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Short Communication

Application of Nanomaterials in Cancer Treatment

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ABOUT THE STUDY

Cancer has a complicated pathological process. Lack of selectivity, cytotoxicity, the development of multi-drug resistance, and the proliferation of stem-like cells are issues with current chemotherapy [1,2]. Nanomaterials are substances with unique optical, electromagnetic, and electrical characteristics that are in the nanoscale (5–100 nm). There are numerous major categories into which nanomaterials employed in cancer treatment may be divided. These nanomaterials have already been modified for a variety of cancer treatments to overcome toxicity and lack of selectivity, boost drug capability as well as bioavailability, and target cancer cells, tumour microenvironment, and immune system. The development of effective and secure anticancer therapies is of the highest importance given the rising cancer death rate. The development of novel anticancer medications and methods is necessary for improved treatment effectiveness [3,4].

Due to their ability to produce Reactive Oxygen Species (ROS) or oxygen radicals, Fenton- and Fenton-like human response Chemodynamic Treatment (CDT) is a novel method for improving anticancer effectiveness. Yet, the produced O2 can alleviate the hypoxic situation in the Tumour Microenvironment (TME), which prevents photodynamic treatment, radiation, etc [5]. As a result, CDT can be used with many different treatment approaches for combination therapy that is boosted by synergy.

The anti-tumour applications of Fenton and Fenton like reaction based nano-materials include: (i) producing abundant ROS in-situ to kill cancer cells directly; (ii) improving therapeutic efficiency indirectly by using combination therapies mediated by Fenton reactions; and (iii) diagnosing and monitoring cancer therapy. These methods demonstrate the CDT-based nanomaterials' potential for effective cancer treatment. The most effective treatment approach for treating both primary and metastatic malignancies is considered to be the combination of phototherapy and immunotherapy.

Several immunological strategies are used in immunotherapy to activate the immune system and help it recognize tumour cells for specialized destruction. By exposing the main tumours to light, phototherapy eliminates them. This light irradiation also triggers immunogenic cancer cell death, which sets off a chain reaction of immunological reactions. Thus, a novel anti-cancer approach known as Photo Immunotherapy (PIT) is developing when immunotherapy and phototherapy are combined [6].

This complementary approach to treating cancer can advance both medicines efficacy while also overcoming their inherent drawbacks, ushering in a new age for the field of anti-cancer medicine. A platform for PIT has recently been made possible by the development of nanomaterials. Due to their distinct physiochemical features, inorganic nanoparticles stand out among all of these nanomaterials as the best PIT mediators. Inorganic nanoparticles can operate as photo-thermal agent or electrochemical techniques in phototherapy due to their superior optical properties, in addition to serving as carriers for transport immunomodulatory drugs in immunotherapy due to their outstanding drug-loading capability. In recent years, phototherapy, especially Photothermal Therapy (PTT) and Photodynamic Therapy (PDT), have attracted increasing attention as non-invasive therapy techniques for the treatment of cancer [7].

CONCLUSION

For the purpose of eliminating tumours, PTT and PDT can produce localized effects of hyperthermia and Reactive Oxygen Species (ROS), respectively. Development of stimulations in nanomaterials for cancer distribution of the phototherapeutics has received a lot of attention in an effort to enhance therapeutic performance while reducing the negative side effects of phototherapy. Biomedicine has advanced significantly in recent years, especially with regard to the therapy and detection of malignancies. For biomedical imaging, methods to increase the efficacy of diagnosis, including photo acoustic, Positron Emission Tomography (PET) image analysis, and multimodal imaging based upon Cu-based NMs, is outlined. Cu-based NMs were also demonstrated to have a number of distinctive structures and functionalities, as well as an underlying property–activity link, which highlights their prospective therapeutic performance. Many immunotherapies, including Photothermal Treatment (PTT) and Chemodynamic Therapy (CDT), have made extensive

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use of Cu-based NMs. Moreover, the complex design of Cu-based NMs' composition, structure, and surfaces manufacturing can provide these NMs more modality in the detection and treatment of cancer.

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