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Review on - Targeted Drug Delivery System

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A B S T R A C T

This review article's primary goal is to present the fundamental ideas of drug targeting as they have changed over the course of earlier decades. This section will discuss the key biological and chemical traits of the carrier molecules that are used to target specific drugs. Smart drug delivery is another name for targeted drug delivery. This is a discrete, self-contained dosage form that is applied to intact skin at a regulated rate to the bloodstream. Compared to conventional drug delivery, targeted drug delivery has fewer side effects, avoids hepatic first pass metabolism, improves drug absorption, requires a lower dose, and lessens fluctuations in blood drug levels. The two most popular drug delivery systems are those that target tumours and the brain, respectively. This cutting-edge drug delivery system makes extensive use of lipoproteins, liposome's, immune micelles, and micelles. This cutting-edge drug delivery system makes extensive use of lipoproteins, liposome's, immune micelles, and micelles. To prolong, localize, target, and have a protected drug interaction with disease tissues is the aim of a targeted drug delivery system. Drug targeting can make use of a variety of carriers, including dendrimers, nanotubes and nanowires, nanoshells, quantum dots, nanopores, gold nanoparticles, virosomes, cubosomes, nanobots, and transferosomes.

Keywords: Drug Targeting, transferosomes, chemotherapeutic, Gold Nanoparticle, Drug delivery system, Nanotubes, cubosomes, Nanobots.

Introduction

The pharmacological characteristics of a medication determine its biological effects in a patient.1.The interactions between the drug and the receptors at the drug's site of action result in these effects. Unless the medication is delivered to its site of action at a concentration and pace that results in the fewest negative effects and the greatest number of therapeutic effects, the effectiveness of this drug-target interaction has been compromised.2 Targeted drug delivery is a therapeutic approach that includes the delivery of the medicinal substance to a particular tissue while preventing it from entering other bodily parts.3. As a result, it only administers the drug to the body's targeted regions. This lessens side effects and provides increased treatment efficacy.4. Drug delivery efficiency and specificity are increased, and a robust interaction with tumor cells is made possible by the design and optimization of these targeting molecules and delivery vehicles. Furthermore, targeted drug delivery using nanocarriers can decrease drug distribution in normal tissue and increase drug accumulation in tumor tissue.5,6 One common drug delivery method for enhancing the bioavailability, biodistribution, and accumulation of medications is the use of nanocarriers. Furthermore, nanocarriers have the ability to load one or more drugs in addition to modifying via controlled chemosynthesis in order to decrease immunogenicity. By altering their surface, nanocarriers can improve the targeting effect on tumor cells and more accurately deliver medications to tumor tissue. With such a targeted delivery approach, medications can accumulate more in tumors and have less harmful side effects on healthy cells or tissues.7Another potential advancement that can be made with DSs based on nanotechnology is targeted delivery to tumors.8. Drugs can be released under controlled conditions with nanoparticle (NP)-based drug delivery. This gives drugs enough time to react to specific stimuli, such as pH, light, heat, or enzymes, and act with enhanced therapeutic action.9

When a drug is targeted, it can be administered to4,14

• The target site's capillaries.

• The particular kind of cells, such as cancerous cells.

• Particular organs or tissues that are able to identify the drug carrier.

Causes of using Targeted drug delivery system

The following are some of the reasons why a targeted drug delivery system might be used:15

1. Poor stability of drugs.

2. Ineffective drug uptake.

3. The medication's brief half-life.

4. The drug's extensive distribution network.

5. Low specificity for drugs.

6. The medication's limited therapeutic index.

What makes a targeted drug delivery system ideal

Some characteristics that the targeted drug delivery system needs to have are as follows:

1. It must be biodegradable, stable, safe (non-toxic), and compatible with bodily fluids.

2. Only administer the medication to the intended location.

3. Regulate the drug's release at a set pace.

4. The pharmacological effect is unaffected by the drug release rate.

5. Minimal drug leakage while being transported to the intended location.

6. Making use of a carrier that is easily removed, biodegradable, or inert.

7. The drug delivery system should be inexpensive, simple, and easy to prepare.

Advantages of Targeted Drug Delivery System

1. The drug administration protocol gets easier to follow.

2. Targeting a particular site reduces the drug's toxicity.

3. A modest dosage can produce the required pharmacological response.

4. Prevent the effect of first pass.

5. An increase in the medication's absorption from the intended site.

6. There was no peak or valley in plasma concentration as a result of drug targeting.

Disadvantages of Targeted Drug Delivery System

1. The body quickly eliminates drugs, which leads to frequent high doses.

2. The immune response could be triggered by the targeted drug delivery system's carrier.

3. Insufficient time is spent localizing the drug delivery system at the tumor tissue.

4. The drugs that are released and their subsequent redistribution.

5. A high level of expertise in this field is required for the production, storage, and administration of the targeted drug delivery system.

