Research Article

Vaccine Efficacy on SARS-CoV-2 (COVID-19) Variants

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Received Date: March 25, 2021
Publication Date: April 01, 2021

Abstract:

The objectives of the study are to identify current available COVID-19 vaccines against SARS-CoV-2 (COVID-19) variants of concern and their adverse events. A comprehensive search was carried out in mainstream bibliographic databases or Medical Subject Headings, including ScienceDirect, PubMed, Scopus, and ISI Web of Science. The search was applied to the articles that were published between 2020 and early 2021. With strict literature search and screening processes, it yielded 12 articles (2020 = 2; and early 2021 = 10 articles) from 400 articles of the initial literature database (2020-early 2021). The WHO recommendations on COVID19 vaccines in the context of SARS-CoV-2 (COVID-19) variants contribute to the plans of the next steps on COVID-19 vaccine production, such as Pfizer and BioNTech announced on February 25, 2021, that they had started evaluating the safety and immunogenicity of a third dose of their vaccine to observe whether it would boost immunity to SARS-CoV-2 (C)OVID-19) variants, particularly B.1.351;

Moderna announced on February 24, 2021 that it had shipped a booster vaccine candidate based on B.1.351 to NIAID for a phase 1 trial; and Novavax, whose the first-generation vaccine has not been authorized yet in the United States, announced on January 28, 2021 that it was working on developing a booster, a combination bivalent vaccine, or both to protect against SARS-CoV-2 (COVID-19) variants. From experience with avian coronavirus, vaccines against one variant will protect against similar variants, but not always against highly divergent variants. It is hard to predict long terms risk of immune escape. In long term, multivalent vaccines that include the viral nucleoprotein might be more robust. As SARS-CoV-2 (COVID-19) variants are too divergent, similar to flu vaccines, COVID-19 vaccines will be changed. In conclusion, rapid identification and characterization of variants of concern by the national and global surveillance will provide much more proactive. More challenging will be deciding when and how to deploy COVID-19 vaccines 2.0. Modifying COVID-19 vaccines would probably be the most straightforward step in involving SARS-CoV-2 (COVID-19) variants.

Keywords: *COVID-19, SARS-CoV-2, Variants, Vaccines, Efficacy.*

Abbreviations: *COVID-19: Coronavirus Disease 2019, EUA: Emergency Use Authorization, hACE: human Anti-Converting Enzyme, PHEIC: Public Health Emergency of International Concern, SARS-CoV-2: Severe- Acute-Respiratory- Syndrome Coronavirus type 2, UK: United Kingdom, US CDC: United States Centers for Disease Control and Prevention.*

Introduction

The first three COVID-19 vaccines with expressing spike Protein and a progressing national rollout has authorization of emergency use in the United Kingdom (UK) and demonstrated protection against COVID-19 **(**1,3**)** and decreased transmission after vaccination in the preliminary report **(**4**)**. Challen et al indicated that B.1.1.7 variant might be related to increased mortality that supplements to the central questions of the ability of an old version of the spike the glycoprotein of SARS-CoV-2 (COVID-19) to produce protective antibodies against newer emerging variants **(**5**)**. The current variants of concern, lineages B.1.351, B.1.1.7, and P1 affect the function of the spike protein and other SARS-CoV-2 proteins and can alter interaction with hACE2 **(**6**)**.

Objectives of The Study

The objectives of the study are to identify current available COVID-19 vaccines against SARS-CoV-2(COVID-19) variants of concern and their adverse events.

Methods of The Study

A comprehensive search was carried out in mainstream bibliographic databases or Medical Subject Headings, including ScienceDirect, PubMed, Scopus, and ISI Web of Science. The search was applied to the articles that were published between 2020 and early 2021. Our first involved performing searches of article abstract/keywords/title using strings of [("SARS-CoV-2" or "COVID-19", "Vaccines", "Variants" or "Variant", "Vaccine Efficacy", and "Vaccine Adverse Events")]. After a first approach of search, published articles focusing on SARS-CoV-2 or COVID-19 vaccines were retained and the information on vaccine efficacy and vaccine adverse events were extracted for having a crude knowledge involving their themes. Another round of publication search was conducted for adding the missing published articles that were not identified by the first round.

All key words combinations from SARS-CoV-2, COVID-19, Variants, Vaccine Efficacy, Vaccine Adverse Events to bind the population of cases under consideration. Search string for disease groups include ["SARS-CoV-2" or "COVID-19" or "Variants" "Vaccine Efficacy" or "Vaccine Adverse Events"]. The initial literature databases were further manually screened with the following rules : 1)non-SARS-CoV-2, non-COVID-19, non-SARS-CoV-2 (COVID-19) variants-related articles were excluded; 2) articles that did not report SARS-CoV-2 or COVID-19 related to vaccine efficacy and vaccine adverse events were not considered, such as commentary articles, or editorial; 3) non-peer-reviewed articles were not considered to be of a scholarly trustworthy validity; and 4) duplicated and non-English articles were removed. The articles were carefully selected to guarantee the literature quality, which is a trade-off for quantity.

