



REVIEW ARTICLE

Various Novel Drug Delivery Systems in Treatment of Cardiovascular Diseases

S. Gousia Begum*, D. Mustafa

ABSTRACT

Cardiovascular disease the life threatens issues in the present days, which includes other diseases like angina pectoris, atherosclerosis, and myocardial infarction. The various novel drug delivery systems like transdermal patches, liposomes, micelles, nanoparticles, microbubbles, drug-eluting balloons, and an eluting drug stents are used for targeted drug delivery and improved therapeutic efficacy and showed better patient compliance in the present days.

Keywords: Balloons, Dendrimers, Liposomes, Micelles, Nanoparticles, Stents.

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INTRODUCTION

In this challenging world, people are mostly affected by cardiovascular diseases. Although various conventional dosage forms are available in the market, the novel drug delivery system seeks the interest of the people because of its targeted drug delivery and prolonged drug resistance to the affected areas of the heart. The novel drug delivery systems include the patches and also nanoscale formulations like micelles, liposomes, nanoparticles, dendrimers, which has the major advantage, i.e., avoiding hepatic first-pass effect and renal excretion and exhibit the permeability and retention effects.

NOVEL DRUG DELIVERY SYSTEMS (NDDS)

The NDDS are defined as the systems which are capable of controlling the rate of drug delivery, sustaining the duration of therapeutic activity, or targeting the delivery of the drug to tissue.

TYPES OF NARCOTIC AND DANGEROUS DRUG SECTION

- Oral drug delivery systems
- Nasal/pulmonary drug delivery systems
- Parenteral drug delivery systems
- Topical drug delivery systems
- Transdermal drug delivery systems
- Transdermal drug delivery systems
- Targeted drug delivery systems
- Protein and peptide drug delivery systems

CARDIOVASCULAR DISEASES

CVDS are classes of diseases that involve the heart or blood vessels. CVDS include coronary artery diseases (CAD) such as angina, myocardial infarction, heart failure, heart muscle disease (cardiomyopathy)

Santhiram College of Pharmacy, Nandyal, Kurnool Dist, Andhra Pradesh, India

Corresponding Author: S. Gousia Begum, Santhiram College of Pharmacy, Nandyal, Kurnool Dist, Andhra Pradesh, India. E-Mail: gousiya009@gmail.com

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Transdermal Patches

A transdermal patch is a polymer layered that follows the diffusion mechanism, and the drug gets dispersed in a uniform manner in the targeted site. Some of the examples of transdermal patches are nitroglycerin transdermal patch and ethosome patches of ligustrazine. The usage of these patches decrease hemorheological indices of myocardial ischemia and protect from acute ischemia myocardium.

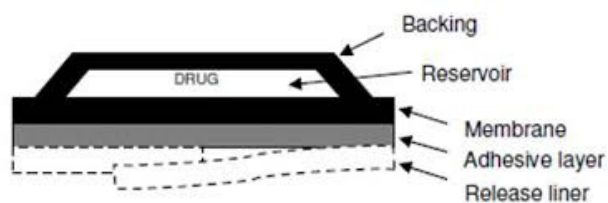


Figure 1: Transdermal patches

The schematic diagram of the transdermal patch is given in Figure 1.^[1,2]

Micelles

Micelles are polymer (or) lipid-based amphiphilic molecules with hydrophobic cores and hydrophilic shells. They act as carrier vehicles to overcome the solubility problems by enclosing the hydrophobic portion of the drug by creating an aqueous environment in the drug. An example of micellar drug delivery is chlorine loaded polymeric micelles (Figure 2).

Liposomes

Liposomes are the bilayered forms consisting of phospholipids and cholesterol suitable for both hydrophilic and hydrophobic drugs (Figure 3).

- *Advantages of liposomal drug delivery systems:*

- ◇ It is suitable for potent drugs.
- ◇ It mainly improves the therapeutic efficacy of a drug.
- ◇ It provides stabilization of entrapped drug.

