*ejpmr, 2020,7(10), 286-292*

SJIF Impact Factor 6.222

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Review Article

ISSN 2394-3211

EJPMR

# NOVEL DRUG DELIVERY SYSTEM: A REVIEW ON MODIFIED DRUG DELIVERY SYSTEM, MICROENCAPSULATION AND TARGETED DRUG DELIVERY SYSTEM

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**Article Received on 30/07/2020** **Article Revised on 20/08/2020** **Article Accepted on 10/09/2020**

## ABSTRACT

Novel drug delivery system has led to many advances in pharmaceutical industries. Newer drug delivery techniques has largely influenced the medical field. There are various drug delivery systems which are broadly categorized as conventional drug delivery system and modified drug delivery system. Conventional drug delivery systems includes certain limitations due to which new system was developed named modified drug delivery system i.e. novel drug delivery system. Novel drug delivery system many such techniques such as microencapsulation, targeted drug delivery system and nanotechnology. The pharmaceutical industries has went far away in manufacturing new medicines which eventually develops a medical practice. The main advantage of these novel drug delivery is that it gives patient compliance. Patient gets many advantages through this system because it consists of certain such as targeting receptor, controlled drug delivery, nanotechnology which helps a patient to a greater extent. Conventional drug delivery system may cause many adverse reactions due to high dose or may cause reduced therapeutic effect due to reduced dose. Also, every individual can show different pharmacological actions to same drug and dose. Hence, novel drug delivery maintains the drug concentration as well as delivers a dug to a particular site of action.

**KEYWORDS:** Drug delivery, conventional drug delivery, novel drug delivery, therapeutic effect, site of action.

## INTRODUCTION

Drug delivery systems can be defined as a perspective mechanism to introduce clinically used agents into systemic circulation.[1] It can be a dosage form or any device aids administration of therapeutic agents into body which enhances the efficacy of drugs and safety of drugs by the controlling the rate, time and release of drug. This mechanism of drug delivery includes administration of therapeutic drug, the release of active ingredients into body and the transportation of drug to a particular site of action.[2]

### Conventional Drug Delivery Sytem

Conventional drug delivery system is the process of administration of drug such as tablets, capsules, powders or any other pharmaceutical products to humans or animals to achieve therapeutic efficacy of medication.[3]

### Novel drugs

Novel drugs are the new innovative products which are non-obvious and mainly used to advance the patient healthcare and benefit patients.[4]

### Novel drug delivery system

Novel drug delivery systemsis the new advance technique. Recent advances in the understanding of pharmacokinetic & pharmacodynamics behavior of drug have offer a more rational approach to the development of optimal drug delivery system. The novel drug delivery systems (NDDS) are carriers which maintain the drug concentration in therapeutic range for longer period of time.[5]

**Limitations of conventional drug delivery system**

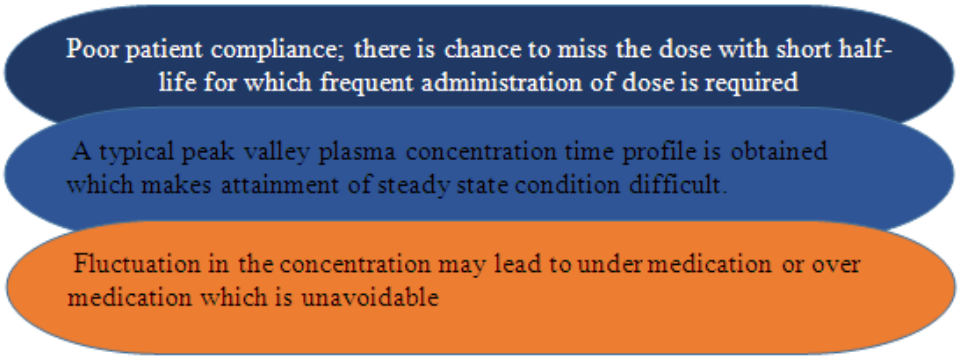



**Fig 1: Limitations Of Conventional Drug Delivery System.[6]**

**Modified Drug Delivery System**

Modified drug delivery systems have been developed to deliver drug to the part of the body where it will be absorbed, to simplify dosing schedules, and to assure that concentration of drug is maintained over an appropriate time interval. To overcome the limitations of conventional drug delivery system, modified drug delivery system was developed.

