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A review on Novel Drug Delivery System

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ABSTRACT: The approaches, formulations and systems for transportation of Pharmaceutical compounds in the body that alters the rate of drug release or site of drug absorption, drug delivery for site specific action needed for achieving safe therapeutic effects categorized as Novel Drug Delivery System (NDDS). The major drawbacks of conventional dosage forms like immediate drug release pattern, reduced efficacy of certain drugs with increase side effects can be effectively combated by formulating in novel form as in NDDS. A very slow progress in effective treatment of severe disease pointed out the use of novel approaches for site specific drug delivery to enhance therapeutic effectiveness. A combination of advance techniques and new dosage form makes the novel drug delivery system better than the conventional dosage form. The controlled, sustained and targeted release drug delivery systems are the major classes of NDDS that are responsible for drug release for extended period of time with site specific Pharmalogical action.

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INTRODUCTIONS:

The method of administering pharmaceutical compound to achieve a therapeutic effect is called as drug delivery system. NDDS can be broadly categorized as the approaches, formulations and systems for transportation of pharmaceutical compounds in the body that alters the drug release, rate or site of drug absorption, drug delivery for site specific action needed for achieving safe therapeutic effects [1].

Needs of NDDS:

A major drawback of conventional dosage forms is that it follows an immediate drug release pattern results in fluctuation of drug concentration in blood depending on the dosage form. Therefore, in order to overcome such drawbacks of conventional drug administration and to

maintain an effective therapeutic concentration of drug for extended period of time needs NDDS.

NDDS is a combination of advance technique and new dosage form which are better than conventional dosage forms. The conventional methods of drug administration's results in reduced efficacy of certain drugs with increase side effects. Such problems can be easily combated by the use of novel technologies of drug delivery that helps in increasing therapeutic efficacy and minimizing the side effects. A very slow progress in effective treatment of severe disease pointed out the use of novel approaches for site specific drug delivery to the enhanced therapeutic effectiveness. The therapeutic efficacy of a drug is significantly affected by the methods used to deliver the drug. Certain drugs are having an optimum concentration range within which maximum benefits can be obtained and a high or low concentration results in toxicity or drugs having no pharmacological actions. Such problems can be easily overcome by the novel methods of drug administration.

NDDS provides a combination of advance technologies and new dosage forms as a result it is far better than the conventional one. NDDS improves drug potency; control the drug release pattern to get sustained drug action results in greater safety and site specific drug targeting. The novel drug delivery system is classified into categories like Controlled release drug delivery system (CRDDS) and Sustained release drug delivery system (SRDDS) [2,3].

CONTROLLED RELEASE DRUG DELIVERY SYSTEM:

The drug delivery at a pre determined rate for locally or systemically, for a specified period of time is called as controlled release drug delivery system. CRDDS controls the release of drug from the dosage form as well as control the concentration of drug in the body. The drug release kinetics involves zero order.

Advantages of CRDDS [4]:

- Fewer doses and dosing frequency.
- Decrease in G.I. side effects.
- Improved patient compliance and acceptability.
- Less fluctuation at plasma drug levels.
- More uniform drug effect with improved efficacy/safety ratio.
- Increased bioavailability.
- By passing first pass metabolism.
- Supports better treatment of chronic diseases. e.g. - Arthritis, cancer.
- Reduced toxicity/side effects.
- Decrease in healthcare cost both short and long term.

Limitations of CRDDS [4]:

- Dose dumping.
- Less flexibility for accurate dose adjustment.
- Poor in *vitro* - *in vivo* correlation.
- Variations in drug response among patients.
- Delayed onset of action.
- All drugs cannot be formulated suitably in controlled release form.

SUSTAINED RELEASE DRUG DELIVERY SYSTEM (SRDDS):

A predetermined rate of drug release for a specific period of time by providing a constant drug level with least side effects is called as sustained release drug delivery system. SRDDS results in therapeutic range drug concentration for prolonged time interval which results in decrease in dosing frequency. i. e. four times a day to once daily. The prolonged drug release by sustained dosage form is accomplished by employing suitable polymers that results in coating of granules or tablets (Reservoir systems), or a matrix where the drug is dissolved or dispersed (Matrix system). The drug release kinetics may be Reservoir systems which follows zero order kinetics and Matrix system which follows linear release pattern due to function of square root of time [5,6].

Advantages of SRDDS:

- Improved drug performance by increase in duration of drug action.
- Decrease in dose and dosing frequency.
- Providing uniform drug delivery.
- Minimizing toxicity by facilitating slow drug absorption.
- Increased drug stability by protection from hydrolysis and other.
- Localization of drug action.
- Improved patient compliance by decrease in frequent drug administration.
- Reduced healthcare cost by improve therapy.
- Decrease in length of therapy.
- Maximum drug utilization.

