REVIEW ARTICLE
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Efficacy and landscape of Covid-19 vaccines: a review article

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SUMMARY

INTRODUCTION: The rapid advance of Coronavirus disease 2019 (Covid-19) has led to the incessant search for therapeutic and prophylactic measures to fight the pandemic. Because it is a viral infection, the safest long-term prophylactic form, in addition to social distance and hygiene, is the vaccine.

OBJECTIVE: Thus, this study aimed at conducting a review of the efficacy and landscape of Covid-19 vaccines.

METHODS: The following electronic databases were used MEDLINE via PubMed, SCIELO, LILACS, NEJM, and Clinical Trials. Our study includes the 7 vaccines (phase 3) that reported an efficacy rate for Covid-19, including characteristics inherent to each one of them.

RESULTS: Preliminary studies have shown that, although an efficacy ≥70% is necessary to eliminate the infection, a prophylactic vaccine with efficacy <70% will still have an important impact and can contribute to the elimination of the virus, provided that appropriate measures of social distancing remain.

CONCLUSIONS: The effectiveness of the vaccines obtained in this study varied between 50.38 and 95%, data that may represent a reduction in serious cases, hospitalizations, sequels, and deaths caused by Covid-19, respecting the panorama presented in this article.

KEYWORDS: Covid-19. Vaccines. Efficacy.

INTRODUCTION

The imminent need for effective solutions and the rapid advance of Coronavirus disease 2019 (Covid-19) has led to the relentless search for therapeutic and prophylactic measures to fight the pandemic. Because it is a viral infection, the safest long-term prophylactic form, in addition to social distance and hygiene, is the vaccine. Several teams around the world are working on developing effective and safe vaccines for human beings[1].

A total of 93,956,883 cases of Covid-19 have been confirmed including 2,029,084 deaths, reported to World Health Organization (WHO) and 223 countries, areas, or territories with cases as of 19 January 2021[2]. Hence, a race against time is being established for

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months so that fewer people will be affected by this devastating virus. Given the urgent need, vaccine development and production are being fast-tracked to hopefully make a safe and effective vaccine available for the more vulnerable group of the population, to minimize the impacts of the pandemic worldwide[3].

Although the production capacity may not be able to meet the global demand for vaccines in the very near future, it would be beneficial to have a limited number of vaccines available for emergency use and the more vulnerable population as soon as possible with the ultimate aim of distributing vaccines globally to the rest of the population by the end of 2021[4]. Thus, this study aimed at conducting a review of the efficacy and landscape of Covid-19 vaccines.

METHODS

Our study includes the 7 vaccines (phase 3) that reported an efficacy rate until 19 Janeiro 2021 for Covid-19, including relevant information about vaccine name, countries, developers, type, vaccine platforms, number of doses, the interval between doses, storage, mechanisms of action and efficacy of Covid-19 vaccines as well as characteristics inherent to each one of them. The search used in this review article was carried out using the following electronic databases: Medline via Pubmed, SCIELO, LILACS, NEJM, and Clinical Trials.

The landscape of Covid-19 vaccines

Vaccines generally require many years of detailed research and testing before reaching the clinical stage. Due to the great current need, researchers are working hard to make effective vaccines available to society. To develop a safe and effective vaccine, pre-clinical and clinical trials must be done with vigilance to avoid severe adverse effects[5]. Various platforms are being looked at for the development of Covid-19 vaccines. These include RNA-based vaccine, DNA-based vaccine, viral vector (non-replicating), inactivated vaccine, protein subunit, and virus-like particle[6].

There were 64 vaccines in clinical development and 173 vaccines in pre-clinical development, totaling 237 potential vaccines to act as prophylaxis for the new coronavirus infection. Of the vaccines under clinical development, there were 15 in phase 3 of the clinical study, 6 using the inactivated virus, 4 with viral vector without replication, 2 with protein subunit, 1 using DNA, and 2 using viral RNA to induce the production of antibodies against the SARS-CoV-2[2]. Table 1 shows some relevant characteristics about the vaccines.

Table 1. Inherent characteristics of the 7 different vaccines (phase 3) for Covid-19.

ID	Vaccine name	Country	Developers	Type	Vaccine plataform	Phase	Doses	Interval between doses	*Storage*
1	Coronavac	China	Sinovac Research and Development Co., Ltd	SARS-CoV-2 vaccine (inactivated)	Inactivated virus	3	2	14 days	2–8°C
2	BBIBP-CorV	China	Sinopharm+Wuhan Institute of Biological Products	Inactivated SARS-CoV-2 vaccine (Verocell)	Inactivated virus	3	2	21 days	2–8°C
3	BBIBP-CorV	China	Sinopharm+Beijing Institute of Biological Products	Inactivated SARS-CoV-2 vaccine (Verocell)	Inactivated virus	3	2	21 days	2–8°C
4	Astrazeneca	England	AstraZeneca + University of Oxford	ChAdOx1-S-AZD1222 (Covishield)	Viral vector (Non-replicating)	3	1-2	0+28 days	2–8°C
5	Sputinik V	Russia	Gamaleya Research Institute; Health Ministry of the Russian Federation	Gam-COVID-Vac Adeno-Based (rAd26-S+rAd5-S)	Viral vector (Non-replicating)	3	2	0+21 days	2–8°C
6	BTN162b2	USA and Germany	Pfizer/BioNTech+ Fosun Pharma	BTN162 (3 LPN–mRNAs)	RNA-based vaccine	3	2	21 days	-70°C
7	mRNA-1273	USA	Moderna+National Institute of Allergy and Infectious Diseases (NIAID)	mMRNA	RNA-based vaccine	3	2	28 days	-20°C

Source: World Health Organization, 2021. Some information was collected from the respective clinical studies.

