Nanoparticle-Based Antimicrobial Photodynamic Therapy

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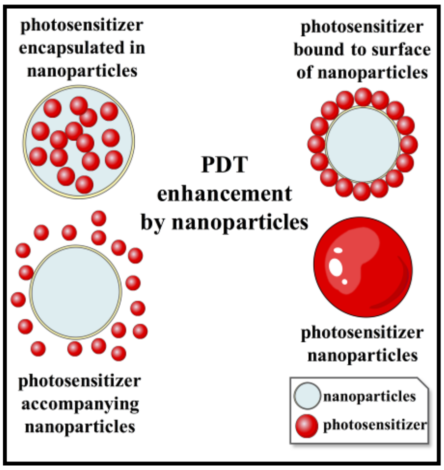
The global concern about antibiotic resistance has created a strong demand for new methods of therapy. Antimicrobial photodynamic therapy (APDT) particularly presents mechanisms that lead to the lack of microbial resistance development as well as promising results against infections colonized by drug-resistant pathogens.

APDT represents a therapeutic modality that involves the combination of a photosensitizing drug (PS) with luminous radiation of appropriate wavelength and molecular oxygen to produce reactive oxygen species (ROS) that can inactivate microbial cells by oxidative stress. Reports in literature have confirmed its efficacy against pathogenic yeast, parasites, viruses, algae and bacteria [1]. Depending on parameters APDT is able to surpass the antioxidant defenses of cells and initiate a process of cellular death via different pathways [2].

However, the APDT outcome may be limited due to the difficulty in administering the PS in a biological system, which compromises the clinical use of several molecules. Thus, nanotechnology is an interesting approach for APDT mainly because nanoparticles (NP) can be structured to increase PS concentration at the target and reduce toxic effects to normal tissue and cells.

Different types of NP (organic and inorganic) such as metallic (silver and gold NP), crystalline (up conversion- rare earth doped), superparamagnetic (SPION, superparamagnetic iron oxide nanoparticle), and semiconductor (quantum dots) have been described for use in APDT with distinct interactions between NP and PS [3]. Depending on interaction, NP can be active (NP acts as PS) or passive. Four interactions are described by literature [4] (Figure 1): i) the PS is surrounded by a polymeric NP. In this case, nanoparticles are loaded with PS and are used as carriers to deliver the PS into the target; ii) the PS is bound to the NP surface. In this case, the new PS presents better properties compared to original PS; iii) the PS is accompanied by NP. In this case, nanoparticles are used to enhance the photodynamic effect. Metallic NP (gold and silver) and quantum-dots have been reported to enhance APDT; iv) the NP acts as the PS. In this case, NP is itself photoactive and able to generate ROS.



"Fig.1. Illustrative representation of the interaction between nanoparticles and photosensitizers to improve APDT [5]"

Given the remarkable extensiveness of NP-based APDT applications, the significant promise of this therapeutic approach has a potential to revolutionize health care. In this talk we will discuss recent advances in this area.

References

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