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Nano drug Delivery System and their Applications

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Abstract: Nano-medicine and nano delivery systems are a relatively new but rapidly developing science where materials in thenanoscalerangeareemployed to serve as means of diagnostic tools or to deliver therapeutic agents to specific targeted sites in a controlled manner. Nanotechnology offers multiple benefits in treating chronic human diseases by site-specific, and target-oriented delivery of precise medicines

Themostadvancedtechnologyfordeliveringdrugstovarioussitesinthebodyisnanotechnology.The nano-size of particles possesses a trans cellular mechanism in delivering the drug to the target sites. Many diseases can be treated effectively through this delivery using nano-capsules, nano-spheres, noisome dendrimers, polymeric micelles, liposomes, solid lipid nanoparticles (NPs), carbon nanotubes, fullerenes, polymeric-based NPs, and paramagnetic NPs with a size ranging from 1 nm to 500 nm.

Keywords: Nano Drug Delivery Systems (NDDS), Nanoparticles, Targeted Drug Delivery, Controlled Drug Release, Nanomedicine, Drug Delivery Applications

1. INTRODUCTION

Nano drug delivery systems (NDDS) are advanced pharmaceutical technologies that use nano-metric carriers (typically**1–100 nm**) to deliver therapeutic agents specifically to their site of action. By manipulating materials at atomic level, these systems overcome the fundamental limitations of conventional medicine, such as poor solubility, non-specific distribution, and rapid degradation Nano word originated from the Latin word which implies dwarf ideal size range offered by nanotechnology refers to the one-thousandth millionth of a particular unit. Thus nanometer is one thousand millionth of a meter (1nm= 10^{-9}nm). The branch of nanotechnology is the science that deals with the processes that occur at a molecular level and of nano-length scale size. Nanotechnology offers drugs within the nanometer size range which enhances and reinforces the performance in a variety of dosage forms. Various advantages of nano sizing include decreased fed/fasted variability, decreased patient-to-patient variability, enhanced solubility, increased oral bioavailability, increased rate of dissolution, increased surface area, less amount of dose required, and more rapid onset of therapeutic action . Polymeric nano particles are colloidal particles composed of a biocompatible or biodegradable

lipid matrix. These are transport carrier compartment for drugs or other active molecules of non liposomal character having size ranging from 10-1000nm(1μm). This bioactive are entrapped in the polymer matrix as particulates enmeshed or solid solutions or may be bound to the particle surface by adsorption or chemically. The nanoparticles loaded bioactive could not only deliver drugs to specific organs but delivery rate in addition could be controlled as being bystanders, burst, controlled, pulsatile or modulated.Depending on the process used for the preparation, two types of nanoparticles can be obtained nano-spheres or nano-capsules. Nano-spheres may be defined as solid core spherical particulates, which are nano-metric in size, they contain drug embedded within the matrix or adsorbed on to the surface, nano-capsules are vesicular system in which drug is essentially encapsulated within the central volume surrounded by an embryonic continuous polymeric sheet. In nano-capsules, the active drug is mainly encapsulated in solution systems.

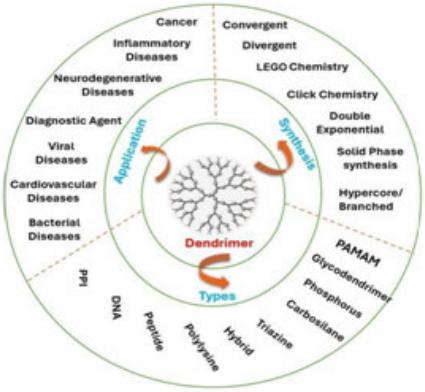
2. Types of nano- Based drug Delivery Systems

The term "NDDS" refers to a broad range of nano materials that have been created to enable the controlled and targeted release of medications.Due to their variations in-composition, structure and mode of action, these materials can be used in a variety of therapeutic contexts.

