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Application of the organic and inorganic nanoparticles for the treatment of the cardiovascular disease: An overview

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Abstract: **As we know that the cardiovascular disease is the most no communicable and diverse effect on our health. This disease is spreading increasingly throughout the world. Many other disease like heart problems, coronary disease, cancers, tissue deaths, blood vessels problems, hypertension, atherosclerosis, myocardial infarctions, chest pains and heart failures are the major disease of the cardiovascular problems. In this literature review of article, we will study about the treatment of these death causes disease to overcome and reduce the increasing risking factors, we have to use the nanoparticles and some other organic and inorganic microparicles. Now a day, Nanotechnology is the best way for the treatment of this kind of the disease. Here we will use and study about their biosynthesis, their chemical, physical properties their imaging affect scanning process, biocompatibility activity, sensing activity, clinical features, and drug delivery process of the organic and inorganic nanoparticles like dendrimers, polymeric micelles, liposomes, drug conjugated polymers, and some other Nano coated particles are included, on the other hand there are some inorganic nanoparticles like quantum dot, suprameganetic iron oxide nanoparticles, zinc oxide nanoparticles, nitric oxide nanoparticles, copper oxide nanoparticles, selenium-Mesoporous Silica Nanoparticles, gold nanoparticles, and some other types of nanoparticles which are used in the treatment of the many disease like cardiovascular disease. Here we will discuss about the future perspective and recommendations of the nanoparticles and their technologies for the treatment of the diseases. Their encapsulation and administrations process of the micro particles for the drug delivery in our targeted body tissues and cells are under studying.**

Keyword: **CVD, nanoparticles, stem cells, cell membrane, micelles, dendrimers, Therapeutic Drugs, atherosclerosis.**

I. INTRODUCTION

Nanoparticles are the very small sized particles (1 to 1000nm) and combination of many atoms. We use these particles in the many technologies so we called as nanotechnology that play a vital role in the many aspects of our health sciences like detection, sensing, transporting of material and treatment of many death leading disease like cardiovascular disease CVD, which effect the blood vessels, peripheral artery, chest pain, and coronary artery, ischemia, tissue death, cancers, atherosclerosis, respiratory infections, hypertension, myocardial infarction and heart failure which causes the mortality and so many other diseases. Nanotechnology and their some particles were discovered by the roman in the 4th century. In this literature based review article we discussed about the application of nanoparticles technology in the treatment of morbidity and most common death leading cardiovascular disease.

According to the WHO's estimation 17.9 to 18 million people die every year in (2019) that means 32% to 38% of deaths all over the worldwide and 85% of CVD deaths are because of the heart attacks and strokes under the age of 70. That's why we have to overcome and decrease the adverse effect of this no communicable disease of CVD by using bio-inspired nanoparticles technology which help us in the delivering the targeted medicine for the CVD. The whole mechanism of the nanoparticle based medicines are encompasses all the area of treatment, diagnosis, improve the injury conditions; regulate the quality of the life and health. The uses and application of nanotechnologies and their organic and inorganic particles which have been developed with in the very short period of time almost 2 decades. In which we use many types of the nanoparticles like dendrimers, polymeric micelles, liposomes, drug conjugated polymers, and some other Nano coated particles are included, on the other hand there are some inorganic nanoparticles like quantum dot, supramеganetic iron oxide nanoparticles, zinc oxide nanoparticles, nitric oxide nanoparticles, copper oxide nanoparticles, selenium-Mesoporous Silica Nanoparticles, gold nanoparticles, and some other types of nanoparticles which are used in the treatment of the many disease like cardiovascular disease.

For instance, cell membrane coated nanoparticles used for the medicine delivery by incorporated into the target cell and create the biocompatibility between them. Stem cell membrane coated nanoparticles are also helpful in the therapy of CVD by repairing the damage the cells or tissues and in this way we can transplant the healthy tissue in the body that decrease the inflammation, death rates and developing the blood arteries and blood vessels. During the cardiovascular improvement and repairing many factors play an important role in the stem cell derived membrane coated nanoparticles therapy such as (SDF1) stromal cell derived factors, (CXCR4) chemokine receptors 4 and (CXCR7) chemokine receptor 7. Immune cell membrane coated nanoparticles play a very important task in the controlling the influence of cell membrane function and cardiac repairing. Here we can infiltrate the immune cells into our cardiac tissues after the infiltration the inflammatory monocytes and leukocytes recovered the heart injuries so, in this way we can easily remove the dead and damage heart cell debris and repair them. And this process of monocytes and leukocytes happen in a very precisely manner and in a controlled way by using some types of receptors and molecules like (αMβ2), (αLβ2), (PSGL1), (VLA4), (α4β1) and (CCR2).

