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Review Article

Nanomedicines and Its Applications in the Healthcare

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Abstract: Nanomedicine is the advanced application of nanotechnology in the healthcare fields and it is one of the key technologies of the 21st century. A nanomedicine can be defined as the advanced applications of nanotechnology for the treatment, diagnosis, monitoring, and control of biological systems. Different sorts of nanocarrier (nanoparticles) are used for the manufacturing and to help delivery of target medicines. The term "nanomedicines" covers a number of materials and structures, for example, proteins, dendrimers, micelles, liposomes, polymers, emulsions, nanocapsules, nanoparticles, etc. Nanoparticles contain some exclusive properties and they can be used in conjunction with therapeutic components to facilitate the diagnosis and treatment of debilitating diseases like cancer, diabetes and so on. As the human body is comprised of different types of molecules; the availability of molecular nanotechnology permits dramatic progress in human medical services. Nanomedicines provide vital scope for medical profession, primarily for the diagnosis and treatment of diseases, and eventually for the improvement of knowledge of natural human biological systems and its functions. It is a developing group of therapeutics that involve the understanding of phenomena on the nanometer scale. Nanomedicines research needs expertise in a range of diverse fields (Life Sciences, Physics & Chemistry) and requires multidisciplinary team members. Future applications of nanomedicine in medical science will be reflected by using nanorobots for detection and treatment of various diseases.

Keywords: Nanomedicine, Nanotechnology, Nanoparticles, Nanorobots, Drug Delivery

1. Introduction

The term 'nano' is derived from the Greek word for 'dwarf' and is used to describe structures and objects that are sized within the scale of 1 to 100 nanometers. Nanotechnology is rapidly becoming a reality that allows the creation of new materials for a wide collection of purposes ranging from medical, electronic, biomaterials, to even energy production. Nanomedicine is the advanced medical applications of nanotechnology. Moreover, nanomedicine is an extensive and exciting field with almost endless possibilities, along with the feasibility for nanotechnology being used for applications ranging from the use of nanomaterials, nanoelectronic biosensors and has a wide range of future applications of molecular nanotechnology [1, 14, 18]. Medicine is one of the prominent arenas of nanotechnological revolution that escorted medical scientists toward new authentic methods which study pathologies and explore appropriate therapeutic applications by utilization of nanotechnology to operate on more specific molecular targets and to reduce the adverse risks and side effects that conventional methods enforce on patients [2]. Nanomedicine has a multidisciplinary nature that comprises the ideas and techniques derived from biology, chemistry, and physics [9]. It is used for the diagnosis, monitoring, treatment, and control of biological systems and nanoparticles are used to improve the effect of drug substances. It is used for better treatment of patients suffering from numerous complex diseases like cancer, kidney diseases, fungal diseases, multiple sclerosis, chronic pain, diabetes and so on. Low bioavailability, low solubility and inappropriate paths of drug molecules delivery led to the advancement of nanomedicines [1-4]. Nanomedicines identify target cells and receptors associated with specific disease and provide quick and safer treatment with minimizing the side effects. As nanomedicines provide targeted drug delivery, it is used to overcome the

problem of conventional drug delivery methods [3].

2. Discussion

2.1. Current Fields of Nanomedicine

Nanomedicines have a wide field ranges from the medical applications of nanoparticles to biosensors for the early detection and treatment of diseases:

1) Nanodiagnostics: (A). Nanobiosensor, (B). Nanoendoscopy, (C). Nanoimaging, (D). New assay method development, (E). Enhancing the limit of detection of existing diagnostic technologies.
2) Nanopharmaceuticals: (A). Nanoparticulate formulation of drug, (B). Nanotechnology-based drug discovery, (C). Nanotechnology-based drug delivery.
3) Regenerative medicine: (A). Tissue engineering, (B). Transplantation medicines, (C). Exosomes for drug-free organ transplant.
4) Nanomedicine specialties: (A). Nanocardiology, (B). Nanomicrobiology, (C). Nanodermatology, (D). Nanonephrology, (E). Nanodentistry, (F). Nanoneurology, (G). Nanogerontology, (H). Nanooncology, (I). Nanohematology, (J). Nanoophthalmology, (K). Nanoimmunology, (L). Nanoorthopedics.
5) Implants: (A). Bioimplantable sensor, (B). Nano-coated steins in coronary arteries, (C). Nanopumps for drug delivery, (D). Nanoeclectrode in in the brain for functional neurosurgery.
6) Neurosurgery: (A). Minimally invasive surgery, (B). Neurosurgery by integration of nanoparticles and external energy.
7) Nanorobotic treatment: (A). Vasculary surgery, (B). Detection and destruction of cancer, [10, 23].

