

Warm Covid Vaccine

Krish Rao¹, and Rajagopal Appavu[#]

¹Unami Middle School, PA, USA

[#]Advisor

ABSTRACT

Throughout the past few years, Sars-CoV-2, also known as Covid-19 has gone rampant around the globe. Millions of people get infected every day and thousands of people succumb to this virus. For this, scientists have created vaccines to solve this issue and to make sure that people who take the vaccine can build up the anti-bodies to protect themselves from Covid-19. The problem is this vaccine is not very accessible. This is because of the storage requirements that must be met for this vaccine to be effective. The demanding ultra-cold temperature makes it extremely hard to disperse the vaccine throughout the community. This makes it almost impossible in area which are less fortunate and do not have the money to support the storage needed for the vaccine. So, that is why a warm vaccine is necessary to make sure that people who are in rural and less fortunate areas, still can protect themselves from the virus. Researchers and scientists all over the world are working to solve this issue and make sure an effective warm Covid-19 vaccine can be created.

Introduction

To this date, there have been over 326 million cases and 5.54 million deaths worldwide caused by the Covid-19 virus. All around the world, Covid-19 has devastated countries and families. But there is a vaccine to help prevent this. The problem is the vaccine for this virus must be stored in very cold temperatures. Some countries, which are not technologically developed, might not have the means to store this vaccine. That is why a warm vaccine needs to be mass-produced and must be as effective as the current vaccine which is stored in cold temperatures. First, the cold vaccine needs to be addressed and why the vaccine needs to be stored in cold temperatures. The current covid-19 vaccine needs to be stored in temperatures as low as -100 degrees Fahrenheit for vaccines such as the Pfizer vaccine. This is quite a low temperature, and some countries do not have the facilities to store the vaccine; therefore, the vaccine cannot be distributed in those countries/areas. The reason the current vaccine must be stored in such low temperatures is mainly because of the mRNA used in the vaccines. Because mRNA is so fragile, it must be stored in cold temperatures because it can get broken down quite rapidly and very easily. As it is, widespread distribution is quite hard to do. The vaccine needs to be stored in special freezers, but these freezers are not common. They are not ones that people can find in local pharmacies and doctor offices; they are not even found in some hospitals or clinics. So, let us see how, exactly, they are stored. The vaccine needs the following: ultra-cold freezer, thermal shipping container, freezer, or refrigerator. The vaccine must arrive at a distributing center at quite a cold temperature. It should arrive at an ultra-cold temperature between -90 degrees Celsius to -60 degrees Celsius with dry ice. Right now, in the US, the Pfizer Vaccine and the Moderna vaccines lead in vaccination rates. According to the CDC, providers consider using thermal shipping containers for temporary storage only. Providers must make sure they avoid light and not use dry ice for permanent/long-term storage, but only use dry ice for short-term/temporary storage.

What is mRNA and why does the vaccine need to be in ultra-cold temperatures?

As I said before, the vaccine for the Covid-19 virus needs to be stored in cold temporaries because of the mRNA. But what exactly is mRNA? Messenger RNA (mRNA) infused vaccines are there to teach our cells to produce contain proteins that will trigger an immune response to hopefully rid the virus inside of our bodies. Vaccines in general put a weakened/inactivated germ into our system. This teaches our cells to make a protein or even a piece of a protein to trigger an immune response in our system. This is so that when the real virus enters our bodies, we can be able to produce antibodies to fight the virus; the vaccines prevent us from getting infected with the real virus. The benefits of mRNA vaccines are that people do not risk the potential risks of getting sick, unlike other vaccines. The Covid-19 mRNA vaccines should be used for both the doses and the booster dose if needed. The Covid-19 vaccine is given in the upper arm muscle, where most of the vaccines are given. The mRNA then will enter the muscle cells and then instruct the cells to produce a harmless piece of a protein which is called spike protein. This protein is found on the surface of the Covid-19 virus. After this spike protein is created, then our cells will break down the mRNA and then remove it. In the end, our bodies will be able to protect and prevent future diseases and viruses that cause Covid-19.

