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Commentary

Immuno-Gene Therapies in Oncology: A New Era Beyond Chemotherapy

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Abstract

The field of oncology is undergoing a revolution, and it is transforming away from the conventional limits of chemotherapy into more targeted, durable, and patient-specific approaches. This commentary explores the compelling case for elevating cancer immuno-gene therapies to the forefront of cancer treatment. By leveraging the body's immune system and gene-editing technologies, these therapies are offering a paradigm shift-one that battles cancer at its gene and immunologic root rather than targeting merely the symptoms or halting cell growth. We scrutinize critically the drawbacks of chemotherapy, such as toxicity, non-specificity, and high relapse potential, against the progress made with CAR-T cell therapy, immune checkpoint inhibitors, cancer vaccine, and genetically modified immune cells. The backdrop is against which developments in CRISPR and synthetic biology are making better and targeted treatments less toxic. In spite of challenges like immense expense, regulatory challenges, and the intricacy of delivery mechanisms, the clinical and scientific impetus behind immuno-gene therapies is overwhelming. This paper argues that these technologies are not add-ons to conventional therapies but the building blocks of future oncology research. Focusing on the development of cancer immuno-gene therapies, the discipline can get closer to the age-old vision of curative, patient-specific cancer therapy.

Keywords Cancer · Immunotherapy · Gene therapy · Chemotherapy · Cancer Vaccine · Immune cells

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Introduction

Cancer remains a significant 2nd leading cause of mortality worldwide, with a substantial impact on human live is projected to become the top killer by 2060 (Zhang et al., 2024). To treat cancer, conventional treatment methods are commonly employed, including surgery, radiotherapy, hormone therapy, chemotherapy, and targeted biological treatments (Salari et al., 2025). Among the most revolutionary of Cancer Treatments are immune checkpoint inhibitors, CAR-T cell therapy, and gene-editing tools like CRISPR-Cas9. The field of cell and gene therapy in oncology has moved rapidly since 2017 when the first cell and gene therapies, were approved by the Food and Drug Administration in the United States, since those approvals, several new products have gone on to receive approval for additional indications. Meanwhile, efforts have been made to target different cancers, improve the logistics of delivery and reduce the cost associated with novel cell and gene therapies. (Gustafson et al., 2023).

Immunotherapy has emerged as a promising alternative, leveraging the immune system to target and eliminate tumour cells (Bandara and Raveendran, 2025). Unlike traditional drugs highlight various cell and gene therapy-related technologies and advances that provide insight into how these new technologies will speed the translation of these therapies into the clinic this approach has been further refined with the leading to the development of immuno-gene cancer therapies that offer more precise and personalized treatment options has emerged as a novel strategy to augment the inhibition of tumor proliferation (Huang et al., 2024). Aime of pursuit to improve the alternative cancer treatment protocols beside chemotherapy there are immune-gene therapy, which focus on specific personal treatment shows significant effective on patient remedy process.

Immuno-Gene Therapies: Mechanisms and Advances

The problem of resistance to therapy in cancer is multifaceted drug resistance continues to be the principal limiting factor to achieving cures in patients with cancer. We take the reductionist stance here to delineate and demarcate the key determinants of drug resistance, the initial solution to the problem of resistance to single-agent chemotherapy the combined administration of agents with non-overlapping mechanisms of action, or polychemotherapy (Vasan et al., 2019). Immuno-gene therapies involve a variety of methods of promoting the immune system's capacity to combat cancer. Through genetic engineering, oncology continues to evolve rapidly, driven by unprecedented advancements in precision medicine, together with advancements in gene-editing technologies like base editing and prime editing, these innovations hold the potential to overcome the limitations of current cancer treatments and expand the scope of gene therapy across oncology (Youssef et al., 2025). The objective of the work is to recognize the recent advancements in the modern health care and drug delivery systems to treat more effective of cancer patents, the future of medical treatments will be oriented towards shifting the focus to personalized medications. The comparison of conventional treatment and personalized treatment is depicted in (Figure 1). Artificial Intelligence is the branch of computer science which aids in problem solving by help of symbolic programming (Dev et al., 2020).

