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Importance of Nanotechnology: A Review

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ABSTRACT: *Mostly drugs possess not only positive pharmacological effects, but also have toxic effects, making the concept of drug targeting very gorgeous. However, one of the important need for any kind of the production of nanoparticles is that the matrix should be recyclable. This review article presents importance, application, formulations and future perceptions of nanoparticles in pharmaceutical industry. The aim is to acknowledge the nanoparticles as highly growing application in pharmaceutical technology and drug delivery system.*

Key words: *Nanoparticles, pharmacy, drug, toxic effects*

INTRODUCTION

Nanoparticles used in pharmacological industry are the solids having submicron size (<100 nm), perform as drug carrier which might or might not be biodegradable. Nanoparticle is a collective term used for both nanocapsules and nanospheres. Nanocapsules are the medium system in which the drug is surrounded by a unique polymeric membrane, while nanospheres are system in which drug is uniformly dispersed. This present review focuses on Classification, health prospective, application and Pharmaceutical attributes of nanoparticles (Pal et al., 2011).

The change from microparticles to nanoparticles results into a number of changes in physical qualities. Therefore, nanotechnology was in great use and also appreciated in the fields of science. As the most drugs not only have positive pharmaceutical potential, but they also show toxic side effects. Nanoparticles were first synthesized around 1970. They were initially designed as carrier for vaccines and anticancer drugs (Pandey and

Ruby, 2014). Usually very persuasive chemotherapeutic agents, including camptothecin, platinating agents, taxenes and doxorubucin have been used extensively against various types of tumor for several decades. On the other hand, they have drawbacks of affecting both normal and tumor cells, with the associated side effects including cytotoxicity, neurotoxicity, cardiotoxicity, nephrotoxicity and ototoxicity. Several chemotherapeutic linked problems have been resolved by the use of nanoparticle formulations of the relevant drugs. Moreover, nanoparticles working as therapeutics carriers have specific properties of lower toxicity, elevated therapeutic efficiency and the capability to encapsulate and deliver less soluble drugs (Diaz and Vivas-Mejia, 2013). They are employed as targeted delivery system to release large and small molecules by altering their pharmacokinetic and pharmacodynamics specifications. Designing of nanoparticle is carried out by controlling their size, surface properties and delivery pattern (Kumar et al., 2015).

Pharmaceutical nanotechnology has given great insight in diagnosis and treatment of disease. Pharmaceutical nanotechnology is highly specialized and resourceful field, which may modernize the pharmaceutical production in near future. Pharmaceutical nanotechnology offers revolutionary prospects to cope with various diseases (Shankar et al., 2013). The effect of particle size on the pharmacokinetic parameters are also investigated to improve this technology (Agnieszka et al., 2012).

IMPORTANCE OF NANO-PARTICLES IN PHARMACY

Nanoparticles play vital role in pharmaceutical industry. They are very important in many ways like

1. Minimization of toxicity and incidence of unfavorable reactions
2. Controlled rate of drug release
3. Better drug utilization
4. Particular site for drug delivery
5. Better patient compliance and /or greater patient convenience
6. Improvement in the therapeutic efficacy of the drug
7. Method of preparation should be reproducible (Pandey and Ruby, 2014).

Importance of Nanoparticles in Drug Delivery

When the drugs are incorporated into nanoparticles by adsorption, physical encapsulation and chemical conjugation, the therapeutic index and pharmacokinetics of drugs can be appreciably improved as compared to the free drug counterparts (Singh et al., 2011). The most important technological improvement of nanoparticles used as drug carriers are their high carrier capacity, high stability, possibility of incorporation of both hydrophobic and hydrophilic substances, and feasibility of variable means of administration, including inhalation and oral application (Prabhakar et al., 2010).

Advantages of Nanoparticles

Various investigations have revealed that nanoparticles having sub-micron size possess a number of advantages over microparticles in drug release system. Drug release depends on particle size. Smaller particles possess larger surface area, thus, most of the drug related to the particle surface, leading to fast drug release (Mohanraj and Chen, 2006). Nanoparticle also possess following advantages.

