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# Different Novel Drug Delivery Systems and Their Application

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## *Abstract:*

*Drug Delivery System (DDS) is defined as the technology which is used to deliver the drugs and gene in the required area of the body. The transferring of drug through Drug Delivery System depends on the time and dose. A significant effect of drug delivered is seen on its efficiency. By the use of optimum concentration, the therapeutic benefit can be achieved and the concentration below or above the optimum concentration can be toxic or produce no therapeutic effect. Different types of drug delivery systems has been developed. The main purpose of drug delivery system is to reduce the degradation and loss of drug, prevention from harmful side effects and the increment in the bioavailability. Targeted drug delivery system (DDS) is one of drug delivery system in which the drug is transported to a targeted tissues, organ or cells by the carrier of drugs. In recent, there are many novel drug delivery systems such as carbon nanotubes, micromicelles, microemulsion, floating drug delivery system, and so on which have high therapeutic value compare to conventional drug delivery system. This paper shows different types of novel drug delivery systems with their application in many fields.*

***Keywords:*** *Micromicelles, Microemulsion, Therapeutic, Drug Delivery System*

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## Introduction

A significant effect on drug efficiency is developed by the method through which drug is delivered. Maximum benefit can be gained by the optimum concentration of drugs, if the concentration is above or below the level of optimum concentration, give the toxic effect and no therapeutic benefit at all. On the other side, the efficacy of severe diseases treatment has very slow progress that suggests a need for a multidisciplinary approach to deliver the therapeutics to the targeted tissues. By this technique, new ideas were generated for controlling the non-specific toxicity, pharmacokinetics, pharmacodynamics, immunogenicity, bio-recognition, and efficiency of drugs. These new therapeutic strategies are known as Drug Delivery Systems (DDS) that are based on interdisciplinary methods include pharmaceutics, bio-conjugate chemistry, polymer science and molecular biology. Drug delivery system (DDS) is defined as the use of new technology of biological polymer materials for delivering the drugs or gene to the selected body parts that depend upon the clinical need time and dose. (Zhan, Ting and Zhu, 2017)

With the development of new technology and new devices, dramatic changes have been introduced. Traditional capsules and ointments have been substituted by the osmotic pumps, electrically assisted drug delivery, wearable ambulatory pumps and host of other delivery methods. These are based on various polymer technologies. In some cases, the new delivery system is required for new drugs because of inefficient and ineffective traditional system. Some drug therapies are very site-specific and need a very high concentration of drugs in selected sites of the body.

These technologies are generated for many purposes such as minimization of drug degradation, increase bioavailability (drug proportion when entering into the body, give an active effect), target to specific cells and also used to reduce the drug amount. These drugs system can be controlled by the release of drugs that decrease the toxicity and harmful side-effects. For improving the curative effect and reducing the effects of patients with an adverse reaction, new technology, and new materials are used by DDS drug research and development. New drug molecule is developed which has a high cost and time consuming. Old drugs's safety efficacy ratio are improved using various methods like individualizing drug therapy, titration of dose and monitor of therapeutic drugs. (Tiwari *et al.*, 2012)

Drug delivery system is the application and development in the field of pharmacy by modern science and technology. Now these days, DDS has become a theme of innovation and development in modern pharmacy. This new drug delivery system development is used to promote the therapeutic effects of a drug and decrease the toxic effects by the increment in amount and persistence of drug in the area of the target cell and decrease the capability of drug exposure at nontarget cells.