We can use the multifunctional technology like theranostic nanoparticles system for the diagnosis and treatment of the CVD. Furthermore it can also help in the imaging and viewing the damage cell area like MRI and CT scan (in vivo and in vitro) with fluorescence light, this theranostic nanoparticles technology can be divided into 2 parts one part is for the targeting agents and other part is diagnostic agents which tracking the medicine of nanoparticles in the damage cell area. Enzymes nanotechnology have the ability to the enzyme like activity for the diagnosis and treatment of cardiovascular disease and many other disease this technique is very easy simple and long lasting storage no harmful environmental effects and high stability increasing metabolic reactions have a property of catalytic activity like catalase CAT, peroxidase POD, glucose oxidase, super oxide dismutase SOD. Peroxidase like Fe3O4 used as a sensing and detecting of disease for the antioxidant, anti-bacterial infection, heart disease and cancer therapy. We can transport the medicine by using the enzyme to the diseases part in our body. But here some issue about the Nano-enzymes that will be reconsider in the future discoveries.

Microfluidic nanotechnology show the very accurate micro-channels with the large geometric designs that can stimulate the vascular networks through this technique the flow condition of fluid is precisely controlled which facilities the imitation of the cardiovascular blood flow. In this way microfluidics proposed the organ on a chip that can be help in the stimulation of all CVD, regulation of cellular behavior, interaction between different cells and mechanisms and further studying related to the pathogens of CVD. There are two types of chips vasculature on a chip and the other one is heart on a chip that play a vital role in the pathogenesis of different CVDs

II. CLINICAL MANAGEMENT OF CARDIOVASCULAR DISEASE:

Diagnostic Assays: When we talk about the managing the cardiovascular disease by clinical methods then in this section we will discuss about the diagnosing of CAD by using the analytical technique for quantification of parameters. There are many biomarkers are used for example, blood level, lipid level , lipoprotein level for biochemistry test, cholesterol level, very high density lipoprotein, very low density lipoprotein, low and high density lipoprotein level, monocyte chemotactic protein level, fibrinogen level, C- reactive protein level, and interleukin levels are also included in the biomarkers and diagnostic assays.

Imaging: There are many ways for locating and detection of exact place of the disease. In which many types of machines and process are used like vascular ultrasound, echocardiogram, and simple ultrasound are used for the detecting the blood clots and dysfunctioning and abnormalities in the blood flowing through the blood vessels. Some other types for the imaging is the coronary angiography (CA), magnetic resonance imaging (MRI), positron emission tomography (PET), single photon emission (SPECT), and computed tomography (CT) these are also widely used nowadays for diagnosing the disease.

Therapeutic Drugs: There are many drugs and anticoagulants are used like rivaroxaban, heparin, and warfarin and thrombolytic are used for the mixing and dissolving the blood and thrombus and commonly used for the blood clotting and thinning of the bloods. Aspirin and clopidogrel is also the drug which is used for the inhibiting of the platelet formation and platelet aggregation formations, in short it is act as the antiplatelet drug. For the reduce the blood pressure from the high blood pressure are Captopril and ramipril which act as inhibiting the activity of enzymes, angiotensin converting enzyme to angiotensin level II which helping the overcome the burden of the pressure of blood in the blood vessels. There are some drugs are which is used for the decrease the chances of the cardiovascular disease by blocking the enzymes of angiotensin II receptors these drugs are Candesartan and Losartan. In this way there are many medicines which are used for therapy of the cardiovascular disease like vasodilators, isosobide dinitrate, nitrates, nitroglycerine, nesiritide are commonly used in the clinics and pharmacies.

