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Carrier Mediated Target Drug Delivery Systems: A Novel Approach - (An Overview)

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Review Article

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Abstract

Conventional dosage forms such as tablets, capsules, gels etc. immediately provide drug delivery and it cause fluctuation of drug level in blood. So for maintaining drug concentration within therapeutic effective range and to deliver drug at specific site now a days target drug delivery system is one of the most considerable novel approach towards drug delivery system. Targeted drug delivery seeks to concentrate the medication in the tissues of interest while reducing the relative concentration of the medication in the remaining tissues thus improving therapeutic index and bioavailability at site specific-delivery . This improves efficacy of the drug while reducing side effects. New drug delivery systems include lipidic, surface active agents, proteic and polymeric technologies to provide new sustained drug delivery with better body distribution, drug protection from the harsh ex-ternal environment and avoidance of drug clearance. Now a days various carrier systems such as liposomes, niosomes, aquasomes, pharmacosomes, dendrimers, nanoparticles, microspheres, solid lipid nanoparticles, resealed erythrocytes etc. are used in target drug delivery system which provide site specific drug delivery. Target drug delivery system is used in various diseases where it is very difficult for a drug molecule to reach its destination in the complex cellular network of an organism.

Key words: Novel drug delivery system, Targeted drug delivery system, Various carriers, Application.

INTRODUCTION

At present, no available drug delivery system behave ideally achieving all the lofty goals, but sincere attempts have been made to achieve them through novel approaches in drug delivery. A number of novel drug delivery system has emerged encompassing various routes of administration, to achieve controlled and targeted drug delivery[1]. Targeted drug delivery is a method of delivering medication to a patient in a manner that increases the concentration of the medication in some parts of the body relative to others[2]. A number of drug delivery systems are currently under investigation to circumvent the limitation commonly found in conventional dosage forms and improve the potential of the respective drug. On the other hand, there has been a focus on the microenvironment of the cells and their interaction with these new dosage forms[3]. Phospholipid vesicles (liposomes) were first described decades ago by Bangham et al. It has been shown that phospholipids spontaneously form closed structures when they are hydrated in aqueous solutions[4]. On the basis of the ability of liposomes to interact with cells and/or blood components, at least two types of liposomes currently can be designed including: (i) non-interactive sterically stabilized (long-circulating) liposomes (LCL) and; (ii) highly interactive cationic liposomes[5]. The main objective of drug delivery systems is to deliver a drug effectively, specifically to the site of action and to achieve greater efficacy and minimise the toxic effects compared to conventional drugs[6]. There are now liposomal formulations of conventional drugs that have received clinical approval and many others in clinical trials that bring benefits of reduced toxicity and enhanced efficacy for the treatment of cancer and other life-threatening diseases[7]. One of the most prolific areas of liposome applications is in biochemical investigations of conformation and function of membrane proteins. These are the so-called reconstitution studies and purified membrane proteins, such as ion pumps (sodiumpotassium-, or calcium-ATPases), or glucose transport proteins are reconstituted in their active form into liposomes and then studied[8]. Drug loading can be achieved either

