Vaccine Therapy for Cancer: The Basics

How does the immune system work?

The immune system is an intricate network of organs, cells and proteins that work to protect our bodies from foreign invaders, particularly infections. The immune system works to neutralize pathogens like bacteria, viruses, parasites and fungus that the body has been exposed to, using an immune response. The immune system also fights against cells already in the body that have changed due to illness, such as cancer. White blood cells, also called leukocytes, seek out these foreign pathogens and destroy them. There are two different types of leukocytes, B lymphocytes and T lymphocytes. B lymphocytes seek out the pathogens and T lymphocytes destroy the pathogens. B lymphocytes also produce antibodies, which are proteins that remain in the body to fight infections in the future that the body has previously been exposed to.

What is a cancer vaccine?

Most of us have received vaccines for infectious diseases, such as measles and hepatitis. These vaccines use weakened or killed viruses, bacteria, or other germs to start an immune response in the body. Cancer vaccines are designed to work in a similar manner, teaching the immune system to recognize, attack and destroy cancer cells. Normally, when foreign cells enter the body (for example, when an infection occurs), the immune system responds to the invasion and clears the body of the foreign cells. Unlike infectious cells, cancer cells are not recognized as foreign by the body. Instead, the immune system thinks the cancer cells are part of the normal body and do not mount an immune response against the cancer. Cancer vaccines allow the immune system to recognize cancer cells as foreign and, therefore, get the immune system to attack the cancer cells. Cancer vaccines are one way to utilize the body’s immune system to fight cancer.

How do non-cancer vaccines work?

Most commonly, vaccines are used to prevent infections. By introducing inactivated or killed forms of a virus or bacteria to the immune system before an infection actually occurs, the immune system is "primed" to recognize potential infections. Antibodies that are specific for the vaccine are produced in the body and allow for a very rapid response to potential infections by the virus or bacteria that the vaccine was made to target. In this way, actual infections can be quickly recognized by the immune system and eliminated before a significant infection can occur.

How do cancer vaccines work?

A true cancer vaccine contains cancer cells, parts of cells, or pure antigens. The vaccine increases the immune response against cancer cells that are already present in the body, in contrast to vaccines for diseases that are designed to prevent infection. Cancer vaccines spur the immune system into recognizing tumor cells as foreign invaders so that they may be destroyed by the immune system. Tumor cells often express distinct antigens known as tumor-associated antigens (TAAs). One of the greatest problems with developing cancer vaccines has been that most TAAs are also present in normal cells. Because the immune system sees these antigens as self-antigens, no immune response is mounted. If the immune system can be taught to recognize the TAAs as foreign, an immune response can be mounted against the tumor. Several TAAs have been identified that are found in specific types of cancers, but not in normal cells. By targeting these TAAs with cancer vaccines, cancer vaccines can cause the immune system to attack cancer cells while leaving normal, healthy cells largely intact. Currently, cancer vaccines targeting cancers of the breast, prostate, liver, kidney, pancreas, and lung, melanoma, and certain types of leukemias and lymphomas are in clinical trials.

Are there any vaccines that prevent cancer?
Some cancers are known to be caused by viral infections. Infection with human papilloma virus has been shown to be a cause of cervical cancer, as well as some head and neck, penile, anal, vulvar and vaginal cancers. Hepatitis B and C viruses are known to cause liver cancer. Vaccines that prevent infection from these viruses would help to prevent their associated cancers. While these vaccines may ultimately prevent cancer, these are not cancer vaccines. These vaccines are directed against viruses, rather than cancer itself. Prevention of cancer is merely a consequence of the prevention of the viral infection.

**Do cancer vaccines work?**

There have been a number of clinical trials testing cancer vaccines. Thus far, there is only one cancer vaccine found to improve overall survival. Sipuleucel-T (Provenge®) is approved for use in some men with metastatic prostate cancer. It stimulates an immune response to prostatic acid phosphatase (PAP), an antigen present on most prostate cancers. In a clinical trial, Provenge increased the survival of men with hormone refractory metastatic prostate cancer by about 4 months. The vaccine is customized for each patient. The exact mechanism of action of sipuleucel-T is unknown, but it is likely that the APCs that have taken up PAP-GM-CSF stimulate T cells to kill tumor cells that express PAP.

Another viral therapy approved for use is called talimogene laherparepvec and it is used in the treatment of melanoma that can't be removed with surgery. The drug is a weakened form of Herpes Simplex Virus Type 1. The medication is injected directly into the melanoma tumor on the skin or in a lymph node. This makes the cancer cells to burst and die. This medication has not been shown to improve overall survival.

**Clinical Trials**

Cancer vaccines remain an important and growing area of cancer research. A number of phase III trials are currently underway to further evaluate the effectiveness of these vaccines in improving outcomes for patients. A number of key questions and areas of research remain. We are still quite a ways away from incorporating cancer vaccines into the routine care of cancer patients. Nevertheless, the possibility of using the body's own immune system to destroy cancer cells remains an appealing possibility and results of early trials are promising. Research into new ways of treating cancer, such as cancer vaccines, remains an important part of the search for a cure.