6. Drug deposition at the target site may increase toxicity.

7. It will be challenging to get the product to be stable.

Strategies of Drug Targeting

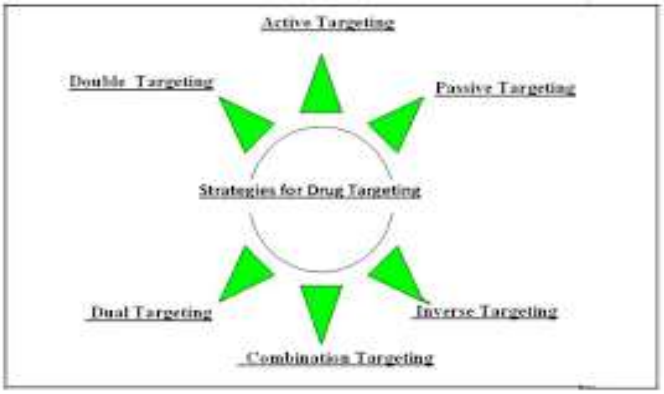

Fig 1 Different strategies of drug targeting

1. Inverse targeting

The goal of inverse targeting is to prevent the reticulum-endothelial system (RES) from passively absorbing the drug delivery system.95,94 This procedure can be carried out by injecting large molecules of dextran sulfate or a blank drug delivery system into the body in order to suppress the defense mechanism and make RES saturated. This will suppress the normal uptake function of RES.Nineteen

When it comes to drug delivery to organs other than RES, inverse targeting is quite helpful.96% Balthasar and Fung targeted methotrexate to peritoneal tumors using an inverse targeting technique.10

2. Physical Targeting

The goal of the physical targeting strategy is to modify the drug delivery systems externally so that they can be directed to a particular location. Applying an electric field, altering the pH, and changing the temperature are examples of the physical changes.99 in This technique has a great deal of promise for gene and tumor targeting.101, In gene therapy, physical targeting was used by Weichselbaum et al.11

3. Double Targeting

The term "double targeting" refers to the strategy's combination of temporal and spatial elements.Nineteen. Whereas temporal delivery entails managing drug release at the target site, spatial delivery entails directing the drug to the intended location.4. Pitto-Barry et al. used a double targeting mechanism to direct an anticancer medication loaded with dendrimers to the tumor site.12

4. Dual targeting

The dual targeting mechanism entails a drug delivery system wherein the drug carrier enhances the therapeutic effect of the entrapped drug by acting in concert with it. For instance, the therapeutic effect of an antiviral drug loaded onto a carrier molecule with antiviral activity is increased. Cui et al. used dual-targeting to deliver curcumin and paclitaxel to treat brain tumors.12

5. Ligand Mediated targeting

The receptor uptake of both synthetic micro-emulsions of low-density lipoprotein (LDL) particles coated in Apo proteins and naturally occurring LDL particles is necessary for this kind of drug targeting.95 A ligand-mediated targeting approach was used by Veiseh et al. to treat cancer.12

Biological Process and Event involve in Drug Targeting 13,14,15

- Cellular uptake and processing
- Transport across the epithelial barrier.
- Extravasations.
- Lymphatic uptake.

Cellular uptake and processing

Since macromolecular assemblies cannot be accessed by such a straightforward method, they are taken up through a process known as endocytosis. Two steps are involved in cellular uptake and processing: (1) internalization of the plasma membrane and (2) concurrent engulfment of extracellular material.

In contrast to phagocytosis, pinocytosis is a universal phenomenon. The molecule that is captured by fluid phase pinocytosis is directly proportional to both concentration and size, and it happens more slowly than phagocytosis.

Transport across the epithelial barrier

The oral, buccal, nasal, vaginal, and rectal cavities are lined internally by one or more layers of epithelial cells. Drugs with low molar mass can pass through the epithelial barrier through both selective and non-selective endocytosis. Through the tight junction of epithelial cells, polar material diffuses. While active transport is dependent on the structural integrity of epithelial cells, passive transport is typically more prevalent in damaged mucosa.