Clinical Successes and Ongoing Research

The clinical application of immuno-gene cancer therapies has yielded promising results. For example, Cancer Vaccines have a potential to change the current landscape of cancer immunotherapy research and development. Vaccines can target and neutralize specific tumor cells by utilizing the body's own immune system which offers a promising modality in treating various cancers (Flores Banda et al., 2025). Vaccines enhance the presentation of tumor antigens to the immune system, thereby amplifying the immune response against the cancer (Akbulut, 2020). Cancer gene therapy, advancements in gene-editing technologies for instance, using gene-editing tools like CRISPR-Cas9. Furthermore, technology marks a revolutionary period in cancer immunotherapy, providing an exceptional tool for accurate genetic editing. This novel method allows for precise alterations in the genome and the correction or removal of mutations that promote cancer initiation and development (Vimal et al., 2024). Additionally, Immunotherapy and gene therapy undeniably represent a paradigm has led to the development of novel treatments that enhance the body's immune response against tumors, as shown in (Figure 2) demonstrates how T cells expanded in a specific format, such as CAR-T cells, can be genetically engineered to attack cancer cells more vigorously. Gene therapy methods are demonstrated that improve the specificity, persistence, and resistance to cancer-induced immune suppression of immune cells. These adjuvant therapies represent a highly individualized, precision-medicine approach to oncology (Smith, 2024).

Emerging Synergies and Future Directions

Despite the availability of technological advances in traditional anti-cancer therapies, there is a need for more

precise and targeted cancer treatment strategies (Zafar et al., 2024). The clinical application of immuno-gene therapies has yielded promising results. The immune system and genetic engineering to provide a customized and focused method for treating cancer, overcoming the constraints of conventional treatments (Srivastava et al., 2024). Cancer immunotherapy has transformed the treatment landscape, introducing new strategies to fight various types of cancer like Prostate cancer, Breast cancer and Lung cancer. This examines the important role of vaccines in cancer therapy (Sareen et al. 2025). Future research would involve refining gene-editing technologies to increase the specificity of the genetic changes, the development of combination therapies pairing immuno-gene therapies with other treatments, and expand.

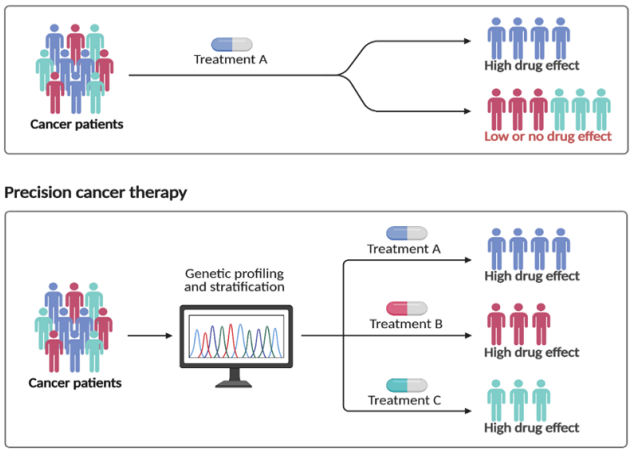

Figure 1: Precision cancer therapy, the future of medical treatments will be oriented towards shifting the focus to personalized medications show comparison of conventional treatment and personalized treatment.

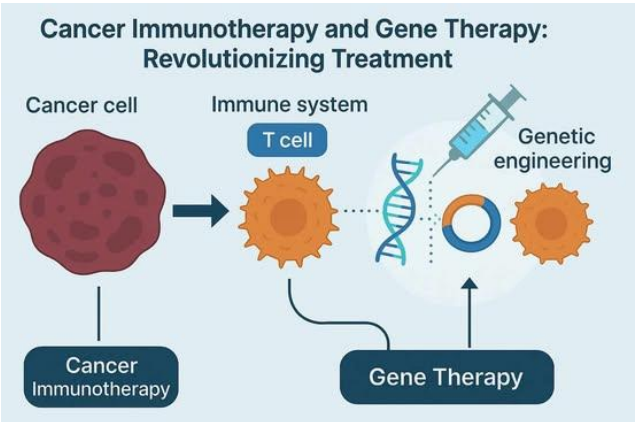

Figure 2: The synergistic role of cancer immunotherapy and gene therapy in revolutionizing cancer treatment.

Conclusion

Immuno-gene therapies are a quantum leap in the field of oncology with the promise to provide more effective and targeted cancer treatments. With the capability to utilize the power of the immune system and take advantage of the newest genetic engineering technologies, immuno-gene therapies can bypass some of the restrictions of conventional therapies and provide improved outcomes for patients. Ongoing research and ingenuity are critical to overcome the challenges facing immuno-gene therapies and ultimately achieve their maximum potential in cancer therapy.

Statements and Declarations

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Ethics Statement Not required.

Transparency Statement The author, Farzand Farhad Hamid, asserts that this manuscript provides an honest, accurate, and transparent account of the reported study. He confirms that no significant aspects of the study have been omitted and that any deviations from the original study plan, including registration if applicable, have been properly explained.

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