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Recent advances in near-infrared light-responsive nanocarriers for cancer therapy

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Teaser: How useful will near-infrared light-responsive nanocarriers be in cancer therapy?

Highlights

- NIR light allows deeper tissue penetration and minimum damage to healthy tissues.
- The uses of NIR responsive nanomaterials in cancer therapy are highlighted.
- Recent trends of using multi-stimuli responsive nanocarriers have been discussed.
- The challenges related to NIR responsive nanomaterials are described.

In recent years, research has focused on the development of smart nanocarriers that can respond to specific stimuli. Among the various stimuli-responsive platforms for cancer therapy, near-infrared (NIR) light (700–1000 nm)-responsive nanocarriers have gained considerable interest because of their deeper tissue penetration capacity, precisely controlled drug release, and minimal damage towards normal tissues. In this review, we outline various therapeutic applications of NIR-responsive nanocarriers in drug delivery, photothermal therapy (PTT), photodynamic therapy (PDT), and bioimaging. We also highlight recent trends towards NIR-responsive combinatorial therapy and multistimuli-responsive nanocarriers for improving therapeutic outcomes.

Keywords: near-infrared light; drug delivery; nanocarriers; cancer therapy; photodynamic therapy.

Introduction

Currently, cancer is one of the biggest challenges worldwide, with over 1 688 780 new cancer cases and 600 920 cancer deaths projected to have occurred in the USA in 2017 alone [1,2]. Current cancer therapies mainly include surgical procedures, antibody therapy, radiotherapy, hormonal therapy, and chemotherapy [3]. Although these therapies are beneficial, they can cause collateral damage and severe toxicity to normal tissues because of their nonspecificity [4]. Furthermore, most chemotherapeutic agents are associated with poor aqueous solubility, a narrow therapeutic index, poor pharmacokinetics, and the development of drug resistance [5,6]. To overcome these limitations, research has focused on nanocarrier-based delivery systems, which offer several advantages, including the potential to prolong the circulation time, enhance the aqueous solubility, and decrease the adverse effects of therapeutic agents by delivering them to specific target sites [7]. Moreover, these nanocarriers can preferentially accumulate in the leaky vasculature of tumors via the enhanced permeation and retention (EPR) effect through passive as well as active targeting [8,9]. More than two dozen nanomedicine formulations have been already approved for clinical use and more are currently in clinical trials [7].

However, most conventionally designed nanocarriers have the drawback of premature drug release in the circulation ,which can damage normal tissues and reduce their therapeutic efficacy [10,11]. Thus, stimuli-responsive nanocarriers