In Acute Cardiovascular Disease, Reducing Endothelial Dysfunction: Adenosine is still being studied like an adjuvant to rehabilitation therapies for the treatment of acute myocardial infarction. Clinical investigations have shown that it has hypocholesterolemic properties. Disadvantages the half-life of adenosine is quite small (1 to 2 s) Hypoglycaemia and arrhythmias are some of the negative effects. [Takahama et al, 2009] for example, administered a liposomal version of administered orally adenosine with an average diameters of 134 nm. Prior to the procedure, a hypoperfusion myocardium rat type was used. The start of revascularization Samples from TEM and luminescence revealed Liposomes accumulating in ischemia regions. The recirculation duration of liposomal adenosine was increased. Decreased adverse effects and a considerable reduction in myocardial infarction Compared to free adenosine baseline, lesion size increased. [Tang, J.st al 2013]

III. APPLICATION OF NANOPARTICLES FOR TREATMENT OF CVD:

1. Polymer based nanoparticles:

Furthermore we have polymer nanoparticles which can provide us the facilities of medicine transport systems, repairing and remolding in the ECM, re endothelization and regeneration of the damage heart cell and tissues [Nenna, A et al 2021]. Polymer based nanoparticles deliver the medicine in a highly controlled way and easily distribute all over the cell debris area which minimize the adverse effects of the CVD. Here we have the poly (lactic co glycolic acid) PLGA is the petrochemical polymer based nanoparticles which help in the drug delivery through the cardiovascular system for their disease but also help in medicine, pharmacy, food and electronic industries [Ou, L.C et al 2021]. It is actually the colloid form of the small organic compound which ranges about the 1 to 1000 nm is usually used for the drug delivery to the target cells or cancerous cells and for the cardiovascular disease. By using this type of nanoparticles we can easily provide the medicine and maximize the therapy for any disease [Shaker, M. et al 2021]. In this review of article for the treatment of cardiovascular disease we have to deliver the statin medicine. It can have much effect on the patient with CVD. Like:

- It can enhance the bioavailability orally.
- Increase the interaction between the target cells and their specificity and improve the effect of statin in patients.
- Increase the vascular endothelial functions.
- It can increase the functioning of the ischemia
- Improve the regeneration of cardiac functions
- Extracellular matrix remodeling in the positive way
- Increased the re-endothelization effect and their growth

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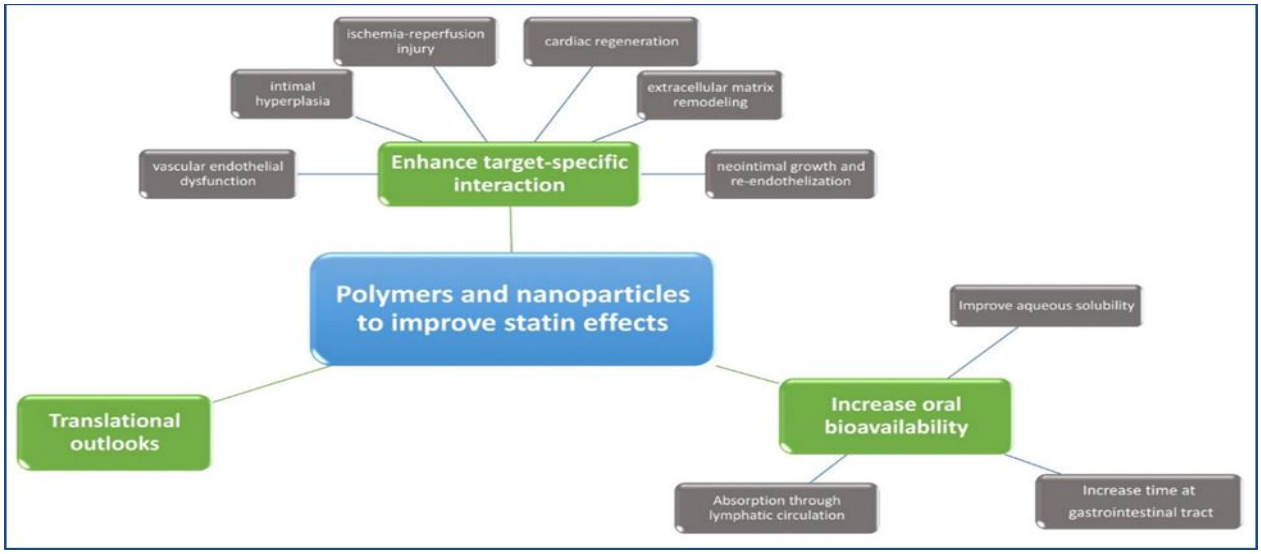