Results

With strict literature search and screening processes, it yielded 12 articles (2020 = 2; and early 2021 =10 articles) from 400 articles of initial literature database (2020-early 2021). Needed article information was extracted from each article by : 1) direct information including journal, (research article, review article, meeting abstract, conference abstract, correspondence, author index, editorial board meeting abstract, discussion), book chapter, title, authors, abstract, full text documents of candidate studies, publishing year; 2) study period; 3) research (study) method used;; and 4) the conclusions made about the SARS-CoV-2 (COVID-19) vaccine efficacy and vaccine adverse events on humans infected with SARS-CoV-2 (COVID-19) variants.

Classifications and Definitions of SARS-CoV-2 (COVID-19) Variants

Due to the recent emergence of variants of SARS-CoV-2 (COVID-19), this powerfully contributes to the adapting scientific response to remain effective against the very naturally mutated viruses **(**7**)**. The United States Centre for Disease Control and Prevention (US CDC) classifies the SARS-CoV-2 (COVID-19) variants as the following **(**8**)**:

1. A variant of Interest These variants are currently interesting in the United States. These variants are (1.1) B.1.526 (First detected in New York, November 2020, with potential reduction in neutralization by monoclonal antibody treatments and potential reduction in neutralization by convalescent and post-vaccination sera), 1.2) B.1.525 (First detected in New York, December 2020, with potential reduction in neutralization by monoclonal antibody treatments and potential reduction in neutralization by convalescent and post-vaccination sera), and 1.3) P.2 (First detected in Brazil, April 2020, with potential reduction in neutralization by monoclonal antibody treatments and potential reduction in neutralization by convalescent and post-vaccination sera)

2. Variants of Concern These variants are 2.1) B.1.1.7 (First detected in the United Kingdom, with approximately 50 % increased transmissibility likely increased severity based on hospital admissions and case fatality rates, minimal impact on neutralization by Emergency Use Authorization (EUA) monoclonal antibody treatments, and minimal impact on neutralization by convalescent and post-vaccination sera), 2.2)P.1 (First detected in Japan or Brazil, with moderate impact on neutralization by EUA monoclonal antibody treatments, and reduced neutralization by convalescent and post-vaccination sera), 2.3) B.1.351 (First detected in South Africa, with approximately 50 % increased transmissibility, moderate impact on neutralization by EUA monoclonal antibody treatments, and moderate reduction on neutralization by convalescent and postvaccination sera), 2.4) B.1.427 (First detected in California, with approximately 20 % increased transmissibility, significant impact on neutralization by some, but not all, EUA treatments and moderate reduction in neutralization using convalescent and post-vaccination sera), and 2.5) B.1.429 (First detected in California, with approximately 20 % increased transmissibility, significant impact on neutralization by some, but not all, EUA treatments, and moderate reduction in neutralization using convalescent and post-vaccination sera)

3. Variant of High Consequence This variant has clear evidence that medical countermeasure (MCMS) or prevention measures have significantly decreased effectiveness that are associated with previously circulating variants. The possible attributes that can impact MCMS have demonstrated the failure of diagnostics, evidence to indicate a significant reduction in vaccine effectiveness, a disproportionately high number of vaccines breakthrough cases, very low vaccine-induced protection against severe

disease, significantly decreased susceptibility to multiple EUA or approved treatments, and more severe clinical disease and increased hospital admissions. This variant would require public health officials to announce a Public Health Emergency of International Concern (PHEIC).

Vaccine Efficacy on SARS-CoV-2 (COVID-19) Variants

Recently, in early March 2021, a study demonstrated the efficacy of various COVID-19 vaccines produced by many manufactures in symptomatic SARS-CoV-2 (COVID-19) patients and patients infected with SARS-CoV-2 (COVID-19) variants as the following manufactures (vaccine name), used technology,doses, efficacy against symptomatic disease, and efficacy against variants (B.1.1.7 (first detected in the United Kingdom) and B.1.351 (first detected in South Africa)) : 1) Pfizer and BioNTech (Comirnaty), mRNA, 2 doses, 95 %, unknown, and unknown; 2) Oxford and AstraZeneca (AZD1222), viral vector, 2 doses, 82.4 % (12 weeks between doses), 74.6 %, to be confirmed (unconfirmed reports as low as 10 %); 3) Moderna and the National Institute of Health (NIH) (mRNA-1273), mRNA, 2 doses, 94.5 %, unknown (but reports of reduction in neutralizing antibodies), unknown; 4) Gamaleya (Sputnik V), viral vector, 2 doses, 91.6 %, unknown, unknown; 5) CanSinoBio (Convidecia),viral vector, 1 dose, 65.7 %, unknown, unknown; 6)Novavax (NVX-CoV2373), protein, 2 doses, 95.6 %, 85.6 %, 60%; 7) John & Johnson (Ad26.COV2.S), viral vector, 1 dose, 72%, unknown, 57 %; 7) Sinopharm (BBIBP-CorV), inactivated virus, 2 doses, 79.34 %, unknown, unknown (but reports of weekend effect); 8) Sinovac (CoronaVac), inactivated virus, 2 doses, 50.4 %, unknown, unknown; and 8) Bharat Biotech(Covaxin), inactivated virus, 2 doses, unknown, unknown, unknown; respectively **(**9**)**.

