LETTER TO THE EDITOR

Nanotechnology in Medicine: "Future in Tiny Hands"

Poonam Agrawal

Abstract

Nanomedicine is the application of nanotechnology for treatment, diagnosis, and monitoring of the course of disease. Though it might be utilized for many diseases as well as enhancement of normal physiology, its utilization for the treatment of cancer is very promising. Today's cancer treatment is facing major challenge in terms of toxicity of the chemotherapeutic agents. Toxicity of chemotherapeutic agents is mainly due to the lack of efficacious drug delivery following systemic drug administration. Site-specific drug delivery and tailored release of these chemotherapeutic agents is the need of the hour. Nanomedicine has come as an answer to these issues, where nanoparticles are utilized for site-specific delivery of these chemotherapeutic agents. Both active and passive targeting of the drug is utilized for such delivery of the drug to the cancer cells.

Keywords: Microvivors, Nanomedicine, Nanotechnology, Respirocytes.

Journal of Medical Academics (2019): 10.5005/jp-journals-10070-0041

Since Dr Richard P Feynman conceptualized "nanotechnology" in 1959 in his classic paper titled **"There Is Plenty of Room at the Bottom,"** we have come a long way shaping his dream into a technology called nanotechnology. Today, nanotechnology is being applied in diverse fields like engineering, energy production, cosmetics, water processing, etc.

Medical science is not behind in this context of nanotechnology. **"Nanomedicine" is the application of nanotechnology for the treatment, diagnosis, monitoring of the course of disease**. Though it might be utilized for many diseases as well as enhancement of normal physiology, its utilization for the treatment of cancer is very promising. Today's cancer treatment is facing major challenges in terms of toxicity of the chemotherapeutic agents. Toxicity of chemotherapeutic agents is mainly due to the lack of efficacious drug delivery following systemic drug administration. Site-specific drug delivery and tailored release of these chemotherapeutic agents is the need of the hour.

Nanomedicine has come as an answer to these issues, where nanoparticles are utilized for site-specific delivery of these chemotherapeutic agents. Both active and passive targeting of the drug is utilized for such delivery of the drug to the cancer cells.

In passive targeting, the nanoparticle containing these chemotherapeutic agents accumulates in the cancer tissues due to leaky endothelium via "Enhanced Permeation and Retention" (EPR) effect. Though passive targeting certainly results in preferential accumulation of the nanoparticle in the tumor, significant nonspecific uptake still occurs in the healthy tissues.

To further increase the site-specific delivery of these toxic chemotherapeutic agents to the tumor tissues, these nanoparticles which contain such chemotherapeutic agents are functionalized, which means the targeting ligand that identifies and binds the receptor on the tumor cell and adjacent endothelium are coated on to the surface of nanoparticles. This strategy is called active targeting.[1,2]

In addition to the platforms which are commonly being used/tried for nanomedicine like liposome, fullerens (bucky balls), dendrimers, nanopores, nonotubes, nanosomes, paramagnetic nanoparticles, and quantum dots, scientists are now considering certain hypothetical design like respirocytes (artificial RBC) and microvivors (artificial WBC).

Department of Biochemistry, Dr Baba Saheb Ambedkar Medical College and Hospital, New Delhi, India

Corresponding Author: Poonam Agrawal, Department of Biochemistry, Dr Baba Saheb Ambedkar Medical College and Hospital, New Delhi, India, Phone: +91 9953645511, e-mail: drpoonam24agrawal@yahoo.com

How to cite this article: Agrawal P. Nanotechnology in Medicine: "Future in Tiny Hands". J Med Acad 2019;2(2):65–66.

Source of support: Nil

Conflict of interest: None

Respirocytes have been hypothesized as a pressure tank which can be pumped up to 9 billion oxygen and CO_2 molecules, and it can deliver 236 times more oxygen per unit volume compared to a natural RBC.[3] If we are successful in its application, these respirocytes may prove as a boon for the treatment of anemia.

Microvivors is hypothesized to be a nanoparticle which when injected in the blood stream may phagocytose bacteria, virus, and other foreign particles in the blood circulation.[4]

Nanorobots are hypothesized to be nanoparticles which because of their nano size will enter the cell and will rectify the mutant DNA, and will also facilitate the repair of the damaged tissue and clot lysis. They will have an inbuilt camera which will utilize the electrolyte of the blood for its power backup.

In addition to the innumerable advantages of the use of nanoparticles in the medicine, its use has shown to be associated with many side effects in animal models such as epitheloid granuloma, interstitial inflammation, peribronchial inflammation, lung necrosis, proaggregatory effect on platelets enhancing the chances of thrombosis, etc.[5]

Though the expectations from nanomedicine is high and list of potential benefit is also endless, the safety profile of nanomedicines is not fully defined, and the best way to use this technology is to weigh it to use it. In future, nanomedicine will certainly play a crucial role not only in the treatment of human disease but also in the enhancement of normal physiology as hypothesized by respirocytes, microvivors, and nanorobots.

The future of nanomedicine is certainly bright and it is not wrong to say in this context that **"the next big thing is only going to be small"**.

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