2. Reconstituted High Density lipoproteins Nanoparticles:

As we know that the high density lipoproteins are inversely proportions to the risk of the cardiovascular disease, mean that if high density lipoprotein level is increasing then the risking of the CVD will be decreases. RHDL is the most important biomarker of the CVD; we can easily diagnose the disease by taking the sample for HDL and analyzes it. HDL have major property of the anti-inflammation, biomedical for the decreasing the cholesterol level and their transportations and also prevent the formation of the plaque and protect our body from the CVD. This rHDL-C have the most important application is the delivery of the medicines to the target cells like atherosclerosis plaque and macrophages. There are many ways to enhance the presence of the HDL level in the blood plasma for examples orally intake or small amount of the administration of the transfer protein like cholesterol Easters and Niacin's. The latest study showed that the anacetrapid will enhance the levels of the HDL cholesterols and overcome the disease of the heart and other cardiovascular disease but only when it combines with the statin therapy. It may changes in the structure of the HDL with lipid metabolisms and their compositions. These alterations in the HDL cholesterols structure may be related to the functions of the cardiovascular protections. There is no possible ways to reverse the structure and compositions of the HDL cholesterol level in its original positions and locations. Many studies and experiments resulted that the rHDL – Cholesterol are heterogeneous in structure or compositions because it is formed by the combinations of the phospholipids and 3 ApoAI using different tools. rHDL cholesterol nanoparticles plays an important role in the CVD and their properties nay be determined by using different microscopes like atomic force microscopy, circular dichroic, spectroscopy, transmission electron microscopy, dynamic light scattering after the purifications by the fast protein liquid chromatography. So by improving the concentrations of the HDL-C can promote the overcome of the atherosclerosis and promote the efflux of the cholesterol levels.

3. Synaptic Acid with Selenium- Mesoporous Silica Nanoparticles:

Apart from the other nanoparticles this porous silica nanoparticles is very useful because of the high biocompatibility, high bio- sensitivity, high bio- stability, high capacity to delivery of medicines, high specificity, and high interaction to the target cells and many other property [Bi, X et al 2021]. Due to its high biocompatibility it has high efficiency for carry the noble metal chemicals like selenium which is very good antioxidant activity. When the selenium bind with the porous silica based nanoparticles it is converted into the selenoproteins and some selenoenzymes for the cleavage of the reactive oxygen species in this biosignalling process and have more bioorganic property and used for the maintenance and regulation of the cardiac stresses (SeIR), (GPxs). (TrxRs) [R. Seyedebrahimi et al 2020]. That's it is very excellent antioxidant dependent treatment for the cardiovascular disease. In the current studies, it was observed that if these conjugations of the selenium nanodots (SeND) are interact with the polyethylene glycol (PEG) [M. C.Llinàs et al 2018]. Then all the property of nanoparticles is increase like enhancing biocompatibility, stability, and their therapeutic efficiency [A. U. Rahman et al 2019]. (SA-PSiO2-SeNDs-PEG) is the nanoparticles which are basically used for the drug delivery to the target cells in the combine form [H. Vahidi et al 2019]. It is made of (Synaptic Acid + porous silica nanoparticles+ Selenium Nano Dots). It is collected in the centrifugation process at 10000 rpm for the 15 mints and

