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REVIEW ARTICLE

Comparison Between COVID-19 Vaccines Developed by Different Pharmaceuticals: A Short review

Taimoor Hassan[1,*], Sana Saeed[2], Sidra Siddique[3], Ifzonia Babar[4], Ambreen Sadaf[2], Fahad Ayub[2]

[1]School of Pharmacy, Changzhou University, Jiangsu, China.

[2]The Department of Health Professional Technologies, The University of Lahore, Pakistan.

[3]School of Allied Health Sciences, Children Hospital, Lahore, Pakistan.

[4]University of Management and Technology, Lahore, Pakistan.

Authors' Contributions

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***Address of Correspondence Author:** Taimoorhassan408.th@gmail.com*

ABSTRACT

Background: Coronavirus declared pandemic by the world health organization in the mid of March 2020, as it caused massive havocs on human health physically, mentally, socially and economically.

Objectives: To find the Comparison between the effectivity of different COVID-19 Vaccines.

Methods: In order to compare the COVID-19 vaccines, this review analyzed all articles published during 2020 to 2021 in both Local and foreign journals. The main question of this paper was to compare the effectivity of Vaccines used for COVID-19. To answer this question, different keywords "COVID-19'', "Vaccine'', "Coronavirus'', "SARS-cov-1", "Pfizer", AstraZeneca", "Moderna", and Pakistan separately and combined were searched in different electronic databases CINAHL, PubMed, HEC digital library, and eMedicine. The articles inclusion criteria were the Vaccines used for COVID-19 and full text available. Articles with copyright and lacking the full text were excluded. In the screening step, 51 articles were selected after review of abstract, according to criteria and duplicate articles removed. In last step, seven articles were selected for the final analysis.

Results: The results demonstrated that Pfizer is the most suitable vaccine against corona virus, its efficiency is 95%. Modern is 94.1% effective against coronavirus, Sputnik V is 92% effective, Johnson & Johnson is 86% effective, Sinovac is 79% and AstraZeneca is 70% effective against coronavirus.

Conclusion: This review study concluded that multiple pharmaceuticals working impressively to develop the vaccine for coronavirus, some of them have worked so well and achieved very desirable results which are helping humans to sustain their normal life.

Keywords: *COVID-19, Vaccine, SARS-cov-2, Pfizer, AstraZeneca, SinoVac.*

INTRODUCTION

As of the February 23, 2021, a plethora of COVID-19 cases exceeded 112 million, and 2.47 million deaths were recorded globally. Since, the eruption of this pandemic, the worldwide lockdowns and easing remain in doldrums [1]. It is a matter of time that now we must move back to social life only with the development of proper vaccine. Globally, all the governments; health practitioners are working by dint off to control this pandemic by experimenting number of techniques and preventive methods [2].

Some countries are considered as more successful while others are not in keeping the health of their safe and rolling out the economic activities. Such as China is leading the world in this race. Multiple methods such as quarantine, self-isolation, testing, treatments, keeping a social distance, washing hands and face, proper sanitization are the methods and techniques which are being used for far to combat this pandemic [3]. Up-till December 2020, the treatment of COVID-19 comprised Anti-flu drugs named Avigan, dexamethasone, remdesivir and asthma steroids. Critically dependents patients were being kept under intensive care units. While discussing the historical background of this pandemic, the world reported that when SARS-cov-1 was emerged, none of the vaccine was developed at that time as the pandemic stopped by its own. SinoVac, a Chinese pharmaceutical company was the only one which performed the Phase-1 clinical trials for SARS-cov-1 outbreak in 2002-2003, as the outbreak disappeared the company closed its further research and the matter left un-resolved [4]. In this new pandemic the Same pharmaceutical used its previous data to develop vaccine for COVID-19, as it has similarities with the previous SARS-cov-1 [5,6].

