Journal of
Cancer Research and Therapeutic Oncology

JScholar
Fostering Scholarly Communication

Short Communication Open Access

Carbon Nanotube-Mediated Viral Antigen Delivery to Cancer Cells: A Hypothetical Strategy to Redirect CD8+ T-Cell Immunity

Mohamed Mahmoud Aboeldardaa*

Clinical pharmacy student at faculty of pharmacy Alexandria university, Egypt

***Corresponding Author:** Mohamed Mahmoud Aboeldardaa, Clinical pharmacy student at faculty of pharmacy Alexandria university, Egypt, E-mail: hamoaoeldardaa@gmail.com

Received Date: June 30, 2025 **Accepted Date:** July 15, 2025 **Published Date:** July 18, 2025

Citation: Mohamed Mahmoud Aboeldardaa (2025) Carbon Nanotube-Mediated Viral Antigen Delivery to Cancer Cells: A Hypothetical Strategy to Redirect CD8+ T-Cell Immunity. J Cancer Res Therap Oncol 13: 1-5

Abstract

Tumor cells have developed different strategies and mechanisms to escape immune detection including downregulating antigen presentation or imitating healthy tissue.

This paper introduces a theoretical approach in which carbon nanotubes (CNTs) are used to deliver viral antigens or live attenuated viruses such as the yellow fever virus (YFV-17D) directly into tumor cells.

This technique will make cancer cells express foreign viral antigens on their surface, which will trigger a strong CD8+ T-cell immune response, causing the immune system to recognize and kill cancer cells as if they were virally infected.

This concept could be extended to include other live attenuated viruses or synthetic antigens not just yellow fever but with similar immunogenic profiles.

Unlike conventional chemotherapy, which often causes widespread damage to healthy tissue, this strategy seeks to induce controlled, targeted cell death through immune system activation potentially resulting in fewer side effects and greater therapeutic precision.

Keywords: Cancer; Immunotherapy; CD8+ T-Cells; Carbon Nanotubes; Lively Attenuated Viruses

Introduction

Most people think that cancer is a foreign disease to the body, but the truth is the complete opposite, cancer is actually a very common disease and recognizable by the immune system, and by saying common it is in the rationale of rapidly abnormal multiplying cells, however using specific techniques the cancer cells tricks the immune system making it believe that the issue is solved and that is when tumors appear.

One of the most effective tricks cancer cells uses is to reduce the presentation of antigens on their surface, which prevents cytotoxic T-cells from recognizing them as a threat.

Some tumors also create an immunosuppressive microenvironment that disables immune cells before they can act.

Escaping the immune detection is a major reason why many cancers progress undetected, even in individuals with healthy immune systems resulting in tumors.

To overcome this, I propose a method that redirects the immune system's powerful antiviral responses against tumors. Live attenuated viruses, such as the YFV-17D strain used in the yellow fever vaccine, are known to trigger strong and durable CD8+ T-cell responses.

Also, the release of tumor antigens following immune-mediated killing would most likely initiate a secondary immune response against other tumor-specific antigens, potentially leading to systemic and lasting immunity.

Carbon nanotubes offer a promising delivery system due to their high surface area, and ability to penetrate cells, also due to their excellent optical property, thermal and electronic conductivity, easy functionalization ability and high drug loading capacity

So as a summary using carbon nanotubes to deliver lively attenuated virus or antigens to cancer cells which then triggers cytotoxic CD8+ T-cells to kill the infected cells as if they were virally infected leading to a more controlled cellular destruction and much fewer side effects.

Methods

Carbon nanotubes (CNTs) should be specific for tumor targeting like multiwalled carbon nanotubes (MWCNTs) and loaded with either viral antigens or attenuated viral particles.

Then it will be administered systemically or locally depending on the tumor itself.

After administration, CNTs are inserted into the tumor microenvironment and internalized by malignant cells.

Once internalized, the viral antigens are anticipated to undergo proteasomal processing and be presented on the tumor cell surface via the MHC class I pathway.

This presentation should make the cancer cells recognizable to CD8+ cytotoxic T lymphocytes as virally infected targets.

Following immune-mediated lysis of tumor cells, it is expected to release tumor-associated antigens, which may be taken up by local antigen-presenting cells, facilitating secondary immune activation through epitope spreading.

This method is designed to stimulate antiviral immune recognition pathways to enhance tumor immunogenicity and promote a cytotoxic T cell–mediated antitumor response.

