

Jordan Whalen

Alabama A&M University

The Future of Cancer Treatment: Exploring mRNA Vaccines For Cancer Treatment

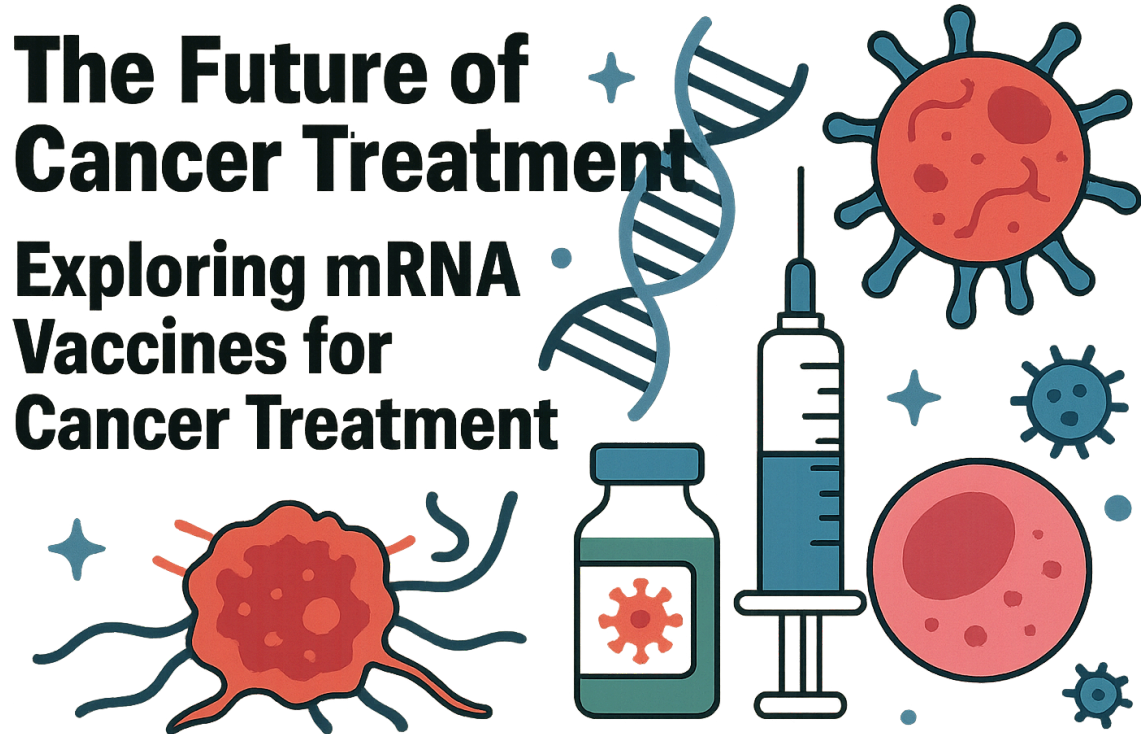


Table Of Contents

Abstract : 3

Background : 4-5

Hypothesis/ Research Question: 5-6

Literature Review/ Discussion6-7

Conclusion 7

Works Cited 8-9

Abstract

Most everyone has heard of mRNA technology due to COVID-19, but did you know scientists are testing the possibility of using mRNA vaccines for cancer treatment? Using mRNA vaccines is revolutionary and could change the game on how we treat cancer in the future. This could even be used in synergy with chemotherapy to lower negative symptoms from chemotherapy and even have higher success rates. You may be asking how could a mRNA vaccine be used to treat cancer, well they work by getting the patient's body to recognize cancer cells as foreign or as an enemy this allows for your body to attack the cancer cells on its own with the immune system. Although this treatment method is still in the beginning phase there's a lot of potential in seeing this treatment in the future. This paper will cover how the mRNA vaccine mechanism works, the effectiveness of the treatment reported in research, and its potential uses in the future.

Background

Just about everyone has experienced knowing someone who has been diagnosed with cancer which is why this is a breakthrough treatment everyone should be excited about. In 2018 WHO (The World Health Organization) released reports showing cancer as being the second leading cause of death worldwide, and that 1 in 6 people die worldwide which is a shockingly high statistic. This statistic shows how important it is to figure this cancer epidemic out and find a treatment that puts an end to the damage cancer has caused to everyone's life whether that be through directly affecting you or affecting someone you know and love.

