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Last Year's Virus, This Year's Cancer Treatment

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Abstract: For hundreds of years, cancer has stumped medical professionals across the world as a cure evaded them. Now, a new approach to battling cancer has entered the arena: viruses. The concept of using one deadly disease to cure another has elevated cancer research to an entirely new level, with some promising results. This article examines recent research regarding the use of a modified measles virus in improving cancer outcomes.

The first recorded case of cancer was documented around 3000 BCE in ancient Egypt. Eight cases of breast tumors were documented in a textbook on trauma surgery.[1] The textbook described the removal process by cauterization using a fire drill. It also described the disease saying, "there is no treatment."[1] Since then, thousands of medical professionals and others have proposed theories and treatments to try to outsmart the disease that alters the lives of millions throughout the world. Cancer is the second leading cause of mortality globally, responsible for one out of every six deaths.[2] This means that for 17% of the population, a solution could not come soon enough. The battle against cancer has relied on utilizing many different toxins to directly target cancer cells, and is still one of the primary treatments for cancer today. A new mindset on fighting cancer has entered the research world, and it focuses on modifying deadly viruses to target and kill cancer cells. While research on the use of viruses to treat cancer is still developing, promising results suggest that this therapy may prove useful in treating several types of cancer that have not responded to previous therapies. This article focuses on the measles virus for cancer treatment.

The measles virus belongs to a family of viruses known as *Paramyxoviridae*, better known as a *Morbillivirus* or the kind of *Paramyxoviridae* that infects primates including humans.[3] *Paramyxoviridae* viruses are very infectious; they spread through the respiratory tract and can travel quickly throughout a population. It can cause significant immunosuppression, morbidity, and mortality in the host.[3] After the measles virus has entered the respiratory tract, it infects cells of the respiratory pathway or any nearby immune cells that it comes in contact with by binding to a specific cell receptor.[4] Early signs of measles infection include high fever, rash covering most of the body, tiredness, and runny nose, with symptoms appearing anywhere from 7 to 14 days after exposure.[4] Complications from the measles virus infection may range in severity from diarrhea to pneumonia, and tend to be more severe in adults or malnourished individuals.[4] Measles infections remain one of the top killers of children throughout the world, resulting in 134,200 deaths in the year 2015 or 15 deaths every hour.[5] However, the measles virus has been declared eliminated in the United States due to strong vaccination efforts.[6]

So how can a highly transmissible virus such as the measles virus be used to treat cancer? Typically, the genetically modified form of the measles virus used for cancer treatment binds to the CD46 receptor.[7] This receptor is found on most all human cells, but tends to be expressed at a higher concentration on malignant tumors. Interestingly, developing research indicates that the measles virus prefers to invade tissues that show a higher number of these receptors such as tumors.[7] The measles virus spreads through the body primarily from a direct cell-to-cell transfer including extremely immature cells, such as cancer cells.[8] Once inside the cells, the measles virus causes the cancer cell membranes to fuse together and create giant cells, affecting the formation and replication of tumor cells.[9] Most importantly, when the measles virus is inside the body, the infected person's immune system is activated to try to fight the virus.[9] One of the reasons cancer is so hard to beat is because it is composed of one's own cells, and, therefore, the immune system of the person with cancer does not recognize it as a target. However, when the measles virus enters the cancer cells, the body tends to respond to the virus by releasing powerful stimulators of one's own immune system.[9] This is enough to trigger the body to try and get rid of the cancer cells, while in cases without the presence of a virus, it would not. Using the measles virus in this way has been investigated for a variety of cancers, including colon, ovarian, Non-Hodgkin Lymphoma, breast, prostate, and pancreatic cancers.[10]

When using a highly transmissible virus to treat cancer, safety must be considered first. An important step in ensuring the safety of everyone involved requires the use of an altered form of the virus incapable of causing disease in normal human tissues, but still capable of triggering an immune response of the cancer-causing cells. This is known as an "attenuated virus," and is similar to the state of a virus in vaccines. Beyond the use of an attenuated virus, there are two primary concerns for safety: the safety of the patient and the safety of the population.[10] The attenuated measles virus proves effective in both areas. It is safe for the patient because it is genetically stable, tumor specific, and will not attack normal host tissues. It is safe for the population because it is largely non-transmissible in the United States since the population is generally immune due to vaccine prevalence. Furthermore, the measles virus has shown excellent consistency in its genetic coding, which is another key factor in determining the safety and stability of viruses for treatment. Some viruses, such as the influenza virus, which causes the flu, are considered "unstable." The reason it is classified as such is

because the virus changes its genetic coding frequently, which explains the change in the flu vaccine from year to year. The measles virus, on the other hand, has essentially remained the same for several decades. This makes it incredibly unlikely that the attenuated virus administered to the patient for cancer treatment will revert back to a dangerous form of the virus, an important factor to consider when evaluating viruses for cancer treatment.[10]

Before viruses are considered a viable option for cancer treatment, there are still many unknowns and questions that need to be answered. One of the biggest challenges researchers face is monitoring where the virus travels in the body after it is administered.[11] It is important to track the virus in the body for several reasons, but one of the most important is to provide researchers with information on how much of the virus is needed for treatment. Some evidence suggests that modifying a specific protein on the surface of the virus may provide a viable option. However, trying to find a non-invasive system for tracking the virus in the body has been a challenge. There is still much work needed in this area to improve tracking of the virus once in the body.[11]

Although the use of the measles virus as a treatment for cancer looks promising, studies have been inconsistent. Clinical trials completed so far have shown that the measles virus effectively eliminated cancer in only some cases.[11] Furthermore, studies have found that the measles virus either did not affect the tumors at all or merely shrunk the tumors in size, but did not eliminate the tumor completely.[11] Therefore, more research is warranted before the use of viruses becomes a widely accessible option for people with cancer, but what prevails provides a promising option.

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