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A Review on Nanoparticles in Targeted Drug Delivery System

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Review article

Abstract

To improve the pharmacokinetic and pharmacodynamics activity of the drug medication system like nanoparticles has made a break through by means of physical application. By means of targeted drug delivery system the targeted drug delivery will be achieved quickly.

To maintain a controlled and sustain the rate of drug exposure on the site of action nanoparticles are used. That's the reason why the nanotechnology became as the most advanced in the field of medicine by maintaining the therapeutic benefits.

Scientists performing many trails in the field of nanotechnology to reformulate the existing essential drugs to minimize the adverse effects and to increase the therapeutic effects. Some of the innovative concepts like nano-delivery, sustain release, etc have already became a breakthrough. The main concept of the paper is to elevate the basic concepts to use in the field of nanoparticles preparation and advantages.

Keywords: Nanoparticles, Site specificity, Targeted drug delivery system

Introduction

Nanotechnology is the science which deals with small; the very small particles. At the NANO size, atoms and molecules exhibits surprising and interesting outcomes by working differently which results in various scientists to concentrate on these to use in many fields like medical, Pharma, engineering etc[1-3]. Delivering therapeutic compound to the target site is a noteworthy issue in treatment of many diseases. Many conventional dosage forms failed in vain in delivering the drug at specific site of action due to its limited effectiveness, poor bio-distribution, and lack of selectivity. These limitations and draw backs can be overcome by novel drug delivery systems [4]. Through novel drug delivery systems various drugs can be delivered to the desired (specific) sites showing its pharmacological activity by minimizing side effects. More over novel drug delivery systems protects drug from rapid degradation and maintains drug concentration at specific sites or in target tissues hence lower doses of drug are required [5-9].

Nanostructures have the ability to cross the cell and tissue barriers as its particle size is very small which makes them widely applicable in biomedical sciences [10].

Advantages

The Novel drug delivery system (Nanoparticles) is used to deliver drugs through oral, nasal, parenteral, intra-ocular etc.

Through nanoparticles particle size can be easily altered resulting in attaining both active and passive drug targeting after parenteral administration became the most advantageous in the treatment of many chronic diseases [11,12].

Nanoparticles have the ability to control and sustain the drug before reaching the specific site of action and protects drug from rapid degradation and maintains drug concentration at specific sites or in target tissues hence with lower doses of drug shows high therapeutic efficacy and reduced side-effects.

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One more important advantage of nanoparticles is high levels of drug can be incorporated without any chemical reaction resulting in the preservation of pharmacological activity of the drug [13-15].

Applications

Used in targeted drug delivery (therapy) to brain and cancer therapy [16-18]

Drug and gene delivery

Bio detection of pathogens

Detection of proteins

Biomarker mapping

Probing of DNA structure

Tissue engineering

Destruction of tumours through heating process (hyperthermia)

Separation and purification of biological molecules and cells

MRI contrast enhancement

Phagokinetic studies

Limitations

In spite of many advantages nanoparticles have some limitations which make researches to work more on it to attain even more best therapeutic efficacy with lesser side effects [19].

Aggregation of particles may takes place due to its altered physical properties especially in liquid and dry forms because of its smaller particle size and larger surface area.

Due to its particle size (smaller) and larger surface area nanoparticles are very reactive in the cellular environment [20,21].

Drug loading and burst release is limited because of its smaller particle size.

Evaluation of Nanoparticles

Zeta potential

Zeta potential is the potential difference existing between the surface of a solid particle immersed in a conducting liquid (e.g. water) and the bulk of the liquid [22]. The surface charge of the nanoparticles is usually measured by Zeta potential. Particles with above ± 30 Mv zeta potential were stable in suspension form as their surface charge prevents aggregation of particles [23-27].

Particle Shape

Particle shape of the nano suspensions is determined by scanning electron microscopy (SEM)[28,29]. Inorder to form the solid particles these Nano suspensions were subjected to lyophilisation. Thus formed solid particles are coated with platinum alloy using a sputter coater [30].