This mRNA technology may seem new because it didn't get popularized until COVID-19 but in all reality, it has been being researched since the 1970s (Beyrer, 2021). The first mRNA vaccine was tested as far back as the year 1990 when the scientist tested a mRNA flu vaccine on mice (Beyrer, 2021). However, the researchers quickly learned this technology would have its pullbacks such as the mRNA being unstable and being degraded by the body quickly before it could enter cells and deliver its message (Beyrer, 2021). Researchers solved this challenge by using advanced nanotech that allowed the mRNA to enter the cell by using lipid nanoparticles that covered the mRNA in a shield (Beyrer, 2021).

With the addition of lipid nanoparticles, it opened up a multitude of new paths this mRNA technology could be used, for example, researchers at the University of Florida used this technology for the treatment of glioblastoma which is the most aggressive and deadly brain tumor (Jaffe, 2024). The Memorial Sloan Kettering Cancer Center also used this technology to test it as a treatment for pancreatic cancer and it is showing promise in priming patients' immune systems to fight the cancer cells (Stallard, 2024). Although their research isn't finished yet it is making impressive findings Memorial Sloan Kettering Cancer Center researchers just now

started phase 2 of this research where they have separate groups in the study and one of the groups gets the vaccine in combination with chemotherapy using the synergy of the two treatments for fewer symptoms and more efficiency(Stallard, 2024). This is the start of a more specialized form of cancer treatment.

Hypothesis/ Research Question

The main question that started this research paper was can mRNA vaccines be used as a treatment that replaces or lowers the amount of chemo needed. Will it help patients treat their cancer with a less toxic treatment than the current method which poisons the patient to near death in hopes the cancer will die off? I believe the mRNA technology will completely revolutionize the way cancer is treated.

Another huge question is will these vaccines provide long-lasting protection for patients, protecting from recurrence? In Stallard's paper, they discuss the possibility of these vaccines lasting four years after vaccination with mRNA vaccines for pancreatic cancer. However, this finding is still being researched which shows how effective these vaccines can be.

An additional question is the safety of these vaccines and are the side effects are more bearable than chemotherapy. The answer to this question isn't available due to this technology still being in an experimental phase, none of the papers post any symptoms and when you google symptoms it only shows symptoms of the COVID vaccine so this will be an answer we will find out the further along this research goes.

A question most of you may be asking still is how this vaccine works. Well it works by using mRNA to deliver a message to your cells in which it primes the immune system to certain antigens depending on the specific cancer they are treating and then the body is primed to

combat the cancer on its own by recognizing it as a foreign invader, It's like the vaccine gives the cell a picture of the invader helping the immune system detect it and handle it.

Literature Review/ Discussion

The mechanism of this revolutionary treatment is fascinating, it works by having the mRNA vaccines contain genetic information based on the specific cancer the patient has. They do this by taking a sample of a patient's tumor which is then sequenced in a lab to identify tumor neoantigens and tumor-associated antigens or TAA for short. They then use the TAAs and tumor neoantigens to make a mRNA sequence that is then wrapped with lipid nanoparticles. This is what is injected into patients that leads to the immune response that helps identify the specific cancer cells as foreign(Stebbing,2024).

This immune response happens because the dendritic cells take up the mRNA which allows them to process the TAA which they then teach the T cells about so they can recognize and attack cancer cells(Stebbing,2024). In the literature that I read and studied for this paper, current experiments are being done with this mRNA vaccine technology for cancers such as Glioblastoma, Pancreatic cancer, Brain cancer, and even Melanoma. In the research that Stallard wrote about from the Memorial Sloan Kettering Cancer Center they found that their mRNA vaccine was well tolerated and on average protected from recurrence for 1.5 years(Stallard, 2024).

