Personalized mRNA vaccines: A new approach in melanoma treatment

May 4 2024, by Justin Stebbing

Credit: CC0 Public Domain

A personalized mRNA vaccine to treat melanoma has now reached late-stage trials in the UK. This is just the latest step in improving the cure

rate of cancer.

This form of cancer therapy harnesses the power of the body's immune system to target and eradicate cancer cells. During the phase 2 trials, the vaccine was shown to reduce the risk of cancer returning in people who were undergoing treatment for melanoma.

The phase 3 trials the vaccine is currently entering will recruit thousands of participants in order to better understand just how effective personalized mRNA vaccines are in treating melanoma.

Melanoma, the deadliest form of skin cancer, has been a formidable challenge for doctors due to its aggressive nature and tendency to spread. It's usually caused by exposure to ultraviolet light—but in many cases we don't fully understand why it occurs.

Early melanomas can be cut out surgically. But if the cancer is more advanced, or if it has spread to the lymph nodes or other places in the body, patients will need drug treatment too.

We've made massive improvements in treating melanoma, especially with drugs that enable the immune system to recognize melanoma cells and kill them (known as immunotherapy). But despite the tremendous successes here, sometimes these drugs are very toxic—causing inflammation of lung or gut tissue, for example. Other times, they fail to work, so melanomas return or spread—known as relapse.

Enter personalized messenger RNA (mRNA) vaccines—a cutting-edge therapeutic approach that leverages the body's own immune system to fight cancer, potentially with fewer side-effects than existing treatments.

Personalized vaccines

An mRNA vaccine works by introducing fragments of mRNA (messenger RNA) into the body. The main function of mRNA is to copy and carry genetic information from our DNA to other cells.

In the case of a cancer vaccine, these mRNA fragments introduce tumor-specific antigens—abnormal parts of cancer—into the body. These antigens are unique to cancer cells and serve as targets for the immune system to recognize and attack. This means that once the immune cells are primed, if any melanoma cells begin to form in future they'll know to attack and destroy them. The immune system will also kill any residual microscopic melanoma cells that could be lurking inside patients.

One of the keys to the effectiveness of personalized mRNA vaccines lies in their customisation to each patient's unique genetic makeup and tumor profile. By sequencing a patient's tumor DNA, researchers can identify the specific mutations and antigens present in their cancer cells. This information is then used to design a personalized mRNA vaccine tailored to target the patient's specific tumor antigens.

The patient's mRNA sequences are then enclosed in lipid (fat) nanoparticles which act like miniature cargo carriers to deliver the the mRNA into the patient's body via an injection. Once inside the body, the mRNA molecules instruct the cells to produce the tumor antigens, triggering an immune response that spreads throughout the body. This immune response targets and eliminates cancer cells bearing those antigens.

The immune system plays a pivotal role in cancer surveillance and elimination. This is why mRNA vaccines are increasingly being investigated as a form of cancer treatment, as they train the immune system to recognize and mount a targeted response against cancer cells

bearing specific antigens, effectively enhancing the body's ability to identify and destroy them.

But cancer cells have many techniques they use to avoid detection, allowing them to grow and spread. As such, we don't currently know whether mRNA vaccines will work alone, or work best in conjunction with existing cancer therapies—and whether vaccines should be deployed as an early or late line of defense against cancer.

At present, the melanoma mRNA vaccine appears to work best when used alongside other cancer treatments. The initial results of the phase 2 trials showed patients who used the personalized mRNA vaccine alongside the immunotherapy drug pembrolizumab had a 49% lower risk of death or melanoma recurrence three years later compared to those who only took the immunotherapy drug.

The phase 3 trials will build on this work, investigating the vaccine in a larger group of people. Hopefully the study will confirm the phase 2 findings and the drug will become available to melanoma patients in the future.

A personalized mRNA vaccine for melanoma would offer a new avenue for treatment—which may increase quality of life and the cure rate of this type of cancer. Vaccines are also being studied for other cancer types, including lung cancer. Research has also shown personalized mRNA vaccines may be effective for treating pancreatic cancer—but again we need more information from larger studies.

Personalized mRNA vaccines represent a paradigm shift in cancer therapy—offering a highly targeted and adaptable approach to treatment. By harnessing the body's immune system to selectively target cancer cells, these vaccines hold enormous potential to improve outcomes and quality of life for patients.

Provided by The Conversation