I DIFFERENT NANO-BASEDDRUGDELIVERYSYSTEMS

2.1.DENDRIMERS

Dendrimers are hyper branched globular shaped particles having a unique-three-dimensional architecture. They can provide perfect control over molecular structure for a nano sized based drug delivery system due to their multiple functional surface groups. Dendrimers are highly branched tree- shaped macromolecules that have several benefits for drug delivery. By adhering to the ligands on their surface by straight forwardioniccontactorchemicalconjugation to the delivery system, dendrimers demonstrate the potential to transport pharmaceuticals to the target region *via* a passive mechanism by improving penetration retention and active targeting.



DENDRIMER APPLICATIONS SYNTHESIS ,METHODS AND TYPES

2.2 Nanoparticles

Nano particles are among the most widely studied types of NDDS. They can be composed of various materials, including lipids, polymers, metals, and ceramics, and can range in size from 1 to 1000 nanometers. Due to their small size, nano particles can easily penetrate biological barriers, such as the blood–brain barrier or tumor vasculature and deliver drugs to targeted are as with high specificity. Moreover, nano particles can be engineered to release their pay load-in response to external stimuli ,such as pH, temperature, or enzyme activity, enabling controlled release over time.

2.3 LIPOSOMES

A potential class of drug delivery methods, liposomes improve the safety and therapeutic effectiveness of a variety of pharmacological drugs. The Greek words “lipos”, which means fat, and “soma”, which means body, are the roots of the word “liposome”.Liposomes deliver the drugs into cells by fusion or endocytosis mechanisms to provide controlled drug release, which is protected from degradationbyplasmaenzymesandhasreduced side effects. Moreover, liposomes can be easily modified by coating the surface or attaching different specific surface biomarkers PEG, antibodies, and peptides to reach cancer cells by active targeting. Liposomes’ efficacy in treating cancer has prompted much ,and their unique properties such as their high entrapment efficiency of active ingredients, accessibility, and scalability in production make them intriguing drug delivery systems (DDS).

2.4 Solid lipid nanoparticles(SLNs)

SLNs which are in the size range of 10–1000 nm, are attracting major attention as a novel colloidal drug carrier with the potential to overcome limitations in drug delivery including poor drug loading capacity, size problems, unstable properties, uncontrolled drug release associated with polymeric nano particle, dendrimers and liposomes. SLNs offer unique properties such as small size, large surface area, high drug loading and entrapment efficiency, low toxicity, excellent physical stability, controlled drug release, protection of drugs from degradation, and avoidance of the use of organic solvents.

The structure of SLNs based on lipids that are solid at room temperature. The lipid structure of SLNs is important to determine whether or not a loaded molecule can be strongly encapsulated within a delivery system. Therefore, the lipids that form the SLNs core structure could be important for high-rate drug loading. Additionally, most lipids that form the structures of SLNs are biodegradable, so SLNs show excellent biocompatibility and have less toxic effects. When

the use of SLNs is investigated, it seems that SLNs have often been selected for lipophilic andhydrophilicdrugcompatibilitywithlipidsthatdonot have toxic effects as carriers. However, in recent years, increasing.attentionhasalsobeenpaidto the coating of SLNsinordertoloadlipophobic and hydrophilic drugs-in the lipid structure and also to provide gene delivery.

2.5 Micelles

Micelles are self-assembled nanoparticles that are created when amphiphilic molecules group together in aqueous-fluids. Poorly water-soluble medications can be encapsulated within the hydrophobic core of micelles, increasing their stability and solubility.

Micelles have been investigated for both passive and active targeting techniques and are especially helpful for the administration of hydrophobic medications, such as anti can cermedicines.Ghezzi*etal*.reportedthatmicelles are perfect for controlled release in certain conditions because of their capacity to react to variations in pH, temperature, or the presence of specific enzymes. By addingligandsontheirsurface, micelles may be made to target certain cells or tissues, increasing drug delivery accuracy and minimizing adverse effects. Micelles are most commonly administered *via* intravenous (i.v.) injection/infusion (mostly used for chemotherapy), although oral and topical (ocular, nasal,buccal) administration have also been shown to have highly intriguing outcomes in terms of enhanced drug bioavailability. Micelles reduce the systemic toxicity of medications by directing drug distribution to certain tissues or cells. This can lower the frequency of dosing and result in a longer-lasting therapeutic impact. Sun *et al.* reported that for the effective administration of topical ocular medication ,PBA-CS-V nano micelles are a muco-adhesive option with improved transcorneal permeabilityandextendedpreocularretention.Inorder

