

6-5-2021

Efficacy and side effects of Sputnik V, Sinopharm and AstraZeneca vaccines to stop COVID-19; a review and discussion

Tella Sadighpour

Herbert Wertheim College of Medicine, Florida international university; American University of Antigua College of Medicine

Nasrin Ghiasi

Department of Midwifery, Faculty of Medicine, Ilam University of Medical Sciences

Rohollah Valizadeh

Student Research Committee, Department of Epidemiology, School of Public Health, Iran University of Medical Sciences

Mohammad Arabsorkhi

Medical Education Department, Medical Education Research Center, Isfahan University of Medical Sciences

Follow this and additional works at: https://digitalcommons.fiu.edu/covid-19_research

Recommended Citation

Sadighpour, Tella; Ghiasi, Nasrin; Valizadeh, Rohollah; and Arabsorkhi, Mohammad, "Efficacy and side effects of Sputnik V, Sinopharm and AstraZeneca vaccines to stop COVID-19; a review and discussion" (2021). *Coronavirus Research at FIU*. 82.

https://digitalcommons.fiu.edu/covid-19_research/82

This work is brought to you for free and open access by FIU Digital Commons. It has been accepted for inclusion in Coronavirus Research at FIU by an authorized administrator of FIU Digital Commons. For more information, please contact dcc@fiu.edu.



Efficacy and side effects of Sputnik V, Sinopharm and AstraZeneca vaccines to stop COVID-19; a review and discussion

Nasrin Ghiasi¹, Rohollah Valizadeh², Mohammad Arabsorkhi³, Tahere Sadat Hoseyni⁴, Korosh Esfandiari⁴, Tella Sadighpour^{5*}, Hamid Reza Jahantigh^{6,7}

¹Department of Midwifery, Faculty of Medicine, Ilam University of Medical Sciences, Ilam, Iran

²Student Research Committee, Department of Epidemiology, School of Public Health, Iran University of Medical Sciences, Tehran, Iran

³Medical Education Department, Medical Education Research Center, Isfahan University of Medical Sciences, Isfahan, Iran

⁴Ali-Asghar Children Hospital, Department of Radiology, Faculty of Medicine, Iran University of Medical Sciences, Tehran, Iran

⁵Herbert Wertheim College of Medicine, Florida international university, Florida, USA and American University of Antigua College of Medicine, Antigua and Barbuda

⁶Interdisciplinary Department of Medicine - Section of Occupational Medicine, University of Bari, Bari, Italy

⁷Animal Health and Zoonosis PhD Course, Department of Veterinary Medicine, University of Bari, Bari, Italy

*Correspondence to

Tella Sadighpour,

Email: Tella.90s@gmail.com,

tsadi003@fiu.edu,

tellas@auamed.net

Received 16 Apr. 2021

Accepted 23 May 2021

Published online 5 June 2021

Keywords: COVID-19, Novel coronavirus, 2019-nCoV, Vaccine, Sputnik V, Gamaleya, Gam-COVID-Vac, Sinopharm, BBIBP-CorV, AstraZeneca, AZD1222

Abstract

We believe that vaccination is just a way to eliminate or strongly stop the COVID-19. In this regard, there are several vaccines with different efficacy and side effects. It is urgently required to have some efficient vaccines for the prevention and control of SARS-CoV-2. In this review, international databases were considered for searching relevant articles from 1 January 2020 to 1 May 2021. Keywords were COVID-19, novel coronavirus, 2019-nCoV, coronavirus disease 2019, vaccine, Sputnik V, Gamaleya, Gam-COVID-Vac, Sinopharm, BBIBP-CorV, AstraZeneca, Vaxzevria, Oxford, ChAdOx1 nCoV-19 and AZD1222. Three Sputnik V, Sinopharm and AstraZeneca vaccines are useful to gain herd immunity. Enough intervals (at least three weeks/21 days) must be considered for sufficient neutralizing antibody titers. What is important is that the vaccination should be accelerated with each of the aforementioned three vaccines to achieve herd immunity in a shorter period of time because all three vaccines provide 100% prevention of severe COVID-19.