The Russians claimed that they were developing the vaccine named 'Sputnik V' since past 20 years for other viral diseases such as Ebola. The concept of Russian Pharmaceutical Gamaleya is quite identical to the Coronavirus prototype vaccine of CanSino (A Chinese based company). As we could see that the race for vaccine development has started [7]. Many other countries participated in this race. In December 2020, a United States-based pharmaceutical company Pfizer's joint-venture with 'BioNTech' introduced their very first COVID-19 vaccine after the approval from Food and Drug Administration for emergency use against SARS-COV-2 in USA and abroad only for 19 years of age and older. Oxford university students developed a Vaccine named 'AstraZeneca' for COVID-19 virus and it has also been approved in United Kingdom for emergency use. In February 2021, World Health Organization approved AstraZeneca's COVID-19 vaccine for use [8]. Globally, it has sent millions of its doses to the developing countries so that they could combat this global pandemic.

'Moderna' is also a US-based pharmaceutical company which has developed its COVID-19 vaccine [9]. 'Johnson & Johnson' is another US-based pharmaceutical company which is also taking part in this race. Right after this, 'Sino-Pharm' a Chinese based pharmaceutical company has also developed its COVID-19 vaccine. Sino-Pharm vaccine have been approved by various countries such as Pakistan, UAE, Chile, Brazil, Turkey, Hungary and many African states. Till now, Sino-pharm has also distributed millions of its vaccines globally [10]. The objective of this study is to find the compare the effectivity of COVID-19 vaccines developed by different pharmaceuticals**.**

Questions

"To find the Comparison between the effectivity of different COVID-19 Vaccines.

METHODS

In order to compare the COVID-19 vaccines, this review analyzed all articles published during 2020 to 2021 by local and foreign journals, based on the Preferred Reporting Items for Systematic Reviews (PRISMA) guideline (Figure **1**).

Search Strategy and Eligibility Criteria:

The main question of this paper was to compare the Vaccines used for COVID-19' To answer this question, different keywords '' COVID-19'', ''Vaccine'', ''Coronavirus'', "SARS-cov-1", "Pfizer", AstraZeneca", "Moderna", and Pakistan both separately and combine were searched in different electronic databases CINAHL, PubMed, HEC digital library, and eMedicine. The article's inclusion criteria were the Vaccines used for COVID-19, and full text available. Articles with copyright and lacking the full text were excluded.

Data Collection and Extraction

After data collection, the collected data reported the year of publication, city, sampling method, data collection tool, sample size. In the identification step, a total of 61 articles were found by mentioned databases. In the screening step, 51 articles after review of abstract, according to criteria and duplicates removed. In last step, seven articles were selected in the final analysis.

RESULTS

Table 1. This table compares the different COVID-19 vaccines developed by different pharmaceuticals on the basis of their peculiar properties and elicit that how they are different [26,27].

Vaccine developer	Pfizer	Moderna	AstraZeneca	Sino-Vac	Sputnik V	Johnson & Johnson
How it works?	Messenger RNA	Messenger RNA	Inactivated cold virus	Messenger RNA	Messenger RNA	Modified cold virus
When approved/expected approval	Has been approved by FDA on 11th December 2020	Has been approved by FDA on 18th December 2020	Has been approved by WHO on 15th February 2021	Has been approved by China's National Medical Products Administration since July 2020 for emergency use.	Different authorization dates for different countries	FDA approved for emergency on 27th February 2021.
Efficacy of vaccines in clinical studies?	95%	94.10%	70%	79%	92%	86%
How many shots do you need?	Two doses, 3 weeks apart	Two doses, 4 weeks apart	Two doses, a month apart	2 Doses, 3 weeks apart	Two doses, 3 weeks apart	One dose
What are the side effects?	Fatigue, headache, chills, muscle pain, especially after the second dose.	Fever, muscle aches, headaches lasting a few days. Effects worse after second dose.	Injection site pain, fever, muscle aches, headache.	Injection to pain side, rash, muscle ache, malaise, headache	Fatigue, headache, chills, muscle pain, especially after the second dose.	Fatigue, headache, myalgia, fever.
How many doses will be available?	50 million, starting Dec. 18; 1.3 billion in 2021	20 million, starting Dec. 21; 80 million for U.S. in 2021	3 billion planned for 2021	4 billion planned for 2021	1 billion planned for 2021	60 million doses for 2021
Which age group is eligible?	People aged 12 and older	People aged 18 years and older.	People aged 16 years and Older	People aged 16 years and Older	People aged 16 years and Older	People aged 18 years or older
Who is it recommended for?	Pregnant women or nursing moms who want the COVID-19 vaccine should get one, experts say. The vaccine has	There's limited data. Studies in rats who were immunized before and during pregnancy found no safety	Not yet available.	Studies reported that Pregnant women can get it.	Studies reported no any side-effects on pregnant women	It is effective for immunocompromised people.

