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REVOLUTIONIZING MEDICINE: THE BENEFITS AND CARRIERS OF TARGETED DRUG DELIVERY SYSTEMS

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ABSTRACT

Targeted drug delivery, also known as excellent drug delivery, may be a therapeutic approach in which a medication is administered more often to one or a small number of body parts than to others. Drug delivery vehicles can provide the medication locally or at regular intervals. Breaking through even the most challenging barriers, like the blood-brain barrier, is the aim of the ideal medication delivery system. Nanomedicine has recently emerged as a result of the application of nanotechnology in medicine. Because nanoparticles are so small, they can be used to deliver medications that are difficult to dissolve in water and also help escape the liver's main pass metabolism. Drug delivery based on nanotechnology will keep the medication in the bloodstream for a longer period of time, which will reduce plasma level variations and, consequently, minimize side effects. These consist of nanoparticle systems including liposomes, quantum dots, dendrimers, and polymer-drug conjugates.

Keywords: Targeted Drug Delivery, Nanotubes, Ufasomes, Liposomes, Pharmacosomes, Niosomes, Dendrimers,

I. INTRODUCTION

A medication's pharmacological characteristics determine its biological effects on a patient.[1] The efficacy of this drug-target interaction has been jeopardized until the medication is administered to its site of action at a concentration and rate that produces the most beneficial benefits and the fewest side effects. The drug and the receptors at the drug's site of action interact to produce these effects.[2] The medicinal material is delivered to a particular tissue while avoiding contact with the rest of the body using a technique known as targeted medication delivery.[3] Consequently, it delivers the medication just to the specific areas of the body that it is intended to reach. This reduces side effects and boosts the efficacy of treatment.[4] In contrast to the traditional drug delivery system, which works by allowing the medication to pass through the body's semipermeable barrier, this one releases the drug in a dose form.[5,6]

Injections, oral formulations consisting of liquids and suspensions, tablets, capsules, and topical creams and ointments are among the traditional dosing forms that have a number of disadvantages.[7] Drug administration by parenteral means is quite intrusive and has transient effects.[8] Even though oral medication delivery is very common and suitable, some medications, such peptide medicines, cannot be administered because of their low oral absorption.[9] These could undergo gastrointestinal tract degradation. Having just local effects instead of systemic ones is a disadvantage of topical ointments and creams.[10]

Drug delivery system technology has improved and now regulates pharmacokinetic, drug bioavailability, and drug absorption characteristics.[11] First, the medication must be able to be loaded to the target site; second, it must not be broken down by bodily fluids; third, it must reach the target site; and fourth, it must be released at the designated time and location. These four principles are necessary for the drug targeting process.[12,13]

Drug targeting allows the medication to be delivered to [4,14]

- Specific tissues or organs that can detect the drug carrier
- The specific sort of cell, such cancerous cells.
- Capillaries in the target place.

Reasons for utilizing the specific medication delivery methods

A targeted medication delivery system may be used for a number of reasons, such as:[15]

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1. Poor stability of the medication.
2. Poor absorption of drugs.
3. The drug's brief half-life.
4. The vast distribution network of the medication.
5. Inadequate medication specificity.
6. The narrow therapeutic index of the medication.

The benefits of medication targeting include:[13]

1. A simpler drug administration protocol.
2. By focusing on a particular location, the medication's toxicity is reduced.
3. A little dosage is sufficient to produce the intended pharmacological reaction.
4. Steer clear of first-pass effects.
5. Better absorption of the medication from the intended location.
6. No peak and valley plasma concentration was observed as a result of drug targeting.

Drug targeting's drawbacks: [16]

1. The body eliminates drugs quickly, leading to a high frequency of doses.
2. The targeted medication delivery system's carrier may trigger an immunological reaction.
3. Insufficient time is spent localizing the medication delivery mechanism at the tumor tissue.
4. How released medicines spread and re-distribute.
5. The targeted medication delivery system needs to be manufactured, stored, and administered with a high level of skill.
6. Deposition of the medication at the target location may increase toxicity.
7. Achieving the product's stability will be challenging.

Carries for drug targeting: [17]

The use of carrier systems can help achieve drug targeting.

a. The systems known as carriers are necessary for delivering the medicine that has been trapped to its intended location.

b. Without releasing it at the non-target site, the carriers capture the drug moiety and transport it to the target site.

Several kinds of carriers were used to target drugs.