## Novel Drug Delivery Systems

Those compound which is based on the physical mechanisms and biochemical mechanism come under Novel drug delivery systems. Physical mechanisms also are known as controlled drug delivery systems in which different types of methods are used such as osmosis, diffusion, erosion, dissolution and electro transport. A uniform concentration of the drug is provided to the absorption site by controlled release drug delivery systems that permit the maintenance of concentration of plasma inside the range of therapeutic value. By this step, the side effects of drugs and administration frequency. (Deepu, Mathew and Shamna, 2014) While biochemical mechanisms contain monoclonal antibodies, gene therapy, and vector systems, polymer drug addicts and liposomes. Optimization of the duration of drug's action, decreasing the frequency of dose, controlling the site of release and maintaining constant drug levels are included in the therapeutic benefits of some new drugs. Many drug carriers are like soluble polymers, insoluble and biodegradable natural and synthetic polymers make microparticles, microcapsules, cells, lipoproteins, liposomes, micelles and cell ghosts. The carrier can be ready slowly degradable, stimuli-reactive and even targeted. Targeting is an ability by which drug-loaded system can target to a specific site of interest. There are two major mechanisms for addressing the desired sites of drug release: Passive and Active targeting. (Rangasamy and Parthiban, 2010)

Proper results of therapy can be achieved by the proper drug delivery system. It is used to give a significant effect on drug therapeutic efficiency. A sharp initial increment in the drug concentration to a peak above the therapeutic range and fast decrement in the concentration to the level below the therapeutic range due to the conventional drug delivery systems. With these drawbacks, repeatable dosing of medication may be difficult for the patients due to their noncompliance. The main focus of drug delivery in controlled drug systems is to achieve the constant release of drug over a long period of time with minimum side effects. The major improvements in these drug delivery systems are as follows: elimination of side effects, optimized therapy, and better patient compliance. Medicine has the application of nanotechnology as the nanomedicine is designated for the diagnosis, imaging

and treatment of various diseases. In case of medicine for the cancer, nanotechnology play a potential role by the development of nanoparticle which used as drug delivery system. (Diaz and Mejia, 2013)

The drugs must be protected against denaturation in the gastrointestinal tract (GIT) before absorption and it should be able to absorb by the wall of stomach and intestine in case of the orally administrated drug. And it should be protected from hepatic enzymes. The amount of drug should be contained by the dosage form that can reach the site of action. The long transit time of approximately 12 hours by GIT is the drawback of the oral dosage form. Parenteral route is an alternative for an oral route. Chronic disease have a short duration of action of drug and therapy, frequent injections are required. (Chothe *et al.*, 2013) Novel drug delivery system has disadvantages like it is costly and need of packaging (Moin, Sharma and Rane, 2017).

**Microchips**

In recent time, one of a new approach in novel drug delivery system is a microchip that is used to give improved release of the drug. It can react in three ways: continues, pulsatile and control release of the drug. For covering the drawbacks of other drug delivery systems, microchips has many advantages. It replaces the daily injection (cause patient non-compliance) by improving the patient compliance.

**Advantages of Microchip**

- It stores and protects the drug for a long period of time.
- The concentration of drug can be maintained in blood for a long period of time.
- Lower occurrence of infections linked with the problems as compared to indwelling catheter-based infusion system.
- The drug delivery steps are improved by delivering drug at the auction site at a particular time.
- The side effects are minimized by releasing drug at the action site as it releases the only a specific amount of drug from microchip.
- It is very easy in use and manufacture.
- In case of controlling release kinetics, it releases the drug in zero order as avoid the toxicity peaks and ineffectiveness troughs created in conventional therapy.
- Dose frequency is also reduced.
- It can contain the drug in three forms; solid, liquid and semi-solid.
- It can store one or more than one drug at a time. (Chothe *et al.*, 2013)

**Microemulsion**

The microemulsion is thermodynamically stable and isotropically clear dispersion of two immiscible liquid like water and oil. This emulsion becomes stable by an interfacial film of surfactant molecules. Molecules of surfactant layer contain both polar and non-polar group. Hence, it has very specific behavior as it can absorb at the interface where it fulfills their dual affinity with hydrophilic groups in the aqueous phase and hydrophobic groups in oil or air and they reduce the mismatching with solvent by the process of micellization. The phase of dispersion contains small particles or droplets with size ranging from 5nm to 200nm and has very low oil or water interfacial tension. This microemulsion is transparent because of the droplet size which is less than 25% of the wavelength of visible light. Without high energy input, the microemulsion is shaped spontaneously. In surfactant the oil phase and water phase, cosurfactant or cosolvent is used in many cases.