to support gene therapy, micellescanalso be employed to transport nucleic acids, such as DNA or RNA. Micelles are useful for treating chronic illnesses with extended pharmacological activity because of their controlled release characteristics. It can be difficult to produce micelle-based medication delivery devices on a large scale. One important area of research is ensuring that micelles stay intact in the body until they arrive at their destination. Micelle-based formulations need to be thoroughly tested for safety and effectiveness, just like anyothernoveldrugdeliverymethod.Micellesareoften used and recognized colloidal particles in drug administration, and bCN micelles constitute a flexible, biocompatible oral drug delivery platform. Use of micelles is a promising drug delivery method, and research is being done to improve their stability, functioning, and targeting abilities.

2.6 **POLYMERIC NANO PARTICLES**

Usually, manmade or natural polymers make up polymeric nanoparticles. Poly(lactic acid) (PLA), poly(lactic-*co*-glycolic acid) (PLGA), chitosan, and polyethylene glycol (PEG) are typical examples.[29]Their usual diameters range from 10 nm to 1000 nm, which enable them to be both large enough to encapsulate a sizable quantity of medicine and tiny enough to pass through blood arteries and infiltrate tissues. While hydrophilic medications can be attached to the surface or integrated into the shell, hydrophobic pharmaceuticals can be enclosed within the core of the nanoparticle.Itispossibletodesignpolymerstoregulate the encapsulated drug's release. This may occur as a result of drug diffusion over time or deterioration of the polymer matrix. These biodegradable polymer-based nanoparticles are becoming more and morepopular due to their biocompatibility and adjustable drug release patterns. Selvam *et al.* reported that when paired with polyethyleneglycol(PEG),hydroxyapatite(HAp)provides increased osteoblastic potential, fracture toughness, mechanical characteristics, biocompatibility, and Young's modulus. Because of their adaptability, polymeric nanoparticles

may be customized for certain therapeuticuses,suchgenetherapyorcancertreatment. By shielding the antigensandguaranteeing their gradual release, polymeric nanoparticles can be used to deliver antigens in vaccinations, enhancing the immune response. Proteins or peptides that the body's enzymes couldordinarilybreakdowncan be delivered *via* polymers. Even while polymers like PLGA are biocompatible, some of their breakdown products might be harmful at larger doses or if they build up in particular organs. Polyethylene glycol (PLGA) NPs were used by Park *etal.* to encapsulate adriamycin. In order to generate multifunctional carriers with improved capabilities, researchers are investigating hybrid systems that mix polymeric nano particles with other drug delivery methods (such as liposomes or micelles). The extremely hydrophobic curcumin was encapsulated in PLGA NPs by Szymusiak *et al.*, which enhanced oral absorption and reduced the dosage of the medication required to produce similar amounts in mice's plasma and nervous system tissue following oral treatment by around twice-as compared to en encapsulated curcumin.

3. Importance of nanoparticles in drug delivery

When drugs is loaded into nano particles through physical encapsulation, adsorption or chemical conjugation, the pharmacokinetics and therapeutic index of the drugs can be significantly improved in contrast to the free drug counterparts.Many advantages of nano particle-based drug delivery have been recognized, including improving serum solubility of the drugs , prolonging the systemic circulation lifetime, releasing drugs at a sustained and controlled manner, preferentially delivering drugs to the tissues and cells of interest, and concurrently delivering multiple the rapeuticagentstothesamecells for combination therapy. Nano structures biomaterials and nano particles have unique physicochemicalproperties such as ultra small and controllable size, large surface area to mass ratio, high-reactivity, and functionalizable structure. Biological membranes and access cells, tissues and organsareeligibleforentranceofnanoparticles.These cells are not crossed by the larger-size dparticleseasilyi.e.byconventionalmedicine.

Advantagesofnanoparticles

-Relativelysimplepreparation.

-Specific medication delivery.

-Theyhavetheabilitytoincorporatebothhydrophilic and hydrophobic drug molecules.