Genetic vaccines (DNA and RNA vaccines)

Genetic vaccines, in contrast to vaccines that employ recombinant bacteria or viruses, consist only of DNA or RNA, which is taken up by cells and translated into protein. Genetic vaccines are a group of vaccines that deliver one or more of the coronavirus's own genes into our cells to provoke an immune response. Among those that are part of phase 3, we can mention The Cominarty (Tozinameran or BNT162b2) — Pfizer BioNTech, The mRNA-1273 — Moderna, and The CVnCoV — Curevac[7].

The mRNA-1273, for example, is a vaccine composed of synthetic mRNA encapsulated in Lipid nanoparticle which codes for the full-length, pre-fusion stabilized spike protein S of SARS-CoV-2[8], while the BNT162b1 is a codon-optimized mRNA vaccine that encodes for the trimerized SARS-CoV-2 RBD, a critical target of the virus nAb[9].

Viral vector vaccines

The viral vector vaccines contain viruses engineered to carry coronavirus genes. Some viral vector vaccines enter cells and cause them to make a viral protein while other viral vectors slowly replicate, carrying coronavirus proteins on their surface. Among those that are part of phase 3, we can mention the Sputnik V (previously Gam-Covid-Vac), the AZD1222, AstraZeneca, the Convidecia (also known as Ad5-nCoV) — CanSinoBIO, and the Ad26.COV2.S — Johnson&Johnson[7].

Protein-based vaccines (subunit)

Vaccines that contain coronavirus proteins but no genetic material. Some vaccines contain whole proteins, and some contain fragments of them of which[7]. A protein-based vaccine is based on synthetic peptides or recombinant antigenic proteins, which are necessary for invigorating long-lasting protective and/or therapeutic immune response, however, the aid of an adjuvant is necessary[10].

Inactivated virus vaccines

Inactivated or attenuated coronavirus vaccines are created from weakened coronaviruses or coronaviruses that have been killed with chemicals. We can mention the BBIBP-CorV — Sinopharm and the CoronaVac (previously PicCoVacc) — Sinovac Biotech[7]. Among the advantages presented by inactivated virus vaccines, there are: it has the pre-existing technology and infrastructure required for its development; It can be used along with adjuvants to increase their immunogenicity; has already been tested for SARS-CoV and various other diseases[11].

Efficacy of vaccines

Experts are currently trying to do what is necessary to convince the population of the benefits of a Covid-19 vaccine, which is apparent by the number of vaccines under clinical trials and the funding being directed toward vaccines to obtain one before 2021, however, there is a concern about rushing vaccines and producing one with limited effectiveness. One of the main current concerns is that the vaccine is ready for use but does not show results as effective as expected in the population, this could lead to loss of trust in vaccines. In consequence, when an effective vaccine is introduced fewer people may be willing to accept it resulting in a worsening of the pandemic and further reduce the confidence in already approved and effective vaccines for other diseases[12].

