IRESPUB Journal of Medical, Dental & Pharmaceutical Sciences

Volume: 2 | Issue: 1 | JAN - FEB 2022 | Available Online: www.irespub.com

Applications of nanomedicine

Tolulope J. Ashaolu[1*], Joseph O. Ashaolu[2]

[1]College of Food Science, Southwest University, Beibei, Chongqing, P.R. China

[2]International Health Programme, School of Medicine,
National Yang-Ming University, Taipei, Taiwan

ABSTRACT

The medical application of nanotechnology to the diagnosis, management, and treatment of disease is nanomedicine. Nanomedicine seeks to manufacture drugs and other products that are packaged into nanoscale systems for improved delivery. Although many nanomedicines are already in use or are being studied in clinical trials, many challenges and risks impede bringing these drugs to market.

KEYWORDS

Nanomedicine; Nanotechnology, Nanoparticles

CORRESPONDING AUTHOR*

Dr. Tolulope J. Ashaol

INTRODUCTION

Nanomedicine is that special aspect of medicine that involves the development and application of materials and technologies with nanometer length scales. Medicine itself refers to the science, engineering, and practice of diagnosing, treating, curing, and preventing diseases. Nanomedicine applies nanoscale materials towards medicine, and it is an interdisciplinary discipline that combines nanoscience, nanoengineering, nanotechnology, nanoelectronics, and life sciences. Nanomedicine cuts across drug delivery, vaccine development, antibacterial, diagnosis and imaging tools, wearable devices, implants, and high-throughput screening platforms [1].

Nanomedicine is regarded as one of the most promising technologies of the 21st century. It is a rapidly growing area that is focused on developing nanoparticles (NPs) for different applications. Nanoparticles are key components of nanotechnology and nanomedicine. They are a form of transport for drugs. They differ in characteristics like shape and size. They are being developed to diagnose and treat various diseases. Some of the nanoscale materials have shape-dependent optical, electronic, and magnetic properties. Nanoparticles such as graphene, carbon nanotubes, and tungsten disulfide are being used in bone tissue engineering applications [2, 3]. Applications for NPs include use in vaccinations, magnetic resonance imaging, pathogen detection, protein identification, DNA structure probing, and tissue engineering. In addition, there have been trials applying nanoparticles on catheters, hand gels, and therapeutic vaccines have been conducted [2].

Nanomedicine is an offshoot of nanotechnology, the engineering of tiny machines [4, 5]. The control of structures at the nanometer level has allowed nanotechnology to be distinct from other traditional science fields. Developing components on the nanoscale allows engineers and scientists to take advantage of physical, chemical, and biological interactions that are not feasible on larger size scales. It may be used as part of tissue engineering to help reproduce or repair damaged tissue. It has produced major advances in areas of energy, food, and agriculture. Nanomedicine, a marriage of nanotechnology and medicine, is taking the place of nanotechnology in the fight against unmet diseases.a more serious infection.

APPLICATIONS

The most active areas of nanomedical research and development are cancer treatments, imaging contrast agents, and drug delivery [2].

• Cancer

Cancer is known as one of the leading causes of death. Traditional cancer treatments are limited to surgery, radiation, and chemotherapy. All three methods cause damage to healthy tissues. Nanomedicine is poised as the future of cancer treatment [6]. Nanomedical products are prominently used is in the treatment of cancers. The small size of nanoparticles (5 to 100 nanometers) endows them with properties that can be very useful in oncology. Nanoparticles can be designed to deliver anti-cancer drugs directly to tumor cells while leaving healthy cells alone. Nanomedicine is capable of safely treating children's cancer. Nanomedicine for cancer therapy is advantageous over traditional medicine because it has the potential to enable the preferential delivery of drugs to tumors owing to the enhanced permeability and retention effect [7]. Cancer nanomedicines have been envisioned to overcome the pharmacokinetic limitations associated with traditional drugs. Successful nanomedicines for cancer treatments include Abraxane, Depocyt, Oncospar, Doxil, and Neulasta.

• Drug Delivery

It is challenging within the pharmaceutical industry to locate drugs more efficiently to their disease targets. Nanoparticles used for drug delivery are usually in the nanometer range. They can be engineered to package and transport drugs directly to where they are needed, enabling more precise targeting with a controlled release. The targeting property of nanoparticles is dictated by certain factors such as particle size, surface charge, and surface modification. Nanomedicines off er many advantageous properties for drug innovation and development: increased solubility/bioavailability, better safety and efficacy profile, targeting specific tissues, crossing biological barriers that conventional products cannot bypass, extended drug exposure with a larger therapeutic window, and other impressive features [8].

