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# Cancer Vaccine – A Review

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***ABSTRACT***

*With the goal of enhancing the body's immune response against cancer cells, the creation of cancer vaccines represents a revolutionary change in oncology. Cancer vaccines, in contrast to conventional vaccinations, are intended to assist the immune system in identifying and getting rid of pre-existing malignancies. This article reviews the current landscape of cancer vaccine research, highlighting following categories: prophylactic vaccines and therapeutic immunizations. Recent advancements in personalized medicine and the integration of immune checkpoint inhibitors have further bolstered the efficacy of cancer vaccines. Challenges such as tumour heterogeneity, immune evasion, and the need*

*for robust biomarkers remain critical areas for ongoing research. Overall, cancer vaccines hold significant promise for improving patient outcomes and integrating into broader cancer treatment regimens. Continued clinical trials and innovative strategies will be essential to realize their full potential in oncology.*

***KEYWORDS*** *: Cancer, Treatment, Prevention, Vaccine, Immune system, uses*

## INTRODUCTION

The immune system recognizes and gets rid of foreign antigens through a sophisticated network of chemicals, cells, tissues, and organs. Its primary function is to discriminate between self-antigens and foreign ones. Immune responses are split into two types: innate immunity, which responds fast and non-specifically, and adaptive immunity, which is slower but more targeted. The advent of several immunotherapy medications has expanded the area. For the treatment of melanoma and renal cell carcinoma, immune-stimulating cytokines such as interleukin-2 (IL-2) and interferon alpha (IFNα) have proven particularly beneficial. We'll talk about the future of cancer vaccinations in this review.[1,4,7]

## CANCER VACCINE

Therapeutic vaccinations, commonly known as treatment vaccines, are injections designed to treat cancer that has already metastasized. These vaccines fall under the category of immunotherapy for cancer treatment. Cancer vaccines are created using patient tumour cells to enhance the body's defences. They educate T lymphocytes to identify and eliminate malignant cells within the tumour. The development of a cancer vaccine can involve multiple antigens, such as pulsed dendritic cells or whole cells, or specific antigens like RNA, DNA, or peptides.[2,3]

## EXPLORING VACCINES THAT PREVENT CANCER DEVELOPMENT[5]

Two kinds of vaccinations for cancer prevention are:

## HUMAN PAPILLOMAVIRUS VACCINATION

This guards against the human papillomavirus (HPV), which, if allowed to proliferate in the body, can cause a number of malignancies. HPV vaccinations have FDA approval to prevent:

• Cancers of cervix

• Anal carcinoma

• Condyloma acuminatum

Among the many malignancies for which the FDA has not approved a vaccination because of HPV infection is oral cancer.

## HEPATITIS B PROPHYLAXIS

The hepatitis B virus (HBV), which can cause liver cancer, is prevented by this vaccine.

## CANCER VACCINES: HOW THEY HELP FIGHT TUMOURS

Substances on cell surfaces known to be potentially hazardous are called epitopes. After eliminating certain antigens, the immune system develops a "memory" to combat particular antigens in the future. These antigens, which are present on cancer cells but absent from healthy cells, are recognized and eliminated by the immune system with the help of cancer vaccines. These ingredients educate the immune system to find and eliminate cancer cells when administered as a vaccination. Some cancer vaccines target common cancer antigens and are administered to individuals whose tumours express these particular antigens. Personalized cancer vaccines are manufactured using tumour samples from individual patients.[2,6,9]

Provenge was approved by the FDA to treat metastatic prostate cancer. The following actions are performed in order to customize sipuleucel-T for every patient:

- The patient's blood is drawn to extract white blood cells to combat infections and illnesses.
- These cells are altered in the lab to specifically target prostate cancer cells.
- The patient is then given the transformed cells again by the doctor via a vein, much like a blood transfusion.
- These changed cells aid in the immune system's ability to identify and eliminate prostate cancer cells.

A different kind of immunization involves injecting the body with a weakened strain of Bacillus Calmette-Guerin (BCG). Treating early-stage bladder cancer with this attenuated bacterium enhances the immune system's response.[8]

## DISADVANTAGES

- They are expensive
- When it comes to rapidly developing malignancies, they are useless
- The immune system takes time to respond

## CANCER VACCINE TYPES

Antigen vaccines contain specific antigens derived from the patient's tumour that can effectively target and kill cancer cells. Advances in genetic engineering will enable large-scale production of these vaccines in the future.