First, Microemulsion concept was given by Hoar and Schulman in 1943. They prepared microemulsions by the addition of oil in an aqueous surfactant solution followed by the addition of alcohol as a co-surfactant and made a transparent, stable formulation. Then, various technologies were used for the confirmation of this theoretical structure. The definition of the microemulsion is adopted which was given by Attwood: "*A microemulsion is a system of water, oil and amphiphilic compounds (surfactant and co-surfactant) which is a transparent, single optically isotropic, and thermodynamically stable liquid*".

**Advantages of Microemulsion**

Drug carrier system, microemulsions are used for various routes of administration. These have many advantages over another dosage form.

- Increase the rate of absorption.
- Variability is eliminated in absorption.

- The lipophilic drug is solubilized by the help of it.
- An aqueous dosage form is provided for water-insoluble drugs.
- Bioavailability of a drug is increased
- To deliver the product, various routes can be used like tropical, oral and intravenous.
- Drug moiety's penetration is rapid and efficient
- It is helpful in taste masking
- The protection is provided by it from hydrolysis and oxidation as drug immersed in oil phase in Oil/Water microemulsion.
- Patient compliance is increased by the liquid dosage.
- The requirement for less amount of energy. (Saini *et al.*, 2014)

**Floating Drug Delivery Systems (FDDS)**

An extremely variable process is a gastric emptying of dosage forms. It has an ability to prolong and control the emptying time give the valuable benefits for a dosage form that exist in the stomach for a long time compared to conventional dosage forms. For better absorption and enhanced bioavailability, designed controlled release systems have many difficulties in which one difficulty is the incapability to confine the dosage form in the chosen area of the gastrointestinal tract. The absorption of the drug from the gastrointestinal tract is a difficult procedure and have many variables. It is well known that the level of GIT drug absorption is connected to interaction time with the small intestinal mucosa. For drugs which are not completely absorbed, small intestinal transit time is a very important parameter. The cosmic emptying is affected by basic human physiology that includes gastric emptying, motility patterns, and variables of physiological and formulation. The gastric residence time of drugs is prolonged by the gastroretentive systems which exist in the gastric region for several hours. The bioavailability is improved by the prolonged gastric retention and others reduction in drug waste and improves solubility for drugs which are less soluble in a high pH environment. For local drug delivery to the stomach and proximal small intestines, it has applications. For patients, gastro retention is very useful because it provides better availability of new products with new therapeutic possibilities and substantial benefits. For assessing the efficiency and application of the system, FDDS has been discussed by scientists in vivo and vitro evaluation.

**Advantages of Floating Drug Delivery System**

- The absorption of drugs (Ferrous salts and Antacids) through the stomach is done with the help of gastroretentive systems.
- Hydrodynamically Balanced Systems (HBS) may be useful for the administration of aspirin (Acidic substance) and another similar drug because it reduces the irritation on the stomach wall.
- Floating dosage forms like tablet and capsules are administered for long time result in the form of dissolution of the drug in the gastric fluid. This dissolved drug would be available for the absorption in the small intestine after emptying of the stomach contents. Hence, it is assumed that floating dosage forms will be fully absorbed if it remains in the solution form even at the alkaline pH of the intestine.
- The gastroretentive systems are very advantageous for drugs that mean the local action in the stomach like antacids.
- This system is advantageous in case of poor absorption during the certain types of diarrhea as it keeps the drugs in floating condition in the stomach and gives better response in improving the condition.
- It decreases the frequency of dose by which the compliance of patient improves.
- It avoids the fluctuation in plasma drug concentration due to which desirable plasma drug concentration is maintained by continuous drug release and enhance the bioavailability.
- It provides the better therapeutic effect of short half-life drugs.
- Increase the gastric retention time because of buoyancy.
- The drug which is solubilized in the stomach, enhance absorption power.
- In floating dosage forms, microspheres releases drug uniformly and no risk of dose dumping.