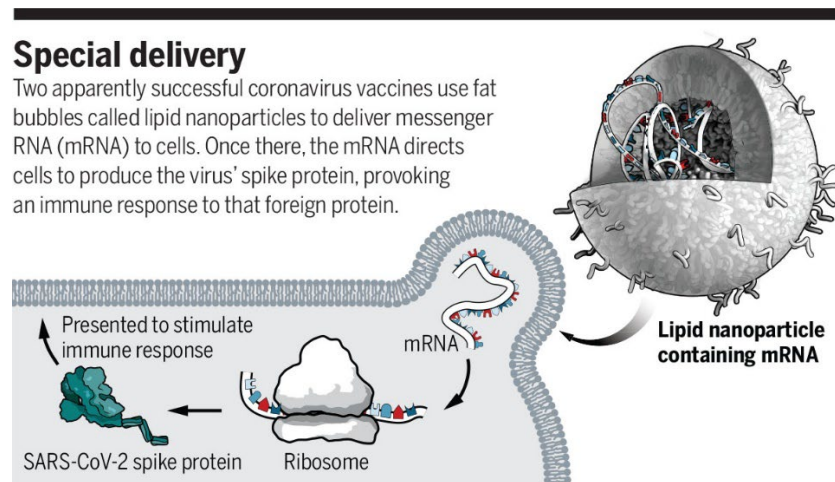


Figure 1- The Figure above details the function of mRNA, which is to allow ribosomes to create the required COVID-19 proteins through translation, which could then be used to create an immune response (Kaiser, 2020).

What else is there to know about the effects of the vaccine?

According to the CDC, this vaccine is supposed to be harmless with minimal to almost no risk, but some people report having experienced some temporary discomfort after a dose of the mRNA vaccines, but this is a natural response and shows that the vaccine is working and is effective. People hear things like the vaccine will give them the virus and that they will get extremely sick if they take the vaccine. Some others even speak of absurd side-effects, but these are false. There will always be a chance of negative side effects, but these vaccines are tested hundreds and thousands of times to make sure they are safe for the public to use and distribute.

Can a warm Covid-19 vaccine be created, and if it can, who are some of the people researching about it?

A group of scientists in India was working on a warm covid vaccine since in rural areas there are not the resources to store the cold stored covid vaccine; these vaccines can be stored at elevated temperatures at 100 degrees Celsius for 90 minutes (1 and a half hours). It can also be stored at 37 degrees Celsius for more than a month or even a bit longer. The vaccine was also effective. There was not a compromise to make it more transportable. It was said in their

experiment that it was able to combat multiple strands and variants of the covid-19 virus. The main reason for creating a warm covid vaccine is for easier transportation and for countries without the necessary resources, to be able to provide their citizens with the vaccine. Scientists have also learned that the mRNA of the Covid-19 vaccine is weaker than other viruses. This makes the vaccine much harder to transport effectively because it must be stored in even lower temperatures than other vaccines. There was a study and research done on this warm vaccine topic. In this article, they said that they had developed a lipid nanoparticle- encapsulates mRNA which encoded the receptor-binding domain (RDB) as a Covid-19 vaccine candidate. This gives the mRNA some protection during the production of the vaccine and the storage by inserting the vaccine into a carrier. The lipid also shields the mRNA from the blood which is full of enzymes. The lipid nanoparticle is built to slowly degrade over some time so that it will not affect the liver and cause harm. This was around when they were developing the first covid vaccine. These people here were working on a warm stored covid vaccine, but this was never released. It is clearly shown that people are desperately trying to create vaccines that are both easier to store and distribute. But these are not the only issues. Price is also quite a big problem.

Vaccines are not necessarily cheap. The scientific research and process of making that vaccine is highly costly and takes a lot of time and effort. Another major thing that recently happened was that the covid vaccines now can be stored in lower temperatures. Another thing to consider is the price of the freezers needed to store the vaccines. Since the vaccines need to be stored at such low temperatures a normal freezer is not enough to do the job. Not even a very cold freezer is enough. For the covid vaccine storage, a special type of freezer is needed... As mentioned before, the leading vaccines in the U.S. at this moment, are the Pfizer and Moderna vaccines.