• Imaging

Nanoparticles can be used for imaging of diseased cells. Nanotechnologies already offer the possibility of intracellular imaging through attachment of quantum dots. Image-guided nanomedicine can deliver nanoparticles locally using non-invasive imaging. Medical image-guided interventional oncology approaches should be one of the promising solutions for current nanomedicine [9].

An advanced application of nanomedicine involves the use of nanorobots and nanodevices as miniature surgeons. Nanomedicines have the potential to address challenges encountered in the treatment of cardiovascular disease, tuberculosis, diabetes, and hematological malignancies.

PROS AND CONS

A major benefit of using nanoscale for medical technologies is that smaller devices are less invasive and can possibly be implanted inside the human body. Due to their tiny size, nanomedicines can readily target difficult-to-reach sites with improved solubility and reduced adverse effects. The application of nanomedicine, particularly in cancer treatment, promises to have a profound impact on health care. Medications can be more efficiently delivered to the site of action using nanotechnology. The nanoscale physical properties afford them the potential for biomedical applications. Hence, they are used for the treatment of cancer, heart and lung, blood, inflammatory, and infectious diseases. Nanoparticles can also help with the solubility of drugs. Nanomedicine can make use of nanorobots (planted in the body) to repair or detect damages and infections. However, nanomedicines present a wide range of technological, scientific, and legal challenges. There are also current challenges in manufacturing, characterization, and regulation. Some nanotechnological-based drugs can be toxic and not biodegradable. Some critics have urged government agencies and private companies to proactively address the ethical, social, and regulatory aspects of nanomedicine. Nanomedicines should pass through stringent clinical trials to ensure safety and minimize risks. Investors are very cautious about making large investments in nanomedicine partly because they are concerned about whether the FDA will be stringent in regulating nanomedicines. There is currently a lack of a specific regulatory framework for nanomedical products. FDA is being asked to develop regulatory guidelines that are specific to nanomedical products since current FDA regulations were written before the advent of nanotechnology. Because of these challenges, nanomedical products currently occupy only a tiny niche of the biotech market.

CONCLUSIONS

Nanomedicine is focused on medical intervention at the molecular scale. It has the potential to address many of the challenges facing global health care in the future. Despite the variety of challenges that impede the development of nanomedicines, research and investment are expected to increase, causing them to become part of mainstream medicine in the future. Nanomedicine will lead to many more exciting medical breakthroughs. The full promise of nanomedicine will perhaps not arrive until after the development of programmable medical nanomachines and nanorobots, which are the eventual dream of every medical doctor. It is crucial for our future medical practitioners to have a solid understanding of the potential for nanomedicine to revolutionize therapeutics and diagnostics.

REFERENCES

[1] Diverse applications of nanomedicine,‖ ACS Nano, vol. 11, no. 3, March 2017, pp. 2313–2381.

[2] R. Gaurab et al., —Nanomedicine: Therapeutic applications and limitations,‖ in S. Soni, A. Salhotra, and M. Suar (eds.), Handbook of Research on Diverse Applications of Nanotechnology in Biomedicine, Chemistry, and Engineering. Hershey, PA: IGI Global, 2015, chapter 5, pp. 64-86. [3]

[3] Nanomedicine, ‖ Wikipedia, the free encyclopedia https://en.wikipedia.org/wiki/Nanomedicine

[4] M. N.O. Sadiku, M. Tembely, and S.M. Musa,‖ Nanotechnology: An introduction,‖ International Journal of Software and Hardware Research in Engineering, vol. 4, no. 5, May. 2016, pp. 40-44.

[5] K Riehemann, —Nanomedicine—Challenge and perspectives,‖ Angewandte Chemi Int. Ed. Engl., vol. 48, 2009, pp. 872–897.

[6] R. Sebastian, —Nanomedicine - the future of cancer treatment: A review,‖ Journal of Cancer Prevention & Current Research, vol. 8, no. 1, 2017.

[7] R. K. Jain and T. Stylianopoulo, —Delivering nanomedicine to solid tumors,‖ Nature Reviews, vol. 7, Nov. 2010, pp. 653-664.

[8] B. Flühman et al., —Nanomedicines: The magic bullets reaching their target?‖ European Journal of Pharmaceutical Sciences, vol. 128, Feb. 2019, pp. 73- 80.

[9] D. H. Kim, —Image-guided cancer nanomedicine,‖ Journal of Imaging, vol. 4, no. 18, 2018.