passively (i.e. the drug is encapsulated during liposome formation) or actively (i.e. after liposome formation)[9]. Major component of niosomes is non-ionic surfactant which give it an advantage of being more stable when compared to liposomes thus overcoming the problems associated with liposomes i.e. susceptibility to oxidation, high price and the difficulty in procuring high purity levels which influence size, shape and stability[10, 31]. Niosomes enhances the efficacy of drug, such as nimesulide, flurbiprofen, piroxicam, ketoconazole and bleomycin exhibit more bioavailability than the free drug[11]. They are osmotically active and stable, as well as they increase the stability of entrapped drug. Handling and storage of surfactants requires no special conditions. They improve oral bioavailability of poorly absorbed drugs[12]. Nanotechnology (nanomaterials and nanoscale devices) for diagnosis, treatment and monitoring diseases is a fast developing area of biomedical research. It is an amalgamation of engineering science with pharmaceutical and medical sciences[13]. Development of nanostructures such as liposomes, nanocapsules, nanoemulsions, solid lipid nanoparticles, dendrimers, polymeric nanoparticles, etc, for delivery of Drugs[14]. US FDA has approved in the recent past an IV administered 130nm albumin nanoparticles loaded with Paclitaxal (Abraxane) for cancer therapy[15]. The major goals in designing nanoparticles as a delivery system are to control particle size, surface properties and release of pharmacologically active agents in order to achieve the site-specific action of the drug at the therapeutically optimal rate and dose regimen[16]. The SLNs are sub-micron colloidal carrier which is composed of physiological lipid, dispersed in water or in an aqueous surfactant solution[17]. SLNs as colloidal drug carrier combines the advantage of polymeric nanoparticles fat emulsions and liposomes[18]. Aquasomes are used for drug and antigen delivery. Properties like protection and preservation of fragile biological molecules, conformational integrity, and surface exposure made it as a successful carrier system for bioactive molecules like peptide, protein, hormones, antigens and genes to specific sites[19,30]. It has been reported haemoglobin loaded aquasomes using hydroxyapatite core as potential artificial oxygen carrying system[20]. Pharmacosomes are the colloidal dispersions of drugs bound covalently,electrostatically or by hydrogen bonds to phospholipids, and may exist as ultrafine vesicular, Micellar, or hexagonal aggregates, depending on the chemical structure of drug-lipid complex[21]. Erythrocytes have been the most interesting carrier and have found to possess great potential in drug targeting. Resealed erythrocytes are gaining more popularity because of their ability to circulate throughout the body, biocompatibility, zero order release kinetics, reproducibility and ease of preparation[23]. Application of erythrocytes as promising slow drug release or site-targeted delivery systems for a variety of bioactive agents from different fields of therapy has gained a remarkable degree of interest in recent years[22]. Dendrimers are monodisperse macromolecules, unlike linear polymers. The classical polymerization process which results in linear polymers is usually random in nature and produces molecules of different sizes, whereas size and molecular mass of dendrimers can be specifically controlled during synthesis[24]. Microspheres received much attention not only for prolonged release, but also for targeting of anticancer drugs to the tumour. In future by combining various other strategies, microspheres will find the central place in novel drug delivery, particularly in diseased cell sorting, diagnostics, gene & genetic materials, safe, targeted and effective *in vivo* delivery and supplements as miniature versions of diseased organ and tissues in the body[25]. A new research that addresses from simple organoleptic or technological problems to more complex issues involving the targeting of specific tissues and organs has emerged. With the aim to reduce dosing frequency, to improve the compliance of the existing pharmacotherapy and to target viral reservoirs, the design of novel drug delivery systems is becoming complementary to new drug discovery[26]**.** The current focus in development of cancer therapies is on targeted drug delivery to provide therapeutic concentrations of anticancer agents at the site of action and spare the normal tissues[27]. Recent studies revealed that a new formulation of small sized (less than 100 nm) long circulating liposomes appears to offer selective tumor localization. This localization is probably related to long circulation time of liposome and to increase probability for extravagation to the tumor vascular endothelium[28]. Nanoparticles serving in anticancer therapies may be comprised, in whole or in part, of various lipids and natural and synthetic polymers. Most commonly used synthetic polymers to prepare nanoparticles for drug delivery are biodegradable[29]. Cardiovascular disease processes such as atherosclerosis, restenosis, and inflammation are typically localized to discrete regions of the vasculature, affording great opportunity for targeted pharmacological treatment. Liposomes are potentially advantageous targeted drug carriers for such intravascular applications[30,31]. Nanomedicines marked the field of medicine from nanobiotechnology, biological micro-electromechanical systems, microfluidics, biosensors, drug delivery, microarrays to tissue microengineering. Since then nanoparticles has overcome many challenges from blood brain barrier to targeting tumors. Where solid biodegradable nanoparticles were a step up liposome, targeting nanoparticles opened a whole new field for drug delivery[32,33,34]. Various strategies like non-invasive methods, including drug manipulation encompassing transformation into lipophilic analogues, prodrugs, chemical drug delivery, carrier-mediated drug delivery, receptor/vector mediated drug delivery and intranasal drug delivery, which exploits the olfactory and trigeminal neuronal pathways to deliver drugs to the brain, are widely used[35].