It was recently revealed in a study that the Moderna vaccine may have a slight edge over the Pfizer vaccine in terms of storage. The study showed that the Moderna vaccine can now be stored at lower temperatures than before. The Moderna vaccine can now be stored at -20 degrees Celsius while the Pfizer vaccine must be stored at colder temperatures. The scientists who made the Pfizer vaccine are currently trying to figure out a way to make the storage temperature to be a bit warmer, but they have not had success yet. For some reason, some of the scientists who worked on the Pfizer covid vaccine have also now said that the temperature requirements are unclear. They have done a few tests where the vaccine was still effective in higher temperatures and some which were not as effective if it was stored in ultra-cold climates. Whatever it is, this process can take a lot of time. (“Tab Hound Add-in - The Fastest Way to Find ... - Excel Campus”) There was one more study saying that the vaccine could even be stored at temperatures as low as freezer temperatures. This though, is without the certainty that effectiveness will be maintained. The reason that all this storage hassle is because of the mRNA in the vaccine. Different vaccines have different requirements for temperatures for storage/transport. The covid vaccine, mRNA vaccines that have lipids wrapped around the genetic material which encodes the proteins (for antibodies) will degrade at room temperature. So, it cannot be stored at cool temperatures. But what if there was a way to create a covid vaccine without the mRNA. That is the biggest reason the vaccine needs to be stored in cold temperatures. So, without it, the vaccine could be stored in warm temperatures. But that is easier said than done. The mRNA is there because that creates the demand for the cells to create the proteins and antibodies for the virus. So, without it, that is not possible.

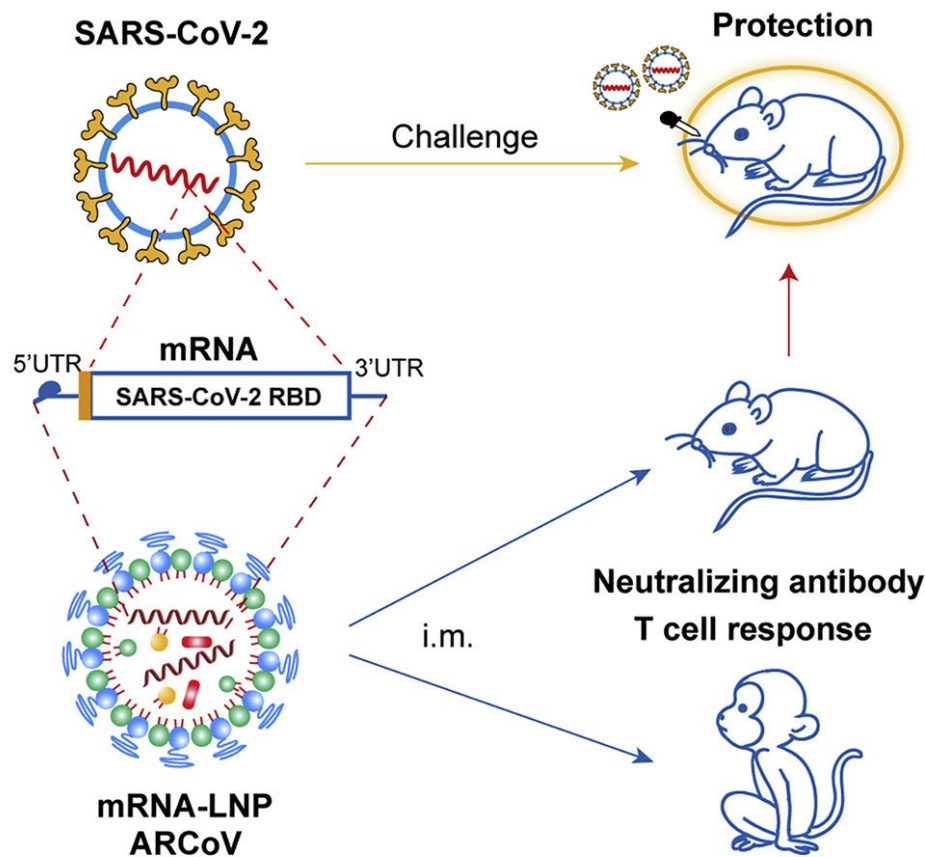


Figure 2- This image shows the pattern of antibody production from a stimulus, in this case the mRNA virus, SARS-CoV-2 virus (Zhang et al., 2020).

