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DESIGN AND DEVELOPMENT OF A NOVEL DRUG DELIVERY SYSTEM FOR ENHANCED THERAPEUTIC EFFICACY

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ABSTRACT
The emergence of innovative drug delivery systems has transformed pharmacology, facilitating the precise and efficient administration of therapeutics to designated locations within the body. This extensive review offers a thorough analysis of the latest developments in drug delivery technologies, with a particular emphasis on nanoparticle systems, liposomes, hydrogels, and materials responsive to stimuli. Traditional drug delivery techniques frequently encounter challenges such as limited bioavailability, systemic toxicity, and insufficient targeting capabilities. Advanced methods of drug delivery that focus on understanding the pharmacokinetic and pharmacodynamic properties of pharmaceuticals are known as novel drug delivery systems or NDDS. The goals of these systems are to enhance drug bioavailability, reduce drug loss, and avoid negative effects. The term "novel drug delivery system" (NDDS) describes methods, compositions, apparatus, and systems for delivering a medicinal substance throughout the body as required to safely provide the intended therapeutic effects. The Advanced Novel Drug Delivery System (NDDS) represents a significant evolution in pharmaceutical sciences, focusing on enhancing drug efficacy, safety, and patient compliance. Current developments in our knowledge of the pharmacokinetic and pharmacodynamics behaviour of drugs provide a more logical framework for designing the best possible drug delivery system. It is understandable that multidisciplinary efforts will play a major role in the success of drug delivery research in the future

Keywords: *Liposomes, Noisome, Transferosome, Nanoparticles, Ectosomes.*

INTRODUCTION

The healing effectiveness of a medication largely relies on the way it is delivered into the body. To enhance act penalties, liberal Medicine Delivery Schemes (DDS) have been developed through the collaborative efforts of polymer science, pharmaceutics, bioconjugate chemistry, and molecular biology. These cross-disciplinary techniques have resulted in the development of innovative transporters like soluble polymers, degradable and non-biodegradable microparticles, microcapsules, modified cells, and cellular remnants. Novel Drug Delivery Systems (NDDS) offer a systematically structured approach for devising optimal therapeutic stages by enhancing understanding of a drug's pharmacokinetic and pharmacodynamic properties. Numerous delivery methods have been established, while several others are still being researched, all aiming to reduce drug waste, minimize side effects, and improve systemic bioavailability.

NEED AND OBJECTIVES
NECESSITY AND GOALS

Requirement

- Enhanced Bioavailability
- Regulated and Continuous Delivery
- Focused Medication Administration

Improved Drug Absorption – Enhancing drug absorption and efficacy, ensuring they effectively reach the intended site.Decrease in Drug Toxicity – Reducing the likelihood of negative effects by avoiding drug buildup in non-target regions.

IMPORTENCE OF NDDS

Improved patient compliance: Delivery methods that reduce dosing frequency or simplify administration can boost patient adherence to treatment regimens.

Targeted drug delivery: These systems can accurately direct medications to the site of action, increasing their concentration at the target area while reducing overall exposure in the body.

Controlled medication release: Sophisticated delivery systems enable the regulated release of drugs, maintaining therapeutic levels for extended durations and reducing the need for frequent administration.

FACTOR INFLUENCE OF NDDS

Factor Influence of NDDS

1. Physiochemical Factors
   - Particle Size & Shape
   - Hydrophobicity/Hydrophilicity
   - Drug Solubility & Stability
2. Biological Factors
   - Immune System Response
   - Blood-Brain Barrier (BBB) Permeability
   - Enzymatic Degradation
   - PH and Microenvironment Sensitivity
3. Formulation Factors
   - Encapsulation Efficiency
   - Drug Release Mechanism
4. External Environmental Factors
   - Storage Conditions
   - Manufacturing Techniques

CLASSIFICATION OF NDDS

MECHANISM OF ACTION

I. Passive Delivery System

Definition

A passive drug delivery system is characterized by its dependence on inherent physiological mechanisms, such as diffusion, osmosis, or dissolution, to facilitate the controlled release of medication.

Principles:

1. Diffusion-controlled release: The movement of drug molecules occurs through a membrane or matrix.
2. Osmosis-controlled release: The influx of water initiates the release of the drug.
3. Dissolution-controlled release: The drug gradually dissolves in bodily fluids.
4. Hydrogel-based wound dressings

II. ACTIVE DELIVERY SYSTEM

Definition:

An active drug delivery system refers to a specialized mechanism that employs external energy sources or stimuli to regulate the release and targeting of therapeutic agents.

Principles

1. Targeted delivery: Drug molecules are directed towards specific locations or cells.
2. Controlled release: The release of the drug is initiated by external stimuli. The absorption of the drug is facilitated permeability
3. Enhanced permeability: The absorption of the drug facilitated Through increased permeability.