Limitations OF SRDDS:

- Reduced potential for accurate dose adjustment.
- Slow onset of drug action.

- Expensive process and equipments used for preparation of SRDDS.
- Less flexibility of the physician in the adjustment of dosage regimen as it is fixed during the design of dosage form.

Factors influencing controlled/ sustained release dosage form:

The factors influencing controlled/ sustained release drug delivery can be broadly classified into 2 categories: Physicochemical and Biological factors [6,7].

Physicochemical Factors:

The physical factors affecting controlled/ sustained release dosage form are aqueous solubility; molecular size and diffusivity; protein drug binding; drug stability; margin of safety; route of administration; target site; duration of treatment; partition coefficient; release rate and dose and pKa.

Biological factors:

The biological factors affecting controlled/ sustained release dosage form are absorption; distribution; metabolism; duration of drug action; dose dependent bioavailability; elimination half life, role of disease state and therapeutic index.

Criteria for formulation of sustained release dosage forms:

The criteria which must be associated with drug for formulation of sustained release dosage forms are desired half life, large therapeutic index, low dose, desired absorption, desired solubility, desirable absorption window and first pass clearance [8].

TARGETTED DRUG DELIVERY SYSTEM (TDDS):

The phenomena of drug delivery to the selective target site of action or absorption and not to the non targeted organs, tissues or cells are called as TDDS. TDDS implicates obtaining a desired pharmacological response at a selected site without un desirable interaction at other sites [8,9].

Advantages of TDDS [8,9]:

- Prolonged targeted drug action.
- Restricting drug action to target site.
- Increased efficacy and decreased toxicity of drugs by alteration of pharmacokinetics and bio distribution.
- Decrease in drug dose and reduction in toxicity due to lower concentration of drug at non targeted sites.
- Selective targeting to infactious cells compared to normal cells.
- Peak and valley plasma concentration are avoided.
- Decrease in dosing frequency.
- Development of regenerative techniques.

Limitations of TDDS [8,9]:

- Drug targeting is highly integrated and requires active participations chemists, biologists, engineers for optimization.
- TDDS demands considerations of different approaches such as:- local drug administration, carriers and vehicles, differential metabolism, molecular recognition, site specific activation, molecular specificity.
- Faster drug clearance of targeted system.
- Use of well established sophisticated technology for drug formulation.
- Depot of drug at target site may lead to toxicity symptoms.
- Use of craft for formulation manufacturing, storage and administration.
- Difficulty in maintaining dosage form stability.
- The erythrocytes released must be stored at 4 °C.
- Diffusion and reposition of released drugs.

Drug Targeting Methods:

Drug targeting to a specific area in the body enhances therapeutic effectiveness and lowers toxicity which may arise. Drug targeting to specific organ/tissue involves 2 main methods that are passive and active targeting.

Passive targeting:

The drug delivery system that are targeted to systemic circulation known as passive targeting. Drug at target sites known as Enhanced Permeability Retention (EPR). Example: Targeting anti cancer drugs to specific sites, targeting anti malarial drugs in treating candidiasis and leishmiansis. Passive targeting occurs as a result of body's natural response to physicochemical characteristics of drug or drug carrier system.

Active targeting:

In this process drug targeting to specific site involves modification made on its surface than natural uptake by RES. The different surface modification methods include surface coating with bio adhesive, non ionic surfactant or specific cell or tissue, antibodies (monoclonal antibody) or by albumin protein.

Active targeting is of three types:

- First order targeting: It includes drug distribution to capillary beads of target sites- organs, tissues. Example is compartmental drug targeting in lymphocytes.
- Second order targeting: It involves drug targeting to specific sites like tumour cells and not to normal cells. Example is drug targeting to kupffer cells in liver.
- Third order targeting: It refers to intracellularly localized drug targeted to specific site by endocytosis or through receptor based ligand mediated entry.

Components of targeted drug delivery system:

The first component is Target which includes specific organ, cell and group of cells. The second component is Drug carriers/ markers; those are a special system required for effective transport of loaded drug to the pre selected sites. Different targeted drug delivery systems include drug carriers, Micelles, Liposomes, Liquid crystals, Nanoparticles, Hydrogels, Niosomes, Resealed erythrocytes, Monoclonal antibodies, Nanodiamond, Nanoemulgel, Nanodots, Aquasomes, Nanaoconjugates and Magnetic microparticles [9,10].

CONCLUSION:

The requirement of safe and effective treatment showed the path to develop novel drug delivery systems. The advantages of various classes of novel drug delivery systems like controlled, sustained and targeted release drug delivery over conventional dosage forms makes it a suitable platform for achieving improved patient care and treatment.

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