-NopartiItinvolveshighermanufacturingcostswhich mayinternleadtoincreaseinthecostofformulation.

-Theyhavelowencapsulationefficacy.

-Thesystemcanbeadministeredviadifferentroutes including oral, nasal, parenteral, etc.

-Effective size and size dispersion control.

-The medicine in the capsule is well protected.

-Theyhavelongerclearancetime.

-Drug retention at the site of action.

-Theyarecapableofbeingstoredforaperiodofupto one year and hence have longer shelf stability

-Enhancedtherapeuticeffectiveness.

-EnhancedbioavailabilityandDoseequivalence

-In an aquatic environment ,active substances dissolve more quickly with increased surface area.

-Greaterbioavailabilityistypicallycorrelatedwithfaster dissolution.

-Tinier drug

-Lessvariationbetweenfedandfastingstates.

-Reduced-toxicity

Disadvantages of Nanoparticles

-Itinvolveshighermanufacturingcostswhichmayintern lead to increase in the cost of formulation.

-They have lowencapsulationefficacy.

-Watersolubledrugscanberapidlyleakedoutinthe presence of blood components.

-Their small size and large surface area can lead to particle-particle-aggregation, making physical handling of nanoparticles difficult in dry and liquid forms.

-Theymaytriggerimmuneresponseandallergic reaction.

-Theymayinvolveuseofharshtoxicsolventsinthe preparation

process.

-Toxicityconcernswiththewidespreadusageof polyvinyl alcohol as a detergent.

-Limited to ability .

-It is not feasible to stop therapy.

-cytotoxicity .

-Pulmonaryinflammatorydisease and lung cancer risk

-Inflammationofthealveoli.

-The interference with autonomic balance caused by nanoparticles, which has an immediate impact on vascular and cardiac function

Action mechanism of nano-drug Delivery Systems

Nano particles can be used to enhance drug delivery. In an effort to improve the effectiveness, safety, and toleranceofingestedmedications,several nanoparticle formulations have been used in drug research. High solubility controlled release, and better pharmacokinetic and pharmacodynamic features have all been demonstrated by formulations based on nano particles.
Effectivenanoparticledeliverysystemscanbemadeusingavarietyofprocesses,andparticlesize,surfacecharge, and shape ..

Particle size:

The most crucial aspects of nano materials are their particle size and size distribution, which affect their chemicalandphysicalproperties..They have the ability of control medication loading, release, and stability.

According to reports ,nanomaterialshaveanadvantageover micro-scale particles because of their tiny size and high mobility, which allows for greater cellular uptake and makes them appropriate for a variety of cellular and intracellular targets.

SurfaceCharge:

Surfacechargeistypicallyexpressedandevaluatedin terms of a nano-material's zeta potential,

which represents the electrical potential of particles and is impacted by both the composition-of the particle and the media inwhichitis disseminated. According to reports, zeta potentials with valuesbelow30mVare stable insuspensionandhelpkeep particles from aggregating .Nanomaterial surfacecharge is essential for drug loading. Several techniques, including covalent conjugation, hydrophobic contact, charge-charge interaction, and encapsulation, can be used to load drugs. The nature of the medication and the nature of the target molecule both influence how molecules are loaded, which also changes the surface charge. It is possible to identify the attachment or adsorption of charged molecules to a nanoparticle's surface by adjusting the zeta potential.

Loadingdrugs

Medication loading is the process of incorporating a drug on or in nano materials.The best drug delivery system for nano particles should be able to load large amounts of medication without aggregating. High medication loading capacity can reducedosageoradministration. Dispersibility is required for the medications to bedeliveredsmoothlyand effectively. Drug loading can be done in a variety of ways, but the effectiveness of drug loading and entrapment depends on the drug's solubility in the nanoparticles, the dispersion medium, the size and composition of the nanomaterials, the drug's molecular weight (MW), its solubility, the interaction between the drug and the nanomaterials, and/or the presence of surface functional groups (such as carboxyl, amine, ester,etc.) on either the drug or the nanomaterial.

