Internet Journal of Medical Update

Journal home page: http://www.akspublication.com/ijmu

Guest Editorial

Nanomedicine

Dr. Reema R Mody, PhD, MBA

Takeda Pharmaceuticals International, Inc., One Takeda Parkway, Deerfield, IL 60015, USA

Nanomedicine, as defined by the NIH Roadmap Initiative, can be considered as an offshoot of nanotechnology, dealing with highly specific medical interventions at the molecular scale for curing disease or repairing damaged tissues, such as bone, muscle, or nerve. Simply stated it is the medical application of nanotechnology. By controlling and modifying matter at a nanoscale, the physical properties of materials change dramatically, offering a wide variety of applications in the medical field including advanced drug delivery systems to alter the pharmacokinetics and biodistribution of drugs, improved in *vivo* imaging, and targeted drug delivery by localizing therapy to a certain region of the body such as tumors.

Nanotechnology is often viewed as a relatively young field, with tremendous potential to reinvent existing therapies and significantly improve standards of living. Surprisingly though, the seeds of nanotechnology as a new frontier in medicine were laid centuries ago when the movement from macro to micro had gained momentum. The invention of microscope afforded opportunities to detect and study microorganisms such as bacteria, understand histopathology of healthy and diseased tissue, etc. Microsurgery opened avenues to carry our surgeries that would have been deemed risky and fatal on the conventional platforms. Nanotechnology has now laid the platform of understanding the cellular processes at the molecular level, incorporate advances in proteonomics and genomics to provide possibilities for development of technologies, therapies which will integrate into mainstream medicine. Nanotechnology will lead to the most exciting advances in medicine in the 21st Century. In the past few decades, the semiconductor manufacturing process, microfabrication technology has enabled the development of microsensors, micro-actuators, and various microsystems, integrating electrical, mechanical, optical, and fluidic components. These well established technologies can now provide tools and instruments to understand and manipulate the biological nano environment.

Various nanotechnology platforms like fullerenes, nanotubes, quantum dots, nanopores, dendrimers, liposomes, magnetic nanoprobes and radio labelled nanoparticles are being developed or conceptualized to support novel medical advances. Nanomedicine offers an opportunity to significantly improve the safety and efficacy profiles of a drug by tissue specific drug targeting of the drug. Nanoscale multifunctional materials, capitalizing on progress in genomics and proteomics, allow targeted delivery of molecular therapies with enhanced efficacy. Development of newer drug delivery systems based on nanotechnology methods is being tried for conditions like cancer, diabetes, fungal infections, viral infections and in gene therapy. An emerging application of nanotechnology is in the understanding of disease processes. Science has made significant advances in the understanding of the biochemical basis of many disease processes and the underlying biochemical pathways. In many instances, the genetic basis for the disease process is also well understood. Unfortunately, the need for ultra-sensitive, real-time monitoring and detection technologies remains. Nanotechnology can be used to design multi-functional and multi-analyte diagnostic systems that not only define early stage changes or progression to a disease state, but also allow the identification and detection of biomarkers, chemicals and structures that cannot be detected by the current assay technologies.

The current issue of Internet Journal of Medical Update focuses on emerging applications of nanotechnology in the fields of nuclear imaging and cancer nanotechnology. The review article on Nuclear Imaging discusses how radio nuclei can be tagged to tissue targeted nanoparticles using various approaches and rendering them available for nuclear imaging. One major advantage of this approach is the potential to improve the safety the radio nuclei by limiting the exposure of radiation to specific tissue thus improving the therapeutic index. The next review on Cancer Nanotechnology discusses the application of this exciting field in the area of cancer research and treatment advances.

The lack of effective chemotherapy mainly results from the non-selective delivery of the chemotherapy to all biological tissue, including the tumor. This results in significant side-effects with the therapy, reducing the therapeutic index and increasing the potential for a toxic outcome. Cancer nanotechnology is being perceived as an area of research that may be able to overcome the drawbacks of the conventional treatment. In addition to discussing the conventional approaches using nanoparticles and liposomes for delivery of chemotherapeutics, the article also reviews the more recent advances in this area that include use of arrays of nanocantilevers, nanotubes and nanowires for multiplexing detection, multifunctional injectable nanovectors for therapeutics and diagnostics are discussed. The third article discussed the fascinating area of ultrasonography and the application of nanoparticle imaging technology to improve the resolution and tissue differentiation using ultrasonography. The review article highlights how the acoustic properties of tissues can be modified differentially using contrast agents thus improving the ability to distinguish between tissues, allowing for improved image quality and resolution.

Nanomedicine is a very promising frontier of science expected to deliver significant advances in the areas of medical diagnosis and therapeutics. The expectations are high and unforeseeable applications of nanotechnology are being conceived and developed. At the same time though, the safety of this technology is not adequately understood in humans. The very same properties of nanoparticles that offer them unique advantages can be related to safety concern that may arise. The biological effects of various nanoparticles vary according to physiochemical properties of the particle which may include size, chemical composition, and surface structure. The small size of nanoparticles subjects them to same risk as toxicities associated with particulate matter. The toxic properties of these nanoparticles and their biocompatibility need to be investigated for the technology to be viable. Adequate evaluation of risk and safety will be of paramount importance for broad acceptance of this very exciting field. Nanomaterials are likely to receive closer attention from regulatory bodies for toxicological potential in a number of different applications. As the field matures, nanomedicine will play an important role in the diagnosis and treatment of human disease. It is a matter of time when this approach to disease intervention will become an integral part of modern medicine.

Disclaimer: The opinions expressed here are the views of the writer and do not reflect the views and opinions of Takeda Pharmaceutical Company Limited or its affiliates.

Dr Reema R Mody
Email: reema.mody@tpna.com