Extravasations

Many diseases are caused by the malfunction of cells that are not part of the cardiovascular system, so for a drug to have therapeutic effects, it must leave the central circulation. This transvascular exchange process, known as extravasation, is controlled by the walls of the blood capillaries.

Lymphatic uptake

Drug molecules have two options after extravasation: they can either reabsorb into the bloodstream directly or enter the lymphatic system and travel to the blood circulation with the lymph. Moreover, medications delivered by subcutaneous intracellular transdermal peritoneal routes can enter the lymphatic system and enter the systemic circulation. The difference between the osmotic and hydrostatic forces is directly related.

Types of targeted drug delivery system

1) Active Targeting

2) Passive Targeting

1) Active Targeting

Active targeting refers to a particular type of interaction between ligand and receptor for intracellular localization, which happens only after extravasations and blood circulation.First order targeting, which is defined as restricted drug carrier system distribution to the capillary bed of a predetermined target site, organ, or tissue (e.g., compartmental targeting in lymphatics, peritoneal cavity, plural cavity, cerebral ventricles and eyes, joints), is one of the three levels of targeting that can be applied to this active targeting approach.

2) Selective drug delivery to particular cell types, such as tumor cells, rather than to normal cells, such as the liver's kupffer cells, is referred to as second order targeting**.**

3) Third order targeting is the process of delivering a drug specifically to a target cell's intracellular site, such as through endocytosis, which is a receptor-based ligand-mediated mechanism that allows a drug complex to enter a cell.16

2) Passive Targeting

It describes the buildup of a medication or drug carrier system at a particular location, such as an anti-cancer medication, the cause of which may be traced to pharmacological or physicochemical aspects of the illness. Therefore, in order to maximize circulation times and targeting ability during cancer treatment, the size and surface properties of drug delivery nanoparticles must be specifically controlled to prevent uptake by the reticulo-endothelial system (RES).In essence, passive targeting is a misnomer for a straightforward method of drug delivery through blood circulation. Only specific locations within the body, like a tumor, are affected by drug release or actions; the liver is not one of these sites.Other instances include the use of antimalarial medications to treat brucellosis, candiadsis, and leishmiansis.17

Carriers use in Drug Targeting

Nanotubes

Nanotubes are a kind of drug delivery system that consists of a hollow, cylindrical carbon tube that is simple to fill and seal with the necessary medication.18, 19

Nanowires

It is a very thin wire composed of either organic compounds or metal. Due to its large surface area, the nanowire's surface can be treated to enable it to bind with particular biological molecules when it is inserted into the body. It can be applied to the diagnosis and treatment of neurological conditions like parkinsonism, seizures, and other disorders of a similar nature.20-21

Nanoshells

Nanoshells are novel forms of nanoparticles that are composed of a silica hollow dielectric core encased in a gold shell29, It can be applied therapeutically or for diagnostic purposes. Antibodies on the surface of nanoshells can attach to them, enabling them to conjugate with specific areas like cancer cells.22

Quantum dots

The unique optical properties of quantum dots, which are nanocrystalline semiconductor particles, give them the potential to be used in tumor imaging. That carrier is a useful tool for cancer medication targeting.23

Nanospore

One strand of DNA at a time can pass through these minuscule holes, known as nanopores. Permit very accurate and efficient DNA sequencing, then.24

Conclusion

A novel method called "drug targeting" aims to deliver drug molecules to a particular organ or site within the body. The dosage and consequently the adverse effects of the medications were decreased as a result of this delivery method. Drug targeting uses a variety of delivery systems, including liposomes, transferosomes, gold nanoparticles, niosomes, cubosomes, virosomes, and nanotubes. Treatment for a number of cancers, including brain, breast, prostate, and colon cancers, depends heavily on the targeted drug delivery system. To address the issues with traditional drug delivery methods, advances have been made in the field of drug targeting.

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Conflict of interest statement

The authors declare that there is no conflict of interest.

References

1. Mishra N, Pant P, Porwal A, Jaiswal J, Aquib M. Targeted drug delivery: A review. Am J Pharm Tech Res. 2016;6:2249-3387.

2. Rani K, Paliwal S. A review on targeted drug delivery: Its entire focus on advanced therapeutics and diagnostics. Sch J App Med Sci. 2014;2(1C):328-31.