- *Disadvantages of liposomal drug delivery systems:*

The major disadvantage structure of liposomes is when the parenteral route administers these liposomes; they show rapid clearance by the reticuloendothelial system.

To overcome this disadvantage of liposome's recently targeted ligands helped in the modification of liposomes was done, i.e., decrease toxicity and increased targeted

drug delivery. The polyethylene glycolated liposomal adenosine increased cardioprotective activity of adenosine and reduced hemodynamic effects. The difference between the micellar drug delivery and liposomal drug delivery is the micellar drug delivery is used for targeted drug delivery, and liposomes are used as proangiogenic drug delivery systems.

Dendrimers

A dendrimer is a nanoparticle consisting of continuous branched molecules that possess molecular uniformity and low dispersity. The other name of dendrimers is Cascade molecules (Figure 2).

- *Mechanism of action:*

The drug particle is embedded in cavities of the core structure and folding of branches that form cages and channels (i.e.) simple entrapment process.

- *Examples of dendrimers:*

Starburst dendrimers are the name for a subclass of PAMAM dendrimers based on tris amino ethylene imine core, which regulates the gene transfer *in vivo* and *in vitro* environment. The dendrimer complexes increase the gene transfer in murine cardiac grafts.^[3]

Nanoparticles

Nanoparticles are the nano-sized particles used in the targeted drug delivery through the encapsulation process.

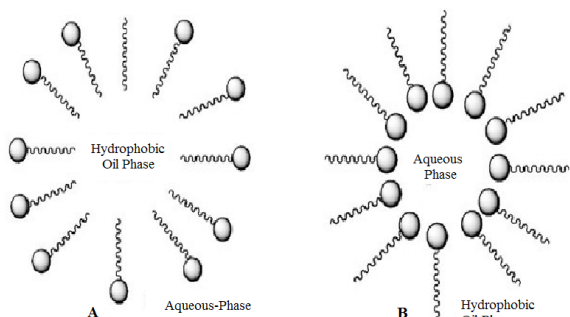


Figure 2: Micelles

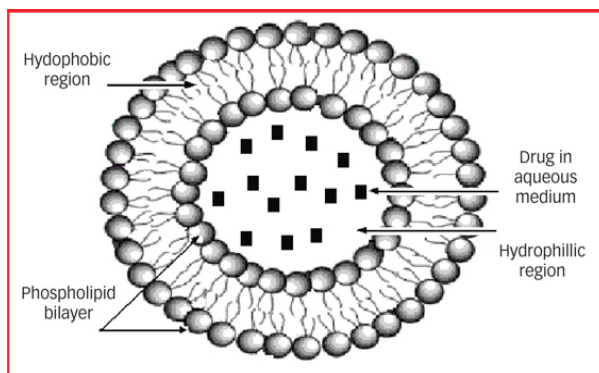


Figure 3: Liposomes

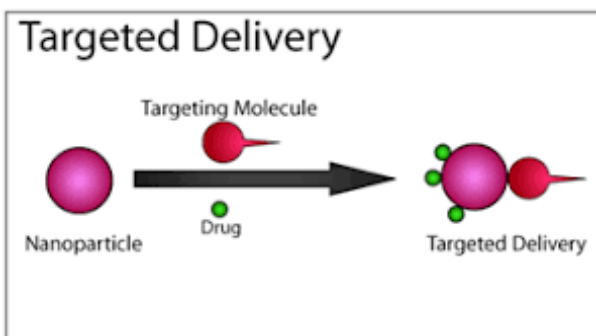
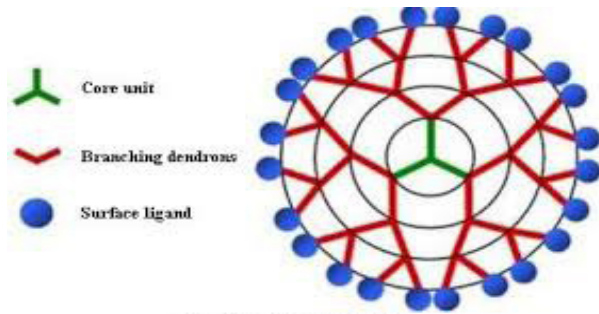