Novel drug delivery system:

New Drug Delivery System (NDDS) has got new impetus since early eighties to have improved therapeutic outcome from the same drug, because the NDDS have several advantages over the conventional dosage forms. Several types of NDDS have been developed during last few decades like Microparticles, Nanoparticles, Osmotic Modulated Drug Delivery Systems, and Brain Targeted Delivery System etc. NDDS have been and are being developed in order to attain greater control over a drug's pharmacokinetics and pharmacodynamics after administration so that the dosage forms thus produced would be highly effective, safe and better than the conventional products.

A dramatic improvements have been made in the development of Drug Delivery Systems which in turn control the rate of drug delivery, sustain the duration of therapeutic action and targeting the drugs at specific sites. These improvements result in the development of novel drug Delivery System for the following purposes-

- Controlled administration of therapeutic dose
- Maintenance of drug concentration with an optimal range for prolonged action
- Maximum efficacy-dose relationship
- Reduction of adverse effects or toxic effects
- Reduction of frequent dose intake
- Enhancement of patient compliance

It is hoped that with more and more research endeavours being focussed into this arena, in near future, a large portions of the conventional dosage form would be replaced by these NDDS and an overall betterment of health care delivery is expected with that change over.

TARGETED DRUG DELIVERY SYSTEM:

The best controlled mechanism would be delivery of drug exclusively to the targeted cells or cellular components. In many cases, it would be desired to deliver drugs at a specific site inside the body to a particular diseased tissue or organ. This kind of regional therapy mechanism would reduce systemic toxicity and achieve peak drug level directly at the target site. A few examples of drugs that require this kind of therapy are anticancer drugs, antifertility agents, and antiinflammatory steroids. These drugs have many severe unintended side effects in addition to their therapeutic effects.The targeted or site- specific delivery of drugs is indeed a very attractive goal because this provides one of the most potential ways to improve the therapeutic index of the drugs. The article focuses on various advantages of vesicular and particulate systems to develop the effective delivery system to achieve maximum effective concentration. Lipid vesicles were found to be of value in immunology, membrane biology, diagnostic techniques, and most recently, genetic engineering. Vesicles can play a major role in modelling biological membranes, and in the transport and targeting of active agents. Various types of vesicular systems such as liposomes, niosomes, aquasomes, pharmacosomes and transfersomes have been discussed.

1.**LIPOSOMES**[2,6]**:**

Liposomes are spherical, selfclosed vesicles of colloidal dimensions, in which (phospho) lipid bilayer sequesters part of the solvent, in which they freely float, into their interior. In the case of one bilayer encapsulating the aqueous core one speaks either of small or large unilamellar vesicles while in the case of many concentric bilayers one defines large multilamellar vesicles. Liposomes are micro-particulate or colloidal carriers, usually 0.05-5.0 /~m in diameter which form spontaneously when certain lipids are hydrated in aqueous media (Bangham and Horne, 1964). Liposomes are composed of relatively biocompatible and biodegradable material, and they consist of an aqueous volume entrapped by one or more bilayers of natural and/or synthetic lipids.

