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Commentary

Targeted Nanomedicine for Cancer Immunotherapy

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DESCRIPTION

Nanomedicine generally refers to as the usage of nanotechnology for the development of medicine. While this includes the development of Nano-sized materials and methods for ex vivo disease diagnosis and management, the term nanomedicine is historically used to describe 1-100 nm sized drug delivery that travel all across the body after intravenous infusion to selectively accumulate in pathophysiological regions and elicit pharmacological effects there, while avoiding drug accumulation and drug actions elsewhere in the body.

Nanomedicine-based tumour targeting is generally accomplished through two mechanisms: passive and active targeting. Active targeting is accomplished by coating nanoparticles with targeting ligands like as antibodies or peptides that precisely bind receptors overexpressed at the diseased site. Aside from directly destroying cancer cells, nanomedicines can assist in the fight against cancer through regulating antitumor immune responses. This can be accomplished by developing nanomedicines that

- Target cancer cells in order to elicit immunogenic cell death
- Target immune cells, such as macrophages, dendritic cells, and T cells, or immunosuppressive pathways in the tumour immune microenvironment
- Target the peripheral immune system, which is found, for example, in lymph nodes and the spleen

Nanomedicine has the potential to significantly increase the efficacy of cancer treatment. Nanomedicines, or 1-100 nm-sized drug delivery systems, have mostly been employed to enhance the balance between the effectiveness and toxicity of conjugated or encapsulated chemotherapeutic agents. The clinical performance of cancer nanomedicines has been relatively unsatisfactory, owing mostly to a lack of tools and technology for patient classification. Immunotherapy, on the other hand, has achieved outstanding clinical success, establishing full cures and inducing long-term survival in advanced-stage patients. Unfortunately, immunotherapy only works successfully in a tiny percentage of people. A growing body of pre-clinical and clinical research shows that combining nanomedicine with immunotherapy might improve treatment results by converting "cold" non-immunoresponsive tumours and metastases into "hot" immunoresponsive lesions. Nano-immunotherapy may be accomplished in three ways: nanomedicines are utilized to (1) target cancer cells, (2) target the tumour immune microenvironment, and (3) target the peripheral immune system.

Nanomedicines that target cancer cells often try to elicit immunogenic cell death, causing the release of tumour antigens and danger-associated molecular patterns such as calreticulin, high mobility group box 1 protein, and adenosine triphosphate. Adjuvants signal antigen-presenting cells to pick up, process, and deliver the former, encouraging the production of $CD8^+$ cytotoxic T lymphocytes. Nanomedicines that target the tumour immune microenvironment enhance cancer immunotherapy by suppressing immunosuppressive cells like M1-like tumor-associated macrophages and decreasing the production of immunosuppressive chemicals like transforming growth factor beta.

Furthermore, nanomedicines can be used to stimulate antigen-presenting cells and cytotoxic T cells in the tumour immunological microenvironment. Nanomedicines targeted at the peripheral immune system seek to increase innate immunity and cytotoxic T cell generation in secondary lymphoid organs such as the lymph nodes and spleen, as well as to create and enhance peripheral effector immune cell numbers, increasing anticancer immunity. While the majority of immunomodulatory nanomedicines are still in pre-clinical research, promising outcomes from early clinical studies have already been published. We must include biomarkers in clinical development to guarantee that the proper nanomedicine formulation is paired with the right immunotherapy in the right patient, in order to enable efficient translation of nano-immunotherapy structures and ideas. In this context, we must learn from continuing nano-biomarker identification efforts as well as partially established immuno-biomarker projects such as the Immunoscore and the cancer immunogram. Together, these techniques will help to determine the nano-immuno-status of individual patients, allowing for the discovery and application of individualised and enhanced nanomedicine-based therapies to increase cancer immunotherapy performance.

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