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Editorial Open Access

Significance of Polymers in Drug Delivery System

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Editorial

In the recent past, there has been advancement in state-of-the-art therapies utilizing biopharmaceuticals, like proteins, peptides, nucleic acids and bioactive molecules, as therapeutics for diagnosing diseases. These novel drugs require refined drug delivery system which can be used to improve their pharmacokinetics and pharmacodynamic properties as well as enhance cell/tissue specificity and biocompatibility. In this regard, the development of new drug delivery systems and mechanisms to control them is mandatory which has led to the progress in the next generation of drug delivery system [1]. The development in the biomedical sciences has substantially influenced the design and growth of novel and smart drug delivery systems for more controlled and target-based drug usage. The high-tech drug delivery system is one of the fastest emerging sectors of the pharmaceutical market costing around $ 134.3 billion in 2008 and approximately $ 196.4 billion in 2014. The chief section of it is controlled and target-based drug delivery which has reached $ 50.9 billion in 2009 [2].

During the last four decades, controlled drug delivery has become one of the most demanding and fast progressing scientific areas. It can provide several advantages in comparison to traditional dosage forms, such as better absorption rates and biocompatibility, cell and tissue specific targeting of drugs, safety of the drug against degradation by proteolytic enzymes, control of drug concentrations in the body over longer duration, within the therapeutic range [3]. However, the most encouraging possibility for controlled drug delivery is provided by polymers because of their favorable, flexible characteristics, can be easily produced at industrial scale and potential for additional alteration [4].

Polymers play a vital role in the progression of drug delivery technology by offering repeated dosage, release of both type of drugs (i.e., hydrophilic and hydrophobic), in a synchronized manner and constant release of formulations over extended periods. Polymer therapeutics include linear or branched polymer chain works either as the bioactive molecule, e.g., polymeric drug or as the inert carrier to which a drug can be covalently linked, e.g., polymer-drug conjugates, polymer-antibody conjugates, polymer-DNA conjugate, dendrimers, polymeric micelles, nanocapsule, nanosphere and multicomponent polyplexes [5]. The polymers for drug delivery are logically classified based on the following characteristics: (i) Origin- The polymer can be synthetic, natural, or a combination of both. (ii) Chemical nature- It can be polyester, polyanhydride, protein-based, cellulose derivatives, etc. (iii) Backbone stability- The polymer can be biodegradable or non-biodegradable. (iv) Solubility- the polymer can be hydrophilic or hydrophobic [6,7] in nature. However, all the above-mentioned features have their own limitations, such as natural polymers, although most abundant and biodegradable, are difficult to reproduce and purify. Synthetic polymers have high immunogenicity, which prevent their long-term usage. Non-biodegradable polymers are needed to be removed by surgery after they release the drug at the targeted site. The general characteristic features that makes the polymer a potential candidate for drug delivery include safety, efficacy, hydrophilicity, absence of immunogenicity, biological inactivity, sufficient pharmacokinetics, and the presence of functional groups for covalent conjugation of drugs, targeting moieties, or formation of copolymer [8].

There are several advantages of polymer acting as an inert carrier to which a drug can be conjugated, for example, the polymer improves the pharmacokinetic and pharmacodynamic properties of biopharmaceuticals through various ways, such as, increases the plasma half-life, decreases the immmunogenicity, boost stability of biopharmaceuticals, improves solubility of low molecular weight drugs, and has potential for targeted drug delivery [9-11]. The polymer conjugates have targeted various diseases, such as rheumatoid arthritis, diabetes, hepatitis B and C, cancer and ischemia [12].

The polymer-based drug delivery system is divided into various categories, such as, diffusion-controlled, chemically-controlled (biodegradable), externally-triggered systems (e.g., pH, temperature) [13], solvent-activated [14] and nanosized polymer-based delivery systems that implements three main technologies [15]: (i) PEGylation [16,17], (ii) active cell and organ specific targeting [18-20] and (iii) passive targeting by use of the Enhanced Permeability and Retention (EPR) effect [20,21]. The nanosized particles include coated nanoparticles, pegylated nanoparticles, Solid Lipid nanoparticles (SLN) and nanogels. Besides this, more advanced multifunctional polymer-based drug delivery systems are being envisioned as multifunctional all-in-one systems which will provide instantaneously better pharmacokinetics, reduced toxicity, expedited targeting, and a programmed profile of drug release. In addition, more effective treatment could be offered through combination therapy involving delivery of two or more drugs/diagnostics agents simultaneously [22-24].

However, there are some major challenges in using polymers as drug delivery vehicle that are needed to be addressed. For example, all kind of polymers has some level of heterogeneity. Each polymer-drug conjugate molecule differs in regard to molecular weight, drug loading and subsequent conformation. Also, the complexities in synthesis and characterization increases as the conjugates become more complex (i.e. multifunctional nanomedicines). Hence it is crucial that the disparities in such properties should be minimized in order to fulfil stringent regulatory criteria and the polymeric conjugates must be synthesized in a reproducible manner. The validated methods for physiochemical characterization must also be established to certify the quality of reproducible product. The amount of drug release is directly proportional to the efficacy and safety of polymer-drug conjugates, therefore novel approaches such as the design of better linker

chemistries will be helpful in facilitating further improvement of polymer-drug conjugates [25].

In the past two decades, the arena of polymer therapeutics and the rational design of polymer-drug conjugates have seen expanding very swiftly with rise in the number of candidates presently under clinical trial. There has been plethora of development in the area of polymers' structural design and their chemistries. Novel uses of polymer-drug conjugates are being recognized. There is a dire need of multidisciplinary collaboration between polymer chemists, medicinal chemists, pharmaceutical scientists, biologists, and clinicians for the design, advancement, and clinical rendition of polymer diagnostics and polymer-drug conjugates. This is critical for the persistent growth of this field and will continue to harvest accomplishment in the synthesis of novel biopharmaceuticals and further benefit in the development of controlled and site- specific drug delivery technologies which will be of great assistance to the health care of the people suffering from ailing diseases.

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