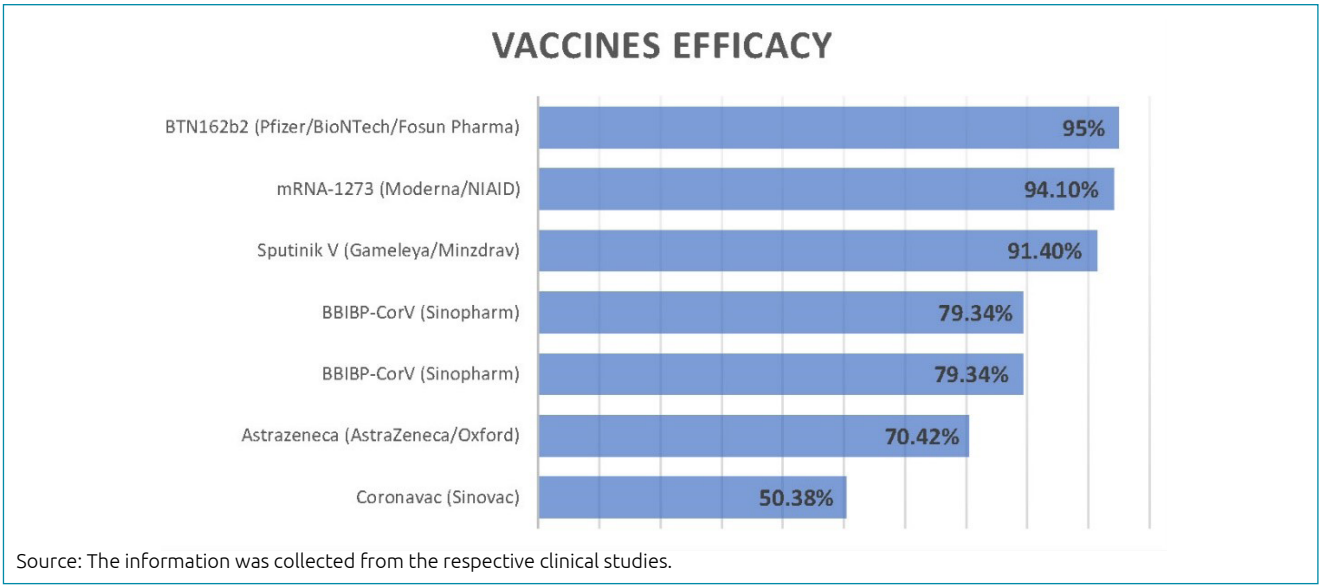
Because of the rapid development of vaccines and clinical trials underway, questions arise as to how much efficacy is needed for the vaccine to be immunogenic. Preliminary studies have shown that, although an efficacy ≥70% is necessary to eliminate the infection, a prophylactic vaccine with efficacy <70% will still have an important impact and can contribute to the elimination of the virus, provided that appropriate measures of social distancing. Vaccines with efficacy below 70% can also contribute to reducing the duration of infection in people infected with the virus[13]. Figure 1 shows the 7 vaccines that have defined efficacy until this article publication.

Belonging to the vector viral group vaccines the Sputnik V vaccine was the first registered vaccine in the world on a well-studied human adenoviral vector-based platform and is between the top 10 candidate vaccines approaching the end of clinical trials have reached the efficacy of 91,4% on data analysis at the end of it and starting the mass production by the WHO list. AstraZeneca showed significant vaccine efficacy of 70.4% after two doses and protection of 64.1% after at least one standard dose, against symptomatic disease, with no safety concerns[14,15].

On 2020 December 8 the FDA released their independent analysis of the clinical trials. They determined that the BTN162b2 has an efficacy rate of 95 percent. Less than two weeks after the first dose[7]. Moderna showed vaccine efficacy of 94.1% based on 196 covid-19 cases, of which 185 were in the placebo group[16]. Both vaccines BTN162b2 and mRNA-1273 are RNA-based vaccines.

In the group of inactivated vaccines, the Coronavac was studied in Turkey, in phase 3 clinical tests, concluded that the efficacy of 78% in the prevention of mild cases of Covid-19 and 100% in the prevention of severe and moderate cases were concluded. At this point, it was not clear how the researchers came to the conclusion of efficacy, and further details were not officially demonstrated in the studies. The confusion is justified by Turkey and Indonesia who provided different results in the effectiveness of doses. However, in Brazil, the Butantan Institute approved the vaccine with 50.39% efficacy[17,18].

A Covid-19 vaccine developed by a Beijing firm linked to Sinopharm has a protection rate of 79.34 percent against the disease, the firm said in a statement on December 2020. The 79%



Source: The information was collected from the respective clinical studies.

Figure 1. Efficacy of the 7 different vaccines (phase 3) for Covid-19.

figure by Sinopharm is lower than the 86% that was reported by the United Arab Emirates on December 9 for the same vaccine[19].

Challenges and future perspectives

It is known that the process of immunization of the world population is not easy, mainly because it is a pandemic that has been devastating the world since the end of 2019. In addition to issues of production itself, respect protocols, phases, to develop a safe and effective product, there are a whole logistics of transport, storage, ethical and political issues involved.

Therefore, some of the main questions that remain for the future are how long these current vaccines will be able to maintain human immunity to the new coronavirus and whether such vaccines that are being developed and applied to the population will be useful in combating possible mutations viruses that may occur.

CONCLUSIONS

The effectiveness of the vaccines obtained in this study varied between 50.38% and 95%, data that may represent a reduction in serious cases, hospitalizations, sequels, and deaths caused by Covid-19, respecting the panorama presented in this article.

AUTHORS' CONTRIBUTIONS

TCPA: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing –original draft. **PVF:** Conceptualization, Formal analysis, Methodology, Writing – original draft. **PHPC:** Conceptualization, Formal analysis, Methodology, Writing – original draft. **EAPM:** Conceptualization, Formal analysis, Methodology, Writing – original draft. **TJMR:** Formal analysis, Supervision, Validation, Writing – review and editing. **FTB:** Formal analysis, Supervision, Validation, Writing – review and editing. **CFSR:** Formal analysis, Supervision, Validation, Writing – review and editing. **FWSR:** Conceptualization, Formal analysis, Methodology, Supervision, Validation, Writing – review and editing. All authors have reviewed and approved the final text of the article and are responsible for its content.

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