 (82%; 95% CI, 80–84%) than Pfizer (67%; 95% CI, 65– 68%) and AstraZeneca(63%; 95% CI, 59–66%). Vaccine effectiveness was increased ≥7 days after the second dose against Alpha for all three vaccines: mRNA-1273=92% (95% CI, 88–95%), Pfizer=89% (95% CI, 87–90%), and AstraZeneca=91% (95% CI, 62–98%). Comparatively higher vaccine effectiveness was found against hospitalization than symptomatic infection caused by all four variants of concern (Nasreen *et. al.*, 2021).

Vaccine efficacy against B.1.351

The effectiveness of BNT162b2 mRNA vaccine is documented to be 75% against all clinical forms of B.1.351 infection, and 97% against severe, critical or fatal disease in Qatar lower efficacy of AstraZeneca is documented for B.351 (Madhi *et. al.*, 2021).

Vaccine efficacy against P.1

In a study conducted in Brazil, Vaccine effectiveness of a single dose of ChAdOx1 is 33.4% (95% CI, 26.4–39.7) against Covid-19, 55.1% (95% CI, 46.6–62.2) against hospitalization, and 61.8% (95% CI, 48.9–71.4) against death. Vaccine effectiveness of the two-dose regimen after 14 days of the second dose is 77.9% (95% CI, 69.2–84.2) against Covid-19, 87.6% (95% CI, 78.2–92.9) against hospitalization, and 93.6% (95% CI, 81.9–97.7) against death (Hitchings *et. al.*, 2021).

In a study documenting efficacy of both B.1.351 and P.1 variants together, efficacies for double dose mRNA vaccines are 84%, 88%, and 77% respectively in multivariate analysis. Efficacy reported for greater for B.1.351 compared to P.1 (Nasreen *et. al.* 2021)

Efficacy of vaccine against B.1.617.2–

Vaccine efficacy after partial vaccination is 83% for mRNA-1273 and 56% for BNT162b2 against Delta. Full vaccination with BNT162b2 increased protection against Delta to 87% [11]A study in the UK showed that ChAdOx1 nCoV-19 confers 67.0% protection against Delta.

Vaccine efficacy against B.1.529 variant-

Two dose regimen of AstraZeneca was showed no effect against Omicron from 15 weeks after two AstraZeneca doses, while VE after two BNT162b2 doses was 88.0% (95%CI: 65.9 to 95.8%) 2-9 weeks after dose 2, decreasing to between 34 and 37% from 15 weeks post-dose 2.From two weeks after a BNT162b2 booster, VE reported to increase to 71.4% (95%CI: 41.8 to 86.0%) for AstraZeneca primary course recipients and 75.5% (95%CI: 56.1 to 86.3%) for BNT162b2 primary course recipients.(Andrews *et. al.*, 2021)

Vaccine effectiveness against omicron variant was documented 55.2% (95% confidence interval (CI): 23.5 to 73.7%) and 36.7% (95% CI: -69.9 to 76.4%) for the BNT162b2 and mRNA-1273 vaccine, respectively, in the first month after primary vaccination. However, the VE is significantly lower than that against Delta

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infection and declines rapidly over just a few months (Hansen *et. al.*, 2021)

Discussion:

Efficacy of mRNA and AstraZeneca vaccines against Alpha, Beta Gamma Delta and Omicron variants are compared and documented in previous section. However limited studies against newer variant Omicron indicated lower vaccine efficacy.

Vaccines provides strong protection against variants of concern and two doses of vaccines are more effective. Comparison of differences in efficacies between the various vaccines will help in updating these vaccines and help in public decision making. Vaccine efficacy from booster dose against variants still need to be examined. This review is based on peer reviewed articles and some pre-print articles are also included.

This review also has some limitations. Lack of statical analysis, Random Data collection based on different target populations from different countries and testing efficacy for few vaccines can be weakness of this review.

Results indicated that vaccines are our chief weapon in fighting against covid 19 pandemic. . Efficacy of vaccines against Alpha variant are documented more compared to Beta Gamma Delta (Harder et. al., 2021, Zeng *et. al.*, 2021) and omicron variant.

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