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# Asia Pharma 2016 : Smart nano and nano-in-microparticles carrier systems for controlled pulmonary drug delivery - Ibrahim M El-Sherbiny - Zewail City of Science and Technology

**Ibrahim M El-Sherbiny**

Zewail City of Science and Technology, Egypt

A substantial body of research has focused recently onto pulmonary drug delivery as a well-accepted treatment for many lung diseases. This work was aiming to develop and evaluate (in vitro and in vivo) new series of carriers for controlled pulmonary drug delivery. The developed carriers combine the benefits of nanoparticles (NPs) and respirable/swellable microparticles while avoiding their shortcomings. The carriers are based on PEG-grafted-chitosan (PEG-g-CS) and cross linked with sodium tripolyphosphate and/or sodium hyaluronate in form of hydrogel NPs. Drug-loaded hydrogel NPs were then used to develop respirable/swellable 2-5 microns size microparticles (MPs) through controlled spray drying of an aqueous suspension of the NPs and lactose as excipient. Particle size was determined by laser diffraction and DLS. Surface morphology was investigated by AFM and SEM. In vitro aerosolization was performed using a Next Generation Impactor. Dynamic swelling, in vitro biodegradation, particle density and moisture contents were also determined. In vitro release profile of the loaded drug was investigated in simulated body fluids. In vivo investigation of the drug was also performed using insufflation method. The average sizes of the PEG-g-CS NPs and MPs were found to be 83.2±2.4 nm and 4.1±0.03 µm, respectively. The NPs-MPs carriers showed high swelling within few minutes, low aerodynamic density (0.2±0.03 g/cc), moisture content of 4.1- 9.0%, good in vitro biodegradation, high drug loading capacity exceeding 93% and a promising sustained drug release both in vitro and in vivo. In conclusion, the newly developed NPs-MPs systems are very promising and could be utilized as potential carriers for sustained delivery of various drugs to the lung.

Since ancient times, humans have widely used plant-based natural products as medicines against various diseases. Modern medicines are mainly derived from herbs on the basis of traditional knowledge and practices. Nearly, 25% of the major pharmaceutical compounds and their derivatives available today are obtained from natural resources. Natural compounds with different molecular backgrounds present a basis for the discovery of novel drugs. A recent trend in the natural product-based drug discovery has been the interest in designing synthetically amenable lead molecules, which mimic their counterpart's chemistry .Natural products exhibit remarkable characteristics such as extraordinary chemical diversity, chemical and biological properties with macromolecular specificity and less toxicity. These make them favorable leads in the discovery of novel drugs. Nanotechnology is shown to bridge the barrier of biological and physical sciences by applying nanostructures and nanophases at various fields of science,specially in nanomedicine and nano based drug delivery systems, where such particles are of major interest . Nanomaterials can be well-defined as a material with sizes ranged between 1 and 100 nm, which influences the frontiers of nanomedicine starting from biosensors, microfluidics, drug delivery, and microarray tests to tissue engineering .Nanotechnology employs curative agents at the nanoscale level to develop nanomedicines. Nanostructures stay in the blood circulatory system for a prolonged period and enable the release of amalgamated drugs as per the specified dose. Thus, they cause fewer plasma fluctuations with reduced adverse effects. Being nanosized, these structures penetrate in the tissue system, facilitate easy uptake of the drug by cells, permit an efficient drug delivery, and ensure action at the targeted location. The uptake of nanostructures by cells is much higher than that of large particles with size ranging between 1 and 10 µm. Hence, they directly interact to treat the diseased cells with improved efficiency and reduced or negligible side effects. At all stages of clinical practices, nanoparticles have been found to be useful in acquiring information owing to their use in numerous novel assays to treat and diagnose diseases. The main benefits of these nanoparticles are associated with their surface properties; as various proteins can be affixed to the surface. For instance, gold nanoparticles are used as biomarkers and tumor labels for various biomolecule detection procedural assays. The alkaloids, flavonoids, tannins, terpenes, saponins, steroids, phenolic compounds, among others, are the bioactive molecules found in plants. However in most of the cases, these compounds have low absorption capacity due to the absence of the ability to cross the lipid membranes because of its high molecular sizes, and thus resulting in reduced bioavailability and efficacy. The scientific development of nanotechnology can revolutionize the development of formulations based on natural products, bringing tools capable of solving the problems mentioned above that limits the application of these compounds in large scale in the nanomedicine. Utilization of nanotechnology techniques in the medical field has been extensively studied in the last few years . Hence these can overcome these barriers and allow different compounds and mixtures to be used in the preparation of the same formulation. In addition, they can change the properties and behavior of a compound within the biological system . Besides, bringing benefits to the compound relative to the solubility and stability of the compounds, release systems direct the compound to the specific site, increase bioavailability and extend compound action, and combine molecules with varying degrees of hydrophilicity/lipophilicity. As nanomedicines gain popularity, their affordability would be another area of research that needs more research input. Finally, the regulation of nanomedicines, as elaborated in the previous section will continue to evolve alongside the advances in nanomedicine applications. Since the 1990s, the list of FDA-approved nanotechnology-based products and clinical trials has staggeringly increased and include synthetic polymer particles; liposome formulations; micellar nanoparticles; protein nanoparticles;

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nanocrystals and many others often in combination with drugs or biologics. Even though regulatory mechanisms for nanomedicines along with safety/toxicity assessments will be the subject of further development in the future, nanomedicine has already revolutionized the way we discover and administer drugs in biological systems. Thanks to advances in nanomedicine, our ability to diagnose diseases and even combining diagnosis with therapy has also become a reality.

**Biography:**

Ibrahim M El-Sherbiny has earned his PhD in Smart Drug Delivery in 2007 from Massey University, New Zealand. He has joined the University of New Mexico as a Post-doctoral fellow, then Texas University, USA as Research Assistant Professor. He is currently a Professor of Nanomaterials and Director of the Center for Materials Science at Zewail City of Science and Technology. He has more than 50 papers in reputed journals and same number in international conferences. He is the author of three books, twelve book chapters and more than eight review articles. Besides, he is a named inventor on more than fifteen patents.

ielsherbiny @zewailcity.edu.eg