- It gives continuous release effect, floatability and uniform release of drug by a system of multi-particulate through which gastric irritation is avoided. (Ekbal et al., 2016)

**Nanocapsules**

Nanoparticles have a characteristics class that is made up of active material and the proactive shell is known as Nanocapsules. This is used for the confinement of therapeutic substance. Nano-capsules have a protective coating that is easily oxidized and pyrophoric in nature, have great interest. From the last five decades, many carriers which are in the nanometer range have been developed in which nanoparticles is one of them. Most of the carrier are used in the therapy of cancer and its diagnosis. Inert nanocarriers have anticancer drugs referred to as nanomedicines. Over other free drugs, they have high therapeutic value. While inert carrier materials have low drug loading contents because it is a major component and thus, it is necessary the use of parenteral excipient excessively.

**Application of Nanocapsules**

Nanocapsules have many applications because of the micronized size and high reproducibility. In many fields like life science, products of cosmetics, agrochemicals, cleaning products, genetic engineering, componential adhesive and treatments of wastewater, they have prospective applications. Other than these fields, they are used in enzyme encapsulation, catalysts of organic and inorganic compounds, oils, adhesives, polymers of the surface, microparticles, and nanoparticles of inorganic compounds, particles of latex and also include the biological cells. (Kothamasu *et al.*, 2012)

**Nanomiemgel (Mixture of nonomicelle and nanoemulsion)**

The skin inflammation does not have wholly effective therapies. So, there is a need to develop effective controlled-release drug delivery system that delivers anti-inflammatory agents for reducing the pain and inflammation. It can also find the cause of progression in disease and prevent adverse reactions. A non-steroidal anti-inflammatory drug, 'Aceclofenac' is used in the treatment of musculoskeletal system's inflammation and degenerative disorders. For the treatment of rheumatoid arthritis and osteoarthritis, it is broadly suggested. With other anti-inflammatory drugs, capsaicin is used and it can be used alone by which the itching linked with the skin inflammatory condition is reduced. The skin is an effective barrier that prevents the invasion of drugs applied for therapeutic purposes. There are very few drugs which are allowed to penetrate the skin. Generally, most of the topical dosage forms have poor penetration by which they give poor therapeutic benefits. Hence, the delivery system is used to penetrate the skin through multiple mechanisms and enhance the power of the drug. By the use of aceclofenac for a long time gives a serious gastrointestinal side effect such as bleeding and ulceration. Therefore, with a high degree of percutaneous permeation, an improved topical aceclofenac formulation can be used as an alternative for the treatment of locally inflamed skin.

Microemulsion and nanoemulsion are the most promising drug delivery systems that have the capability of penetrating the skin for the permeation of drug. As we discussed above the nanoemulsions, it is a thermodynamically stable transparent dispersion of oil in aqueous solution and stabilizes by an interfacial layer of surfactant and co-surfactant molecules. Another drug delivery system, 'nanomiemgel which use the multi absorption mechanism concept. Two types of matrices (A and B) consisted of Nanomiemgel. Matrix A is referred to nanoemulsion and Matrix B is for nanomicelles. It is assumed that every nano drug delivery system is unique and the size, charge, and composition of the nano drug delivery system decide the rate, mechanism, and extent of absorption. The combination of different drug delivery systems is utilized for drug delivery because it gives the better absorption than the individual drug delivery systems due to the use of many potential paths of absorption for the particular drug. (Somagoni *et al.*, 2014)