Discussion

SARS-CoV-2 (COVID-19) variants of concern might be related to changes in both morbidity and mortality. Suppression of the host immune response, altered viral transmission dynamics, or higher viral loads in COVID-19-infected persons might worsen the clinical outcomes. The serious adverse events from AZD1222 occurred in 168 patients, 79 in the vaccine group, and 89 in the control group **(**9**)**. Two cases demonstrated transverse myelitis that later determined to be unlikely to be associated **(**9**)**, whereas, there are unknown serious adverse events from CoronaVac in phase III trials **(**9**)**. More serious adverse events were reported in the control group than in the vaccine group **(**9**)**.

Recently, the World Health Organization (WHO) stated that in the context without SARS-CoV-2 (COVID-19) variants, particularly B.1.351, the Oxford/AstraZeneca vaccine offers protection against severe COVID-19, COVID-19-related hospitalization, and COVID-19-related death **(**7**)**. Interestingly, the difference in the vaccine efficacy of the Ad26COV2.S COVID-19 vaccine was demonstrated in the United States and South Africa (72 % vs 57 %) **(**10**)**. The South Africa trials demonstrated lower vaccine efficacy

compared with trials in other countries where the B.1.351 variant was not dominant **(**11**)**, whereas a recent study demonstrated that a two-dose regimen of the ChAdOx1 nCoV vaccine did not protect against mild-to-moderate B.1.351 COVID-19 variant **(**12**)**. Current COVID-19 vaccines are based on the SARS-CoV-2 spike protein, whereas the SARS-CoV-2 (COVID-19) variants contain mutations in the spike protein that contributes to spurring vaccine efficacy concerns **(**11**)**.

The WHO recommends on the effectiveness of COVID-19 vaccines in the context of SARS-CoV-2 (COVID-19) variants that 1) The manufacturers must be prepared to adjust to the SARS-CoV-2 (COVID-19) viral evolution, 2) Trials must be designed and maintained to allow any changes in efficacy to be assessed, 3) Enhanced genomic surveillance must be backed by rapid haring of genetic and meta-data to allow for global coordination and response, 4) Priority should be given to vaccinating high-risk groups everywhere, 5) Governments and donors, as well as development banks, should further support COVAX, and 6) The existing mechanism for tracking and evaluating COVID-19 variants that may affect vaccine composition must be enhanced **(**7**)**.

The WHO recommendations on COVID-19 vaccines in the context of SARS-CoV-2 (COVID-19) variants contribute to the plans of the next step on COVID-19 vaccine production, such as Pfizer and BioNTech announced on February 25, 2021, that they had started evaluating the safety and immunogenicity of a third dose of their vaccine to observe whether it would boost immunity to SARS-CoV-2 (C)OVID-19) variants, particularly B.1.351; Moderna announced on February 24, 2021, that it had shipped a booster vaccine candidate based on B.1.351 to NIAID for a phase 1 trial; and Novavax, whose first-generation vaccine has not been authorized yet in the United States, announced on January 28, 2021, that it was working on developing a booster, a combination bivalent vaccine, or both to protect against SARS-CoV-2 (COVID-19) variants **(**11**)**.

From experience with avian coronavirus, vaccines against one variant will protect against similar variants, but not always against highly divergent variants. It is hard to predict log terms of the risk of immune escape. In long term, multivalent vaccines that include the viral nucleoprotein might be more robust. As SARS-CoV-2 (COVID-19) variants are too divergent, similarto flu vaccines, COVID-19 vaccines will be changed.

Conclusion

Rapid identification and characterization of variants of concern by the national and global surveillance will provide much more proactive. More challenging will be deciding when and how to deploy COVID-

19 vaccines 2.0. Modifying COVID-19 vaccines would probably be the most straightforward step in involving SARS-CoV-2 (COVID-19) variants.

Authors Contributions

Dr. Attapon Cheepsattayakorn conducted the study framework and wrote the manuscript. Associate Professor Dr. Ruangrong Cheepsattayakorn and Professor Dr. Porntep Siriwanarangson contributed to scientific content and assistance in manuscript writing. All authors read and approved the final version of the manuscript.

Competing Interests

The authors declare that they have no actual or potential competing financial interests.

Funding Sources

The authors disclose no funding sources.

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Volume 2 Issue 4 April 2021