



BRIDGE/HSS 2021: COVID-19 Vaccines

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Abstract

- ① Since the inception of the pandemic, there have been 25 million cases of COVID-19 and over 602,000 deaths. Throughout the pandemic, there have been many myths and speculations of different drugs and practices that can help cure the virus, but it was only in late 2020 that the first confirmed vaccine was developed.
- ② Currently, the Pfizer, the Moderna, and the Johnson and Johnson vaccines are being distributed across the country.
- ③ We researched the information about 3 vaccines that have been approved by the FDA.

Introduction

The Global Thrombosis Forum (GTF) is a non-profit organization that spreads awareness about the dangers of thrombosis, and informs the people about a variety of other medical conditions leading to thrombotic events.

Since 2020, when COVID-19 infected the U.S. population, we have seen 25 million infections and have lost countless precious lives.

Since there was no cure for COVID-19, the medical professionals and scientists worked together very quickly and came out with an inoculant to the disease. We will discuss the information about 3 vaccines that have

Brief History of COVID-19

- COVID-19 is a deadly virus that was first seen active on December 31, 2019.
- On March 11, 2020, the COVID-19 pandemic was declared.
- Since then, scientists have been attempting to find a cure and a vaccine to this illness.
- As of today, there have been around 602,000 deaths in the United States due to COVID-19.
- Medical professionals have created a prototype of a vaccine for this virus that can potentially be useful in slowing down COVID-19's spread.

Challenges to Humankind

There are several challenges to COVID-19:

1. The COVID-19 virus is completely unknown to us
2. There was no vaccine, since COVID-19 caught the world completely off guard
3. Since no one knew about COVID-19, there was no known treatment available
4. COVID-19 has caused numerous hospitalizations, and in some places, filled almost 100 % of the hospital capacity
5. As the condition progressed, the health professionals discovered several complications of COVID-19 that affected almost every major organ of the body

The Process of the Generation of a Vaccine

- ① To the scientist and health care professionals, the only known technique to prevent COVID-19 was to use a vaccine.
- ② Vaccines have been used very successfully in the past against chicken pox, smallpox, whooping cough, and other viral and bacterial conditions.
- ③ Several companies took upon them the challenge to create vaccines against COVID-19: Astra-Zeneca, Covaxin (India), Johnson & Johnson, Moderna, Pfizer and Sputnik (Russia)

What is a Vaccine?

- ① When injected, it acts like an antigen.
- ① The antigen (vaccine) stimulates the production of antibodies and provides immunity against the virus/bacteria.
- ① Prepared from the causative agent of a disease, its products, or a synthetic substitute, it is treated to act as an antigen without inducing the disease.

Generation of Moderna Vaccine

Methods:

- ① A phase 1, dose-escalation, open-label trial including 45 healthy adults (N=15 in each dose group), 18 to 55 years of age, received 2 vaccinations, 28 days apart, with mRNA-1273 in a dose of 25 μ g, 100 μ g, or 250 μ g.

Trial procedures:

- ① The vaccine was administered as a 0.5 ml injection in the deltoid molecule on days 1 and 29
- ① Follow-up visits were scheduled for 7 to 14 days after each vaccination and on days 57, 119, 209, and 394.

Generation of Moderna Vaccine, (contd.)

- ① The doses of the vaccine were escalated by enrolling four participants in the 25 μg group.
- ① If no halting rules were met after all participants in those groups completed day 8, the dose was increased until the participants received the 250 μg dose.

Generation of Moderna Vaccine, (contd.)

Results:

- ① After the first vaccination, the antibody titers were higher with the higher dose.
- ① After the second vaccination, antibody titers increased.
- ① Adverse events that occurred in more than half of the subjects included fatigue, chills, headache, myalgia, and pain at the site of injection.
- ① Systemic adverse effects were more common after the second vaccination, particularly the higher dose, and three participants in the 250 µg dose group reported one or more severe adverse events.

