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Perspective

Cancer Nanomedicine in Practice: A Summary of Available and Active Research

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DESCRIPTION

Nanomedicine, which is the use of nanotechnology in the medical industry, has the potential to fundamentally alter how life-threatening diseases like cancer are diagnosed and treated. Cancer nanomedicine offers sensitive cancer diagnosis and/or improves treatment efficacy in compared to conventional cancer diagnostics and therapy, with much less side effects than conventional treatments. In laboratory and animal model research, cancer nanomedicine has been used more and more in fields including nanodrug delivery systems, nanopharmaceuticals, and nanoanalytical contrast reagents. The successful introduction of various innovative nanomedicine items into clinical trials and even into the commercial market in recent years has demonstrated successful clinical translation of basic research. In order to study the trend of nanomedicine development, future potential, and challenges of this rapidly expanding field, this paper will look at a number of nanomedicines for cancer therapies and/or diagnostics-related applications.

In general, nanotechnology is defined by the National Nanotechnology Initiative (NNI, a multiagency US government programme launched in 2001) as the science and engineering involved in the design, synthesis, characterization,. Since its inception several decades ago, nanotechnology has attracted increasing interest from the academic and industrial sectors for applications not only in materials science and engineering, like light-emitting devices and solar cells, but also in the fields of biotechnology and medicine, including disease diagnostics, prevention, and treatment.

As a result, there has been a significant increase in the creation of novel nanotechnology platforms for medical applications as well as a sharp increase in government funding and venture capital investment due to the level of interest in nanotechnology demonstrated by both academic and industrial investigators. A recently coined subterm, "nanomedicine," describes the use of manmade nanoparticles in the medical industry.

The early detection and treatment of cancers, the passive and active targeting of diseases, improved biocompatibility, and multifunctionality encompassing both imaging and therapeutic capabilities, allowing for concurrent disease treatment and monitoring are just a few of the potential advantages that nanotechnology offers to medical applications. The following are some of the main benefits of using nanomaterials in medical applications. They share the same size range as biomolecules like nucleic acids, antibodies, and receptors. Additionally, biomolecules can be used to functionalize nanomaterials so they can target specific organelles inside particular tissues or even whole cells to localize in the desired place. Issues with solubility and stability can frequently be resolved by surface modification/wrappings or extra formulation in nanostructures. Nanostructures feature novel physical properties that can be used for bioimaging, such as optical properties from quantum dots.

Due to their small size, nanostructures typically have a high surface area made up of thousands of atoms, allowing for the transport or encapsulation of a greater therapeutic payload (such as chemotherapeutic medicines or radioactive isotopes). The high-dose therapeutic load can harm cancer cells at the intended place even more devastatingly once it has been delivered and acknowledged by a receptor. Through passive or active targeting, nanoparticle (NP) formulations can frequently release therapeutic payloads at cancer locations, greatly minimizing nonspecific toxicity. Opportunities usually come with problems, though. The first barrier that nanomedicine may present is thorough characterization. Second, safety and manufactureability issues shouldn't be disregarded. For instance, efficient quality control techniques must be used to confirm the batch-to-batch consistency of each nanomedicine. Nanomedicine may also be ineffective if a therapeutic component of a particle separates from the nanoparticle platform during delivery, bloodstream circulation, or particle degradation. Acute toxicity that is unrelated to the pharmacokinetics of the nanoparticle platform itself may come from pretargeting release of a therapeutic payload (such as a chemotherapy) from the nanoplatform.

Clinical translation of NPs necessitates a thorough comprehension of their relationship with the human body, specifically their biodistribution, toxicity, and biocompatibility, as well as their particle size, composition, formulation, internal and external structure, chemical reactivity and stability.

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CONCLUSION

Meeting all the safety requirements for clinical acceptability, particularly those imposed by the FDA and other regulatory authorities, is now nanomedicine's toughest obstacle. To satisfy these requirements and market demand, a variety of nanoparticle/nanomedicine platforms have been screened and investigated in terms of their size, shape, and surface properties over the past ten years. These include "target-specificity": ideally, a nanomedicine will accumulate primarily in the afflicted organs/sites, avoiding the healthy ones, a suitable size (often ultrasmall): thus, they can be eliminated from the body preferably through the renal filtration system, and nontoxic and biocompatible, with a surface made up of natural polymers/biomolecules. Being versatile allows for the combination of multifunctional therapeutic agents and multimodality imaging capabilities (such as optical, MRI, SPECT, PET, and/or CT) into a single nanomedicine, which not only makes disease early diagnosis easier but also has the potential to allow for real-time monitoring of the therapeutic delivery's progress.

Despite all the difficulties, nanotechnology has evolved been used to enhance the therapeutic, diagnostic, and other qualities of health care goods, and it is now closely associated with the treatment of cancer. In order to create and translate cancer nanomedicines, biotech, pharmaceutical, and medical sciences businesses have actively contributed to this evolution and are dynamic collaborators with researchers, the government, and educational institutions. It is highly anticipated that the upcoming generations of nanomedicines will have a targeting moiety, may carry multiple drugs that could potentially be released in a controlled manner, and will be equipped with an imaging capability based on the full spectrum of cancer nanomedicines in clinical trials and on the market that have been discussed in this paper.