Vaccines against dendritic cells: It is widely known that dendritic cells have the ability to identify and assault tumour cells. This vaccine, created in a lab, has a significant chance of causing tumour regression.

Vaccinations comprising DNA or RNA: These vaccinations have shown to be highly effective at causing tumour regression.

Vaccines derived from whole cancer cells are used in place of particular antigens, DNA, or RNA.[4]

## CANCER VACCINE FUNCTIONALITY

Dendritic cells (DCs) deliver vaccinations to T cells after processing them more thoroughly than peptide-based vaccines. However, in comparison to DNA and RNA vaccinations, peptide vaccines are less successful in delivering antigens for MHC I presentation. Tumor antigens are processed by DCs and presented on MHC I and II molecules. Certain receptor interactions with the MHC-peptide complex activate T lymphocytes. While activated T cells generate CD8+ memory and effector T cells, activated CD4+ T cells assist B cells in developing into memory and plasma cells. To eradicate tumour cells, effector T cells, antibodies, B cells, and specific cytokines cooperate.[10]

## ONGOING CLINICAL STUDIES OF CANCER VACCINES

With the use of dead tumour cells, vaccines elicit immune responses against a variety of tumour antigens without requiring prior identification. Racocumumab is an anti-idiotypic vaccination that has been licensed for use in Cuba and Argentina in the treatment of advanced non-small cell lung cancer. The effectiveness of the vaccinations has been moderate. Monoclonal antibodies are used in anti-idiotypic vaccinations to inhibit antibodies specific to tumour antigens. They elicit immune responses and amplify responses to less immunogenic lipid and carbohydrate antigens by imitating cancer antigens. Preclinical research points to a potent antimetastatic impact.[3,6]

## CLINICAL APPLICATIONS

Cancer vaccines platforms :

Cell-based vaccinations utilize cell lines from mammals, insects, or, less frequently, birds to create vaccines. This approach differs from the more common method, which involves using cells from chicken embryos to produce the antigens.[10]

Tissue-specific antigens (TSAs) and tumour-associated antigens (TAAs) are the targets of peptide-based vaccines, which stimulate CD8+ T lymphocytes and CD4+ T helper cells using epitope peptides. In order to enhance the immune response and increase therapeutic efficacy, adjuvants and nanomaterials are added.[7]

Viral-based vaccines, also known as viral vector vaccines, use modified viruses to deliver nucleic acid that codes for an antigen from another infectious agent into cells. These vaccinations are designed to prevent the recipient from contracting the virus that serves as the vector or source of the antigen. Importantly, the recipient's DNA does not contain any of the genetic material from the vector virus.[10]

RNA or DNA from a pathogen is used in nucleic acid vaccines to elicit an immune response against bacteria or viruses. This material gives directions on how to make an antigen, which is a particular protein that the immune system identifies as foreign. It produces antigens after it enters host cells, which sets up an immunological response.[8]

## PREVENTIVE CANCER VACCINES [6]

Vaccines are crucial for cancer prevention since viral infections are a primary cause of many malignancies. For instance, hepatitis B virus (HBV) is associated with liver cancer, but human papillomavirus (HPV) can cause malignancies of the head, neck, and cervical regions. Four of the vaccinations against HPV and HBV that have been produced have been approved by the FDA to prevent cancer.

Examples : **Cervarix, Gardasil, Hepatitis B (HBV) vaccine (HEPLISAV-B®)**

## PERSONALIZED NEOANTIGEN VACCINES [6]

Unlike normally produced but overexpressed proteins like PAP, cancer mutations create unique targets. Neoantigens, or "new antigens," are expressed solely by tumour cells in a patient and not by any healthy cells. Neoantigen vaccines can therefore specifically target tumour cells while protecting healthy cells from immune responses, potentially reducing consequences.

Apart from the vaccinations already mentioned, a number of neoantigen vaccines are being evaluated in clinical trials, both in combination with other medicines and in isolation, for various cancer types.

Example - **Sipuleucel-T (Provenge®)**

## CONCLUSION

The development of cancer vaccines represents a major advancement in the treatment of solid tumours. Improvements in sequencing technologies and a deeper understanding of immune systems could accelerate the production of personalized cancer vaccines. Strong immune systems, modest tumour burdens, and high recurrence risks make patients ideal candidates for cancer vaccine therapy. Vaccines that target numerous neoantigens may lessen immune evasion and aid in tumour elimination. In general, cancer vaccines appear to hold potential for improving immune response and monitoring against cancer.[9]

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