Particle size

Particle size and its distribution is important characteristics in nanoparticles as they plays a major role in distribution, pharmacological activity, toxicity and targeting to specific sites (site specificity)[31-33]. On the other hand drug loading capacity, percentage of drug release and stability of the nanoparticles also depends on its particle size and distribution [34]. Advanced methods to determine the particle size of nanoparticles is by photon-correlation spectroscopy or dynamic light scattering. The results thus obtained were examined by scanning electron microscopy (SEM)[35].

Drug Entrapment Efficiency

Ultracentrifuge the nanoparticles at 10,000 rpm for 30 min and maintain temperature at 50C in order to separate them from aqueous medium [36]. To remove the unentrapped drug molecules the supernatant was decanted and then it is dispersed into phosphate buffer saline pH 7.4[37,38]. Repeat twice the procedure for complete removal of

unentrapped drug molecules. The difference between the amount of drug used to prepare nanoparticles and amount of drug present in the aqueous medium gives the amount of entrapped drug into the nanoparticles [39-43].

Drug Entrapment efficiency (%) = Amount of drug released from nanoparticles after centrifugation/Total amount of drug used to prepare nanoparticles.

Preparation of Nanoparticles

Nanoparticles were prepared from a wide variety of materials and polymers. Materials like polysaccharides, proteins whereas polymers like synthetic polymers. Selection of the matrix materials should be done based on many factors like nanoparticle size, properties of drug like solubility of the drug in aqueous medium and drug stability, permeability and charge of the drug molecules, extent of biodegradability, biocompatibility and toxicity and drug release profile[44].

Preparation of nanoparticles has been done by three methods

Dispersion

This method is the most common method to prepare the bio degradable nanoparticles from poly lactic acid, poly D,L-glycolide, poly D,L-lactide-coglycolide by means of two methods,

a) Solvent evaporation method: the polymer is dissolved in the organic solvents like dichloromethane, chloroform or ethyl acetate which helps in dissolving the hydrophobic drug, and then by using surfactants or emulsifiers the drug solution and polymer solution are mixed to form an oil in water emulsion [45-47]. After the formation of a stable emulsion the solution is then evaporated by reducing pressure. Particle size was found to be influenced by the polymer concentration, Polymer type, concentrations of stabilizer and homogenizer speed. In order to produce small particle size, often a high-speed homogenization or ultra-sonication may be employed [48-50].

b) Spontaneous emulsification: this is the modified method of Solvent evaporation, where water miscible solvent along with the water immiscible organic solvent is used as an oil phase [51-53]. Due to spontaneous diffusion interfacial turbulence is created between the two phases creating the small particles.

Polymerization

In this method the monomers are polymerized to create the nanoparticles in an aqueous solution. The drug particles are then introduced to the aqueous solution then the suspension is purified to remove the impurities like surfactants and stabilizers which are used earlier [54-58]. By using ultracentrifugation or re-suspending the particles in the isotonic surfactant-free medium the nanoparticles are collected [59,60]

Ionic gelation method or coacervation technique

Ionic gelation method is carried out using the biodegradable hydrophilic polymers such as chitosan, gelatin and sodium alginate by means of ionic gelation [61-63]. In the process, the hydrophilic chitosan nanoparticles are ionized by ionic gelation by positively charged amino groups of chitosan reacts with negative charged tripolyphosphate to form the nanoparticles by coacervation [64,65].

Conclusion

Novel drug delivery systems plays a major role in site specific drug delivery (Targeted drug delivery) compared to conventional dosage forms due to its advantages in site specificity and stability. The main aim in designing Novel drug delivery system (nanoparticles) is to alter or modify particle size of the drug, its surface properties thus reaching pharmacologically active drug molecules to its specific site action with minimal dose and reduced dosing frequency. Nanoparticles became very popular drug delivery system as it increases the stability and protects drug molecules from rapid degradation.

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