**Types of modified drug delivery system**

- Sustained/Controlled release drug delivery system
- Delayed release drug delivery system
- Extended release drug delivery system.[7]

**Sustained Release Drug Deivery System**

To achieve a prolonged therapeutic effect by continuously releasing medication over an extended period of time after administration of single dose sustained release dosage form was developed. The main aim of preparing sustained release formulations was intended to modify and improve the drug performance by;

- Increasing the duration of drug action
- Decreasing the frequency of dosing
- Decreasing the required dose employed
- Providing uniform drug delivery.[8]

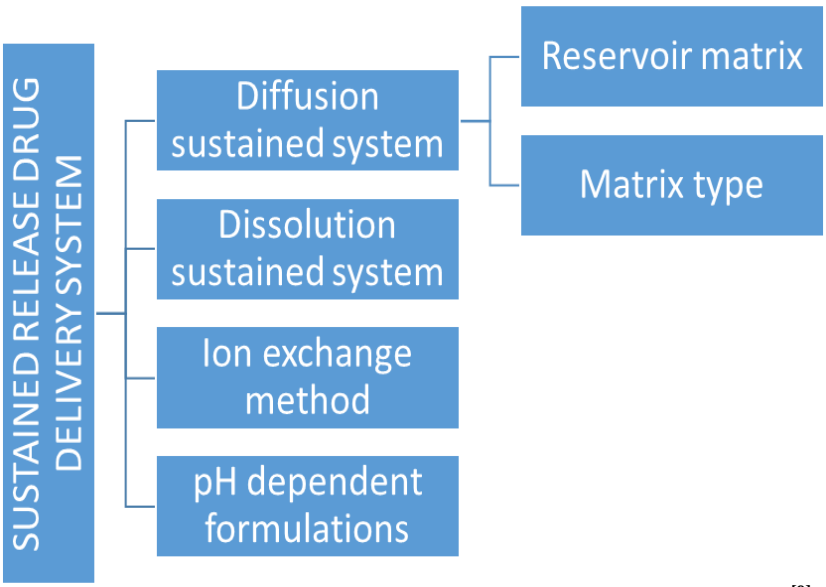



**Fig. 2: Types Of Sustained/Controlled Relase Drug Delivery System.[9]**

**1. Diffusion sustained system**

Diffusion sustained system is the passage of drug molecules from higher concentration to the lower concentration.

The flux of drug is given by,

**J= - D dc/dx**

D = diffusion coefficient in area/ time

Dc/dx = change of concentration 'c' with distance 'x'

**2. Dissolution sustained system**

A product that naturally retains the drug at a slow dissolution rate and reduces its dissolution rate by sufficient salt or derivative formation for those drugs with high water solubility.[10]

**3. Ion exchange method**

It is based on the drug resin complex formation when an ionic solution is kept in contact with ionic resins. The drug from these complexes gets exchanged in

gastrointestinal tract and released with excess of Na+ and Cl- gastrointestinal tract.[11]

**4. Ph Dependent Formulation**

The gastrointestinal tract present some unusual features for the oral route of drug administration with relatively brief transit time through the gastrointestinal tract, which constraint the length of prolongation, further the chemical environment throughout the length of gastrointestinal tract is constraint on dosage form design. Since most drugs are either weak acids or weak bases, the release from sustained release formulations is pH dependent.[9]

**Extended Release**

The main objective to formulate an API in an extended drug delivery system is related to its pharmacokinetics parameters. An appropriate formulation can make the absorption, distribution, metabolism and elimination (ADME) profile of a drug much more favorable.

By incorporating the dose for 24 hours into one tablet from which the drug is slowly released, peaks of high plasma concentration and troughs of low plasma concentration can be prevented. This helps avoids the side effects associated with high concentration and the lack of activity associated with low concentration giving better overall therapy.[12]

**Delayed Release System**

Delayed release system are those that use repetitive, intermittent dosing of a drug from one or more immediate release units incorporated into single dosage form. Examples of delayed release system are repeat-action tablets and capsules and enteric coated tablets where timed release is achieved by barrier coating.[13]