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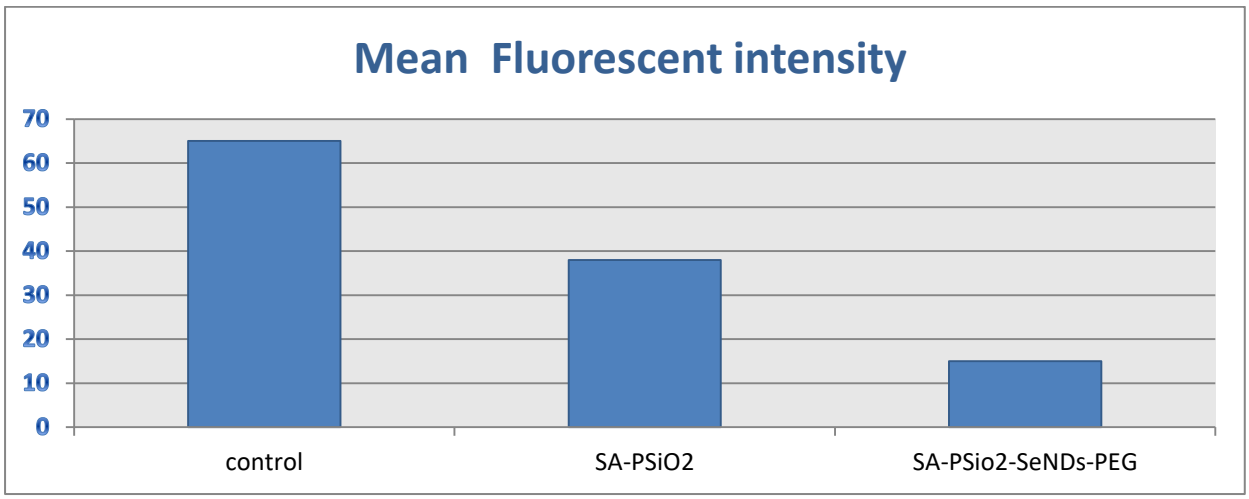
washed by the water for three times. In Human umbilical vein endothelial cells administered by salt water, SA-PSiO2, as well as 4 g/mL of SA-PSiO2-SeNDs-PEG nanostructure, the reactive Oxygen species (ros measurement was performed by absorbance value [X. Wang et al 2019]. The photocatalytic activity of DCFH-DA labeled samples transfected by SA-PSiO2-SeNDs-PEG nanostructure was much lower than that of seawater cells throughout the investigation, indicating that SA-PSiO2-SeNDs-PEG nanotechnology has the capacity to reduce Oxidative exposure. Furthermore, even we compared to such SA-PSiO2-SeNDs-PEG nanocomposite therapy, the SA-PSiO2 treatment had a minor effect on Superoxide lowering [G. Deng, et al 2018]. This meant that even the most important elements in triggering oxidative characteristics to harm from happening Generation of reactive oxygen species included Se and SA. Additionally, this finding showed that administering a modest dose of SA-PSiO2-SeNDs-PEG nanostructure might be an effective therapy for lowering the chance of heart disease.



This chart shows that the magnification of the fluorescent image is about 400X of stained HUVECs (DCFH-DA) which impact on the reactive oxygen species and their drugs and nanoformations. This data analysis is statically important.

4. Dendrimer

Dendrimer is derived from the Greek word 'dendron,' which means 'tree,' and appropriately describes the arrangement of such frequently branching structures. Dendrimers are distinguished by their complex network, three-dimensional design, low monodispersity, and achieve significant [Sherje et al. 2018]. In comparison to certain other applications of nanotechnology, there are numerous obvious benefits of using micro particles as non-viral carriers for clinical application. They are preferable to certain other antiviral and non-viral equivalents owing to its high absorption, better strength, excellent biocompatibility, and capacity to permit efficient administration of anticancer components, DNA, and RNAs [Mendes et al. 2017]. One disadvantage of dendrimers would be that their surroundings are frequently hotly contested given the large number of branches at their surface, each with its own surface properties.

Nitric oxide (NO) is a strong bronchodilator that also regulates cardiovascular cellular proliferation and keeps cardiovascular equilibrium in check. As a result of these actions, it may be useful in avoiding atherosclerotic. NO encapsulating inside polymeric nanoparticles has been found to offer possibilities as a treatment modality for injured tissue in investigations. NO extraction from poly (propylene imine) dendrimers was effective, indicating that they might be useful as pharmaceutical distribution systems. In an effort to limit the elevation of inflammatory in selected locations inside the damaged endothelium, dendrimers with promise as genome engineering tools for the therapy of CVDs have indeed been studied. Research has revealed that dendrimers containing DNA templates improved the gene's survival, integrity, and functionality inside this cytoplasm, indicating that they might be used as a potential treatment.