4.Targeting Drug Use

Nanomaterials that target the tumour improve chemotherapy and offer a highly specialised and adaptable
platform for cancer treatment. Due to fenestrated blood arteries, enhanced permeability and retention allow for
selective localisation in tumours on an as-needed basis, as in the case of drug-loaded liposomes (doxorubicin-
liposome complex).As opposed to targeting ligand-drug conjugates, targeting nano-materials as drug delivery vehicles or nanocarriers for site-specific delivery provides a number of benefits.When a ligand connects with its receptor, a substantial payload of therapeutic agent compared to the number of ligand-binding sites can be delivered to the target cell or tissue by efficient drug loading of high concentrations of drug within the nanocarriers.

The medicine is loaded without regard to how the ligands are coupled because the nanocarriers are connected to the ligand. Additionally, this avoids pharmacological activity that may be caused by the conjugation of a ligand
and a drug or that has been rendered inactive by a potentially harmful coupling event. Depending on the size of the nanomaterials and the size of the medicine, several ligand molecules can be attached to the nanocarriers to
boost the likelihood of binding to target cells, particularly for those with low binding affinities.

5. Attachment to receptor sites

When drugs are given to the MPS (Mono Phagocytic System), which includes the liver, spleen, lungs, and bone

marrow, they change the drug distribution profile. However, when injected intravenously, nanoparticles as drug carriers can be detected by the human immune system, which causes phagocytes to remove them from circulation. The amount of blood components (such as opsonins) that bind to a nanoparticle's surface and influence its in vivo fate depends on the nanoparticle's size,surfacehydro phobicity, and surface coating functionalities.Preventing opsonization and extending the circulation of nanoparticles in vivo are crucial for improving the odds of medication targeting success. The nanoparticles can do this by utilising nanoparticles with biodegradable hydrophilic copolymers, such as PEG (Polyethylene Glycol), or by pre-coating them with. hydrophilic polymers and/or surfactants.The increased permeability and retention (EPR) effect causes extravasation of nanoparticles as they enter tumour tissues.

6. Drug Release

Drug release is the process of releasing a drug from a nanoparticle into the body, whereas biodegradation is the
collapse of the drug delivery system within the body. When creating a nanoparticle drug delivery system, it'scrucial to take into account both drug release and biodegradation. The drug's effectiveness is further influenced by its solubility, diffusion, and particle size in addition to its active ingredients. Due to the small size of the particles, a high surface-to-volume ratio causes a quicker drug release at the surface.Nanomaterials' interactions with cells give them an advantage while trying to pass the blood–brain barrier. The blood brain barrier is made up of a layer of endothelial cells that surrounds the brain and blocks the passage of high-molecular weight substances. Nanoparticles' ability to cross the blood–brain barrier is a significant benefit for drug delivery systems for successful therapies.

Challenges in nano-based drug delivery systems

Although medication delivery methods using nanoparticles show promise, a number of obstacles prevent their broad clinical use.

1.Toxicity and biocompatibility

A primary concern for NDDS is potential toxicity. Even when using biodegradable polymers, the long-term accumulation of metabolic byproducts remains a risk, potentially triggering inflammatory or allergic responses. This is particularly critical in chronic therapies where repeated dosing may lead to nanoparticle sequestration in major organs like the **liver, spleen, and kidneys**, resulting in organ damage. Consequently, rigorous biocompatibility profiling and toxicity assessments are mandatory to ensure clinical safety.

2.Scalability and manufacturing

Ensuring consistency in the size, shape, and medication loading of nanoparticles is one of the primary challenges. Transitioning from laboratory success to commercial production is a significant hurdle. NDDS require precise control over **particle size, morphology, and drug-loading efficiency**. Minor deviations in the manufacturing process can drastically alter the drug's safety and efficacy. Furthermore, high production costs and the complexity of maintaining batch-to-batch consistency often deter large-scale industrial adoption.