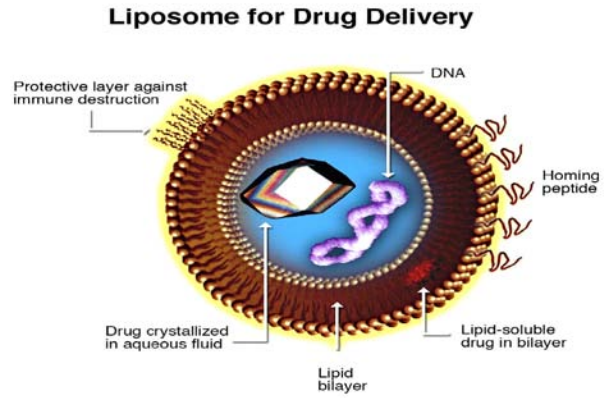

Figure-1: structure of a drug loded Liposome[2]

2.NIOSOMES[10,11]**:**

Niosomes were first reported in the seventies as a feature of the cosmetic industry by Vanlerberghe et al, Handjani-vila et al.The first niosomes were formulated using cholesterol and single-chain surfactants such as alkyl oxyethylenes. Niosomes are non-ionic surfactant based unilamellar or multilamellar vesicles in which an aqueous phase of solute is entirely enclosed by a membrane resulted from the organization of surfactant macromolecules as bilayers.(Vyas and Khar) The niosomes are very small in size their size lies in the nanometric scale (50nm-1000nm). Niosomes are different from liposomes and they offer certain advantages over liposomes. Niosomes are prepared from uncharged single chain surfactants whereas liposomes are prepared from double chain neutral or charged phospholipids.[33]

3.PHARMACOSOMES[21]**:**

Pharmacosomes are the colloidal dispersions of drugs bound covalently,electrostatically or by hydrogen bonds to phospholipids, and may exist as ultrafine vesicular, Micellar, or hexagonal aggregates, depending on the chemical structure of

drug-lipid complex. These are amphiphilic lipid vesicular systems possessing phospholipid complexes to improve bioavailability of poorly water soluble and poorly lipid soluble drugs The idea for the development of the vesicular pharmacosome is based on surface and bulk interactions of lipids with drug. Any drug possessing an active hydrogen atom (-COOH, -OH, -NH2, etc.) can be esterified to the lipid, with or without spacer chain. Synthesis of such a compound may be guided in such a way that strongly result in an amphiphilic compound, which will facilitate membrane, tissue, or cell wall transfer, in the organism. Pharmacosomes exhibit certain advantages over conventional vesicular systems.

4.DENDRIMERS[25]:

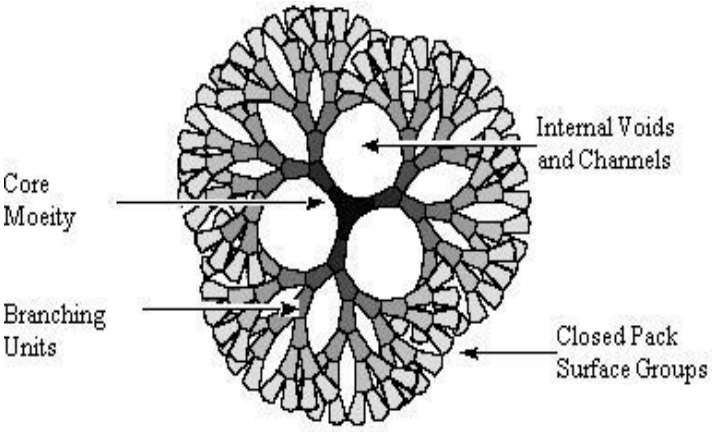

Figure:2 : The Dendritic Structure[25]

Dendrimers are a new class of polymeric materials. The term originates from 'dendron' meaning a tree in Greek. First discovered in the early 1980's by Donald Tomalia and co-workers. A dendrimer is generally described as a monodisperse macromolecule, which is characterized by its highly branched 3D structure that provides a high degree of surface functionality and versatility. The structure of these materials has a great impact on their physical and chemical properties when compared to traditional linear polymers. In solution, linear chains exist as flexible coils; in contrast, dendrimers form a tightly packed ball. This has a great impact on their rheological properties. Lower generation dendrimers, which are large enough to be spherical but do not form a tightly packed surface, have enormous surface areas in relation to volume.

