Crimson Publishers
Wings to the Research

Perspective

Polymeric Nanotheranostics: A Perspective

Victor SP, Paul W and Sharma CP*

Central Analytical Facility, Biomedical Technology Wing, Sree Chitra Tirunal Institute for Medical Sciences & Technology, India

ISSN: 2770-6613

***Corresponding author:** Chandra P Sharma, Central Analytical Facility, Biomedical Technology Wing, Sree Chitra Tirunal Institute for Medical Sciences & Technology, Poojappura, Thiruvananthapuram 695012, India

Submission: September 08, 2021

Published: September 16, 2021

Volume 2 - Issue 2

How to cite this article: Victor SP, Paul W, Sharma CP. Polymeric Nanotheranostics: A Perspective. Polymer Sci Peer Rev J. 2(2). PSPRJ. 000533. 2021.
DOI: 10.31031/PSPRJ.2021.02.000533

Perspective

Theranostic nanomaterials, a concerted fusion of therapeutic agents with diagnostic moieties offers an unparalleled regime in combining therapeutics and diagnostics. These materials are emerging as the forerunners in providing a successful transition from conventional to personalized care enabling targeted, safer and efficient pharmacotherapy [1]. Several kinds of materials including liposomes, dendrimers, carbon nanotubes, quantum dots, metallic nanoparticles and polymeric nanoparticles have been employed for imaging and therapy to treat a number of diseases such as cancer, Alzheimer's disease, kidney diseases, cystic fibrosis and numerous genetic disorders [2]. Specifically, polymeric nanoparticles provide several advantages that include a reliable and inexpensive surface for functionalization, sites for specific attachment of targeting moieties and can be tailored to exhibit specific optical and magnetic properties [3]. These polymeric theranostic agents necessarily contain four parts- an imaging moiety, a drug, a coating for improved biocompatibility and stability and functional moieties for cell targeting. Polymer-based theranostic agents are characterized by a wide array of diagnostic, imaging and targeting modalities. Magnetic theranostic agents such as Polyethylene glycolylated multi responsive liposomes [4] containing Magnevist successfully released doxorubicin in tumour-bearing mice in vivo. 90% encapsulation of doxorubicin was reported by J Chang et al. in a PLGA core and PEGylated liposome shell [5]. Similarly, amphiphilic multiarm star block polymers were functionalized to introduce folate and gadolinium-based contrast agents to release paclitaxel in a controlled manner [6]. In addition, there is a lot of emphasis on SPION based polymeric theranostic agents [7] which have successfully delivered several drugs including doxorubicin and chlorambucil [8]. These systems have superior attributes such as high drug loading efficiency, prolonged blood circulation time, super paramagnetic behaviour [3], improved MRI and hypothermia.

The use of NIR in imaging has several benefits including deep tissue penetration, lesser scattering and diminished auto fluorescence. Consequently, there have been efforts to develop polymeric theranostic agents by conjugation with a fluorescent dye. To mention a few, Perez et al. [9] demonstrated successive uptake of cytochrome C from hyperbranched polyhdroxyl particles containing an NRI dye. Polyethylene amine multishell nanoparticles containing carbocyanine and Nile red successfully permitted imaging and delivery of methotrexate [10]. Rhodamine B was also studied in doxorubicin conjugated micelles to obtain tumour targeting efficacy [11]. In addition, polymer-based theranostic agents have been utilized for ultrasound-based drug delivery taking into accounts its merits that include low cost, local heating of tissue, acoustic cavitation and enhanced control over biodistribution and pharmacokinetics of drug moieties [3]. Paradossi et al. developed micro bubbles based on polyvinyl alcohol decorated with hyaluronic acid for the localized delivery of doxorubicin [12]. Studies by Wheatley et al on paclitaxel loaded PLA micro bubbles demonstrated superior cellular uptake combined with efficient antitumor activity in rabbits *in vivo* [13]. Furthermore, polymer-based theranostics

have also found application in image-guided gene delivery, image-guided photodynamic therapy and image-guided hyperthermia. These systems have been summarized by Christoforu et al. [3] and offer immense potential in the treatment of several diseases. Though polymer-based theranostic agents are endowed with several advantages they also face a multitude of challenges that result in low clinical applicability. Issues such as the sensitivity of the signal, interaction between drug and imaging molecules, drug compatibility, chelation, dye quenching and metabolism of dyes have to be addressed. This requires a systematic effort and efficient cooperation between researchers, engineers and clinicians to enable the emergence of polymeric theranostics as a targeted, safe and efficient route of treatment.

References

1. Hapuarachchinge S, Dmitri A (2020) Theranostic pretargeting drug delivery and imaging platforms in cancer precision medicine. Front Oncol 10: 1131-1143.
2. Kelkar SS, Reineke TM (2011) Theranostics: combining imaging and therapy. Bioconjug Chem 22(10): 1879-1903.
3. Christoforou T, Georgiou TK (2013) Polymeric theranostics: using polymer-based systems for simultaneous imaging and therapy. Journal of Material chemistry B 1: 3002-3035.
4. Kono K, Nakashima S, Kokuryo D, Aoki I, Shimomoto H, et al. (2010) Multi-functional liposomes having temperature-triggered release and magnetic resonance imaging for tumor-specific chemotherapy. Biomaterials 32(5): 1387-1395.
5. Liao Z, Wang H, Wang X, Zhao P, Wang S, et al. (2011) Multifunctional nanoparticles composed of a poly(dl-lactide-coglycolide) core and a paramagnetic liposome shell for simultaneous magnetic resonance imaging and targeted therapeutics. Adv Funct Mater 21(6): 1179-1186.
6. Li X, Qian Y, Liu T, Hu X, Zhang G, et al. (2011) Amphiphilic multiarm star block copolymer-based multifunctional unimolecular micelles for cancer targeted drug delivery and MR imaging. Biomaterials 32(27): 6595-6605.
7. Mahmoudi M, Sant S, Wang B, Laurent S, Sen T (2011) Superparamagnetic iron oxide nanoparticles (SPIONs): development, surface modification and applications in chemotherapy. Adv Drug Deliv Rev 63(1-2): 24-46.
8. Guo M, Yan Y, Liu X, Yan H, Liu K, et al. (2010) Multilayer nanoparticles with a magnetite core and a polycation inner shell as pH-responsive carriers for drug delivery. Nanoscale 2: 434-441.
9. Santra S, Kaittanis C, Perez JM (2010) Cytochrome C encapsulating theranostic nanoparticles: a novel bifunctional system for targeted delivery of therapeutic membrane-impermeable proteins to tumors and imaging of cancer therapy. Mol Pharm 7(4): 1209-1222.
10. Quadir MA, Radowski MR, Kratz F, Licha K, Hauff P, et al. (2008) Dendritic multishell architectures for drug and dye transport. J Control Release 132(3): 289-294.
11. Hu X, Wang R, Yue J, Liu S, Xie Z, et al. (2012) Targeting and anti-tumor effect of folic acid-labeled polymer–Doxorubicin conjugates with pH-sensitive hydrazone linker. Mater Chem 22: 13303-13310.
12. Cavalieri F, Finelli I, Tortora M, Mozetic P, Chiessi E, et al. (2008) Polymer microbubbles as diagnostic and therapeutic gas delivery device. Chem Mater 20(10): 3254-3258.
13. Cochran MC, Eisenbrey J, Ouma RO, Soulen M, Wheatley MA (2011) Doxorubicin and paclitaxel loaded microbubbles for ultrasound triggered drug delivery. Int J Pharm 414(1-2): 161-170.