As Figure illustrates, a variety of carriers are used in the targeted drug delivery system, including:

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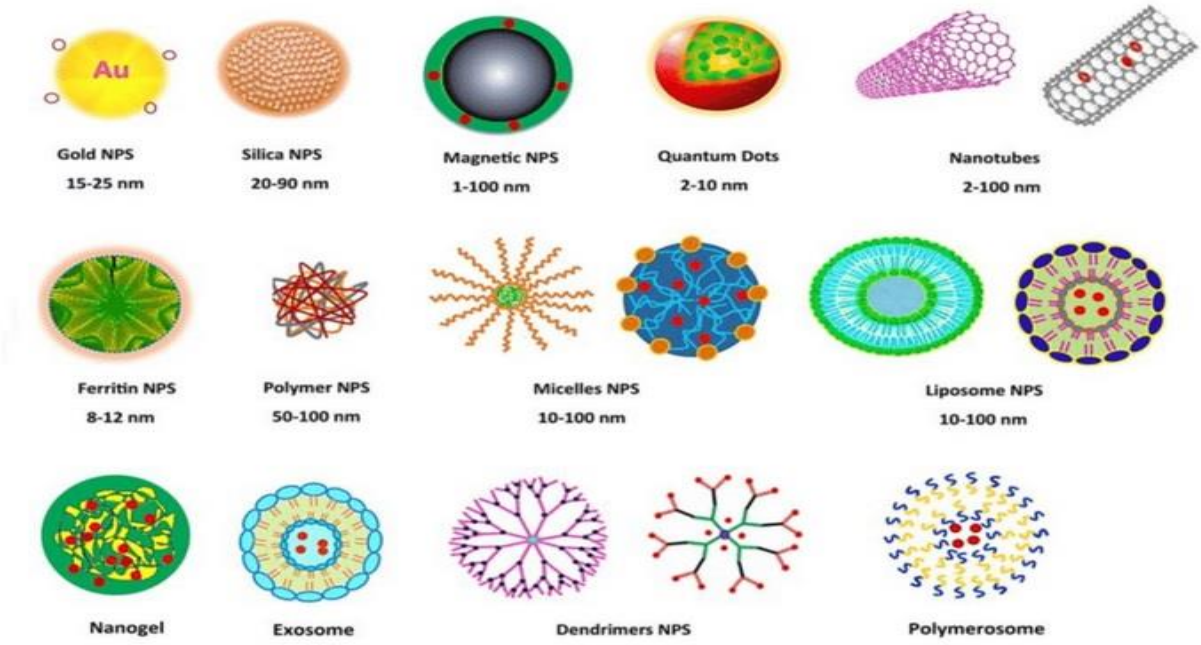

Figure: Various drug-targeting carrier types.

Nanotubes:

One type of drug delivery device is a hollow, cylindrical carbon tube called a nanotube, which is easy to fill and seal with the required medicine.[18,19] They are typically employed to deliver the medication to the cancerous cell.[20,21] To target the tumor in mice, Liu et al. used carbon nanotubes.[22] Additionally, Mc Devitt et al. used radiolabeled carbon nanotubes functionalized with antibodies to target tumors.[23]

Nanowires:

It is made of metal or other organic materials and is very thin. The nanowire's large surface area allows it to be altered such that, when inserted into the body, it may interact with certain biological molecules. It may be applied to the diagnosis and management of brain disorders such parkinsonism, seizures, and others.[24,25] Parkinson's disease and related conditions can be treated with this technology.[26] Additionally, it may be applied to tumor localization and detection.[27] Fluorescent zinc oxide nanowires were employed by Hong et al. to image cancer cells with molecular targeting.[28]

Nanoparticles of gold:

Scientists are using the gold nanoparticles to create an ultrasensitive DNA[29] and protein marker detection system that can identify the presence of many cancer kinds[30], including as prostate and breast cancer.[31] Gold nanoparticles were employed by Peng et al. to diagnose lung cancer.[32]

Nanopores:

One strand of DNA at a time may travel through nanopores, which are made of tiny holes. Permit very precise and efficient DNA sequencing.[33,34] This method has promise for biotechnology and genetic engineering[35,36] DNA translocations via nanopores made in graphene membranes were documented by Schneider et al.[37]

Nanoshells:

Nanoshells are novel approaches to nanoparticles that are composed of a gold shell encasing a hollow dielectric core of silica[38,39]. It might be applied to treatment or diagnosis. By attaching antibodies to their surfaces, nanoshells may conjugate specific regions, such cancer cells.[40] The antineoplastic medication is effectively targeted by this method.[41] The potential of nanoshells for cancer imaging and therapy was investigated by Loo et al.[42]

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The quantum dots:

Quantum dots are nanocrystalline semiconductor particles with special optical characteristics that make them appropriate for imaging tumors.[43-45] This carrier works well for delivering anti-cancer medications.[46] Pardo et al. targeted tumors and delivered drugs using quantum dots and nanotubes.[47]

Dendrimers:

Synthetic nanoparticles known as dendrimers have a certain diameter.[48] They are composed of layers of polymers around a control core.[49] The medicine may adhere to any one of the many locations on the dendrimers' surface.[50] Both gene transfection and medical imaging employ them.[51 to 55] Agatemor and Abd-El-Aziz examined the uses of dendrimers in biomedicine.[56]

Niosomes:

Non-ionic surfactant vesicles called niosomes have the ability to ensnare both lipophilic and hydrophilic drugs. Because phospholipid has inherent qualities, niosomes are more stable than liposomes.[57-59] It was discovered that niosomes work well to target antiviral, antibacterial, antifungal, anti-inflammatory, and antitumor medications.[60]. A new daunorubicin (DNR) niosomal delivery method was created and assessed by Liu et al. to combat acute myeloid leukemia (AML).[61] To target the analgesic and anti-inflammatory effects to the site of pain, Ahmed et al. synthesized piroxicam niosomes.[62]

Liposomes:

Liposomes are tiny, bilayer-shaped vesicles made of phospholipid from nature.[63] The phospholipid bilayers or the aqueous space can contain both hydrophilic and lipophilic medications.[64,65] The physical and chemical characteristics of the medicine as well as the makeup of the lipids determine the percentage of drug that is trapped.[66] Liposomal anti-tumor medicines were used in a study by Huwyler et al.[67]

Ufasomes:

When fatty acid and ionic surfactant (soap) are combined with cholesterol, a dispersion of unsaturated fatty acid vesicles known as ufasomes is created. For medications meant for topical administration, ufasomes make an excellent carrier. The stratum corneum, the skin's outermost layer, is thought to be the primary barrier preventing medication penetration. Because ufasomes are made of lipid membranes that may adhere to the skin, they can be used as DDS to solve this issue. The antifungal effectiveness of oxiconazole-loaded ufasome against Candida albicans was investigated and improved by Kaur et al.[68]

Virosomes:

Virosomes are unilamellar vesicles made of phospholipids that are used as medication delivery vehicles.[69,70] The virus-derived glycoproteins are bound to certain spots on the virosome surface to help identify and direct the virosomes to the intended location within the body. [71] Lucarini et al. create a novel platform that uses erythro-magneto-HA-virosomes to treat brain cancers.[72]

Pharmacosomes:

With an ideal ratio of polyphenol to phospholipids in the form of a complex, pharmacosomes are neutral molecules with both positive and negative charges that exhibit hydrophilic and lipophilic properties. The medication forms a hydrogen bond or is conjugated to the lipoidal complex via electrostatic force.[73] From the words pharmakon, which means drug, and soma, which means carrier, comes the phrase pharmacosome. The medication may conjugate to the lipoidal complex as hexagonal aggregates or micelles.[4] Pharmacosomes of aceclofenac were created and assessed by Semalty et al.[74]

Cubosomes:

Cubosomes are nanostructured drug delivery vehicles composed of specific lipids. They are described as cubic-shaped injectable liquid crystalline nanoparticles.[75] Azhari et al. used Tween 80 to stabilize phytantriol-based cubosomes for the transport of macromolecular treatments to the brain.[76]

Nanobots:

Nanorobotics is a revolutionary medicine delivery method.[77,78] Their diameter is 10-9 m, making them a nanoscale machine.[77] Self-propelling tailored magneto-nanobots were created by Andhari et al. to penetrate deep into tumors.[79]

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Nanocrystal:

Materials that are smaller than 100 nm in size and have a single crystalline structure are called nanocrystals.[80] The dimensions of nanoparticles are less than 1000 nm, which is how they vary from nanocrystals.[81] Liu et al. investigated the role that drug-loading nanocrystals play in cancer therapy and targeting.[82]

Transferosomes:

One such innovative vesicular medication delivery method is transferosomes. Transformers are particularly self-optimizing, self-regulating, and "ultra-flexible" in terms of deformation. Due to the existence of "edge activators" in a vesicular membrane, surfactants have been utilized as edge activators. They have an inner aqueous core encircled by a complex lipid bilayer with special features. Therefore, it may effectively enter the skin by forcing itself through pores that are five to ten times smaller than their diameter.[83,84] By doing this, the vesicle won't completely burst and the medication will stay intact after entering the skin.[85] Miconazole nitrate transferosomal gel was created by Qushawy et al. to effectively treat cutaneous candida infections.[86]

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