There must be a replacement for the mRNA in the vaccines so that warm storage can be possible. This could lead to a worldwide vaccination rates increase. This could early put an end to the pandemic. There is a group in India who, this year, have found a mass-producing solution to this whole dilemma. In India, this pandemic has gone on an absolute rampage. There was a sudden outburst, the most cases a world had seen in one day. The warm covid vaccine study was led by researcher and professor Raghavan Varadarajan. He says that they have made substantial progress and are even almost finished mass-producing this vaccine (Kumar, 2020). As I explained before, this is the vaccine is an mRNA vaccine. The reason it be stored in ultra-cold temperatures is because of this. To have the vaccine be able to withstand warm climates at an exaggerated period, there needs to be a substitution for the mRNA in the vaccine. So, these researchers have decided to make a DNA vaccine. The vaccine is quite impressive; it is an outstanding achievement. But how exactly does it work, and it is a compromise in terms of immunity to the virus?

This vaccine, as stated before, uses DNA. In India, there are group of scientists who have created a vaccine which does not use mRNA but uses circular strands of DNA to “prime the immune system against the virus, Sars-Cov-2” (Kumar, 2020). India has approved the vaccine and it will begin its distribution soon. This is one, if not the first, DNA vaccine which will be mass produced. This could influence many other DNA vaccines to come to market. There is one downside though...it is not as effective as other vaccines. According to the data they collected, the vaccine is found to be 67 percent protective against the virus, which is still quite respectable number of success rate, but it is not as good compared to many of the other vaccines (Kumar, 2020). The scientists need to focus on making the vaccine more successful to be able to mass produce it and to have it be effective at the same time as well.

Nonetheless, this is still better than no vaccine because there was not any ultra-cold storage to store the vaccine. Around the globe, there are currently a dozen companies trialing this DNA vaccine, but none of them have gotten the success rate up to the success rate of vaccines like the Pfizer or Moderna vaccine. Also, according to their data, the RNA vaccines that they tested were quicker to show signs of a strong immune response (Kumar, 2020). The thing is DNA vaccines have quite a few more benefits than these other vaccines because they are both easier to make and easier to distribute. So, that means that if scientists can get it completely correct, or at least close to the effectiveness of other vaccines, then the vaccine distribution will be much eased. People will be able to get the vaccine in rural areas and impoverished areas who do not have the resources to store the mRNA vaccines. Time is of the essence because a quick end to this dreadful pandemic is something this world needs. There was also one more successful research done.

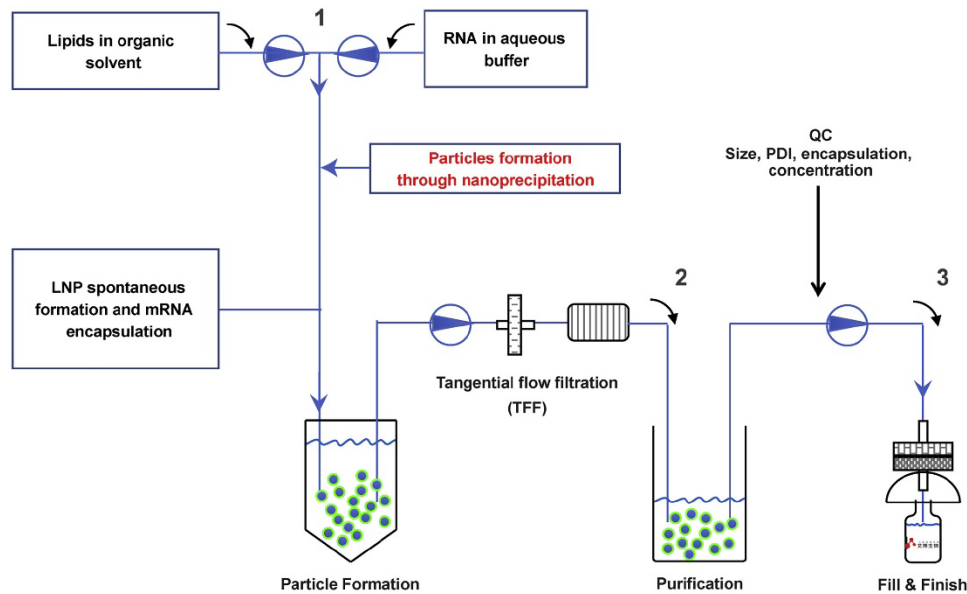


Figure 3- This process is the process in which tangential flow filtration is used to remove ethanol and to try to concentrate the solution. It is also said, “Following the Quality Control (QC) procedure, the final product was filtered into sterilized glass syringes or glass vials” (Zhang et. al., 2020).