Citation:

Ghiasi N, Valizadeh R, Arabsorkhi M, Hoseyni TS, Esfandiari K, Sadighpour T, Jahantigh HR. Efficacy and side effects of Sputnik V, Sinopharm and AstraZeneca vaccines to stop COVID-19; a review and discussion. *Immunopathol Persa*. 2021;7(2):e31. DOI:10.34172/ipp.2021.31.

Introduction

Coronavirus disease 2019 (COVID-19) is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), and is the causative agent of a potentially deadly disease worldwide that has become a major public health concern. Coronavirus is one of the largest pathogens targeting the lung. Previous outbreaks of coronavirus have included severe acute respiratory syndrome (SARS) and the Middle East respiratory syndrome (MERS) which have previously been identified as very threatening to public health. In late December 2019, a number of patients were admitted to hospitals with an initial diagnosis of pneumonia of unknown cause. These patients were epidemiologically related to a wholesale seafood and wet animals market in Wuhan, Hubei province, China (1,2). Globally, at the time of publication, there have been

Key point

Three Sputnik V, Sinopharm and AstraZeneca vaccines are helpful to gain herd immunity. Enough intervals (at least 3 weeks/ 21 days) must be considered for sufficient neutralizing antibody titers. All three vaccines provide 100% prevention of severe COVID-19.

165069258 confirmed cases of COVID-19, including 3422907 deaths, reported to World Health Organization (WHO) and a total of 1422282170 vaccine doses have been administered to people (3,4).

Vaccine is the final key to eliminate the COVID-19 pandemic. Vaccine is a living organism and has the power to resist and overcome germs, which is called immunity (5). In many diseases caused by the virus, once a person gets the disease and gets better,



he or she will be immune to it. For example, smallpox, measles, and chickenpox are diseases that, once infected, can be permanently immune and they will never be infected again. However, other diseases, such as the flu, can affect humans several times. Therefore, in order to get rid of them, immunity must be created artificially in the human body called “active immunization” (6).

By injecting the weakened virus into the body, it causes a mild form of the disease. Active immunization or vaccination is a very important and valuable measure by which infectious diseases can be prevented at a low cost. With the implementation of the universal vaccination program in the world, the prevalence of many dangerous diseases among infants, children and adults has been significantly reduced, so that now the prevalence of serious diseases such as diphtheria, tetanus, pertussis, measles and polio with successful vaccination in children (7). Vaccines have now been developed for more than 20 diseases, some of which are commonly used and others for specific conditions. The decision to prepare and use a vaccine for a disease is made based on the balance of two issues, one is the need for the vaccine and the other is the risks and complications (8).

The preventive effect of a vaccine is obtained by comparing the number of infected people in the two groups of vaccinated and unvaccinated people who are accidentally exposed to the disease. The most effective vaccines are those that mimic the preventive mechanism resulting from the recovery phase in the normal form of the disease (9). Herd immunity is established when a sufficient number of people are immune to stop new cases. This means that enough people are protected to stop the person-to-person transmission in the community (10). Herd immunity may exist worldwide like smallpox. For example, the United States and many other countries have achieved herd immunity to polio and measles, although universal immunity to these two diseases does not yet exist (11).

The percentage of people who need to achieve herd immunity varies with specific disease e.g., measles needs about 95% of vaccination among the community. Nevertheless, this threshold for polio is approximately 80%. To achieve herd immunity for COVID-19, exact percentage is not known (12). There are several effective and approved vaccines for COVID-19. Doroftei et al concluded that three vaccines had an efficacy of more than 90% (Pfizer–BioNTech, ~95%; Moderna, ~94%; and Sputnik V, ~92%) except for Oxford–AstraZeneca (~81%) (13). Vaccines may have specific complications that should be studied. In this study, we reviewed three vaccines including AstraZeneca, Sputnik V and Sinopharm in detail.

Objective

This study aimed to review the efficacy and side effects of Sputnik V, Sinopharm and AstraZeneca vaccines.

