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THE BASIC KNOWLEDGE CONTROL DRUG DELIVERY SYSTEM

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ABSTRACT
Controlled drug transport is one which offers you the drug at a predetermined rate, for locally or systemically, for a selected duration of time. Continuous oral shipping of drugs at predictable and reproducible kinetics for predetermined length at a few stage in the route of GIT. Controlled release drug shipping employs drug-encapsulating devices from which healing sellers may be released at controlled costs for prolonged durations of time, starting from days to months. Such systems offer numerous benefits over traditional techniques of drug shipping, which incorporates tailoring of drug release fees, protection of fragile pills and improved affected person comfort and compliance.
KEY WORD :- *Control drug delivery system , Extended Release Formulation, Delayed Release Preparation, Targeted Release Drug Product, Site Specific Targeting System,*

INTRODUCTION

Controlled drug delivery structures can include the preservation of drug stages inside a desired range, the want for fewer administrations, most reliable use of the drug in question, and increased affected person compliance. While those benefits may be significant, the ability disadvantages can not be omitted like the viable toxicity or non-biocompatibility of the substances used, unwanted by-products of degradation, any surgical treatment required to implant or remove the system, the threat of affected person discomfort from the delivery device, and the better value of controlled-launch structures as compared with conventional pharmaceutical formulations. The best drug delivery system have to be inert, biocompatible, mechanically strong, snug for the affected person, capable of achieving excessive drug loading, secure from accidental launch, easy to administer and remove, and clean to manufacture and sterilize. The goal of many of the authentic controlled-launch structures became to gain a delivery profile that could yield a excessive blood level of the drug over a long length of time. With conventional drug delivery structures, the drug degree in the blood follows the wherein the degree rises after every management of the drug and then decreases till the following administration. The key factor with conventional drug administration is that the blood level of the agent have to remain among a most value, which may also represent a toxic degree, and a minimal value, below which the drug is now not effective.

Advantages of Controlled release drug delivery system over the conventional dosage form

- Reduced dosing frequency.
- Dose reduction.
- Improved affected person compliance.
- Constant level of drug attention in blood plasma.
- Reduced toxicity because of overdose.
- Reduces the fluctuation of peak valley concentration.
- Night time dosing may be avoided.

Controlled Release

It consists of any drug delivery device which releases the drug pre decided rate over an prolonged period time.Limitation of oral conventional dosage form.

1. Poor affected person compliance, increased chances of lacking the dose of a drug with quick 1/2 of existence for which frequent management is necessary.
2. The unavoidable fluctuations of drug attention may result in under medicine or over medicine in narrow healing index drug.
3. A typical peak-valley plasma attention time profile is obtained which makes attainment of steady-state condition impossible.

• **Examples** include Plendil ER (Felodipine), Agon SR (Felodipine), Kapanol (Morphine sulphate) and Slow-K (Potassium chloride)

Disadvantages of Controlled Release Formulations

controlled release formulations like other formulations have several disadvantages. These include

- Development costs: Expensive specialized equipment and inert components can be required for some controlled release formulations.
- Release rate: The drug release rate may be altered by food and gastric transit time; as a end result differences might also additionally stand up in the release rate among doses.
- Can now no longer crush or chew products: Controlled release products should now no longer be crushed or chewed because it

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can cause lack of the `slow release` characteristics as well as toxicity.

Drug Selection For Conrolled Drug Release System

The biopharmaceutical assessment of a drug for ability use in managed launch drug transport system requires knowledge at the absorption mechanism of the drug shape the G. I. tract, the overall absorbability, the drug`s molecular weight, pKa, solubility at one-of-a-kind pH and apparent partition coefficient.

Table.1. Parameter for drug selection

Parameter	Preferredvalue
Molecular weight/ size	< 1000
Solubility	> 0.1 µg/ml for pH 1 to pH 7.8
P_{ka}	Non ionized moiety > 0.1% at pH 1 to pH 7.8
Apparent partition coefficient	High
Absorption mechanism	Diffusion
General absorbability	From all GI segments
Release	Should not be influenced by pH and enzymes

Carriers used in controlled release solid dispersions

Water insoluble providers are typically used to provide managed launch strong dispersion. The residences of the providers have the fundamental impact on the discharge profile of the dispersed drug. Fig. 1 suggests the chemical shape of a few providers used for the instruction of managed launch strong dispersion.[4]

Design controlled release formulation

Diffusion-controlled delivery describes methods where a drug's release is regulated by its diffusion across a matrix or polymeric membrane.

The concentration gradient between the drug-loaded system and the external release environment—such as blood, interstitial fluid, or gastrointestinal fluids—is the driving force.

The polymer regulates the release rate by acting as a barrier.

a. **Membrane-controlled reservoir systems**
   The drug's liquid or solid core is encased in a polymeric membrane that regulates its pace.
   This membrane allows the drug to infiltrate into the surrounding liquid.
   Drug solubility, polymer permeability, and membrane thickness are the main factors influencing the release rate.