2.2. Nanoparticles Used in Nanomedicines

Nanoparticles contain good characteristics and a wide variety of nanoparticles are used for the manufacturing of nanomedicines, for instances, (i). Carbon/diamond nanoparticles, (ii). Quantum dots, (iii). Polymer based nanoparticles, (iv). Lipid based nanoparticles (e.g. liposome), (v). Metal based nanoparticles, (vi). Magnetic nanoparticles, (vii). Solid lipid nanoparticles, (viii). Viral nanoparticles, (ix). Ceramic nanoparticles, (x). Dendrimers, (xi). Nanospheres, (xii). Micelles, (xiii). Nanoemulsions, (xiv). Albumin nanoparticles [11, 13, 15, 16, 18, 24, 25].

2.3. Objective of Nanomedicines

The main objectives of nanomedicine drug delivery include:

a) Emerging systems that improve the solubility and bioavailability of hydrophobic drugs.
b) Reducing toxicity: very lower doses of highly targeted drugs means less systemic toxicity.
c) Designing delivery career that can improve the circulatory presence of drugs, for example, protein-based drugs which are difficult to intake orally due to their degradation in the alimentary tract before they reach their target site of action.
d) Designing mechanisms for target drugs to specific cells or tissues.
e) Enhancing specificity: To destroy or kill target individual pathogens or biomolecules.
f) Developing sustained and controlled drug delivery systems for slow release to maintain a level therapeutic dose.
g) Developing new nanostructures for specific applications, for instance, ocular, wound management, diagnosis of diseases, cancer therapy, neurology, orthopaedics, [5].

2.4. Applications of Nanomedicine

Nanomedicines, coupled with nano-sized devices, are used for the diagnosis, prevention and treatment of disease and to advance increased understanding of the complex patho-physiology of disease. Nanomedicine has significant applications in medical sciences for the detection and treatment of diseases. The ultimate goal of nanomedicine is to improve the quality of human life [6]. Nanomedicines have a number of advanced applications, for example, (i) Imaging and identification of cells, (ii) delivering medicine in exact location, (iii) destruction of bacteria, viruses and cancer cells, (iv) repairing of damaged cells, (v) early detection and treatment of cancer, (vi) ophthalmic treatment, (vii) protein and peptide delivery, (viii) detection of diabetes (Nanobiosensor) [3, 8, 10, 12-15, 17, 19, 20, 22-25].

2.5. Advantages of Nanomedicine

Nanomedicines exhibits a number of advantages like-

(a). Exhibits targeted drug delivery, (b). Prolonged and controlled drug release, (c). Less side effects, (d). Easy to detect diseases, (e). Nanomedication generally do not need surgery, (f). Disease can be cured faster, safer and more accurate with nanomedicine, (g). Improved bioavailability, (h). Protect degradable drugs, (i). Molecular targeting by nano engineered device, (j). Do not occlude blood to brain and intracellular compartment, (k). In larger scale production is possible [3, 5, 13, 16, 21].

2.6. Disadvantages of Nanomedicine

Although nanomedicines provide a wide variety of advantages, nevertheless, it has a few disadvantages with respect to cost, difficult to implementation and poor miscibility of some drugs with the polymer carrier [3, 6, 21].

2.7. Future of Nanomedicines

Nanomedicine is improving the public health by providing targeted drug delivery, improve drug solubility, extend drug half-life, improve a drug's therapeutic index, and reduce a drug induced immunogenicity. Active involvement of public health professionals is required to maximize individual improvements and population health as a whole [3]. Future applications of nanomedicine in medical science will be founded on the ability to create nanorobots. Actually, these sort of nanorobots can be programmed to rectify specific diseased cells of patients, functioning like antibodies in human natural healing processes.

Human health system has always been determined on the nanometer scale and the practical impact of nanoscience on human health will be massive [7, 18]. CytImmune is one of the largest companies conducting research on nanomedicines for cancer treatment. CytImmune, a successful diagnostics company, established in 1988, changed into a clinical stage nanomedicine entrepreneur with a prime focus on the invention, development and commercialization of nanomedicines [8].

3. Conclusion

Nanotechnology plays a vital role in the development and manufacturing of nanomedicines. Nanomedicine has created new field of therapeutic, diagnostic and molecular exploration, and ultimately to combat different diseases effectively. During manufacturing of nanomedicines through nanotechnology, it is very important to ensure quality, safety and efficacy of particular product properly. Regulatory authority and health care professionals should inform patients elaborately about the advantages and disadvantages of nanomedicines with respect to cost-benefit and ensure the appropriate applications.

Authors declare that there is no conflict of interest associated with this work.

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