	not yet been studied in pregnant women.	concerns. The CDC says pregnant women may choose to receive the vaccine.				
What about pregnant women and nursing moms?	People with a history of serious allergic reactions, anyone with a history of allergic reactions to vaccine ingredients inc luding polyethylene glycol, and anyone with a history of allergic reactions to polysorbate.	People with a history of serious allergic reactions, anyone with a history of allergic reactions to vaccine ingredients inc luding polyethylene glycol, and anyone with a history of allergic reactions to polysorbate.	Not yet available.	People with a history of serious allergic reactions, anyone with a history of allergic reactions to vaccine ingredients inc luding polyethylene glycol, and anyone with a history of allergic reactions to polysorbate.	Yes, they can get	Yes, they can get its dose.
Is there anyone who shouldn't get the vaccine?	50 cases of anaphylaxis in people who received the vaccine, mostly women.	21 cases of anaphylaxis in people who received the vaccine, all in women.	Four total serious side effects, including two cases of transvers e myelitis.	34 cases of anaphylaxis in people who received the vaccine, all in women.	26 cases of anaphylaxis in people who received the vaccine, all in women.	Not yet available.
Any significant side effects?	Four cases of Bell's palsy, a type of temporary facial paralysis, reported in people who received the vaccine. This is not more than would be expected in the general population.	Four cases of Bell's palsy reported in the clinical trials including 3 in the vaccine group, and 1 in the placebo group. This is not more than would be expected in the general population.	Several blood clotting cases are reported.	Not reported any severe side-effect yet.	Not reported yet.	6 cases of clotting are reported since April 2021
What about people with lowered immune function?	Ok for people whose immune function is lowered by HIV or	Ok for people whose immune function is lowered by HIV or	Not yet available.	Ok for people whose immune function is lowered by HIV or	Ok for people whose immune function is lowered by HIV or	Not yet available.

	immunosuppressing drugs if they have no other reasons to avoid it. There is limited safety data in this group.	immunosuppressing drugs if they have no other reasons to avoid it. There is limited safety data in this group.		immunosuppressing drugs if they have no other reasons to avoid it. There is limited safety data in this group.	immunosuppressing drugs if they have no other reasons to avoid it. There is limited safety data in this group.	
Safety or effectiveness data?	No data are available on the safety or effectiveness of mRNA vaccines in people with autoimmune disease. People with autoimmune conditions may still get the shots if they have no other reasons to avoid vaccination.	No data are available on the safety or effectiveness of mRNA vaccines in people with autoimmune disease. People with autoimmune conditions may still get the shots if they have no other reasons to avoid vaccination.	Not yet available.	No data are available on the safety or effectiveness of mRNA vaccines in people with autoimmune disease. People with autoimmune conditions may still get the shots if they have no other reasons to avoid vaccination.	No data are available on the safety or effectiveness of mRNA vaccines in people with autoimmune disease. People with autoimmune conditions may still get the shots if they have no other reasons to avoid vaccination.	Not yet available.
GBS cases	Not yet available.	Not yet available.	Not yet available.	Not yet available.	Not yet available.	Not yet available.