Dendrimers possess three distinguished architectural components namely

- An initiator core.
- Interior layers (generations) composed of repeating units, radically attached to the interior core.
- Exterior (terminal functionality) attached to the outermost interior generations.[22,23]

5.RESEALED ERYTHROCYTES[23,24]:

Erythrocytes:

Red blood cells (also referred to as erythrocytes) are the most common type of blood cells and the vertebrate organism's principal means of delivering oxygen (O2) to the body tissues via the blood flow through the circulatory system. They take up oxygen in the lungs or gills and release it while squeezing through the body's capillaries. These cells' cytoplasm is rich in hemoglobin, an iron-containing bimolecule that can bind oxygen and is responsible for the blood's red color. In humans, mature red blood cells are flexible biconcave disks that lack a cell nucleus and most organelles. 2.4 million new erythrocytes are produced per second.

Resealed Erythrocytes:

Such drug-loaded carrier erythrocytes are prepared simply by collecting blood samples from the organism of interest, separating erythrocytes from plasma, entrapping drug in the erythrocytes, and resealing the resultant cellular carriers. Hence, these carriers are called resealed erythrocytes.

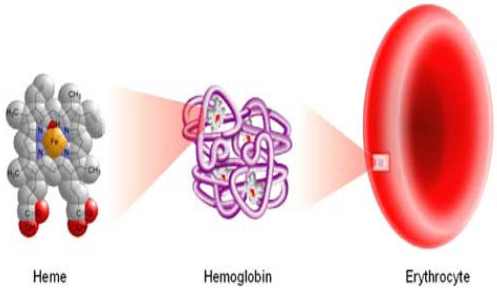

Figure:3 seperation of erythrocytes from plasma[23]

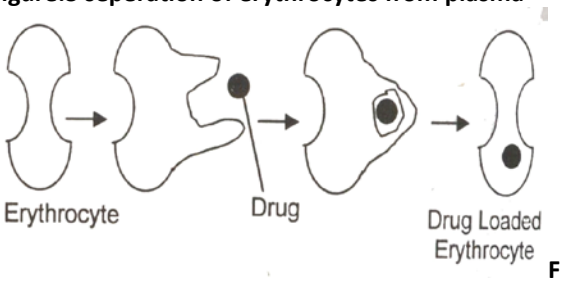

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Figure:4 Process of loading of drug in erythrocytes[24]

6.NANOPARTICLES[15,16]:

Nanoparticles are potentially useful as carriers of active drugs and, when coupled with targeting ligands, may fulfill many attributes of a 'magic bullet'. Prof. Speiser in the late 1960s developed the first nanoparticles for drug delivery purposes and for vaccines. Infections like tetanus and diphtheria require multiple injections to build up antibody levels in the body that are sufficient for protection. The objective was sustained drug release from nanocapsules that would be able to circulate in the blood after intravenous injection. In order to test the feasibility of a sustained release from such capsules, Speiser first focussed on the development of nanoparticles for vaccination purposes, with the hope that due to the sustained release properties of nanocapsules a constant immune stimulation would be achieved, and only one injection would suffice to

achieve the necessary antibody response (Kreuter, 2007).

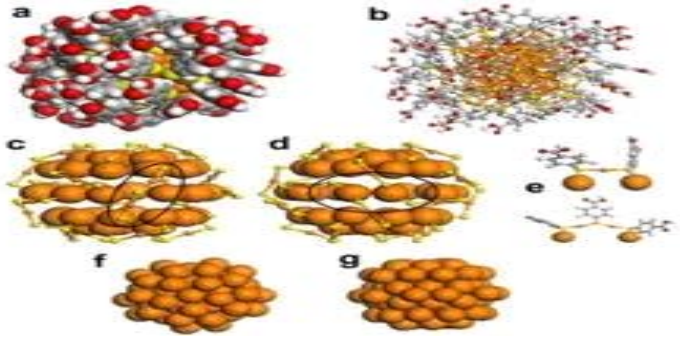

Figure: 5&6 silver and gold nano particles[15,16]

Silver **Nanoparticles**. Since it was introduced in th 1980's and Gold **Nanoparticles** for cancer cell detection.