What other solutions are scientists producing?

Another startup company in India, called Mynvax, managed to “synthesize a fragment/sequence of the S-Protein that is found on the surface of the SARS-Cov-2, and found it to be thermo-tolerant” (*Study Shows New “warm Vaccine” Effective against All Key Virus Variants*, 2021). This means that they did, indeed, find a way to substitute the mRNA in the vaccine. This now makes it thermo-tolerant and can stay in warmer temperatures. They had found that when the vaccine is freeze dried, it is highly stable. The vaccine could be stored at temperatures as high as 37 degrees Celsius for more than a month and it can withstand temperatures for a brief period at almost 100 degrees Celsius. This is insanely successful, especially since the Pfizer vaccine must be kept in temperatures lower than 50 degrees Celsius. This suggest that the cold- chain, which is the chain of transporting the vaccine while keeping it at ultra-low temperatures, should not have to be required. Right now, they have been quite successful in testing animals. They have not gone to human testing quite yet because they do want to make sure there are no ill effects. They also said, “Neutralizing antibodies, the clearest known correlate of protection against SARS-Cov-2, are primarily directed against RBD of the viral spike protein...” (*Study Shows New “warm Vaccine” Effective against All Key Virus Variants*, 2021). They will further test this vaccine to see is it could be tried as a vaccine candidate, which now they know that there is a thermo-tolerant RBD because it is able to generate antibodies to combat and block RBDD. For testing on animals, they used guinea pigs when they first started immunizations. The researchers made sure to use a generic version of MF59, a co-

injection of vaccine cells or molecules which stimulates the immune system and make the immune system response. The MF59 has a good safety record in humans as well. They then injected the RBD formulation into the guinea pigs. To their surprise, after two does, it showed that there were significant levels of RDB-blocking antibodies in the guinea pigs. They then started to test if they can use the formulation to protect the animals from the virus; they will be taking toxicity reading checks and conducting safety assessments before they start to test on humans. They want to make sure the vaccine is perfect before they start human clinical trials. It is not just this group, but many groups are also working tirelessly and endlessly on these warm vaccines. This would make such a dramatic difference because of the amount of people who could now take the vaccine.