Ingredients of the Moderna Vaccine

- ① mRNA: Much like the Pfizer Biotech Vaccine, it is an active ingredient that helps generate an immune response.
- ① The Pfizer and Moderna vaccines are similar, and both are found to be safe and efficacious in preventing symptomatic COVID 19 in clinical trials.

Conclusions for Moderna Vaccine

- ① The mRNA-1237 vaccine included anti-SARS-CoV-2 immune responses in all participants and no trial limiting safety concerns were identified. These findings support the further development of this vaccine.

Generation of the Pfizer-BioTech Vaccine

- Between May 4, 2020 and May 19, 2020, 76 participants were screened and 45 participants were randomly selected and vaccinated.
- Per dose level (10 μ g and 30 μ g), 12 participants were vaccinated on days 1 and 12, 12 participants received a 100 μ g dose, and on day 1 and 9 participants received a placebo.
- The population of this study had healthy males and females with a mean age of 35.4 years (range, 19-54 years), 51.1% were male and 48.9% were female.

Ingredients of the Pfizer BioNtech Vaccine

- ① mRNA: mRNA is the only active ingredient in this vaccine.
- ① The mRNA molecules contain the genetic material for the body to produce a viral protein that triggers the immune response. Once the viral protein is made and in the cell, the mRNA is completely broken down.

Ingredients of the Johnson and Johnson Vaccine and other vaccines

- ① Viral Vector: Unlike the Pfizer or the Moderna vaccine, the Johnson and Johnson vaccine is a viral vector vaccine, which is a modified version of a virus that is injected so that the cells can produce the according antibodies.
- ① Like the other two vaccines, the Johnson and Johnson vaccine only contains one active ingredient which is the viral vector.
- ① The ingredients of Astra-Zeneca, Covaxin, and Sputnik vaccine have not been mentioned because they have not been approved by the U.S. FDA.

How Do Vaccines Work?

- ① Vaccination is a simple, safe, and effective way of protecting people against harmful diseases, before they come into contact with them. It uses your body's natural defenses to build resistance to specific infections and makes your immune system stronger.
- ① Vaccines train your immune system to create antibodies, just as it does when it's exposed to a disease. However, because vaccines contain only killed or weakened forms of germs like viruses or bacteria, they do not cause the disease or put you at risk of its complications.
- ① Most vaccines are given by an injection, but some are given orally (by mouth) or sprayed into the nose.
- ① Vaccines do NOT induce COVID-19

How the mRNA Vaccine Works

- ① Both these vaccines work by utilizing a novel messenger(mRNA) mechanism.
- ① In both of these vaccines, the mRNA carries instructions to create the SARS-CoV-2 “spike” protein.
- ① After injection, mRNA is taken up by the macrophages and instructs the cells to start producing the spike protein.
- ① The spike protein appears on the surface of the macrophages and induces an immune response that mimics the way that we fight off infections and protects us from natural infections. Enzymes in the body degrade and dispose of the mRNA. No live virus is involved, and no genetic material enters the nucleus.

The Onset Development of Antibodies

- ① The first time a person is infected with the virus that causes COVID-19, it can take several days or weeks for their body to make and use all the germ-fighting tools needed to get over the infection.
- ② After the infection, the person's immune system remembers what it learned about how to protect the body against that disease.
- ③ About twelve hours to 10 days later after your cells use the mRNA to develop the spike protein, immune messenger cells called dendritic cells come into play. Dendritic cells are patrolling and will come into contact with the antigen that they haven't seen before, raise the alarm, travel to a lymph node, find the right T and B cells, and activate them.

The Onset Development of Antibodies (contd.)

- ① The body keeps a few T-lymphocytes, called memory cells, that go into action quickly if the body encounters the same virus again. When the familiar antigens are detected, B-lymphocytes produce antibodies to attack them.
- ① Different types of vaccines work in different ways to offer protection, but with all types of vaccines, the body is left with a supply of “memory” T-lymphocytes as well as B-lymphocytes that will remember how to fight that virus in the future. It typically takes a few weeks for the body to produce T-lymphocytes and B-lymphocytes after vaccination.

