Nanotheranostics: future of nanomedicine.

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Theranostics is a combination of diagnostics and therapeutics, and it provides a new process of imaging-guided therapy for patients, and also it provides possible chance in cancer detection at the very stage with intelligent signal corresponding to the molecular change of disease. At the beginning of theranostics, imaging group was simply conjugated to the delivery carriers loaded with drugs and the widely employed imaging methods include magnetic resonance imaging (MRI), computed to mography (CT), positron emission tomography (PET) and optical imaging. Among them optical imaging is attractive as it can provide images in real time with high spatial resolution and the use of non-ionizing irradiation [1-4].

Various types of exogenous contrast agents can be used for multiplexed molecular imaging, such as conventional fluorescent dyes and quantum dots (QDs). Conventional fluorescent dyes have been well-established and commercialized, in which some have been approved for use in the clinic. Fluorescent dye molecules with emission wavelength ranging from visible to near infrared could be used as a chromophore for *in vitro* tumor diagnostics. But the optimal and now commercially available fluorescent dyes are those whose emission lies in the near infrared region (NIR). Pronounced background auto fluorescence and severe tissue absorption and scattering greatly limit the application of dyes with emission in the visible region, while their interferences with long wavelength light are minimal [5].

Nanotheranostics is a combination of nanomaterials and theranostics include both the drug nanocarriers and efficient imaging agents, which is attractive candidates for a diverse range of imaging-guided therapy applications. Polymeric nanoparticles responsive to external pH stimuli have attracted much attention for a wide range of applications, especially in biology, such as imaging-guided drug delivery, molecular sensing, tissue engineering, etc. [6].

Polypeptide materials are one kind of biodegradable material with potential application in biomedical areas. They can be facilely obtained by the ring opening polymerization of amino acid N-carboxyanhydrides (NCA). Natural amino acids with various side groups provide the possibility for the preparation of polypeptide materials with versatile structures and properties [4,7].

Recently, photodynamic therapy (PDT) has attracted much attention in cancer therapy when light was turn on in the presence of a photosensitizer, singlet oxygen reactive oxygen species (ROS) can be generated in the presence of oxygen. For example, pH-responsive multifunctional polypeptide nanoparticles has been prepared, which showed efficient ROS generation and large drug carrying ability, can be used for imaging-guided photodynamic therapy (PDT). By the nanoparticles, cancer cells can be detected and treated synchronously by near-infrared fluorescence (NIRF) imaging guided PDT. BODIPY-Br_2 photosensitizer with efficient singlet oxygen yield has been utilized which owns both fluorescence emission and ROS generation ability under the NIR light irradiation. The results of *in vitro* experiments on HepG2 cancer cells revealed that the efficient cell suppression rate can be increased more than 40% in the presence of NIR light at an extremely low energy density (12 J/cm^2) and low concentration of photosensitizer (5.4 μM). Synchronously, the uptaking of the nanoparticles by cancer cells can also be detected by NIR imaging, indicating the nanoparticles is a potential imaging-guided PDT nanotheranostics [8].

In addition, a pH-Sensitive doxorubicin conjugated polypeptide has been synthesized which can be assembled into micelles with entrapping of near infrared (NIR) photosensitizer BODIPY which works as both imaging agent and photosensitized. The polymer was synthesized by a combination of ring opening polymerization of N-carboxyanhydride with mPEG-NH_2 and post chemical modification; chemical drug doxorubicin was conjugated to the polymer by the hydrazone-bond for pH-responsive drug delivery. Then a NIR dye BODIPY was encapsulated in the micelles for imaging-guided PDT. The nanoparticles showed low cytotoxicity and high ROS yield under the NIR light irradiation, which provide a combination of imaging-guided PDT (NIR) and chemotherapy in a nanoparticle system, indicating that the new kind of polymeric nanoparticle is a potential nanotheranostic for cancers. In addition, the energy density required of the laser for the PDT is also extremely low [9].

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