7.SOLID LIPID NANOPARTICLES (SLNS)[17,18]**:**

Colloidal particles ranging in size between 10 and 1000 nm are known as nanoparticles.They are manufactured from synthetic/natural polymers and ideally suited to optimize drug delivery and reduce toxicity. Over the years, they have emerged as a variable substitute to liposomes as drug carriers. The successful implementation of nanoparticles for drug delivery depends on their ability to penetrate through several anatomical barriers, sustained release of their contents and their stability in the nanometer size. However, the scarcity of safe polymers with regulatory approval and their high cost have limited the wide spread application of nanoparticles to clinical medicine. To overcome these limitations of polymeric nanoparticles, lipids have been put forward as an alternative carrier, particularly for lipophilic pharmaceuticals. These lipid nanoparticles are known as solid lipid nanoparticles (SLNs).

These consist of a solid hydrophobic core having a monolayer of phospholipids coating. The solid core contains drug dissolved or dispersed in the solid high melting fat matrix.

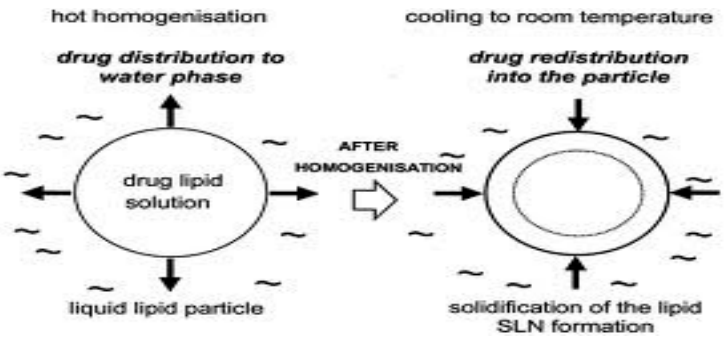

Figure:7 Formation of solid lipid nano particles[18]

The hydrophobic chains of phospholipids are embedded in the fat matrix. Depending on the type and concentration of the lipid, 0.5 to 5% emulsifier (surfactant) is added for the physical stabilization of the system.

8.MICROSPHERES[26]**:**

Microspheres are characteristically free flowing powders consisting of proteins or synthetic polymers which are biodegradable in nature and ideally having a particle size less than 200 µm. A well designed controlled drug delivery system can overcome some of the problems of conventional therapy and enhance the therapeutic efficacy of a given drug. There are various approaches in delivering a therapeutic substance to the target site in a sustained controlled release fashion. One such approach is using microspheres as carriers for drugs. It is the reliable means to deliver the drug to the target site with specificity, if modified, and to maintain the desired concentration at the site of interest without untoward effects. Microspheres received much attention not only for prolonged release, but also for targeting of anticancer drugs to the tumour.

9.AQUASOMES[19,20]**:**

Aquasomes are nanoparticulate carrier system but instead of being simple nanoparticles these are three layered self assembled structures, comprised of a solid phase nanocrystalline core coated with oligomeric film to which biochemically active molecules are adsorbed with or without modification. Alternatively aquasomes are called as “bodies of water”, their water like properties protect and preserve fragile biological molecules, and this property of maintaining conformational integrity as well as high degree of surface exposure are exploited in targeting of bio-active molecules like peptide and protein hormones, antigens and genes to specific sites. These carbohydrate stabilize nanoparticles of ceramic are known as “aquasomes” which was first developed by NirKossovsky

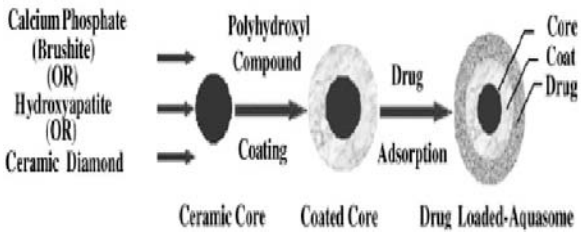

Figure:8 Formation and drug loading process in Aquasome[20]

