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## Advancements in Drug Delivery Systems: Novel Technologies & Formulations

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### Review Article

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#### ABSTRACT

Targeting the drugs to specific organs and tissues has become one of the critical goals as the use of conventional dosage forms do not help in achieving the desired concentration at the target site during a proper time period [1].

Discovery of new drug delivery systems is one of the growing research areas. The recently discovered new drug delivery systems include lipid, protein and polymer technologies with better lipid distribution in the body, prevention of drug degradation from external environment and reduced rate of drug clearance [2].

This review article is about the latest advancements in drug delivery systems and novel technologies and formations produced to achieve the desired drug delivery [3-5]

#### INTRODUCTION

The method of drug delivery plays a very crucial role on its therapeutic efficacy. Some drugs have low therapeutic index which have an optimum concentration range within which maximum therapeutic benefit is achieved and drug concentrations above or below this optimum range can be dangerous or produce no therapeutic benefit [6-10]. Some drugs on other hand have a high therapeutic index and require higher concentrations of drugs to be used to produce maximum therapeutic benefit and these results in toxic effects [11]. So under all these cases targeting the drugs to specific organs and tissues has become one of the critical goals as the use of conventional dosage forms do not help in achieving the desired concentration at the target site during a proper time period [12,13].

The new drug delivery systems are discovered with the aim to resolve solubility problems, prevent external environment issues on the drug such as photo degradation and pH changes, make the drug more lipid soluble so that it can easily cross lipid barriers in the body and achieve desired concentration at the desired location for maximum therapeutic effect [14-20]. Moreover, sustained and controlled targeting at the site of action and reduced time of exposure of non-targeted tissues increases the drug efficacy and reduces side effects and thus improves the patient compliance towards the drugs. Currently, a number of new drug delivery systems are currently under investigation to overcome the limitations of the conventional dosage forms and improve the therapeutic efficacy and potency of the drug [21-23].

The therapeutic benefits of the new drug delivery systems include [24-26]:

- Increased efficacy of the drug
- Site specific delivery
- Reduced side effects
- Increased patient compliance & convenience
- Reduced healthcare costs

#### NEW DRUG CARRIERS SYSTEMS

There are several new drug carriers in the market which are being used and several others are under process of clinical trials and several others are being discovered by researchers and scientists for giving maximum benefits to the patients [27,28].

Some of the novel drug delivery systems include [29]:

1. Transdermal Drug Delivery Systems

2. Colloidal Drug Carrier Systems
  - a) Liposomal delivery systems
  - b) Nano particulate delivery systems
  - c) Micelles
  - d) Dendrimers
3. Variable Release Delivery Systems
4. Implantable Delivery Systems
5. Nasal Delivery Systems

### APPROACHES FOR ACHIEVING THE DESIRED SYSTEMS

There are several approaches used for achieving the desired form of delivery systems. Some of the Major approaches include [30-35]:

1. Sustained Release Systems
2. Controlled Release Systems
  - Reservoir Systems
  - Monolithic Systems
  - Laminated Systems
  - Chemical Systems
3. Targeted Drug Delivery Systems
  - Local Targeted Delivery
  - Differential Metabolism Approach
  - Biological Recognition
  - Bio-physical Approach
  - Prodrugs
4. Pulsatile Delivery Systems

### RECENT TECHNOLOGIES & FORMULATIONS

#### a) Micro needle Arrays:

Micro needle arrays are an example of a new technology to deliver medications through the skin. In these arrays, there are several microscopic needles, thinner than a strand of hair, are coated or filled with medicine [36]. The needles due to their very small size, although penetrate through the skin, don't reach the nerves in the skin and thus deliver the drugs without any pain [37,38].

NIBIB-funded scientists are developing a micro needle patches for delivery of vaccines. These patches are easy to use, do not need to be refrigerated, and these do not require particular disposal techniques, so they can be used by patients at home [39-43]. These techniques will be helpful in rural areas without many health care providers or adequate storage facilities.

#### b) AquaTech

Dynapar AQ is a new discovery of diclofenac injection prepared by the Aquatech process, which contains the full dose of 75 mg [44], diclofenac in just 1 ml. The reduced injection volume and low viscosity of the solution ensures that the injection is painless. The small volume helps the drug administration into the deltoid muscle as well as by the IV bolus route [45,46].

#### c) Decompaction

Decompaction technology helps in quick decompaction of granules to micro-fine particles resulting in increased and faster absorption and a quicker onset of action [47-50]. Products manufactured using this technology is very useful in those conditions where a rapid onset of action is desirable. The two products available using this process are Dynapar Tablets (Diclofenac + Paracetamol) & Xykaa Rapid (Paracetamol) [51,52].

#### d) Dry Solve

Dry solve process offers very narrow particle size distribution which ensures that 90 % of particles are less than 15 micron size and more than 96% of particles are less than 10 micron size [53-60]. Dry Solve Technology product is Optogest which offers optimum absorption of progesterone [61,62].

#### e) Duophase

Dosing of drugs having shorter half-life is usually three to four times a day which is not patient compliance [63,64]. An extended release drug delivery with a mono-phasic drug release from the matrix usually doesn't provide a pharmacokinetic profile which provides meaningful therapeutic action. To provide therapeutically meaningful extended delivery of such drugs, Troikaa has developed the Duophase Technology [65]. Through this technology, the drug dose is split judiciously into two components, where one part delivers the drug immediately and the other releases the drug in a sustained release pattern. Thus, the drug delivery is biphasic and ensures the requisite pharmacokinetic profile. Drugs developed using this technology are extended release Paracetamol tablets of 650mg. and 1000mg. (Xykaa Extend) and extended release Ibuprofen tablets of 600 mg [66,67].