**Microencapsulation**

Microencapsulation is described as a process of enclosing micron-sized particles of solids or droplets of liquids or gasses in an inert shell, which in turn isolates and protects them from the external environment The products obtained by this process are called microparticles, microcapsules and microspheres which differentiate in morphology and internal structure. When the particle size is below 1 mm they are known as nanoparticles, nanocapsules, nanospheres, respectively and particles having diameter between 3–800 mm are known as microparticles, microcapsules or microspheres. Particles larger than 1000 mm are known as macro particles.[14]

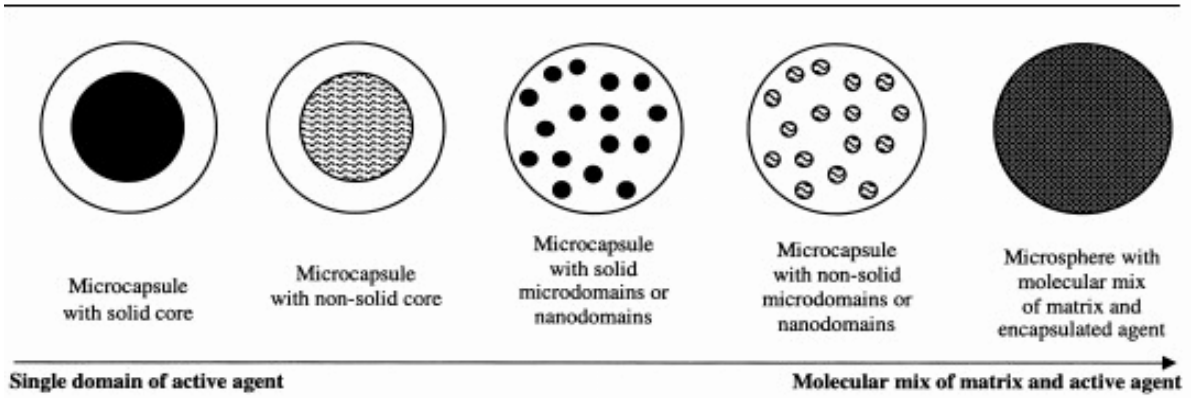



**Fig. 3: Different Structure Of Microcapsule And Microspheres.[15]**

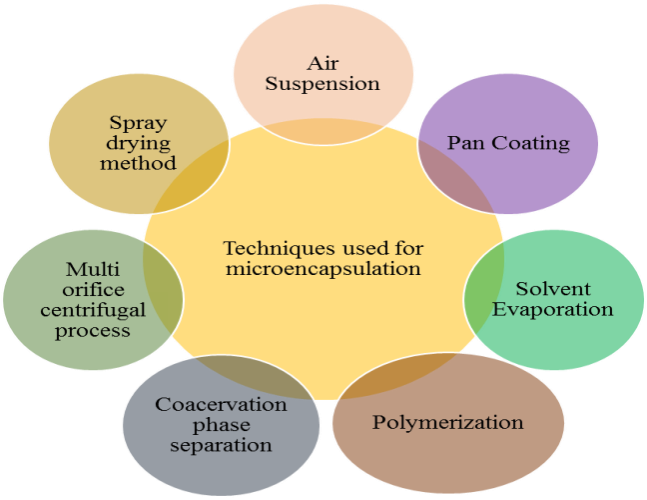



**Fig. 4: Techniques Used For Microencapsulation.[16]**

**Advantages of Microencapsulation**

1. It gives protection against UV, heat, bio-oxidation, acids, and bases.
2. Shelf life is improved due to preventing degradation reactions.
3. Masking of bitter taste and odours.
4. Control of hygroscope.
5. It enhances flow ability, solubility and permeability.
6. It handles liquids as solids.[17]

**Targeted Drug Delivery System**

Targeted drug delivery is a kind of smart drug delivery system which is miraculous in delivering the drug to a patient. This conventional drug delivery system is done by the absorption of the drug across a biological membrane, whereas the targeted release system is that drug is released in a dosage form. Targeted drug delivery system is based on a method that delivers a certain amount of a therapeutic agent for a prolonged period of time to a targeted diseased area within the body. This helps maintain the required plasma and tissue drug levels in the body; therefore avoiding any damage to the healthy tissue via the drug. The drug delivery system is highly integrated and requires various disciplines, such as chemists, biologist and engineers, to join forces to optimize this system.[18]

- **Strategies of Drug Targetting**

Drug targeting to an area of interest within the body increases the therapeutic effectiveness as well as it reduces the toxicity that may arise otherwise. Two strategies are widely used for drug targeting to the desired organ/tissue.