Table-1 Detail discription of various carriers used in targeted drug delivery system[1,2,3,7,11,15,17,19,21,23,25]

S. N	Carriers used in TDDS	Size range	Features	Specifications	Recent updates and future aspects in therapeutic advantage
1.	Liposomes	25nm-100µm	microscopic vesicles composed of one or more concentric lipid bilayers, separated by water or aqueous buffer compartments.	Made up of phospholipids so chemically unstable, low encapsulation efficiency, rapid leakage of water-soluble drug, expensive	Amphiphilic tyrosine hydroxylase Biocompatible Efficient gene transporter
2.	Niosomes	10 to 1000 nm	non-ionic surfactant vesicles are bilayered structures	Relatively stable and less expensive than liposome but physically unstable due to aggregation, leakage and hydrolysis of drug may occur	increase solubility and stability of flurbiprofen
3.	Pharmacosome	-	pure drug vesicles formed by colloidal dispersions of drugs boundcovalently,electrostatically or by hydrogen bonds to phospholipids.	drug is covalently linked, loss due to leakage of drug, does not take place, Entrapment efficiency is not only high but predetermined	great potential of drug thiophene for applications in quantum optical devices.
4.	Aquasome	60-300nm	The particle core is composed of noncrystalline calcium phosphate or ceramic diamond, and is covered by a polyhydroxyl oligomeric film.	these are three layered self assembled structures, comprised of a solid phase nanocrystalline core coated with oligomeric film to which biochemically active molecules are adsorbed with or without modification.	Molecular plasticizer, carbohydrates prevent the destructive drug carrier interaction and helps to preserve the spatial qualities and the crystalline nature of core, gives structural stability and overall integrity
5.	Dendrimers	variable	Dendrimers are a new class of polymeric materials generally described as a monodisperse macromolecule	well defined three-dimensional structure, the availability of many functional surface groups, low polydispersity and ability to mimic, high aqueous solubility	Dendrimers have been tested in preclinical studies as **contrast agents** for magnetic resonance. Magnetic resonance imaging (MRI) is a diagnostic method producing anatomical images of organs and blood vessels.
6.	Resealed Erythrocytes	2.5-7.8µm	Cellular drug-loaded carrier prepared by erythrocytes from plasma, entrapping drug in the erythrocytes, and resealing the resultant cellular carriers.	Drug-loaded carrier erythrocytes are prepared simply by collecting blood samples from the organism of interest, separating erythrocytes from plasma, entrapping drug in the erythrocytes, and resealing the resultant cellular carriers	Formation of erythrosome for macromolecules and nano-erythrosomes (for covalent conjugation of daunorubicin).
7.	Nanoparticles	10-1000nm	submicron-sized colloidal biodegradable polymeric system	increase the stability of drugs/proteins and possess useful control release properties, small size and large surface area can lead to particle aggregation, imited drug loading and burst release.	increase water solubility of major constituents such as flavonoids and lignans of ***Cuscuta chinensis*** and has hepatoprotective and antioxidant effects.
8.	Solid Lipid Nanoparticles (SLN)	50-1000nm	submicron colloidal carriers containing solid hydrophobic core having a monolayer of phospholipids.	polymers withregulatory approval and their high cost have limited the wide spread application of nanoparticles so lipids are used as alternative carrier with high drug loading	DNA in Cationic SLN efficiently bind and tranfect plasmid DNA.
9.	Microspheres	<200 µm	Microspheres are free flowing powders consisting of proteins or synthetic polymers	Microspheres are characteristically free flowing powders consisting of protiens or	In future in diseased cell sorting, diagnostics, gene & genetic materials, safe, targeted

			which are biodegradable in nature.	synthetic polymers which are biodegradable in nature	and effective *in vivo* delivery and supplements as miniature versions of diseased organ and tissues in the body.