Methods

In this review, international databases including PubMed, Web of Science and Scopus were considered for searching of English articles from 1 January 2020 to 1 May 2021. All types of articles were included. Keywords were COVID-19, novel coronavirus, 2019-nCoV, coronavirus disease 2019, vaccine, Sputnik V, Gamaleya, Gam-COVID-Vac, Sinopharm, BBIBP-CorV, AstraZeneca, Vaxzevria, Oxford, ChAdOx1 nCoV-19 and AZD1222. After collection of articles of interest, references were imported to Endnote software and removed duplicate titles. The selected studies were performed on humans and published in English. Totally, according to the UNICEF website, there are 13 vaccines with approval from emergency use listing (EUL), with licensure from countries or with conditionals use (Table 1) (14). In Iran, there are three vaccines including Shifa Pharm Industrial Co with four trials, Razi Vaccine and Serum Research Institute (Razi Cov Pars) with two trials and FAKHRAVAC (MIVAC) with one trial (15).

AstraZeneca/ Oxford/ChAdOx1 nCoV-19/AZD1222/ChAdOx1

The WHO has given EUL to the AstraZeneca COVID-19 vaccine to prevent COVID-19 in people 18 years of age and older, including people over 65. The COVID-19 AstraZeneca vaccine is licensed by WHO produced by AstraZeneca and COVISHIELD by the Indian Serum Institute (SII) for universal access during the COVID-19 epidemic. The EUL allows two doses of the vaccine to be given with four to 12 weeks interval (16). According to a study published as an interim study for AstraZeneca vaccine, this vaccine should not be injected under the age of 18 and two doses of 0.5 ml should be injected every 4 to 12 weeks (17). According to a WHO statement on February 11 “While the vaccine has not yet been recommended for emergency use by the WHO, it has been reviewed by the European Medicines Agency (EMA)”. The EMA has thoroughly evaluated vaccine quality, safety and efficacy data and recommended that conditional marketing authorization be granted to those 18 years of age and older (18).

According to the Drugs Controller General of India (DCGI), common side effects of Indian AstraZeneca include tenderness, pain, warmth, redness, itching, inflammation, and blisters at the injection site. It also leads to general feeling of discomfort, lethargy, fatigue, chills and fever, headache, nausea, arm pain, joint and muscle pain that subside within a few days to a week after vaccination (19). The secretary of the Ministry of Health of India stated that the common side effects following the AstraZeneca vaccine will be eliminated within 24 hours (20). In Europe, the most common complication was fever and then headache, which is normal due to the activation of the immune system following vaccination, and fever is also reported following Pfizer and Moderna. No serious side effects have been reported for the AstraZeneca

Table 1. Number of vaccines approval reported by UNICEF (14)

Vaccine developer	WHO EUL	Licensure	Emergency/conditional use
Anhui Zhifei Longcom Biopharmaceutical	-	1	1
AstraZeneca	2	4	65
Beijing Institute of Biological Products (CNBG)	1	2	16
Bharat Biotech	-	-	6
CanSino Biologicals	-	-	5
Chumalov	-	1	-
Gamaleya Research Institute	-	8	54
Janssen	1	1	37
Moderna	1	1	33
Pfizer/BioNTech	1	6	58
Sinovac	-	-	23
Vector State Research Center	-	1	-
Wuhan Institute of Biological Products	-	1	1

vaccine. Additionally, 10 to 15 of those vaccinated experience nausea up to 12 hours after vaccination. Of the 10000 vaccinated, 149 reported flu-like symptoms. Fever has been reported in 25% of cases (21).