The Duration of Protection Provided by Antibodies

- ① The early-stage research shows that the vaccines show good results of protection for at least 6 months (CDC has, however, not given any guidelines beyond 6 months).
- ① After receiving the first dose, the patient should receive a second dose of the vaccine after 3-4 weeks.

Should There Be a Booster Dose of the Vaccine?

- ① There is no current specific recommendation for booster doses given in the absence of information on how long the vaccines will be protective.

Short-Term Side Effects

These include:

- ① Pain, erythema (reddening of skin), warmth and pruritus (itching of skin) at the site of insertion, fatigue, headaches, and fever (not as very common).
- ① Allergic reactions including anaphylaxis to the vaccine are known to be uncommon, and the side effects of fatigue and headaches are mainly seen in the younger patients who received the vaccine.

Long-Term Side Effects

- ⦿ Since this vaccine was recently made open to the public, professionals have not been able to observe long-term side effects, and are currently acquiring the data that would help determine these long-term outcomes.

Johnson and Johnson Vaccine

- ① Six cases of Cerebral Venous Sinus Thrombosis (CVST), associated with thrombocytopenia occurred among women aged 18–48 years, with one death. This condition has been labeled as Vaccine Induced Thrombotic Thrombocytopenia (VITT)
- ① The interval from vaccine receipt to symptom onset ranged from 6-13 days
- ① The CDC's Advisory Committee on Immunization Practices (ACIP) and FDA have reintroduced the vaccine after a careful review of the data.

Johnson and Johnson Vaccine (contd.)

- People receiving the Johnson and Johnson COVID-19 vaccine could be at increased risk for developing Guillain-Barré syndrome.
- More than 100 cases of Guillain-Barré have been reported. Men and people older than 50 appear to be at the highest risk, most cases occur about 2 weeks following immunization.
- Guillain-Barré syndrome often causes muscle weakness and sometimes temporary paralysis. Most people who develop the rare syndrome recover.
- The mRNA vaccines from Pfizer/BioNTech and Moderna have not been reported to produce this adverse effect.

Johnson and Johnson Vaccine (contd.)

- ① Studies conducted among the patients diagnosed with immune thrombotic thrombocytopenia after the Astra-Zeneca COVID-19 vaccine in Europe show that the pathogenesis of these rare and unusual adverse events after vaccination may be associated with platelet-activating antibodies against platelet factor-4 (PF4)
- ① The use of heparin may be harmful in these cases, and alternative treatments need to be given

How to Treat Side Effects

- ① Although side effects may affect your ability to do daily activities, most should go away on their own after a few days.
- ① If you have pain or discomfort, an over-the-counter pain reliever such as a nonsteroidal anti-inflammatory drug (ibuprofen or naproxen) or acetaminophen can help you feel better.
- ① If a fever after the vaccine is making you uncomfortable, taking acetaminophen or a nonsteroidal anti-inflammatory should bring it right down.

How to Treat Side Effects (contd.)

- ① The CDC advises against the use of pain relievers before vaccination “for the purpose of preventing post-vaccination symptoms,” so wait until after you are experiencing side effects to take any medication.
- ① For a rash, itchiness or redness that appears 5 to 10 days after vaccination, it is beneficial to treat it with over-the-counter antihistamines such as diphenhydramine (Benadryl) or a topical steroid such as hydrocortisone.
- ① Another side effect that may last more than a few days is a swollen lymph node, which may feel like a lump under your armpit or over your collarbone. The swelling is not harmful, although it can last a few weeks. Eventually, it should go away on its own.

Some Heroic, Non-Scientific, and Absurd Approaches

With the advent of the term “fake news”, absurd hypotheses have been made to “cure covid”. These “cures” if tried, would often have negative results, and in turn, harm individuals. False news and scientific proof may lead individuals to believe that certain substances will cure covid 19.

