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Advancements in Novel Drug Delivery Systems and Opportunities for Indian Pharmaceutical companies

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Commentary

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ABSTRACT

Though traditional systems used in development of various dosage forms to deliver the drugs have been in use, the evolution and modern trends in the science and technology insists the pharmaceutical companies to focus on the novel approaches. The Novel drug delivery systems have many advantages over the conventional methods. This commentary article on NDDS tries to provide answers to the following questions: What is meant by NDDS and various technological advancements in drug delivery systems to improve therapeutic efficiency, compliance and bioavailability? What are the applications of nanosystems in NDDS? And how does NDDS business in emerging markets like India contribute to the global business of pharmaceuticals?

INTRODUCTION TO NDDS

Traditionally pharmaceutical companies have used simple and fast reacting chemical compounds in various dosage forms. But in recent years because of improvements and advances in science and technology along with the competition in industry the companies have been forced to develop various novel approaches of drug delivery systems to improve the drug availability, safety, efficacy and patient compliance [1]. Novel drug delivery systems that enable the administration of drugs in different routes when compared to many traditional routes help in improving bioavailability of the drug either by changing its course of action, parameters of pharmacokinetics or by the patterns of release at the site of action, etc [2, 3]. Drug delivery has now become an interdisciplinary science by involving the studies of both biopharmaceutics and pharmacokinetics. The new systems that deliver drugs at specific site of action and at specific time have been developed by the contributions from different fields of science and technology [4].

Recent Advancements

In contrast to the traditional dosage forms, novel drug delivery systems aim to deliver the drug at a rate directed by the needs of the body during the period of the treatment, and channel the active entity to the site of action whereby reducing the side effects in other locations. This new approaches involve various routes of administration, to achieve controlled and targeted drug delivery by encapsulation of the drug in systemic circulation which reduces the tonicity and selective uptake of drug leading to the development of a number of vesicular drug delivery systems such as liposomes, niosomes, transferosomes and pharmacosomes, etc [5]. These novel systems are also abuse-deterrent and tamper-resistant formulations unlike their predecessors and even help in the delivery of insulin directly into the brain by overcoming blood-brain barrier to treat complex diseases like Alzeimer's. Prodrug concept is also

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used in novel formulation which is involved in the drug development process in order to ensure improved bioavailability, reduced toxicity and quick elimination of the parental drugs [6, 7].

Use of Polymers

These modern drug delivery technologies have many advantages like modifying drug release profile, absorption, distribution of drugs inside the body and elimination of the drug out of the body. Such systems often use synthetic biodegradable polymers as carriers for the drugs and bioactive materials and have proven their potential for the development of new, advanced and efficient drug delivery system. Several types of polymers have been investigated as potential drug delivery systems, including nano and micro-particles, dendrimers, nano and micro-spheres, capsosomes and micelles. In these systems, drugs can be encapsulated or conjugated into polymer matrices to control the drug release [8]. Controlled drug delivery technology represents one of the most rapidly advancing areas of science in which chemists and chemical engineers are contributing to human health care. From a polymer chemistry perspective, it is important to appreciate that the mechanisms of controlled-release require polymers with a variety of physico-chemical properties. Targeting antiretroviral encapsulated in lipid or polymeric nanoparticles (Eg. stavudine coated and uncoated lipid nanoparticles) helps in overcoming the problem of HIV therapy using nanoparticles to deliver the drug at target site like spleen, brain, bone marrow etc [9].

Use of Liposomes

Another major and important advancement in the novel drug delivery systems is the use of liposomes for carrying the drugs to the site of action. Liposomes in both modified and unmodified forms are able to change the course of pharmacokinetic parameters of the drugs. These are widely used in delivering the cytotoxic agents to the tumour tissue and preventing side effects like myelosuppression. These are also used in targeting through receptor-mediated endocytosis. Modified liposomes also have huge applications in targeting various drugs to the organs like heart, liver, kidney, lungs and bones [10].

Role of Nanotechnology

This field of pharmaceutical technology has grown and diversified rapidly in recent years and emerged tremendously from macro level to micro level and currently growing at molecular level i.e. nano level. The importance of technology in the field of pharmaceutics and medicine has been ever growing due to the changing trends of developing drugs and drug delivery systems [11]. The use of technology helps in designing and developing better medications and their therapeutic efficiency. Nano technology offers a multitude of applications in the field of medicine and pharmaceutics such as use of nano-materials and nano-electronic biosensors. Nano-medicine helps in early detection and prevention, improved diagnosis, proper treatment and follow-up of complex diseases like diabetes, cancer, Parkinson's disease, Alzheimer's disease, cardiovascular diseases and multiple sclerosis as well as different kinds of serious inflammatory or infectious diseases such as HIV [12]. Another important milestone in the field of nanomedicines is the application of Magnetic nanoparticles in diagnosis and treatment of cancer. Two types of cancer detecting nanoparticles are gold nanoparticles and magnetic iron oxide nanoparticles encased in a biocompatible material. These nanoparticles can make detecting cancer cells easier, even in the early stages of the disease by sticking to the tumor cells turning them into little magnets which are then attracted to the tip of a biopsy needle [13].

Nanotechnology in some novel drug delivery systems like Ocular drug delivery has been used to enhance the bioavailability by overcoming the drawbacks of the conventional dosage forms. This is possible due the capacity of the nanocarriers to protect the encapsulated drug molecule and transport it to various areas of the eyes [14 - 16].

Challenges

Though the application of nanosystems seems advantageous over conventional drug delivery systems there are significant amount of challenges which include complex regulatory issues that concern with efficacy, toxicity and quality of the encapsulated drug, lack of studies in human, *in vivo* instability,

complexity in lab-scale processes, long-term instability and the differences among the policy frameworks. Additionally, the requirements of nanosystems are different depending on the route of administration. However, a significant number of clinical trials have been conducted to fulfill the essential prerequisite to make them viable [17]. Liposomes mediated drug delivery faces the challenges that it is impossible to for them to cross most regular pellicle barriers due to their imposed size [8].

Future Prospects and Opportunities in India

India is one of the most strategic regions for the pharmaceutical market. Therefore many multinational giants have been keen to invest and grow preferentially in this sector. Developments in the new and advanced techniques in the field of NDDS will create huge demand for variety of excipients usage and development. India is well known for its quick adaptability to new excipients and associated technologies. So market for excipients in India will grow on two aspects; one is in the form of exporting new organic excipients and the second one in the form of employing new excipients in various advanced delivery technologies [18]. Majority of the pharmaceutical companies in the country have been applying and receiving new patents in the field of the Novel drug delivery systems. This eventually, in the near future derives huge demand for the products and services offered by pharmaceutical and allied businesses [19]. Nanotechnology offers various modern applications in novel drug delivery systems that potentially improve the diagnosis, treatment and help monitoring of post-administration transformation of drug composition within the body systems [20]. Another important milestone to be mentioned here is Computer aided Drug Design, which offers a lot of scope for the development of this kind of novel and advanced systems. Computer aided Drug Design helps in designing and developing the drugs and delivery systems consuming less time and resources with more accuracy and quality compared to traditional methods [21 - 23].

CONCLUSION

The advancements in the field of NDDS are helpful in overcoming various problems and challenged offered by the traditional systems and have been able to provide solutions to enormous questions that were remained unanswered until very recent years. Although there are some challenges with the current trends, the technology and science have many future prospects that enable the healthcare professionals to develop even better applications to serve the human kind.

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