**Passive targeting**

This is based on the accumulation of drug at areas around the site of interest, such as in case of tumor tissues. This is called Enhanced Permeability Retention (EPR) effect. Such a types of targeting occurs with almost all types of drug delivery carriers. Passive targeting is actually a misnomer because it cannot really be described as a form of selective targeting. Although the EPR effect applies for nanoparticle administered, the majority (>95%) of these nanoparticles tend to accumulate in organs other than those of interest such as liver, lungs and spleen. Thus, it is the distribution of drug by blood circulation. Examples include the use of antimalarial drugs being targeted for the treatment of microbial infections such as leishmaniasis, candidiasis and brucellosis.[19]

**Active targeting**

Active targeting is essential for the delivery of drugs, genes and theranostics to the location of interest avoiding the normal tissues and thereby enhances the therapeutic efficiency and limits the side effects. Active targeting is able to significantly increase the quantity of drug delivered to the target cell compared to free drug or passively targeted nanosystems.[20]

**First order targeting**

This is the distribution of drug to capillary beds of target sites- organ or tissue, for example, in case of lymphatic tissue, peritoneal cavity, pleural cavity, cerebral ventricles, eyes, joints, etc 2.

**Second order targeting**

This is the targeting of drugs to specific sites such as the tumor cells, for example, to kupffer cells in liver.

**Third order targeting**

It is the type of drug targeting wherein the drug is intracellularly localized at the target site via endocytosis or through receptor-based ligand mediated entry.[19]

**Nanotechnology**

The prefix “nano” is a Greek word which means “dwarf”. The word “nano” means very small or miniature size. Nanotechnology is the treatment of individual atoms, molecules, or compounds into structures to produce materials and devices with special properties. Nanotechnology deals with materials in the size of 0.1 to 100 nm; however it is also inherent that these materials should display different properties such as electrical conductance chemical reactivity, magnetism, optical effects and physical strength, from bulk materials as a result of their small size.[21]

- **Devices based on nanotechnology**

**1) Nano tubes**

The term nanotube is normally used to refer to the carbon nanotube, which has received enormous attention from researchers over the last few years and promises, along with close relatives such as the nanohorn, a host of interesting applications.[22]

**2) Nano Shells**

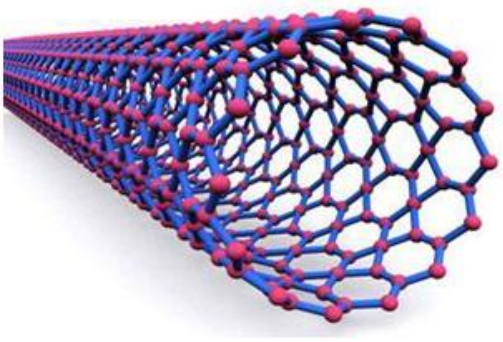
Nanoshells, which are thin coatings deposited on core particles of different material have gained considerable attention.[23]

**3) Quantum Dots**

A quantum dot is a semiconductor nano crystal whose size is in the range 1–10 nm. The size of these particles results in new quantum phenomena that yield significant benefits. Material properties change dramatically at this scale because quantum effects arise from the confinement of electrons and holes in the material. Size changes other material properties such as the electrical and nonlinear optical properties of a material making them very different from those of the material’s bulk form.[24]

**4) Dendrimers**

Dendrimers are highly bifurcated, monodisperse, well-defined and three-dimensional structures. They are globular-shaped and their surface is functionalized easily in a controlled way, which makes these structures excellent candidates as drug delivery agents.[25]