1. In Iran, a rumor arose that alcohol would cure the coronavirus. News reports suggest that 44 have died and hundreds have been hospitalized because of this approach.
2. The alternate medical community has also produced some false claims on curing COVID-19. Not only is there no evidence, but these claims are also not scientifically plausible.
3. Naturopaths have recommended supplements to prevent and hopefully treat the virus.

Some Heroic, Non-Scientific, and Absurd Approaches (contd.)

4. The irrational use of hydroxychloroquine has been suggested by some.
5. Homeopaths have claimed that they have found a cure.
6. Acupuncturists assert that they can assist in the fight against COVID-19 through acupuncture techniques. They claim that acupuncture fortifies the lungs and the kidneys by balancing certain organ systems.
7. Chiropractors claim that certain spinal adjustments will help boost the immune system function by 200 percent.

These claims should not be trusted and can not be accurately and scientifically backed up. The presence of these claims adds to the disinformation surrounding COVID-19

Vaccines for Children

- ① The FDA has approved Moderna and Pfizer vaccines for use in children 12 and above.

Should COVID-19 Patients Receive the Vaccine?

- ① If a patient has suffered from COVID-19, it is perfectly safe for him or her to get the vaccine.

FDA Approved Vaccine Comparisons

- ⦿ *Currently, there is a 4th vaccine created by AstraZeneca but it is not approved by the FDA and has been banned from several countries in Europe because of its development of blood clots.

	Efficacy	Dosage Size	Storage Temperature
Johnson and Johnson	67%	Single dose	Between 47-77°F
Moderna	94%	2 doses, 4 weeks apart	Subzero
Pfizer	96%	2 doses, 3 weeks apart	Subzero

Conclusion

- Overall, the virus is still in a very early stage but vaccines that have proven to be temporarily effective are being distributed.
- Research is still being conducted to prove the exact effectiveness and the efficacy of the vaccines.
- Since the induction of the pandemic, there have been 25 million cases of COVID-19 and over 602,000 deaths. Throughout the pandemic, there have been many myths and speculations of different drugs and practices that can help cure the virus, but it was only in late 2020 that the first confirmed vaccine was developed.
- Currently, the Pfizer, the Moderna, and the Johnson and Johnson vaccines are being distributed across the country.

Future Directions

- In the future, we plan to study the phenomenon VITT (Vaccine-Induced Thrombotic Thrombocytopenia) caused by the J&J and Astra-Zeneca vaccines.

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References

1. <https://www.medscape.com/answers/2500114-197402/how-did-the-coronavirus-outbreak-start#:~:text=It%20was%20initially%20reported%20to,a%20global%20health%20emergency.>
2. <https://www.nejm.org/covid-vaccine/faq#Clinicians>
3. [https://www.idsociety.org/covid-19-real-time-learning-network/therapeutics-and-interventions/remdesivir/#:~:text=to%20this%20subject.-,Overview,%3B%20Brown%2C%20September%202019\).](https://www.idsociety.org/covid-19-real-time-learning-network/therapeutics-and-interventions/remdesivir/#:~:text=to%20this%20subject.-,Overview,%3B%20Brown%2C%20September%202019).)
4. <https://www.ualberta.ca/folio/2020/03/commentary--misinformation-alternative-medicine-and-the-coronavirus.html>
5. <https://www.hackensackmeridianhealth.org/HealthU/2021/01/11/a-simple-breakdown-of-the-ingredients-in-the-covid-vaccines/>
6. <https://www.aarp.org/health/conditions-treatments/info-2020/coronavirus-vaccine-side-effects.html>
<https://healthblog.uofmhealth.org/wellness-prevention/what-happens-after-you-get-covid-19-vaccine>
7. <https://www.cdc.gov/coronavirus/2019-ncov/vaccines/different-vaccines/how-they-work.html>
8. <https://sputnikvaccine.com/about-vaccine/>