#### **f) IFC (Intrinsic Factor Carrier)**

IFC (Intrinsic Factor Carrier) Technology extends the absorption window of active drug from stomach to intestine [68]. IFC (Intrinsic Factor Carrier) Technology product is Nurotroy SR & Troynuron SR which extends the absorption window of Methylcobalamin from stomach to intestine. IFC (Intrinsic Factor Carrier) Technology product is Nurotroy SR & Troynuron SR which extends the absorption window of Methylcobalamin from stomach to intestine [69,70].

#### **g) Lipisol**

It is a natural fact that Oil & Water are immiscible. Lipisol Technology enables an oily formulation to become water miscible, thereby increasing the bioavailability of the active ingredient [71]. A unique solubiliser used in this technology ensures that the oil is divided into micronized droplets, with sizes not more than 15 microns in diameter [72]. These micronized oil droplets are absorbed rapidly, resulting in higher bioavailability. Besides, Lipisol Technology ensures effective absorption of oily drugs, both on fasting as well as with food [73-75].

#### **h) LipoTech**

Dermis is a barrier to topically applied medicaments. The lipids in the stratum corneum layer of the dermis prevent absorption of topically applied drugs [76]. Penetration of drug molecules across the dermal barriers has been deeply studied in the very recent past [77]. As a result, new technologies have emerged, which enable enhanced transportation of drug molecules across the dermis [78,79].

#### **i) LiquiCaps**

LiquiCaps (Liquid-filled & sealed Hard Gelatin Capsules), the latest innovation in encapsulation technology, are being accepted as the next generation capsules [80]. LiquiCaps are 2-piece hard capsules, filled with oily medicaments & sealed with a band. The major benefits offered by LiquiCaps over soft gelatin capsules include lower microbial load in the thin gelatin shell of LiquiCaps, as compared to the heavy microbial burden in soft gels [81].

#### **j) Matrix**

Matrix Technology is the one behind the success of our long range of Sustained Release Formulations. The Matrix facilitates release of small amounts of active ingredient, in a controlled manner, over an extended period of time, from the tablet [82,83].

#### **k) Maxisorb**

Drug is adsorbed on the diluents in the solubilized form, which affects dissolution & absorption of the drug. This technique assures faster dissolution & increased bioavailability of the drugs [84-87].

#### **l) Micro solve**

Water insoluble drugs are poorly absorbed from the intestine resulting in low bioavailability [88]. Micro solve Technology increases the solubility of such drugs and thus improves absorption and result in higher bioavailability transforming it into supra-bioavailable form [89,90].

#### **m) Mucogrip**

The wet mucosa of the oral cavity causes washing out of the mouth ulcer formulations within a few minutes after application. As a result, patient does not get relief and healing of ulcer and takes a long time for relief [91]. Mucogrip

Technology is used to prepare such formulations that make it possible for the drug to stay on the ulcer for a longer time by sticking firmly on the wet and moving mucosa of the mouth. It forms a protective film over the mouth ulcer and hence ensures drug delivery and speedy healing.

#### n) Organogels

Organogels are one of the potential carrier systems for topical drug delivery. These are semi-solid systems in which an organic liquid phase is immobilized in a three-dimensional network consisting of intertwined gelator fibers. Despite of their liquid composition, they demonstrate the appearance and rheological behavior of solids. The gelator molecules have the capability to immobilize large volumes of liquid following their self-assembly into aggregates. Organogel offers high degree of stability to drugs which get degraded by hydrolysis [92,93].

#### o) Parenteral Nano Emulsion

The parenteral nano emulsions are characterized with high levels of uniformity. Uniformity of globules in emulsions depicts the stability of the emulsion [94]. The greater the uniformity greater is the stability of the emulsion and also emulsions with high uniformity display pharmacokinetic profile of the drug that can be predicted [95].

#### p) Quick Penetrating Solution (QPS)

Conventional topical formulations of NSAIDs do not penetrate the barrier of the stratum corneum (outermost layer of skin). Hence, they are less effective in pain management. As a result, the patients continue to depend on oral NSAIDs which cause severe side effects on the stomach, kidneys & cardiovascular system [96].

QPS Technology helps in effective penetration of drugs through the stratum corneum. QPS Technique provides a unique base in which the drug is solubilized. The base gets absorbed into the skin & thus carries the drug through the stratum corneum. QPS base is non-aqueous and still can be washed with water and has unique properties of non-volatile nature, non-irritant, an emollient & non-staining [97].

#### q) SoluTech Process

Conventional tablets disintegrate into granules in the gastro intestinal tract and further dissolution of disintegrated granules takes place which requires additional time resulting in a lag phase between dosing and onset of action [98]. Formulation using SoluTech process ensures complete solubilization of tablet through principles of surface erosion resulting in elimination of lag phase for disintegration and thus offers faster absorption and rapid onset of action [99,100].

### CONCLUSION

Extensive research is in process in discovering new drug delivery systems and drug delivery carriers which could effectively transfer the drugs to the site of action in lesser time giving maximum therapeutic effect and benefits and also to increase the drug stability and prevent degradation in external environment.

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