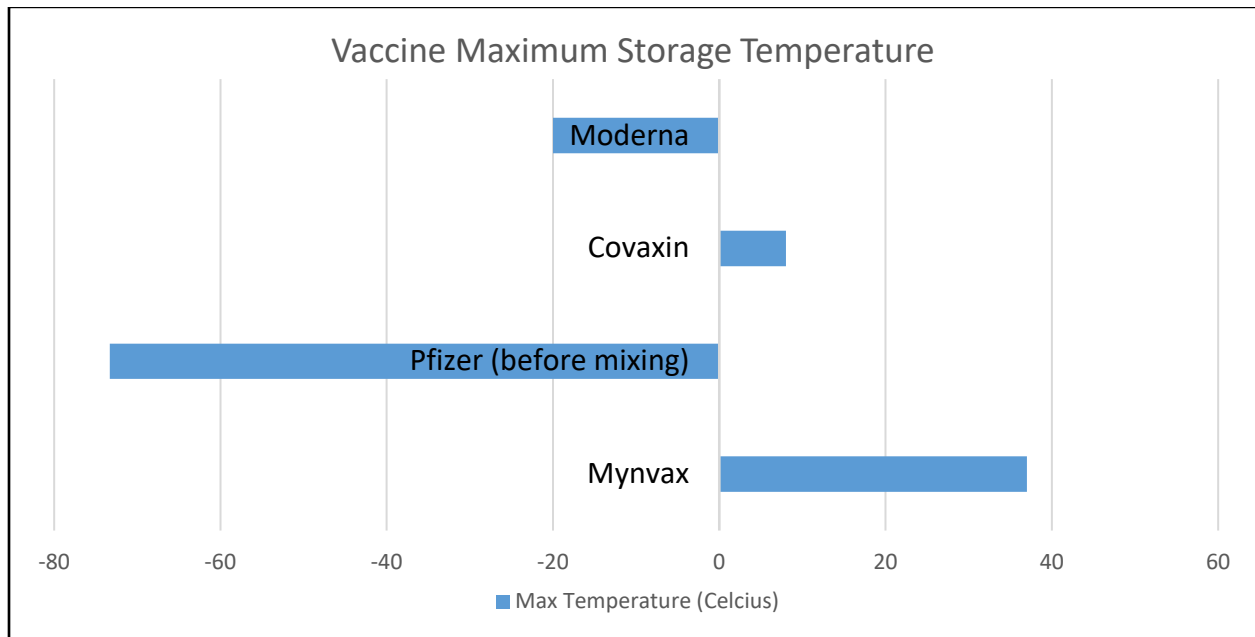


Figure 4- This graph is about the different maximum storage temperatures. There are four vaccine companies, and their max temperature varies quite a bit. The DNA and protein-based vaccines are better at storing the vaccines at higher temperatures. Mynvax, out of all the various companies out there, seems to have the highest temperature tolerance. This is a graphical representation was created by Krish R. Below is a table to show accurate temperature measurements of the vaccines.

Vaccine Company	Maximum Temperature	Type of Vaccine
Moderna (unpunctured vial)	-20°C	mRNA vaccine
Pfizer (before mixing)	-73.3°C	mRNA vaccine
Covaxin (Bharat Biotech)	8°C	Inactivated virus
Mynvax	37°C	Protein-based

Figure 5- This table is an accurate representation of the information of the graphical representation above. This shows the accurate temperatures of the vaccines. This table was created by Krish R.

As seen throughout this article, a warm vaccine is quite essential to the world. Especially areas without resources and facilities to store an ultra-cold vaccine. Many scientists are currently trials and attempting to mass produce a vaccine, which can be stored in hot temperatures, and for it to be put on the market for people to use. The main problem so far is the effectiveness of the vaccine. Right now, the warm vaccines are not as effective as the cold stored vaccines. That is mainly because they must use different substitutes instead of the mRNA. The vaccines must be stored

in the cold because of this mRNA, so people have produced different solutions. They have produced ideas like using pieces or fragments of the spike protein which is found on the outside of the Covid-19 virus. They will then use this fragment and implement it into their vaccine as a main component to hopefully make a successful and effective vaccine. Human testing had begun for a few of the companies working on these vaccines. But, again, time is of the essence. Every day that is assessed, increased people get sick. But that main reason for this mRNA vaccine is so that it is easier to maintain, easier to transport, easier to make, and even costs less. The cold chain would not be needed, and the expensive special freezers also would not be needed. Vaccination rates will hopefully increase, and there will be less covid cases and deaths.

Conclusion

In this article, two different types of vaccines that were ongoing and are being tested can be stored in warm temperatures. One is of the vaccine using the spike protein which is found on the outside of the covid cell; the other was a vaccine that uses DNA. Overall, the DNA vaccine is better. This is because it is both easier to make and easier to store and distribute. Although the success is not where it should be, in the future, it can be quite an effective vaccine and solve the problem of the storage of the covid vaccine. Another reason it is better is that, if studied further, this type of vaccine can be used to create several other vaccines. Other vaccines, which also might face the same problem with storage, could now be solved with this DNA vaccine. The other vaccine seems like a promising idea, and it also is further along with its testing, but other than the covid-19 virus, it does not really help or apply to other viruses. The DNA can be altered to fight off different viruses other than Covid-19. In the world, there are many other types of vaccines being produced and studied, but the Covid-19 virus vaccine is something that everyone needs to focus on and study. New types of vaccines can be created. The thing scientists cannot predict though is different variants and how to adapt the vaccines to them. Right now, the Omicron variant has gone completely rampant and has affected many. So, there needs to be a vaccine that can be widespread and be able to be effective. Finally, it should be able to withstand warmer climates. In all, a warm Covid-19 vaccine would be beneficial in every way to hopefully end this ongoing pandemic.

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