Types

1. Temperature-responsive systems
2. pH-responsive systems

APPLICATIONS OF NDDS

Many possible uses exist for innovative drug delivery techniques in the pharmaceutical and medical fields. These systems aim to enhance patient adherence, optimize treatment effectiveness, and prevent negative outcomes. Here are several important applications for new medication delivery systems.

Precision Medication Delivery: These systems can target drug delivery directly to the action site within the body, like tumours or particular organs. This enables targeted therapy, reducing overall exposure and minimizing adverse effects.

ADVANTAGES AND DIS ADVANTAGES:

ADVANTAGES

1. Drugs are safeguarded against physical and chemical degradation.
2. It facilitates sustained release of medications.
3. The system enhances the distribution of tissue macrophages.

DIS ADVANTAGES

1. Immune responses may arise against carrier systems administered intravenously.
2. The formulation of NDDS drugs necessitates advanced technological capabilities.
3. Dose dumping.

LIMITATIONS AND CHALLENGES

Limitations of New Drug Delivery Systems (NDDS) involve elevated research and development/manufacturing expenses, intricate technology, regulatory challenges, possible material toxicity/biocompatibility concerns, instability, slow drug release causing delayed effects, the risk of "dose dumping," difficulty in dose modification/cessation of effect, as well as differences in patient responses, which restrict accessibility and drive up costs. Development and Production Issues.

Elevated Expenses: Substantial funding required for research, development, and intricate manufacturing.

Advanced Technology: Necessitates expert skills and tools for creation, manufacturing, and quality assurance.

Stability Concerns: It can be challenging to uphold the stability and effectiveness of the drug in the delivery system.

OBSTACLES

Issues and resolutions concerning the distribution of medications with low solubility. Creative approaches for delivering drugs that have low solubility.Addressing challenges to bioavailability for clinical compounds with low solubility.

EVALUVATIONS

Particle size and polydispersity index: The phrase "particle size" refers to the measurements of a particle, often expressed in nanometres (nm) or micrometres (μm). Determining a material's chemical, biological, and physical properties is crucial. In areas like pharmaceuticals, nanotechnology, and materials science, regulating particle size is crucial for stability, bioavailability, and performance. PDI quantifies the diversity of particle sizes in a sample. It shows the uniformity in particle size, with values between 0 and 1:
2.Morphology involves the examination of the structure, shape, and form of various objects, spanning biological, geological, and material sciences. Conversely, surface topography emphasizes the intricate features of an object's exterior, such as roughness, texture, and microstructures. I'm sorry, but it appears that the input text you provided consists only of a reference label".

FUTURE CHALLENGES

The incorporation of the Internet of Medical Things (IoMT) and wearable technology will facilitate real-time monitoring and customized drug delivery system. The future of Advanced Novel Drug Delivery Systems (NDDS) is highly promising, with emerging technologies transforming how drugs are administered, absorbed, and targeted within the body. Key advancements include: The incorporation of the internet of medical things (IoMT)and wearable technology will facilitate real-time monitoring and customize drug release. Additionally, 3D printing and bioprinting will allow for the development of tailored drug delivery systems. Future investigations will aim to address biological barriers, enhance drug solubility, and improve patient adherence. Collaborative efforts among academic institutions, industry stakeholders, and regulatory bodies will foster innovation and accelerate the transition to clinical applications. According to Dhanasekaran and Chopra (2016), a smart drug-targeted delivery system delivers the best therapeutic medicine for malignant and other diseases to the precisely targeted tumour site at the optimum dosage, minimizing the chance of modifications that could affect the efficacy of the methods being tested. According to Yan and Li (2016), liposomes derived from vesicles within hydrophobic domains could selectively filter the passive diffusion of tiny solutes, ions, nutrients, and antimicrobial substances. clarifies the molecular and cellular mechanisms behind disease (Kaur and Kumar, 2019) Nanoparticle sponges: Large substances can be enclosed using a material of small particles with cavities that are only a few nanometres wide.

CONCLUSION

A Novel Drug Delivery System (NDDS) merges advanced techniques with newly developed dosage forms that significantly surpass conventional dosage forms. A new drug delivery system aims to enhance therapeutic effectiveness by decreasing toxicity, increasing bioavailability, and minimizing the frequency of administration to address non-compliance. Innovative drug delivery and targeting methods are emerging techniques utilized in pharmaceutical science. Similar to targeting drug administration, vaccine administration, gene therapy, and the commercial advancement of innovative carriers. The advanced drug delivery system provides benefits to patients, enhanced treatment, lower production costs, effective utilization of costly medications and excipients, optimal dosage at the appropriate time and place, increased comfort and improved quality of life, along with advantages for patients. Among the key types of novel drug delivery systems are targeted and controlled drug delivery systems, among others. Pharmaceutical science emphasizes the delivery of drugs, vaccines, gene therapy, and the commercial creation of novel carriers, along with various innovative approaches for drug transport and targeting.

AUTHOR CONTRIBUTIONS

All authors are contributed equally.

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DECLARATION COMPETING INTEREST

The authors have no conflicts of interest to declare.

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