Comparison of vaccines

In this study we discussed and compared six coronavirus vaccines developed by different pharmaceuticals such as Pfizer, Moderna, AstraZeneca, Sino-pharm, Sputnik V, Johnson & Johnson. We compared vaccines on their peculiar properties such the mechanism of action or how do vaccines work, for instance; Pfizer, Moderna, Sinovac, Sputnik V work by killing the messenger RNA of coronavirus. However, AstraZeneca, Johnson & Johnson inactivate and modify the morphology of coronavirus. Then, we compared the vaccines according to their approval dates. Vaccines get approval for emergency from their respective governments or regulatory bodies such as FDA, WHO, National health authorities. After this we compared the efficiency of these vaccines, FDA approved studies concluded that Pfizer is 95% effective against coronavirus, Moderna is 94% effective, AstraZeneca is 70%, Sinovac is 79%, Sputnik V is 92% and lastly Johnson & Johnson is 66% effective against this novel coronavirus. After this we compared vaccines on their dosage such as Pfizer, Sputnik V and Sinovac need two doses of vaccines with the gap of three weeks, Moderna and AstraZeneca need two doses with the gap of a month, Johnson & Johnson need only single dose [11]. Further comparison included the side-effects caused by vaccines, results of different studies demonstrated that almost all the vaccines expressed minimal side-effects such as headache, fatigue and muscular-pain. Furthermore, vaccines were compared on their administration age eligibility, various studies suggested that all the vaccines are recommended for people who are 16 years old and older [21]. Then the vaccines compared on the basis of their safe-use for pregnant and lactating mothers, the studies showed that Pfizer, Moderna, Sinovac, Sputnik V are safe for use among these women, Johnson & Johnson have not shown any significant studies for these women [16]. While further comparing these vaccines, we compared them on the basis of any significant side-effects showed by any of these vaccines, researches showed that; In Pfizer and Moderna each Four cases of Bell's palsy, a type of temporary facial paralysis, reported in people who received the vaccine. This is not more than would be expected in the general population, While Sinovac, Sputnik V, Johnson &

Johnson, AstraZeneca didn't show any significant specific side-effect [12]. Further we compared these vaccines on a specific point that which persons should not get these vaccines, previous studies concluded that people with severe allergies are strictly prohibited to get these vaccines [13,14].

DISCUSSION

In this study, we studied several articles which were related to the problem question. Based on inclusion criteria, few studies were added for review. During data collection, we found exact studies related to comparison of COVID-19 vaccines. Different articles were collected to gather data that elicited various coronavirus vaccine's development and efficacy. A study stated that World Health Organization has listed 40 candidates for vaccine development and distribution from United States, United Kingdom, China, Russia. These vaccines are currently using at least seven different domains and approaches which involves Technology using messenger RNA and DNA. Other includes replicating viral vectors, live-attenuated virus, whole-killer virus, replication-defective viral vectors and lastly purified viral proteins [16]. Another study revealed that every country is trying its best to win this global game of coronavirus vaccination, that study stated that it's very important to follow the guidelines to ensure the global access of vaccine that involves three steps; production methods, manufacturing speed, and deployment at large scale. In this way we can ensure the safe handling of coronavirus vaccine [17]. One of the studies primarily focused on the efficiency of Pfizer, it mentioned that Pfizer is 95% effective against coronavirus than any other vaccine, the same study also observed the well-beings of humans in regard to side-effects, it was find out that it has the lowest side-effects on human life, its vaccine is very safe for pregnant and lactating mothers, those people who have previously diagnosed with HIV virus can also get this vaccination, as per the age group was concerned they overserved that people from age of sixteen and above can get this vaccination [18]. One of the studies stated that too many pharmaceuticals working on similar cause, it can put a chaos in the minds of people around the globe and this act can doubt the efficiency of big pharmaceuticals, World Health Organization must put a stop here if they think that some of the big-wigs have achieved desirable results [19].

