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Editorial

Emerging trends in pharmaceutical sciences: An introduction to Nanotechnology

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Pharmacy is the science or practice of preparing and dispensing medical drugs. Knowledge about the properties of medicine is not new to world, though earlier there were no separate professions of a doctor and a pharmacist. The introduction of complex compounds into medicines, particularly in the last two Centuries, resulted in pharmacy becoming a specialized work. The 21st Century with rapid advances in medicines, makes the management of medicines of a patient a far more complex task. The work of pharmacist in the medical field has become multifaceted, extending from the manufacturing of quality medicines, to the delivery of pharmaceutical care to patients. The pharma industry has to respond to the emerging patterns of diseases and to growing concerns about disease causing agents becoming resistant to existing drugs. This necessitates new drugs, requiring increased focus on research and development including in the newer frontiers of medicine like bio-technology.

Nanotechnology (NT) is defined as the "intentional design, characterization, production, and applications of materials, structures, devices, and systems by controlling their size and shape in the nanoscale range (1-100 nm)."[1] Due to their similarity in scale to biological molecules (e.g. mutated genes and misfolded proteins) and systems nanomaterials can be engineered to perform various potential medical applications. The emerging field of nanomedicine uses the characteristics and properties of nanomaterials at the molecular level, for the diagnosis and treatment of diseases. Nanomaterials are designed in a way that aid to mediate molecular interactions; to the transport of diagnostic/therapeutic agents through biologic barriers; and to detect molecular changes in a highly sensitive manner. They have a high ratio of surface area to volume as well as different physical, chemical and biological properties which are being incorporated into new generations of drug-delivery vehicles, contrast agents, and diagnostic devices. Cancer is a leading cause of morbidity and mortality worldwide, with recent advancements resulting in modest impacts on patient survival. NT based therapeutics represent a new era of "cancer nanomedicine". This involves favorable pharmacokinetics and capitalization on cellular and molecular targeting leading to enhanced efficacy, specificity, and safety of the therapy. Adaptation of nanomaterial in the form of medicine

(nanomedicine) should be on the basis of specific property indications may confer unique advantages. This will reduce the cost of translating new drugs to the clinic. In this regard strategy of combinatorial nanomedicine may also be able to increase the clinical acceptance of nano. Early detection/treatment of cancers, increased biocompatibility, active and passive disease targeting, and multifunctionality about therapeutic capability are the potential benefits to medical applications offered by NT to allow simultaneous disease monitoring and treatment [1].

Novel and traditional chemotherapeutics suffer from non-specific distribution, with only a small fraction of drugs reaching the tumor. Due to their size and functionalization with biomolecules it is possible to target nanoparticles to specific organelles within certain tissues/cells. If there is any issue about solubility and stability of nanostructures it can be easily overcome through surface wrappings/modification or additional formulation on them. Nanomaterial is in nanosize and composed of thousands of atoms with a high surface area so that producing a higher therapeutic payload at the target site. After delivery and recognition by a receptor more devastating damage to cancer cells occur at the targeted site due to the high-dose therapeutic load at the site. Due to their specific delivery nanoparticles significantly reduces the nonspecific toxicity in the body. Injected materials suffer from sequestration by the reticuloendothelial system of the body which is comprised of monocytes and macrophages that clear foreign materials [2]. This result into accumulation of drugs in healthy organs, with their inherent toxicity for example the case of doxorubicin, a cytotoxic drug (DNA intercalator) results in cardiotoxicity [3]. Taken together several factors such as abnormal blood flow in and around tumors, interstitial pressure gradients, and cellular/nuclear membrane traversals preclude the curative potential of anticancer drugs, warranting more effective ways to deliver them to tumors. Liposomes, polymer micelles and dendrimers are the established nanoparticle platforms for anticancer drug delivery. Liposomes consist of a hydrophobic membrane and an aqueous core accommodating hydrophilic drugs while polymer micelles consist of a hydrophilic corona and a hydrophobic core encapsulating lipophilic drugs. On the other hand dendrimers composed of multiple branches radiating from a central hydrophobic core. Food and Drug Administration (FDA) approved many organic (Doxil, Abraxane, ThermoDox, and Rexin-G) and inorganic (Aurimune, and Auro- Lase) material based nanomedicines presumably due to better biocompatibility and the low/no toxicity [4, 5]. Doxil, Myocet, and DaunoXome are the potent cytotoxic agents for various types of cancers. They are liposomal anthracyclins manufactured by NT based on the liposomal encapsulation of the nanomaterial. Doxil (a liposomal formulation of doxorubicin) was approved by the FDA in the mid-1990s and demonstrated a decreased cardiotoxicity compared with free doxorubicin.

Besides cancer cardiovascular disease (CVD) has been one of the leading causes of mortality and accounts for virtually one third of all deaths in the world. Therefore, there is urgent need to develop novel techniques such as nanotechnology for the early detection and treatment of the CVD. Endothelial selective delivery of therapeutic agents provides a useful tool for modifying vascular function in CVD. It is reported that GPIb (Glycoprotein Ib) conjugated DPLGA (poly-d,llactic-co-glycolic acid loaded with dexamethasone) nanoparticles could be used as a targeted and controlled drug delivery system to the site of vascular injury for treatment of cardiovascular diseases. GPIb have role in platelet adhesion to the vascular wall under high shear flow conditions. Conjugated GPIb-DPLGA nanoparticle complex increased particle adhesion onto targeted surfaces and cellular uptake of these nanoparticles by activated endothelial cells under shear stresses. Dexamethasone loaded, GPIb-conjugated PLGA nanoparticles may be used as a targeted and controlled drug delivery system to the site of vascular injury for treatment of CVD [6]. The ability to detect and treat diseases is the main concern of clinical medicine. With the advantage of nanotechnology, and the generation of multifunctional agents, it becomes possible to perform both actions simultaneously. Nanomedicine approaches keep great promise in revolutionizing therapeutic and diagnostic modalities in the clinical treatment of diseases.

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