Challenges and Considerations

Antigen Presentation Impairment: Tumor cells often downregulate MHC-I. Combining this strategy with agents that restore antigen processing may be beneficial.

Upregulating MHC-1 presentation could be done using cytokines or introducing FHIT gene to the cells which is a gene responsible for encoding a protein that acts as a diadenoside triphosphate hydrolase which plays a major role in controlling apoptosis (controlled automatic cell death) and the loss of this gene leads to progression of many types of cancer.

Carbon Nanotube Biocompatibility: While surface-modified CNTs show improved biocompatibility, their long-term safety and potential toxicity require more evaluation.

The distinctive structures of CNTs increase their hydrophobicity in water and leave them with inherent cytotoxicity, Therefore, elevating hydrophilicity and reducing cytotoxicity through functionalizing CNTs with different chemical groups or biomolecules are of great significance to improve their safety and effectiveness for broad application in cancer therapy, this could be done using two functionalizing methods (covalent, non-covalent)

Covalent modification of CNTs such as oxidation and carboxylation offer a stable platform for drug delivery, while non-covalent functionalization through Van der Waals interactions, π–π interactions, and hydrophobic interactions which causes minimal damage to the surface of CNT

Conclusion

I propose a theoretical cancer immunotherapy technique that uses carbon nanotubes to deliver live attenuated viral antigens directly into tumor cells. This approach aims to force tumor cells to display foreign peptides on MHC-I, allowing CD8+ T-cells to recognize and destroy them as if they were infected, and by making the immune system itself destroy the cancerous cells this minimizes the side effects with a great portion compared to any chemotherapy.

The yellow fever virus (YFV-17D strain) is identified as a strong initial candidate due to its well-studied immunogenic profile regarding the immune-response to its attenuated form used on vaccines as upon administration it generates a robust activation of cytotoxic CD8+ T-cells, but the concept may be applicable to a broader class of viruses that trigger cytotoxic T-cells or natural killer cells resulting in cell death.This hypothesis introduces a way to overcome immune tolerance and resistance in cancer, potentially enabling immunological targeting of tumors that would otherwise remain hidden from immune surveillance.

If proven feasible, it could complement or enhance existing immunotherapy approaches.

References

1. Faria P, Pacheco C, Moura RP, Sarmento B, Martins C (2014) Nanomedicine (Lond). 2014;9(8):1126–1138.

2. Hassan S, Shaheen SM, Abdelhameed R, Ahmed HE, Alqahtani R, Fouad MA, et al. (2016) Nanomedicine. 12: 1013–24.

3. Villa CH, Anselmo AC, Mitragotri S, Muzykantov VR (2013) Mol Pharm.10: 444–52.

4. Gupta S, Singh H, Johnson L, Ramesh G, (2013) Nanomedicine (Lond). 8: 495–512.

5. Liu Z, Tabakman SM, Welsher K, Dai H (2008) Carbon nanotubes in biology and medicine: in vitro and in vivo detection, imaging and drug delivery. Proc Natl Acad Sci U S A. 105: 1410–5.

6. Akondy RS, Monson ND, Miller JD, Edupuganti S, Teuwen D, Wu H, et al. (2009) The yellow fever virus vaccine induces a broad and polyfunctional human memory CD8$^+$ T cell response. J Immunol. 183: 7919–30.

7. Akondy RS, Johnson PLF, Nakaya HI, Edupuganti S, Mulligan MJ, Lawson B, et al. (2015) Initial viral load determines the magnitude of the human CD8$^+$ T cell response to yellow fever vaccination. Proc Natl Acad Sci U S A. 112: 3050–5.

8. Akondy RS, Fitch M, Edupuganti S, Yang S, Kissick HT, Li KW, Youngblood BA, et al. (2017) Origin and differentiation of human memory CD8$^+$ T cells after vaccination. Nature. 552: 362–7.

9. Jiang H, Rekoske BT, Rosenthal AC (2016) Turning the cold tumor microenvironment hot: Enhancing antitumor immunity by targeted radiation therapy. *Cancer Immunol Res.* 4: 911–8.

10. Tang L, Xiao Q, Mei Y, He S, Zhang Z, Wang R, Wang W (2021) Insights on functionalized carbon nanotubes for cancer theranostics. Journal of Nanobiotechnology.