Examples

- Transdermal patches
- Osmotic pump
- Implantable system

Matrix

The medication is evenly distributed throughout a matrix of polymers.

Drug release happens when the drug diffuses out of the matrix; in certain systems, erosion may also be a factor.

The Higuchi model, which states that release is proportionate to the square root of time, is usually followed by the release rate.

Examples

- HPMC, PEO
- Hydrophobic matrice
- Sustained-release tablets and capsule

Dissolution Controlled Release Formulation

The pace at which the medication (or a surrounding barrier) dissolves in the biological medium (such as gastrointestinal fluids) det ermines the release rate of a dissolution-controlled drug delivery system.There are two primary scenarios:

The drug's limited solubility means that its release is controlled by its own dissolution.

A slowly dissolving polymer or coating layer is applied to the medicine; the release is controlled by the barrier's disintegration.

Encapsulation

A slowly disintegrating coating, such as wax, polymer, or sugar coating, envelops the drug core.

Layer by layer, the coating degrades, releasing the drug. able to be created

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- **Sustained release**
- **Enteric release**
- **Pulsatile release**

Matrix Dissolutionmedication contained within a matrix or carrier that dissolves gradually.Release happens as:
As the matrix dissolves, additional surfaces become visible. The drug diffuses out of the matrix that dissolves

Ion-Exchange
Ion-exchange resins, which are synthetic, insoluble, crosslinked polymers containing charged functional groups, are used in ion-exchange controlled drug delivery systems to create a drug–resin complex, or resin.
Ions (such as Na^+, Cl^-, and H^+) in the surrounding physiological fluid are exchanged with those attached to the resin to release the medication.

Physicochemical Properties of CDDS
Molecular Weight
Larger molecules can require specialized systems (like osmotic pumps), while smaller molecules diffuse more quickly.

Solubility
Moderately soluble is ideal. Poor solubility results in partial release, while high solubility causes burst release.

Partition Coefficient (log P)
Evaluates membrane permeability and reflects lipophilicity.

pKa / Ionization
Affects drug-polymer interaction and solubility at varying pH values.
Stability
stability both physically and chemically during production and storage.

Polymorphism
He rate at which various polymorphs dissolve varies.

Diffusion Coefficient
The drug's capacity to pass through membranes or polymers.

Drug Dose
High doses may require complex systems or several processes.

Polymer Properties
Degradation, permeability, swelling, erosion, and molecular weight.

Biological Properties of CDDS
These determine whether the medication can sustain consistent and long-lasting absorption as well as how the body reacts to the dosage type.

Absorption Window
particular area of the GI tract with the highest rate of medication absorption.
• Biological half-life
• Time for drug concentration to reduce by 50%
• Bioavailability
• Extent of systemic absorption.

Therapeutic Index
Harmful to therapeutic dosage ratio.

Permeability
Ability to cross biological membranes (e.g., intestinal mucosa, skin).

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APPLICATION

Oral Controlled Drug Delivery For CDDS, the oral route is the most popular, practical, and recognized method

- Keep your plasma levels constant for 12 to 24 hours.
- Lower the frequency of doses and increase bioavailability.
- Release that is targeted to particular GI segments, like the colon.

Examples

- Metformin HCl extended-release tablets
- Diclofenac SR tablets

Transdermal Controlled Drug Delivery

At a regulated pace, medications are transported through the epidermis to the systemic circulation.

- Steer clear of first-pass metabolism.
- extended period of action (up to a few days)
- Ideal for medications with high lipophilicity and a low molecular weight

Examples

- Nitroglycerin patch

Parenteral Controlled Release (Injectables and Implants)

Long-lasting medication activity without the need for frequent injections is provided by parenteral CDDS.

- Plasma levels that remain constant for weeks or months
- Cancer treatment, hormone therapy, and birth control

Examples

- Leuprolide acetate depot

Implantable Drug Delivery Systems

Implants are inserted intramuscularly or subcutaneously to deliver medications at a regulated pace over the course of months to ye ars.

- Hormone treatment (cancer, contraception)
- Management of chronic diseases
- Localized distribution

Examples

- Nexplanon

Ocular Controlled Drug Delivery

CDDS deliver sustained medication levels in ocular tissues, overcoming the limited residence duration of traditional eye drops.

- Management of infections, uveitis, and glaucoma
- Long-lasting therapeutic impact

Examples

Ocusert

Limitations and Challenges

Not appropriate for all medications, particularly those that contain unstable or very soluble substances.

- Complicated production and quality assurance
- Increased development expenses
- In certain systems, there is a risk of dosage dumping.
- Variability amongst patients as a result of biological variations pH, motility,metabolism

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