Figure 4: Dendrimers



Basic dendrimer components
figure 5: nanoparticles

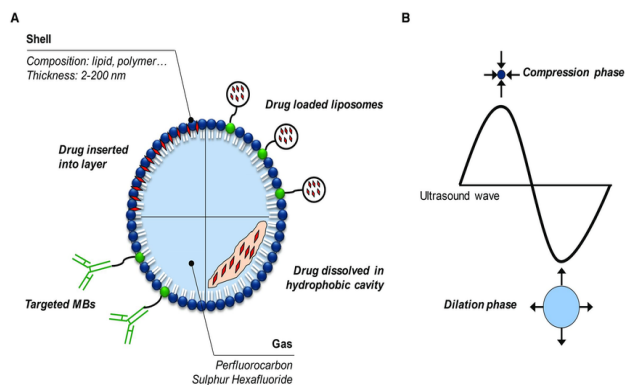


Figure 6: Microbubbles

Even though these nanoparticles show some toxic effects, the polymeric nanoparticles are used in the treatment of acute myocardial infarction, which is caused due to atherosclerotic plaque destabilization and rupture by inflamed monocytes and macrophages. Some other examples of nano-drug delivery systems are PEG gold nanoparticles and nanoparticles containing pitavastatin reduces the inflammation (Figure 5).^[4-7]

Micro Bubbles

Microbubbles are the gas bubbles consisting of phospholipids and biodegradable polymers administered through the intravenous route. These are spherical and small in size as that of red blood cells. The techniques used for encapsulation is coating and surface binding. They are also used in the treatment of vascular thrombosis by sonothrombolysis (Figure 6).^[8]

Drug-eluting Stents

In older days the metal stents were used in the treatment of atherosclerotic vascular disease, but now the use of metal stents was limited because of its inflammatory response, thrombosis, restenosis. So, a new technique was developed, i.e., drug-eluting stents which reduces the restenosis less than 10% due to the polymeric layer disruption at the site of injury. To overcome that problem, the biodegradable polymer stents were developed. Some of the examples of biodegradable stents are poly L lactide stent, bioresorbable stent, porous aluminum oxide coated stent.^[9-11]

Drug-eluting Balloons

Drug-eluting balloons are used in the treatment of coronary restenosis, subsequent revascularization. The paclitaxel drug-eluting balloon is an important device that is used to deliver the antirestenotic drug paclitaxel into the coronary vessel. These drug-eluting balloons are used as an alternative to drug-eluting stents affected coronary artery

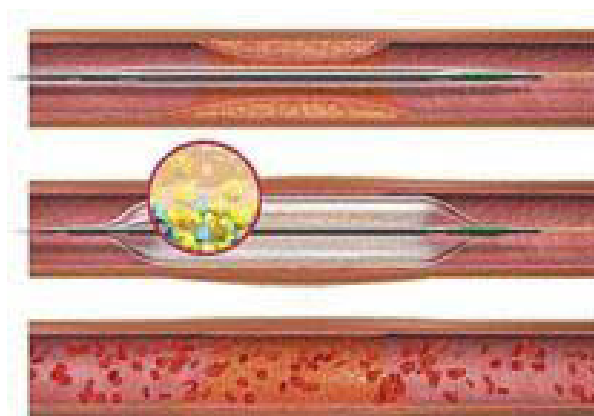


Figure 7: Drug-eluting stents

drug-eluting balloon in the artery treated coronary artery by DEB (Figure 7).^[12-14]

Applications of Novel Drug Delivery Systems

Novel drug delivery systems have been used in a broad range of pharmaceutical applications like

- In drug targeting
- Studying immune response
- Delivery of peptide drugs
- Tissue engineering
- In cancer therapy
- Anti-microbial activity

CONCLUSION

The various novel drug delivery systems used for the treatment of cardiovascular diseases are discussed above, and these systems provide targeted drug delivery and improve the lives of various cardiovascular disorder patients by increasing patient compliance and therapeutic activity.

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