3.Overcoming biological barriers

The blood–brain barrier, cellular membranes, and the extracellular matrix are just a few of the biological barriers that nanoparticles must be able to get through. The blood–brain barrier (BBB) is a highly selective permeability barrier that separates the brain's tissue from its blood arteries. It keeps big molecules out of the brain, including the majority of medications. The lipid bilayer membrane that envelops each cell in the body serves as a selective barrier to keep undesirable things out. To overcome this obstacle, nanoparticles must be engineered with certain properties, such as proper size, charge, and surface changes. Some tactics include employing "smart" nanoparticles that can react to changes in the brain's microenvironment, such as pH shifts, or targeting ligands, such as transferrin or antibodies, that can attach to receptors on the BBB's endothelial cells. Mucus layers serve as a physical barrier to keep infections and external objects out of the body and are found on numerous epithelial surfaces, including the lungs, gastrointestinal system, and eyes. Cellular absorption can be improved by employing cationic particles or by covering the nanoparticles with lipids or proteins that resemble the cell membrane. Techniques such as receptor-mediated transcytosis, in which endothelial cells internalize nanoparticles and translocate them across the blood–brain barrier, and the application of nanoparticle coatings that can improve permeability are being investigated by researchers.

Applications

Recent developments in medication delivery using nanoparticles have shown their therapeutic promise in a number of domains.

1.Cancer treatment

In order to minimize harm to healthy organs, chemotherapeutic medicines have been delivered directly to tumor cells using nanoparticles. Furthermore, the creation of theranostic nanoparticles, which combine therapy and diagnosis, has been made easier by their capacity to transport imaging agents. Currently, a lot of clinical and preclinical research is being conducted on the topic of targeting macrophages in the development of cancer therapies. . Staggering numbers of individuals suffer from cancer world
wide, highlighting the need for an accurate detection method

and novel drug delivery system that is more specific, efficient and exhibits minimal side effects (41). Anticancer treatments are often regarded as superior if the therapeutic agent can reach the specific target site without resulting in any side effects. Chemical modifications of the surface of nanoparticle carriers may improve this required targeted delivery. One of the best examples of modifications at the surface of nanopar ticles is the incorporation of PEG or polyethylene oxide. These modifications enhance not only the specificity of drug uptake, but also the tumourtargeting ability. Incorporating PEG avoids the detection of nanoparticles as foreign objects by the body's immune system, thus allowing them to circulate in the bloodstream until they reach the tumour. Additionally, the application of hydrogel in breast cancer is a prime example of this innovative technology. Herceptin is a type of monoclonal antibody used in breast cancer treatment by targeting human epidermal growth factor receptor 2 (HER2) on cancer cells. A vitamin Ebased hydrogel has thus been developed that can deliver Herceptin to the target site for several weeks with just a single dose. Due to the improved retention of Herceptin within the tumour, the hydrogelbased drug delivery is more efficient than conventional subcutaneous and intravenous delivery modes, thus making it a better antitumour agent .Nanoparticles can be modified in several ways to prolong circulation, enhance drug localisation, increase drug efficacy and potentially decrease the development of multidrug resistance through the use of nanotechnologies.

Examples of FDA approved nanomedicines

Clinical Agent	Formulation	Applications
Eligard	Leuprolide acetate and polymer (PLGA)	Prostate cancer
Genexol-PM	mPEG-PLA micelle loaded with paclitaxel	Metastatic breast cancer
Doxil / Caelyx	Liposomal doxorubicin	Ovarian cancer, breast cancer, Kaposi's sarcoma, multiple myeloma
Onivyde	Liposomal irinotecan	Pancreatic cancer
Abraxane	Albumin-stabilized nanoparticle paclitaxel	Metastatic breast cancer
Myocet	Liposomal doxorubicin	Metastatic breast cancer (combination therapy)

2.Drug Delivery Approach in Skin Diseases

Skin diseases are follicular and cutaneous. These dermatological diseases are treated nowadays with nanotechnology. Nanoparticle delivery for cutaneous disease treatment is preferred, with minor side effects. The conventionally used creams, gels, and ointments are insufficient for delivering drugs due to low penetration in skin tissues. To address this,

polymeric, lipid, and surfactant nanocarriers are used. The polymeric micelles enhance drug penetration into the skin tissue to treat skin cancer. As in this reported study, chitosan polymeric NPs, liposomes, and gold nanoparticles can treat atopic dermatitis by improving drug penetration into the dermal and epidermal layers . Gold nanoparticles are extremely small in size and can penetrate easily and effectively with very low toxicity and no skin damage. As such, they are used widely in nanocarrier formulations for skin diseases.