In addition to common complications, uncommon symptoms include excessive sweating, enlarged lymph nodes, pain, loss of appetite, and confusion (22). According to AstraZeneca Company, prophylactic use of Acetaminophen can reduce some symptoms (23). According to the European Medicines Agency (EMA), general symptoms of the few symptoms reported are vaccine are mild to moderate and include pain and stiffness at the injection site, headache, fatigue, muscle aches, lethargy, chills, fever, joint pain, and nausea (24). As of 19 April 2021, WHO revealed that the AstraZeneca vaccine is an effective and safe vaccine without serious complications including death, hospitalization and severe disease (25). As reported, "COVID-19 vaccine AstraZeneca" uses non-replicant chimpanzee adenovirus ChAdOx1 causing thrombocytopenia (26). Ramasamy et al showed that AstraZeneca/ChAdOx1 nCoV-19 vaccine is better tolerated in older adults than in younger adults and has similar immunogenicity across all age groups after a boost dose (27). Wolf et al reported intracranial venous sinus thrombosis (IVST) in vaccinated people by COVID-19 Vaccine AstraZeneca (28). They indicated that exposure to AstraZeneca vaccine triggers the expression of antiplatelet antibodies, resulting in a condition with thrombocytopenia and venous thrombotic events. Following the use of AstraZeneca vaccine, a 22-year patient developed headaches four days after the vaccination and after a week, the patient experienced a generalized epileptic seizure. Another 46-year patient presented with severe headaches, hemianopia to the right, and mild aphasia about two weeks after the vaccination that was a left occipital intracerebral hemorrhage approved by MRI. In addition, right-hand hemiparesis and extensive venous sinus thrombosis were diagnosed that were managed by heparinization and endovascular recanalization of their venous sinuses (28).

Gam-COVID-Vac/Gamaleya/Sputnik V

This recombinant vaccine was developed for COVID-19 by Gamaleya Research Institute, Russia using human adenovirus vector 26 for the first vaccine and human adenovirus 5 for the second vaccine. At the same time, the effectiveness of the Sputnik V vaccine against COVID-19 has been announced to be 91.6%. However, it may be less effective in the elderly or patients with immunodeficiency. The best immune response also occurs about two weeks after the second dose of the vaccine, but the duration of protection of this vaccine, like other vaccines, is not yet known. On the other hand, clinical studies of this vaccine, like other Corona vaccines in the world, are still ongoing to answer these ambiguities. It should be noted that the Russian Sputnik vaccine is banned in some cases. For example, this vaccine should not be used during pregnancy and lactation. Furthermore, those with a history of severe allergic reactions and any acute illness with or without fever can come for this vaccine about two weeks after recovery. On the other hand, the vaccine is not licensed for people less than 18 years of age. In addition, people who suffer from any severe side effects after the first dose of this vaccine, such as anaphylaxis or severe allergic reaction, seizures and fever above 40 degrees, are prohibited from taking the second dose of the vaccine (29).

Logunov et al reported that the side effects of the first or second dose of the vaccine are generally mild to moderate and go away in about three days. The most common complication is a mild flu-like condition with symptoms such as fever, chills, muscle and joint pain, sore throat, nasal congestion, weakness, malaise, and headache. Local side effects such as pain, swelling, and redness at the injection site may also occur. These symptoms usually resolve on their own, but non-steroidal anti-inflammatory drugs can be used to control fever or antihistamines for topical side effects. However, less common complications include nausea, anorexia, and enlarged regional lymph nodes, and rarely, confusion and syncope have been reported. At the same time, temporary increase in liver enzymes, increase in serum creatinine and CPK, decrease

Table 2. Comparing efficacy and other characteristics of Sputnik V, Sinopharm and AstraZeneca vaccines

Variable	Type	Efficacy	Dose	Storage	Interval of vaccine
Sputnik V	Adenovirus-based	91.6% efficacy against the original strain of the virus 100% against severe COVID-19	2	-18.5°C	21 days apart
Sinopharm	Inactivated SARS-CoV-2 (Vero cell)	79% against symptomatic SARS-CoV-2 infection 14 or more days after the second dose. 100% against severe COVID-19	2	2-8°C	21 -28 days apart
AstraZeneca	Adenovirus-based	76% against symptomatic COVID-19 100% against severe or critical disease and hospitalizations 85% against symptomatic COVID-19 in people 65 years and older	2	2-8°C	28 days apart

in neutrophils, increase in lymphocytes, increase and decrease in platelets, etc have also been reported. The age in the study of Logunov et al was varied from 18 to 87 years (29).