In addition to diagnosis and therapy and cancer screening, gold nanoparticles have showed remarkable potential. Gold is a precious metal that is primarily an innocuous, strong, and biodegradable substance. Rods, spheres, cages, stars, crescents, and prisms are some of the forms and sizes of gold particles, which come in various between 1 to 500 nm. [Varna M, et al 2018] Nanoparticles are eliminated by the kidneys. By adding PEG molecules to the nanomaterial's surface to ensure aqueous solubility and dissolution rate, the clearance rate during renal excretion may be altered. Photo thermal scanning is

based on the identification of both ultrasonic and optically photography, wherein light is employed as a source of stimulation and ultrasonography recognizes natural frequencies created by the subject, resulting in photodynamic therapy. [Chandarana, M, et al 2018]

5. Micelles

Micelles are bifunctional nanostructures having hydrophobic cores and hydrophilic shells that are made using polymeric or liposome amphipathic compounds. They arise spontaneously as a result of a decrease in renewable power caused by the accumulation of hydrophobic sections from the aquatic environment, as well as the formation of a micro emulsion Centre supported by hydrophilic fragmentation uncovered to the liquid. Because of the unfavorable environmental conditions, a rise in the Gibbs free energy happen as a consequence of conversations among both liquid and indeed the water - insoluble segment of the biomolecule, resulting in a decrease in the scheme thermodynamics and constructing of the liquid in way to solve as the composition of a surfactant molecules grows in solution. When the minimum micro emulsion content (CMC) is attained, microspheres develop. Some in mammalian cells research showed satisfactorily the need for a chunk co-polymer micelle constituted from poly(ethylene glycol)(PEG)-block-polycation transporting a (PEG-b-P[Asp(DET)]) side sequence as a genome engineering vector for therapies of cardiovascular events, to cost effective transcriptional and minimal side effects in cardiomyocytes. An innovative development methodology that adapts towards the microenvironment of oxidized atherosclerotic plaques was currently posted [Wu et al. 2018]. Poly (ethylene glycol) and poly (propylene sulphide) were used to make liquid crystalline micelles (PEG-PPS). The micelles were employed to solubilize compound found in order to reduce chronic inflammation and oxygen free radicals (ROS) levels in the management of hypertension. Compound found is a plant-derived chemical that protects the heart by decreasing the gene expression of inducible nitric oxide synthase and increasing the development of vascular endothelial growth factor. Additional mixed micelle accordance with these terms has included the solubilization of olmesartan medoxomil (OLM) by combining distinct Pluronic® mixes (F127 &P123). OLM is a hypertension medication with a reduced absorption due to its poor hydrophilic nature. To circumvent this thermodynamic obstacle, OLM was packed into heterogeneous micelles transporters. Pluronic® combination ratios (1:40, 1:50, and 1:60) were created, as well as different F127:P123 ratios. The combined micelles were shown to have discharge efficiencies of approximately to 43%, compared to 35% in the drug solution, according to the investigation [El-Gendy et al. 2017].

6. Zinc Oxide Nanoparticles (ZnO NPs)

Zinc oxide nanoparticles were made using a simple precipitation procedure with zinc sulphate and sodium hydroxide as starting materials. At various temperatures, the fabricated sample was oxidized for 2 hours. The materials were studied using X-ray diffraction (XRD), scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), and proton-induced X-ray emission (PIXE). As observed in SEM photos, the following reveal that several morphological alterations in ZnO have increased. The samples' structure and morphology were determined using Debye-formula Scherer's from the whole length at half maximum of XRD peaks, and were found to be in the Nano range. Zinc oxide is widely distributed in the industries, biological, biomedical and other household products like the medicines, delivery solutions, food adulterants and additives, cosmetics, sport products, and other electronic products. [Li, Y. et al 2020]. It has many applications like others nanoparticles have in the biomedical fields. It has a property of the illuminating and absorbing a light and fluorescence light by using the ultraviolet radiation and transparency activity. It also injected into the body and enters into the body by the injection, ingestion, penetration into the skin, and inhalation. Zinc oxide has highly organized property of the antioxidant, antimicrobial and anti- cancer [Kielbik P et al 2017]. Due to their property of the ion shedding of zinc oxide it has high toxic metallic nature in the mammalian cells, bacterial cells experimental animals and other clinical studies, oxide nanoparticles as compared to the iron oxide nanoparticles and titanium oxide nanoparticles. [Liu J, et al 2016]

