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Theranostic Nanomedicine: State of the Art Technology

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Abstract

Due to the prevalence and emergence of multiple drug resistance (MDR) to various deadliest diseases, it is very much essential to develop innovative technology for the early diagnosis and treatment in order to improve patient's life. 'Theranostics' nanomedicine is a newfangled advancement in nanoscience which permits us to develop an integrated therapeutic and diagnostic venture into a single nano-formulation for the treatment of various deadliest diseases. Interestingly, this will enable to streamline the therapeutic efficacy of a drug via real time monitoring individual patient throughout the course of medication. Theranostic nanomaterials can be also engineered with superior physio-chemical properties for site-specific drug delivery at organs or tissues, minimizing the adverse detrimental side effects. Indeed, a variety of nanoparticles, including super-magnetic, polymeric, metallic, liposomes, dendrimers, micelles, and carbon-based materials are currently in pre-clinical trials for the sustained release of diagnostic and therapeutic agents at desired organs. Nevertheless, it is now very clear that the theranostic nanomedicine was becoming an imperative safe-guard technology to combat against life threatening diseases.

keywords: Supermagnetic iron oxide nanoparticles; Surface Enhanced raman scattering; Computed tomography; Photothermal therapy

Multifunctional Hybrid Nanomaterials for Theranostic Applications

Currently, several multifunctional hybrid nanothernostic modalities have been developed and investigated under various levels of preclinical settings. The prime attention among researchers was focused on the supermagnetic iron oxide nanoparticles (SPIO) which has been integrated with many nano-drug formulations as a MRI-contrast agent for the detection and treatment of Cancer, Alzheimer's disease, and microbial infections [1-3]. These magnetic nanoparticles can be efficiently targeted to desired sites via applying an extra-magnetic field. Very recently, Peng et al. [4] have formulated Mesoporous Magnetic Gold "Nanoclusters" as Theranostic Carrier for Chemo-Photothermal Co-therapy of Breast Cancer. Similarly, Yong et al. [5] have developed Gadolinium polytungstate nanoclusters as a new theranostic with ultrasmall size and versatile properties for dual-modal MR/CT imaging and photothermal therapy/ radiotherapy of cancer. Interestingly, noble metallic nanotags with Surface Enhanced Raman Scattering (SERS) spectroscopic effect were fabricated for the profound detection and treatment of bacterial pathogens Ankamwar et al. [6], cancer cells, and parasites [7,8]. Fluorescent carbon dots were fabricated to deliver siRNA in cancer treatment, the action of this nanohybrid on tumor growth control was monitored with bioluminescent imaging [9]. Nanoparticle based drug delivery is one of the major areas, providing a wide range of formulations that are now beginning pre-clinical or clinical trials. Liu et al. [10] developed précised Bi2S3 nanorods (NRs for multispectral optoacoustic tomography (MSOT)/X-ray computed tomography (CT)-guided photothermal therapy (PTT) of cancer.

Conclusion

Theranostic nanomaterials being actively investigated as the next generation therapeutics, it prevents the limitations of conventional therapies such as existence of MDR and adverse side effects. This all-in-one approach enables clinicians to diagnose as well as monitor the progress and success of therapy during treatment.

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