According to the report of Centers for Disease Control and Prevention (CDC), and published interim analysis of Gam-COVID-Vac Vaccine in phase 3 in the *Lancet* journal, the most common side effects were flu-like illness, headache, fatigue and injection-site reactions which are similar to other vaccines such as Moderna, Johnson and Pfizer. Since serious adverse events (deep vein thrombosis, hemorrhagic stroke, and hypertension) were reported as well, the independent data monitoring committee revealed that none of these was related to the Sputnik V vaccine (30). Logunov et al, in a large cohort study conducted on 25 hospitals of Moscow, Russia showed that of 21 977 adults (vaccine group=16 501 and placebo group=5476), from 21 days after the first dose of vaccine (the day of dose 2), 16 of 14 964 participants in the vaccine group and 62 of 4902 in the placebo group were confirmed to have COVID-19, therefore vaccine efficacy was reported to be 91.6% for prevention of COVID-19 (29).

Sinopharm/BBIBP-CorV

The first Chinese COVID-19 vaccine that WHO authorized for emergency use is Sinopharm COVID-19 vaccine or BBIBP-CorV as inactivated vaccine produced by Beijing Bio-Institute of Biological Products (BBIBP). In the trials, Sinopharm was safe and well tolerated in such a way that a robust humoral immune response was reported in 100% of vaccinated individuals. Additionally, animal studies about Sinopharm performed on rats, mice, rabbits and guinea pigs showed acceptable protection against SARS-CoV-2 (31). According to the reported on Sinopharm/BBIBP COVID-19 vaccine released by the WHO, most common side effect of Sinopharm vaccine (with 79% efficacy against symptomatic COVID-19 and 79% efficacy against hospitalization) were dizziness, fatigue, headache, nausea, vomiting, fever and allergic dermatitis (32). One of the acceptable features of this vaccine is that the normal refrigeration temperature is enough to be stored. Xia et al showed the results of phase I and II interim and indicated that the most common adverse reaction was

injection site pain and fever, which were mild and self-limiting without any serious adverse reactions. Totally, the frequency of the patients with adverse reactions was low (33). Xia et al in another study on BBIBP-CorV vaccine showed that the most common systematic adverse reaction is fever (18-59 years, 4% in the 2 and 4µg group and 8% in the 8 µg group). All reported adverse reactions were mild or moderate without serious adverse event within 28 days following vaccination. Two-dose immunization with three or four weeks interval gain higher neutralizing antibody titers than the single 8 µg dose or 4 µg dose on days 0 and 14. It shows that enough intervals must be considered for sufficient neutralizing antibody titers (34).

Table 2 shows a summary of efficacy and other characteristics of Sputnik V, Sinopharm and AstraZeneca vaccines.

Conclusion

Three vaccines of Sputnik V, Sinopharm, and AstraZeneca are useful to gain herd immunity. Enough intervals (at least 3 weeks/ 21 days) must be considered for sufficient neutralizing antibody titers (34). What is important is that the vaccination should be accelerated with each of the aforementioned three vaccines to achieve herd immunity in a shorter period of time because all three vaccines provide 100% prevention of severe COVID-19.

Authors' contribution

NG, RV and TS; Concept, design, search and screening. MA, TSH, KS, TS and NG: manuscript draft. TS, NG, RV: revision. Final edit: MRJ. All authors read and signed the final paper.

Conflicts of interest

The authors declare that there is no conflict of interest.

Ethical considerations

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors.

Funding/Support

The authors received no financial support for the research, authorship, and/or publication of this article.

References

1. Kofi Ayithey F, Dzuvoor C, Kormla Ayithey M, Bennita Chiwero N, Habib A. Updates on Wuhan 2019 novel coronavirus epidemic. *J Med Virol.* 2020;92:403-407. doi: 10.1002/jmv.25695.