7. Superamagnetic Iron Oxide nanoparticles (Fe_2O_3 NPs and Fe_3O_4 NPs)

It can be manufactured by the many methods in which micro emulsion, co precipitation, and thermal decomposition and hydrothermal but the most important and famous method by which all magnetic nanoparticles produces are co precipitation. We can synthesize SPIONs through co precipitation by demonstrating the effects of the pH range, ionic strength and many other features like size, characteristics of magnetic particles, ratios if iron, their morphology and

saturation morphology, the range size is less than 20 nm. Through the thermal plasma we can synthesize the SPIONs in which their chemical, phase composition and morphological characterization by using the x ray diffraction and TEM. Superamagnetic iron oxide nanoparticle is very important technology for the diagnosis and therapy of the CVD. Sometime coated superamagnetic iron oxide nanoparticles with other materials like Dextran which show the more property of the treatment for any disease [Jimei Duan et all 2019]. Dextran is the repeating subunit of the glucose and it is organic solvents which act as the anticoagulant, it is used for many diseases and the treatment of the hemorrhage, burns, other trauma and biological experimentations and in industries [Wang S, et al 2016]. Basically it is approved by the clinical technicians with the very good biocompatibility. That's why when Dextran combine with the iron oxide then it show the super magnetic activity for the delivery of the medicines to the target cells via the endothelial vascular cells. Some studies observed that this Dextran coated iron nanoparticles is very useful and survival for the human umbilical vein endothelial cells (HUVECs) [Zheng XT, et al 2017]. And this may decrease the concentration of the cytotoxicity but triggering the autophagy, and may decrease the reaction of the reduction of nitric oxide with the damaging of the reactive species of hydrogen peroxides. In this study of literature review, we also observed that there are many small molecules of the autophagy which is inducers, which help in the protecting of the cardiovascular disease, endothelial vascular damaging cells and their oxidative stresses by implying these inducers. [Jin R, et al 2019] For examples resveratrol, delphinidin-3-glucoide, curcumin, 6- gingerol and ampelopsin.

8. Quantum dots Nanoparticles:

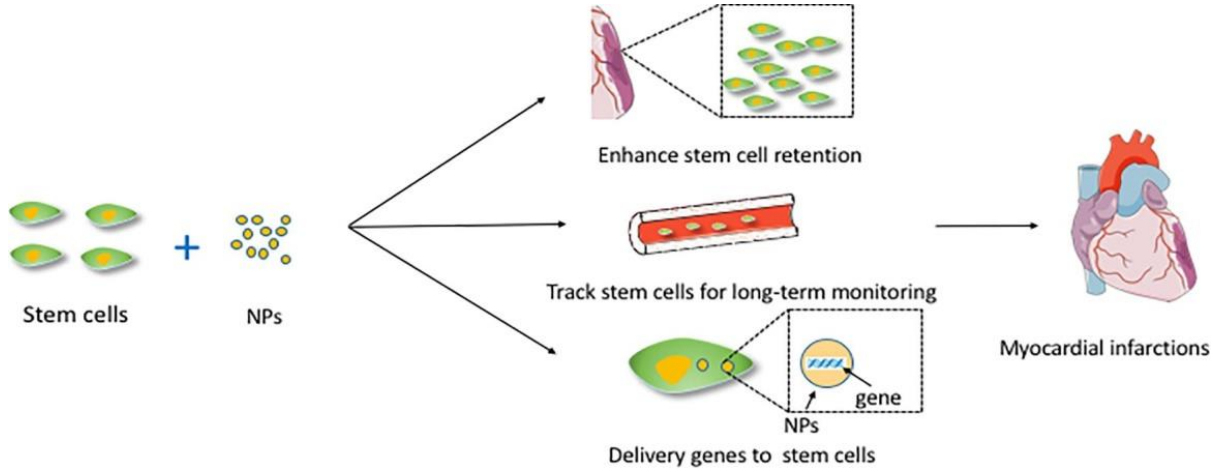
Quantum dots are significant nanotechnology, reducing-dimensional nanostructures that have an exciton Bohr radius of less than double those from the analogous dielectric material in 3 components. QDs are circular particles and also have sizes ranging from 2 to 20 nm [Zhu, M. et al 2019]. They generate stronger and more stable luminescence owing to its unique physical features (wide excitement and compact absorption spectrum). An immunoassays experiment predicated on synthesised magnetic beads and removable QDs for the disconnection and quantification of solubilized CD40 Binding site (furthermore identified as tumour tissue damage element accompanying excitation protein, CD40 Binding site is linked to coronary artery disease) from possible answer was introduced in a prior reports. A research published subsequently demonstrated for the first time how 0D titanium carbide MXene QDs may be integrated into something like a nanocomposite films copolymer to generate a 3D framework with improved physicochemical characteristics for stem cell distribution and tissue healing [Rafieerad et al., 2019]. Additional analysis revealed that selenium QDs can decrease the amount of arterial wall inside the thoracic vessels and minimize vascular permeability.