3. Manish G, Vimukta S. Targeted drug delivery system: A review. Res J Chem Sci. 2011;1(2):135-8.

4. Agnihotri J, Saraf S, Khale A. Targeting: New potential carriers for targeted drug delivery system. Int J Pharm Sci Rev Res. 2011;8(2):117-23.

5. Pushpalatha, R.; Selvamuthukumar, S.; Kilimozhi, D. Nanocarrier Mediated Combination Drug Delivery for Chemotherapy—A Review. *J. Drug Deliv. Sci. Technol.* **2017**, *39*, 362–371. [**Google Scholar**] [**CrossRef**]

6. Khizar, S.; Alrushaid, N.; Alam Khan, F.; Zine, N.; Jaffrezic-Renault, N.; Errachid, A.; Elaissari, A. Nanocarriers Based Novel and Effective Drug Delivery System. *Int. J. Pharm.* **2023**, *632*, 122570. [**Google Scholar**] [**CrossRef**]

7. Dang, Y.; Guan, J. Nanoparticle-Based Drug Delivery Systems for Cancer Therapy. *Smart Mater. Med.* **2020**, *1*, 10–19. [**Google Scholar**] [**CrossRef**] [**PubMed**]

8. Kwon IK, Lee SC, Han B, Park K. Analysis on the current status of targeted drug delivery to tumors. *J Control Release*. 2012;**164**:108–114. doi: 10.1016/j.jconrel.2012.07.010 [PMC free article] [PubMed] [CrossRef] [Google Scholar]

9. Yoo J, Park C, Yi G, Lee D, Koo H. Active targeting strategies using biological ligands for nanoparticle drug delivery systems. *Cancers*. 2019;**11**:640. doi: 10.3390/cancers11050640 [PMC free article] [PubMed] [CrossRef] [Google Scholar]

10. Torchilin VP. Drug targeting. Eur J Pharm Sci. 2000;11:S81-91.

11. Wagner E. Programmed drug delivery: Nanosystems for tumor targeting. Expert Opin Biol Ther. 2007;7(5):587-93.

12. Veiseh O, Kievit FM, Gunn JW, Ratner BD, Zhang M. A ligand-mediated nanovector for targeted gene delivery and transfection in cancer cells. Biomaterials. 2009;30(4):649-57.

13. J. Agnihotri, S. Saraf, and A. Khale, "Targeting: new potential carriers for targeted drug delivery system," International Journal of Pharmaceutical Sciences Review and Research, vol. 8, 2011.

14. T.M. Allen and P.R. Cullis, "Drug delivery system: Entering the mainstream,"Science, vol. 303, 2004.

15. Deepjyoti kumari Drug targeting : Basic concepts and drug carrier system – A review

16. Kannagi R, Izawa M, Koike T, Miyazaki K, Kimura N; Carbohydrate-mediated cell adhesion in cancer metastasis and angiogenesis. Cancer Science, 2004; 95: 377– 384.

17. Gref R1, Minamitake Y, Peracchia MT, Trubetskoy V, Torchilin V, Langer R; Biodegradable long-circulating polymeric nanospheres. Science, 1994; 263(5153):1600– 1603.

18. Martincic M, Tobias G. Filled carbon nanotubes in biomedical imaging and drug delivery. Expert Opin Drug Deliv. 2015;12(4):563-81.

19. Popov VN. Carbon nanotubes: Properties and application. Mater Sci Eng R Rep. 2004;43(3):61-102.

20. Ellis-Behnke RG, Teather LA, Schneider GE, So K-F. Using nanotechnology to design potential therapies for CNS regeneration. Curr Pharm Des. 2007;13(24):2519-28.

21. Agnihotri J, Saraf S, Khale A. Targeting: New potential carriers for targeted drug delivery system. Int J Pharm Sci Rev Res. 2011;8(2):117-23.

22. Sironmani A, Daniel K. Silver nanoparticles–universal multifunctional nanoparticles for bio sensing, imaging for diagnostics and targeted drug delivery for therapeutic applications. Drug Discov Dev Future. 2011;463-84.

23. Nagda D, Rathore KS, Bharkatiya M, Sisodia SS, Nema RK. Bucky balls: A novel drug delivery system. J Chem Pharm RES. 2010;2:240-3.

24. Pardo J, Peng Z, Leblanc RM. Cancer targeting and drug delivery using carbon-based quantum dots and nanotubes. Molecules. 2018;23(2):378.