3.Drug Delivery Approach in Bone Diseases

Bone diseases includes bone defects due to many pathological factors, such as fracture, trauma, osteoporosis, arthritis, infections, and many other diseases. In fact, bone regeneration as a disease treatment is a very complex process, due to which nanomaterials and biological materials are fused to repair bones effectively. The combination of biomaterial and nanomaterial has reduced bone implantation through the development of bone bioscaffolds.

4.Treatment of cardiovascular diseases

Cardiovascular diseases are another field where the proper
ties of nanoparticles may be leveraged. Cardiovascular
diseases are the leading cause of death globally, and the rates are increasing alarmingly, due to an increase in sedentary lifestyles. Common examples of cardiovascular diseases that affect several individuals includes stroke, hypertension and restriction or blockage of blood circulation in a specific area. These diseases are the most common causes of prolonged disability and death.Nanotechnologies offer novel avenues for therapeutic and diagnostic strategies for management of cardiovascular diseases.Gold and silica nanoparticles have been developed to improve NO supply for possible application in cardiovascular diseases, where low NO bioavailability occurs . Drug delivery via liposomes has been proven to be effective for prevention of platelet aggregation, atherosclerosis and thrombosis. Prostaglandin E1 (PGE1) exhibits a wide range ofpharmacological properties, including vasodilation, inhibition of platelet aggregation, leukocyte adhesion, as well as exhibiting an antiinflammatory effect. Liposomal drug delivery of
PGE1 (Liprostin™), is currently undergoing phase III clinical trials for the treatment of various cardiovascular diseases, such as restenosis following angioplasty. Additionally, the use of liposomes carrying the thrombolytic drug urokinase has also been assessed; cyclic arginylglycylaspartic acid (cRGD)peptide liposomes encapsulated with urokinase can selectively bind to the GPIIb/IIIa receptors, and this improves the thrombolytic efficacy of urokinase by almost 4fold over free urokinase .
Efficacy and effectiveness of the conventional thrombo
lytic drugs can also be advanced via novel nanotherapeutic

approaches. Drugs can be selectively targeted to vascular blockage sites through mechanical activation within blood vessels based on the highfluid shear strains present within them. *In vivo* and *in vitro* studies have been encouraging, thus validating this approach for use in lysis of blood clots, using a significantly lower amount of thrombolytic drug . One example of this technology is the use of dendrimers.
Dendrimers have been used in several diseases as a means of delivering therapeutic agents. Plasminogen activator (rtPA) has been successfully attached to dendrimers producing an alternative drug delivery system, allowing for refinement of the rtPAdendrimer complex concentration throughout the duration of treatment using different dilution proportions of each part of the complex. Another potential role of nanoparticles is to decrease haemorrhaging.

5.Gene delivery

Because nanoparticles can transfer nucleic acids (DNA, RNA, and siRNA) directly to target cells, they are increasingly being used in gene therapy, offering promise for genetic diseases and customized treatment.

Conclusion

Nano-based drug delivery systems represent a transformative advancement in modern therapeutics,offering precise, controlled, and efficient drug delivery. Drug delivery made possible by nano technology has a promising future in pharmaceutics. The drug delivery industryis significantly impacted by the development of nano technology, with effects on nearly all routes of administration, including or a land inject able. The current pharmaceutical industry is frequently characterised by inadequate bio-availability, which all too frequently leads to greater patient expenses and ineffective therapy, but more critically, increased risks of toxicity. Since nanotechnology concentrates on the extremely small,it is ideally suited to develop systems that can more effectively deliver medications to the body's tiniest regions. Drugs delivered via nano technology can also pass through cell membranes, which is crucial for the anti cipatedexpansion of genetic medicine over the coming years. Nanotechnology-enabled medication delivery could result in decreased drug toxicity, lower treatmentcosts, higher bio availability, and an extension of the commercial life of unique drugs for both doctors and patients.

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