Table-1Applications of various carriers in targetting drugs falling under various therapeutic categories[1,2,3,7,11,15,17,19,21,23,25]

CATEGORY OF THERAPEUTICAGENTS	DRUGS INCORPORATED	DESCRIPTION
Antineoplastic agents	Paclitaxel and cytarabine Hydrochloride, Doxorubicin, adriamycin etc.	Decrease toxic side effects, prolonged release with double tumoricidal activity and 10 times decreased clearance, reduced light induced degradation
NSAIDS	Aceclofenac, rofecoxib, Diclofenac, Flurbiprofen, etc.	Good entrapment efficiency, reduce gastrointestinal adverse effects and cardiac toxicities ,sustained release , long circulation improving short half-life
Antileishmanial Agents	Amarogentin, sodium stibogluconate,quercetin,etc	non-hepatotoxic and nonnephrotoxic nature, more active than free drug ,greater efficacy and lesser toxicity
Anti-Fungal	Griseofulvin,nystatin, Clotrimazole, and Fluconazole, etc.	Increased oral bioavailability ,reduced Toxicity, sustained and controlled release
Antibiotics	Gentamicin sulphate, cefpodoxime proxetil etc.	ophthalmic controlled delivery, reducing the chances of dose dumping improved bioavailability
Anti-Tubercular	Isoniazid, rifampicin, Pyrazinamide etc.	Increased cellular uptake by macrophage cells,Prolonged release, reduced dose, reduced toxicity
Antiviral	Zidovudine (ZDV), Ribavirin, tenofovir etc.	Increased distribution of drug in lungs, kidney,heart, liver and spleen, improved efficacy of low dose drugs, increased half-life, mean residence time and reduced leakage of drug
Anti-Glaucoma Agents	Timolol maleate, etc.	sustained effect upto 8 hours,,eliminate systemic side-effects especially in patients suffering from heart diseases or bronchial asthma
Gene Delivery	Antisense oligonucleotide, luciferase plasmid etc.	
Brain targeted Delivery	vasoactive intestinal peptide (VIP)	Glucosebearing niosomes exhibits higher VIP brain uptake
Vitamins	Tretinoin, A-tocopherol	
Hormones	Luteinizing hormone releasing hormone (LHRH), etc	niosomes were stable in both muscle homogenate and plasma and had clearance of about 49 hours with sustained release
Muscle Relaxants	Baclofen	Increased skin penetration and Bioavailability and in vitro drug release, decreased Osmotic fragility
Anaesthetics	lidocaine hydrochloride	Increased entrapment efficiency
Anti-Diabetic	Gliclazide	Improved Oral bioavailability, sustained release over a period of 24

		hours, increased stability
Contraceptive	cantchroman	enhanced anti-fertility effect ,no side effects and no other toxic effects.
Diagnosis	as carriers of iobitridol used for X-ray imaging.	Increased rate of encapsulation and the stability
Cosmetics	N-acetyl glucosamine, minoxidil,Finasteride, etc.	improved penetration into the skin in the treatment of hyperpigmentation disorders

CONCLUSION

These new drug carrier systems is clearly high,undoubtedly, those carriers provide the hope to treat and diagnose several diseases. Several technologies have advanced into clinical studies and are nowadays market products that have been shown favorable results. Novel Targeted delivery of drugs, as the name suggests, is to assist the drug molecule to reach preferably to the desired site. The inherent advantage of this technique has been the reduction in dose & side effect of the drug. These new drug carrier systems formulations of conventional drugs have clearly demonstrated therapeutic advantages if disease site targeting and optimised release characteristics are incorporated. It may be expected that many other conventional drugs will benefit from delivery in these new drug carrier systems with similar design features. The design of liposomal systems containing genetic drugs for antisense therapy and gene therapy is becoming increasingly sophisticated.

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AUTHORS' CONTRIBUTIONS

Authors contributed equally to all aspects of the study.

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CONFLICTS OF INTEREST

The authors declare that they have no competing interests.