2. Rothan HA, Byrareddy SN. The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak. *J Autoimmun.* 2020;109:102433. doi: 10.1016/j.jaut.2020.102433.
3. Stufano A, Lisco S, Bartolomeo N, Marsico A, Lucchese G, Jahantigh H, et al. COVID19 outbreak in Lombardy, Italy: An analysis on the short-term relationship between air pollution, climatic factors and the susceptibility to SARS-CoV-2 infection. *Environmental Research.* 2021;111197. doi:10.1016/j.envres.2021.111197.
4. World Health Organization (WHO). WHO Coronavirus (COVID-19) Dashboard. 21 May 2021. Available at: <https://covid19.who.int/>.
5. Heffernan JM, Keeling MJ. Implications of vaccination and waning immunity. *Proc Biol Sci.* 2009;276:2071-80. doi: 10.1098/rspb.2009.0057.
6. Domachowska J. Active Immunization. In: Domachowska J., Suryadevara M, eds. *Vaccines.* Cham: Springer; 2021. doi: 10.1007/978-3-030-58414-6_3.
7. Yaqub O, Castle-Clarke S, Sevdalis N, Chataway J. Attitudes to vaccination: a critical review. *Soc Sci Med.* 2014;112:1-11. doi: 10.1016/j.socscimed.2014.04.018.
8. Plotkin S. History of vaccination. *Proc Natl Acad Sci U S A.* 2014;111(34):12283-7. doi: 10.1073/pnas.1400472111.
9. Frenkel LD, Nielsen K. Immunization issues for the 21st century. *Ann Allergy Asthma Immunol.* 2003;90:45-52. doi: 10.1016/s1081-1206(10)61660-2.
10. Metcalf CJE, Ferrari M, Graham AL, Grenfell BT. Understanding Herd Immunity. *Trends Immunol.* 2015;36:753-755. doi: 10.1016/j.it.2015.10.004.
11. Anderson RM, May RM. Vaccination and herd immunity to infectious diseases. *Nature.* 1985;318:323-9.
12. Coronavirus disease (COVID-19): Herd immunity, lockdowns and COVID-19. Available from: https://www.who.int/news-room/q-a-detail/herd-immunity-lockdowns-and-covid-19?gclid=Cj0KCQjw16KFBhCgARIsALB0g8lyGH6cd0NkeiQbnXCGkEHRUvW-Dlh2o2G_iufhofkbVOup15lrxMaAm2REALw_wcB.
13. Doroftei B, Ciobica A, Ilie OD, Maftai R, Ilea C. Mini-Review Discussing the Reliability and Efficiency of COVID-19 Vaccines. *Diagnostics (Basel).* 2021;11:579. doi: 10.3390/diagnostics11040579.
14. UNICEF. Number of vaccine approvals. May 21 2021. <https://app.powerbi.com/view?r=eyJrIjojNmE0YjZiNzUtZjk2OS00ZTg4LTlMzMtMTRhNzE0NzA4YmZlIiwidCI6Ijc3NDdEwMTk1LTE0ZTEtNGZiOC05MDRiLWFiMTg5MjYyYmZlIiwiaWQiOiJh9&pageName=ReportSectiona329b3eafd86059a947b>
15. Three Vaccines in Clinical Trials in Iran (Islamic Republic of). Available from: <https://covid19.trackvaccines.org/country/iran-islamic-republic-of/>
16. AstraZeneca COVID-19 vaccine authorised for emergency use by the World Health Organization. Available from: <https://www.astrazeneca.com/media-centre/press-releases/2021/astrazeneca-covid-19-vaccine-authorised-for-emergency-use-by-the-world-health-organization.html>.
17. Interim recommendations for use of the ChAdOx1-S [recombinant] vaccine against COVID-19 (AstraZeneca COVID-19 vaccine AZD1222, SII Covishield, SK Bioscience). Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV-vaccines-SAGE_recommendation-AZD1222-2021.1.
18. The Oxford/AstraZeneca COVID-19 vaccine: what you need to know. Available from: <https://www.who.int/news-room/feature-stories/detail/the-oxford-astrazeneca-covid-19-vaccine-what-you-need-to-know>.
19. Coronavirus Vaccine Covishield: Side effects, Benefits of Serum Institute-AstraZeneca vaccination. <https://www.zeebiz.com/india/news-coronavirus-vaccine-covishield-side-effects-benefits-of-serum-institute-astrazeneca-vaccination-145241>.
20. AstraZeneca COVID-19 Vaccine (AZD1222). <https://www.precisionvaccinations.com/vaccines/astrazeneca-covid-19-vaccine-azd1222>.