- Improve the water solubility of the drug
- Increase the bioavailability of the drug
- Protect the drug from degradation
- Offer a targeted delivery of the drug
- Presents appropriate form for all routes of drug administration
- Reduce the toxic side effects of the drug

So, the toxicity and unwanted side effects of the therapeutic agent is minimized and the therapeutic efficacy is increased. Another potent function of nanoparticles is their capacity to deliver drugs to the target sites across biological barriers like the blood-brain barrier (Sachan and Singh, 2014).

Systemic toxicity can also be reduced by the direct delivery of the TB drug to the lungs which is the prominent advantage (Gelperina et al., 2005). As smaller the drug doses caused less toxicity (Pal et al., 2011). Drug delivery can be attained by intake of drugs into polymeric materials to control drug release at a predefined rate for a prolonged period of time (Dikmen et al., 2011).

Drawbacks of Nanoparticles

The synthesis of nanoparticle is very costly process which results in high product cost. Solvents used in the production of nanoparticles are toxic in nature which can result in allergic reactions in body. Frequent use of polyvinyl alcohol as stabilizer may also have side effects. Nanoparticles have larger surface area and smaller size, so they are handled with difficulty in physical form (Kumar, 2015). Low aqueous solubility of active pharmaceutical constituents presents a major problem while developing a final dosages form for drug belonging to classes 2 and 4 of the biopharmaceutical classification system (Margdassi and Margulis-Goshen, 2010).

Utilization of Nanoparticles in Pharmaceutical Field

In the therapeutic modulation, site-specific-targeted drug delivery is very important for effective dose of drug and disease control. It improves bioavailability, less toxic to other organs, minimal side effects, and is cost effective (Gelperina et al., 2005; Gwinn and Vallyathan, 2006).

Drugs are used in nanocapsulated form so that the drug is limited to an oily or aqueous core surrounded by a shell-like wall (Gelperina et al., 2005; Manish and Vimukta, 2011; Ranjit and Baquee, 2013). Pharmaceutical drugs of proteins and peptides are highly specific and potent in their physiological actions (Agrawal, 2012). Protein nanoparticles are widely used for the release of

anticancer drugs. Various strategies like surgery, chemotherapy, immunotherapy and radiation are used in the cancer treatment. Each of these treatment modalities has disadvantages and advantages. Different drug delivery carriers have been used to minimize the side effects and improve the efficacy of cancer treatment (Lohcharoenkal et al., 2014). The main purpose in designing nanoparticles as delivery system are to increase the saturation solubility of poorly soluble drugs by adopting control particle size with surface properties like charge either anion or cation (Gadad et al., 2014)

Challenges for Formulation and Delivery

The challenge of nanotechnology is to synthesize nanoparticles for biomedical applications (Marcato and Durán, 2008). The most important challenge is to release the drug at the right place in the body to avoid any possible side effect (Jong and Borm, 2008). Problems mostly occurring with many drugs are: less solubility, too low bioavailability, less shelf life, less half-life and lack of large scale production (Kumar et al., 2015). Moreover, extra advancement to control the burst release cause increase the duration of drug release (Mitragotri, 2014).

Nanoparticle for Gene Delivery

In gene therapy, a carrier molecule is used to replace an abnormal gene (disease causing) by a nomal gene. Conventional methods of viral vectors are linked with adverse inflammatory reactions and diseases in the host (Gwinn and Vallyathan, 2006). So, nanoparticles are used to follow biomimetic approaches (Pal et al., 2011).

Limitations

1. Full attention is required for safety and toxicological problems to use the Nanotechnology in pharmacy (Jong and Borm, 2008).

2. Delivery is expected to minimize with improving molecular weight of drug.

3. Difficult to incorporate drug in pathological condition like nasal congestion due to allergic reaction or cold.

4 The histological toxicity of various type of penetration enhancer used is not clearly known (Sachan and Singh, 2014).

CONCLUSION

The nanoparticles are used in diverse fields of engineering and technology from ancient time. Recently its growth is increased in the field of pharmaceutical technology. It is giving a new momentum in drug targeting and drug delivery system. Its application in reducing side effects and giving better bioavailability makes it present day formulation a great challenge. Nanoparticles have importance in pharmaceutical technology for economic, sophistication and better therapy separately or in combination.

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