Novel Coronavirus is the biggest pandemic of this century, the world has noticed the havocs from this virus. Right after the identification of Coronavirus, Think-tanks started work on its treatment [20,21]. Many preventive measures suggested by health professionals like, Hand & face washing, wearing masks, keep a distance, use of multivitamins, proper check on oxygen saturation values and many more. Biggest pharmaceuticals industries started their work on the Vaccine development, US-based Pfizer's joint-venture with BionTech & Moderna, Chinese-based Sinopharm, British-based AstraZeneca, Russian-based Sputnik V and many other. Initially, Anti-flu, Anti-viral, Anti-biotics were used to combat this virus, but gradually people noticed their in-effectivity [22,23]. These pharmaceuticals conducted massive experiments, successfully completed their trials and applied in FDA for emergency approval. After the approval, these vaccines started injecting into people, Millions of people so far have been vaccinated from these vaccinations with very minimal side-effects. These countries also distributed their vaccines to third world countries. Chinese-based Sinopharm has distributed their vaccines to Pakistan, Turkey, Indonesia, Brazil [24]. Pfizer has distributed their vaccines to Europe, India, Africa, Russian vaccine has also been distributed to other countries and same as with AstraZeneca [25]. Efficacy of these vaccines have successively improved human health in combating coronavirus, but still, we need to conduct further experiments to improve the quality of vaccines for Coronavirus so that human race won't see any other disaster [23]. In my study, I compared total six pharmaceutical companies that worked hard to get the corona virus; like Pfizer, Moderna, Russian Sputnik V, Sino-pharm. I mainly focused on the working principle of these vaccines, their approval duration from their respective governments, their efficacy, number of doses, any side-effects, their availability and eligibility, any impact on the pregnant/lactating women, any contraindications with HIV patients. In my analysis, I observed that most of the vaccines are safe for human use as they showed quite low side-effects. Their use has comprehensively played role in easing life, as the world noticed global lock-downs.

Current Dynamics and Future prospects of COVID-19 vaccines

While discussing the future prospects of COVID-19 vaccines, we must consider several steps that might

help us to combat this pandemic. **Diversify the types of vaccines**: It is really a need of hour. As we can see that the total global population is around 9 billion. And approximately 70% of global population do not have direct access to global health facilities. So, the diversity of vaccines will increase the quantity and quality of vaccines which will be accessible to most of people. **Considering adjuvants and boosters**: some vaccines develop strong immunity but its effect lasts only for few months such as influenza virus vaccines. It was a need of hour to inoculate people with COVID-19 booster shots to get more promising results. Continue the study of immune responses: It is very important for us to understand the phenomena of immune responses as it plays a vital role in drug-body interactions. **Improve nexus between vaccine developers and regulators:** it is also a fundamental step that needs a dire consideration. Vaccine developers must be in contact with health regulatory authorities so that they can guide each other effectively to improve the quality of life among people. [28]. **Improve research in infectious diseases:** It is another prominent factor which might help us to prevent from another pandemic of this kind. Governments must issue massive funds to start work on researches which includes infectious diseases, disease outbreaks, containment of diseases, prevention of diseases. **Offer education and awareness**: People must get basic education about self-cleanliness, so that they might get able to better their health status in order to prevent the diseases which are being by dirty health standards such as Cholera, dysentery etc. **Eliminate vaccine politics:** COVID-19 vaccine race manifested that it is more like a political issue than health issue. Each country is considering its own vaccine to be more effective than developed by other countries. It needs a serious concerns and urgent legislation by the World Health Organization. In the time of pandemic, it is responsibility of every state to serve humanity [28,25].

CONCLUSION

This short review study concluded that multiple pharmaceuticals working impressively to develop the vaccine of coronavirus, some of them worked tremendously and achieved very desirable results which are helping humans to sustain their normal life.

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