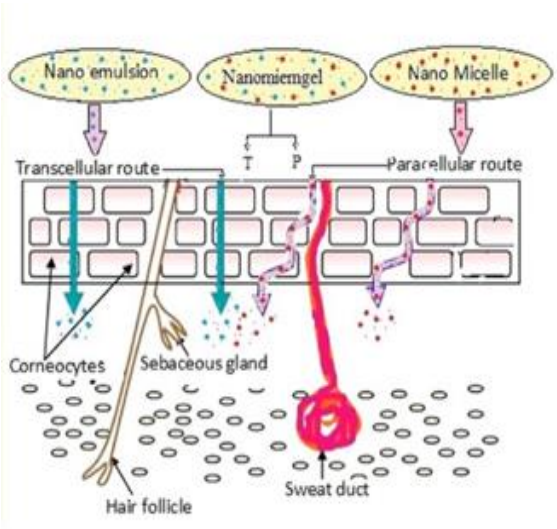


**Figure 1: Route of Nanomiemgel**

**Carbon Nanotubes**

In 1991 by Iijima, it was noticed that the allotropes of carbon have a high interest in multimodal drug delivery systems because of their unique physical and chemical properties. It allows the attachment of drug molecule's multiple copies as well as equipped with the targeting agents and stealth molecules to avoid permission by the immune system. Beside these, they have many prospective advantages over other nano-sized delivery system like it has high drug loading capacity because of the high surface area and probability for including additional therapeutic and diagnostic moieties. It may occur on the surface or inner cavity. They also interact with the cellular membranes as it has been reported that carbon nanotubes enter mammalian cells by an endocytosis-independent, a needle-like penetration mechanism through which direct cytoplasmic delivery of therapeutic payloads take place.

**Properties**

There are many properties which are resulted from the regular formation of carbon atoms in graphene cylinders. Huge cylindrical large molecules that consist of hexagonal arrangement of sp2 hybridized carbon atoms is called carbon nanotubes. In carbon nanotubes, there are two types of wall single and multiple layers. The rolling of the single sheet is called single-walled carbon nanotubes (SWCNTs) while rolling of more than one sheet is called as multi-walled CNTs (MWCNTs). SWCNTs have well-defined walls whereas MWCNTs have structural defects result in the form of the less stable nanostructure. There are three main attributes of CNTs in the medical field; small size, high surface area to volume ratio and the ability to contain chemicals. The large surface to volume ratio give a platform for effective transportation of chemicals and also for the reaction which is needed for ultra-sensitive glucose detection.

**Advantages of Carbon Nanotubes**

Conventional treatment i.e., surgery has obstacle because of accessibility to tumorous cells and high risk of generating these cells near or on vital organs. In chemotherapy and radiation, selective treatment is limited. In recent, treatment methods are very effective in the prevention of spreading of cancer. Targeted delivery of drugs is provided by the nanomedicine. From the time when the cancerous cells are on the nanoscale, the drug delivery system works. It has two major benefits:-

- The total amount of drug that is required, is less. The main motive less amount is linked with the concern as a more costly drug. And there is no requirement of solvent for the delivery of drug result as the prevention of undesired health effects from the solvent.

- Other parts of the body also absorb some amount of toxin but they do not produce any risk of protective nanocarrier degrading. Hence, the patient undergoes treatment have some health side effects

More advantages of nanocarriers depend on the range of drugs that can be attached for different purposes. Diagnostic and therapeutic use, targeting and avoidance of barrier are some purposes by which cancer patient can get specific treatment. (Kushwaha *et al.*, 2013)

**Conclusion**

This paper is discussed about Novel drug delivery systems which overcome the drawbacks of the conventional delivery system. By the use of these novel drug delivery systems, the therapeutic values of drugs are increased as the complete absorption of drug take place in the body and they only act on the required site of tissue. In this paper, different types of delivery system have been discussed as carbon nanotubes and nanocapsules are used to treat cancer. Floating drug delivery system work in the treatment of GIT. Nanomiemgel, a drug delivery system, is a matrix of nanomicelle and nanoemulsion which helps to treat the inflammation as easily penetration in the skin by the drug can enter. These all drug delivery systems have many advantages over the conventional techniques.

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