21. AstraZeneca Vaccine Faces Resistance in Europe After Health Workers Suffer Side-Effects. Available from: <https://www.usnews.com/news/top-news/articles/2021-02-18/astrazeneca-vaccine-faces-resistance-in-europe-after-health-workers-suffer-side-effects>
22. What are the side effects of the AstraZeneca vaccine? Available from: <https://www.openaccessgovernment.org/side-effects-of-the-astrazeneca-vaccine/103646/>
23. COVID-19 vaccine AZD1222 showed robust immune responses in all participants in Phase I/II trial. Available from: <https://www.astrazeneca.com/media-centre/press-releases/2020/covid-19-vaccine-azd1222-showed-robust-immune-responses-in-all-participants-in-phase-i-ii-trial.html>
24. EMA recommends COVID-19 Vaccine AstraZeneca for authorization in the EU. Available from: <https://www.ema.europa.eu/en/news/ema-recommends-covid-19-vaccine-astrazeneca-authorisation-eu>
25. World Health Organization (WHO). The Oxford/AstraZeneca COVID-19 vaccine: what you need to know. Available from: https://www.who.int/news-room/feature-stories/detail/the-oxford-astrazeneca-covid-19-vaccine-what-you-need-to-know?gclid=CjwKCAjwTj2FBhAuEiwAiku19oycJfHxpC8fjhw_WJKAG032evW04RZaHYuzj8H-pEEvhjZD8oL8BoCjlgQAvD_BwE
26. Raadsen M, Du Toit J, Langerak T, van Bussel B, van Gorp E, Goeyjenbier M. Thrombocytopenia in virus infections. *J Clin Med.* 2021;10:877. doi: 10.3390/jcm10040877.
27. Ramasamy MN, Minassian AM, Ewer KJ, Flaxman AL, Folegatti PM, Owens DR, et al. Oxford COVID Vaccine Trial Group. Safety and immunogenicity of ChAdOx1 nCoV-19 vaccine administered in a prime-boost regimen in young and old adults (COV002): a single-blind randomised controlled, phase 2/3 trial. *Lancet.* 2021;396:1979-1993. doi: 10.1016/S0140-6736(20)32466-1.
28. Wolf ME, Luz B, Niehaus L, Bhogal P, Bänzner H, Henkes H. Thrombocytopenia and Intracranial Venous Sinus Thrombosis after "COVID-19 Vaccine AstraZeneca" Exposure. *J Clin Med.* 2021;10:1599. doi: 10.3390/jcm10081599
29. Logunov DY, Dolzhikova IV, Shcheblyakov DV, Tukhvatulin AI, Zubkova OV, Dzharullaeva AS, et al. Gam-COVID-Vac Vaccine Trial Group. Safety and efficacy of an rAd26 and rAd5 vector-based heterologous prime-boost COVID-19 vaccine: an interim analysis of a randomised controlled phase 3 trial in Russia. *Lancet.* 2021;397(10275):671-681. doi: 10.1016/S0140-6736(21)00234-8
30. Centers for Disease Control and Prevention (CDC). Possible Side Effects after getting a COVID-19 vaccine. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/vaccines/expect/after.html>.
31. Wang H, Zhang Y, Huang B. Development of an inactivated vaccine candidate, BBIBP-CorV, with potent protection against SARS-CoV-2. *Cell.* 2020;182:713-721. doi: 10.1016/j.cell.2020.06.008.
32. World Health Organization (WHO). Evidence Assessment: Sinopharm/BBIBP COVID-19 vaccine. Available from: https://cdn.who.int/media/docs/default-source/immunization/sage/2021/april/2_sage29apr2021_critical-evidence_sinopharm.pdf.
33. Xia S, Duan K, Zhang Y, Zhao D, Zhang H, Xie Z, et al. Effect of an inactivated vaccine against SARS-CoV-2 on safety and immunogenicity outcomes: interim analysis of 2 randomized clinical trials. *JAMA.* 2020;324:951-960. doi: 10.1001/jama.2020.15543.
34. Xia S, Zhang Y, Wang Y, Wang H, Yang Y, Gao GF, et al. Safety and immunogenicity of an inactivated SARS-CoV-2 vaccine, BBIBP-CorV: a randomised, double-blind, placebo-controlled, phase 1/2 trial. *Lancet Infect Dis.* 2021;21:39-51. doi: 10.1016/S1473-3099(20)30831-8.