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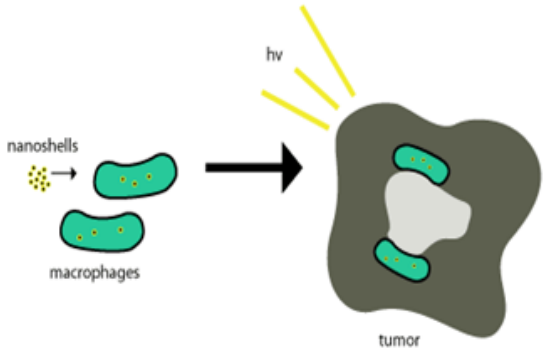
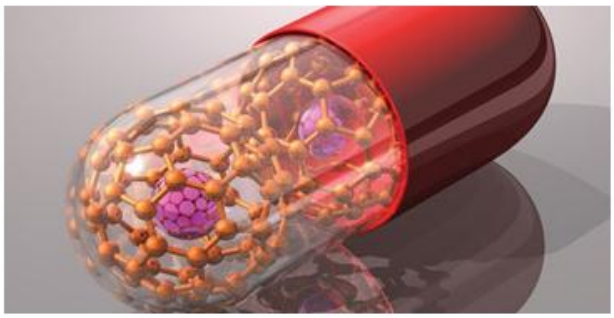



NANOSHELLS

QUANTUM DOTS



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**Applications of nanotechnology**

- **Drug delivery**

The overall medication intake and side-effects can be reduced considerably by deposit the effective broker in the melancholy area only and in no higher amount than needed. This highly particular strategy decreases costs and human struggling. An example can be found in dendrimers and nanoporous materials. They could hold little medication elements moving them to the preferred location. Another perspective is based on little electromechanical systems; NEMS are being examined for the effective launch of medication. Some possibly important programs include cancer therapy with metal nanoparticles or silver seashells.[26]

- **Nanotechnology In Uv Protection**

Zinc oxide (ZnO) and titanium dioxide ($TiO_2$) particles have been widely used for many years as UV filters in sunscreens. Recently, nanoparticles of these oxides have become popular as they retain the UV filtration and absorption properties while eliminating the white chalky appearance of traditional sunscreens. Products using

nanoparticles of ZnO or TiO2 are transparent so have increased aesthetic appeal, are less smelly, less greasy and more absorbable by the skin. Many sunscreens and moisturizers available now use these nanoparticles, including products from Boots, Avon, The Body Shop, L'Oreal, Nivea and Unilever.[27]

- **Nanotechnology In Medicines**

The small size of nanoparticles can be very useful in oncology, particularly in imaging. Quantum dots when used in conjunction with magnetic resonance imaging, can produce exceptional images of tumor sites. These nanoparticles are much brighter than organic dyes and only need one light source for excitation which shows that the use of fluorescent quantum dots could produce a higher contrast image and at a lower cost than today's organic dyes used as contrast media.[28]

- **Nanotechnology In Gene Delivery**

Gene therapy is a recently introduced method for treatment or prevention of genetic disorders by correcting defective genes responsible for disease development based on the delivery of repaired genes or the replacement of incorrect ones. The most common approach for correcting faulty genes is insertion of a normal gene into a nonspecific location within the genome to replace a nonfunctional gene. An abnormal gene could also be swapped for a normal gene through homologous recombination or repaired through selective reverse mutation, which returns the gene to its normal function.[29]

## CONCLUSION

Novel Drug delivery System (NDDS) NDDS is a combination of advance technique and new dosage forms which are far better than conventional dosage forms. Modified release drug products have been successfully marketed for many years. The concept of modified release formulations emerged with an objective to improve patient's compliance. The approach to modified release drug delivery systems has changed from a line extension strategy to a clinically superior approach for marketed drugs as well as for new chemical entities. The benefits offered by modified release systems include reduced dosing frequency with improved patient compliance, better and more uniform clinical effects with lower incidence of side effects and possible enhanced bioavailability. It is very difficult for a drug molecule to reach its destination (site of action) in the complex cellular network of an organism. Nanotech targeted delivery of drug is becoming one of the brightest stars in the medical sciences. The inherent advantage of this technique has been reduction in the dose and the side effect of drug. The application of nanotechnology in drug delivery has particularly enhanced the delivery of drugs. There are numerous nanoparticles that have been approved for clinical use and, although they are still in their development stages, they hold the key to the future of drug-targeting. On the other hand, microspheres and microcapsules are established as unique carrier systems for many pharmaceuticals and can be tailored to adhere to targeted tissue systems. Hence, microcapsules and microspheres can be used not only for controlled release but also for targeted delivery of drugs to a specific site in the body. Hence, novel drug delivery system has given a hope to healthcare system.

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