The article from Jaffee done by the University of Florida talks about an extraordinary finding in their research on using mRNA technology to treat Glioblastoma which is the most aggressive and lethal brain cancer. In their research, they find that in less than 48 hours they see that the immune system begins to attack the cancer cells they once didn't interact with(Jaffee, 2024). New York University released an article on the findings of their research on using mRNA

technology as a treatment for high-risk melanoma patients and had significant findings. In their research, they saw that patients who used the mRNA vaccine had lowered recurrence and death by 44 % (NYU Langone Health, 2024). This is just the beginning of what mRNA technology is capable of, it will completely change the way we think of cancer treatment and even change how the public views mRNA vaccines.

Conclusion

This research shows the groundbreaking findings of a revolutionary treatment for cancer using mRNA vaccines allowing for a safer more effective treatment option. The current research is exciting holding promise to becoming a new gold standard for cancer treatment. This mRNA technology allows cancer treatment to be specialized for a patient's specific cancer allowing it to be more effective and safer for the patient. The Current studies on using mRNA vaccines to treat Brain cancer (Glioblastoma), Melanoma, and Pancreatic cancer show its effectiveness and triggering an immune response and allowing the immune system to attack the cancer cells, these results are undeniable and allow for continued research on this matter. Although this method holds promise there are still challenges faced that could hinder the progress such as limitation with production and production speed, and the cost of the production. I believe with continued funding into mRNA technology being used for cancer treatment we will find a safer more effective alternative to chemotherapy that also efficiently protects from recurrence.

Works Cited

- Beyrer, C. (2021, October 6). The long history of mRNA vaccines. *Johns Hopkins Bloomberg School of Public Health*.
<https://publichealth.jhu.edu/2021/the-long-history-of-mrna-vaccines#:~:text=In%20this%20explainer%2C%20Chris%20Beyrer%20talks%20us,2013.%20What%20was%20happening%20in%20the%20interim?>
- NYU Langone Health. (2024, March 7). *Perlmutter Cancer Center clinical trial tests personalized mRNA vaccine for treating metastatic melanoma*.
<https://nyulangone.org/news/perlmutter-cancer-center-clinical-trial-tests-personalized-mrna-vaccine-treating-metastatic-melanoma>
- Phillips, C. (2024, June 11). *Glioblastoma mRNA vaccine, layered nanoparticle approach shows promise in early studies*. National Cancer Institute.
<https://www.cancer.gov/news-events/cancer-currents-blog/2024/glioblastoma-mrna-vaccine-layered-nanoparticle>
- Sayour, E. J., Boczkowski, D., Mitchell, D. A., et al. (2024). Cancer mRNA vaccines: Clinical advances and future opportunities. *Nature Reviews Clinical Oncology*, 21(6), 489–500.
<https://doi.org/10.1038/s41571-024-00902-1>
- Stallard, J. (2024, April 7). Can mRNA vaccines fight pancreatic cancer? MSK clinical researchers are trying to find out. *Memorial Sloan Kettering Cancer Center*.

<https://www.mskcc.org/news/can-mrna-vaccines-fight-pancreatic-cancer-msk-clinical-researchers-are-trying-find-out>

Stebbing, J. (2024, July 15). An update on mRNA cancer vaccines. *The Royal College of Pathologists*.

<https://www.rcpath.org/resource-report/an-update-on-mrna-cancer-vaccines.html>

Jaffee, M. (2024, May 1). *UF-developed mRNA vaccine triggers fierce immune response to fight malignant brain tumor*. UF Health.

<https://ufhealth.org/news/2024/uf-developed-mrna-vaccine-triggers-fierce-immune-response-to-fight-malignant-brain-tumor>

Winstead, E. (2022, January 20). *How mRNA vaccines might help treat cancer*. National Cancer Institute.

<https://www.cancer.gov/news-events/cancer-currents-blog/2022/mrna-vaccines-to-treat-cancer>

World Health Organization. (n.d.). Cancer. *WHO*.

https://www.who.int/health-topics/cancer#tab=tab_1

Vishweshwaraiah, Y. L., & Dokholyan, N. V. (2022). mRNA vaccines for cancer immunotherapy. *Frontiers in immunology*, 13, 1029069.

<https://doi.org/10.3389/fimmu.2022.1029069>