9. Other cell membrane-coated nanoparticles.

Additional nanomaterial's with cellular membranes coatings. Membranes has been extracted from additional cells or tissues and utilized to coat nanomaterials in the construction of CVD therapies. [W. Lv et al 2018] RBC-NPs have been used for myocardial infarction treatment and researchers can better applications191 due to their lengthy circulation period and function in oxygen supply. A dextran polymeric core was coupled with phosphonic esters to construct a ROS-bioresponsive nanoparticle in the first case. To improve circulation, the nanoparticles has been further successfully fabricated with Cellular membranes. Furthermore, to allow developing marketing, SHp, a stroke-homing peptide, was introduced into the cell membrane. The SHp-functionalized RBC-NP formulation proved able to produce a cytoprotective drug to ischemia neural stem cells in neural tissue. The targeting RBC-NPs demonstrated a significant increase in concentration inside ischaemic tissues when evaluated in vivo. [R. Vankayala et al 2018] Chronic treatment with both the Nano emulsions had much excellent performance in experimental rats of intracerebral blockage, as evidenced by a decreased infarction weight and lower neuropsychological evaluations. In addition to RBC-NPs, monocytes membrane-coated nanomaterials were shown to disproportionately attack acute inflammatory vasculature, and diagnosis of mouse model with serious dorsal ischemic stroke with epidermal growth component, CXCR4-engineered biotechnology membrane-coated nanostructures improved blood revascularization, muscular reconstruction, and limb salvage substantially. [R. J. Bose et.al, 2018] Proposed hybrid surface nanomaterials that complement the features and functionality of multichannel audio cells into a single nanomaterial are sometimes used to target coronary artery disease, and more research along those same lines could result in social media channels with fascinating properties and increased versatility for CVD implementations. [D. Dehaini, et al 2017]

10. Stem cell based Nanoparticles:

Throughout the case of thrombotic events, mesenchyme stem cells (MSCs) represent a possible cell-based therapeutic approach for treating cardiovascular problems. [Sun Y, et al 2020] The RIMECARD research study found revealed human-based MSCs might help the patients suffering ischemic stroke rehabilitate their cardiovascular system (MI). MSCs were found to alleviate cirrhosis in damaged regions in the POSEIDON-DCM experiment. In furthermore, a medical study examining the safety and effectiveness of heterologous MSCs implanted intramyocardially in patients with final age ischemic myocardium has begun, although the findings are not yet released [Yun, C et al 2019]. Human-based induced pluripotent stem cells (hiPSC) are just another stem specialized cells which could be used in treatment for cancer, and current researches have shown that cellular membranes produced from human embryos improve cardiovascular system in rhesus monkeys with significant MI regions. Furthermore, no new treatments demonstrating its impact on individuals suffering heart illness have been conducted. MSCs play a significant role in artery remodeling in cardiovascular events, much as they do in cvd. Infusions of adipose-derived MSCs were found to become a sensible choice to produce treatment angiogenesis in patients suffering from acute limbs impairment in a pilot testing (a severe manifestation of PVD).



Nevertheless, because the representative sample was so tiny, the findings were unsatisfactory. MSCs combined with endothelial progenitor cells (EPCs) treatment is medically beneficial for supplying oxygen mostly in myocardial infarction hands and feet of sick people with limb myocardial infarction, according to a phase II clinical experiment. EPCs were also used in mammalian as well as membrane protein configurations of atherosclerotic disease and therefore can be disconnected from hiPSC. Moreover, there are significant drawbacks to using stem cells to address CVD, such as the reduced life expectancy of implanted cells, fast mortality of cellular components hypoxemia, and particularly limited transferred cell growth due to the proinflammatory and antiangiogenic milieu in body myocardium. Several studies have indicated that NPs can be used to treat stem cells. Stem cell therapy (SCT) is now a possible, however divisive, approach to treating acute myocardium. It has the opportunity to lower oxidative stress and inflammation and hence lower the intensity of impairment, making this one of the possibilities to revascularization [Zhang, N. et al. (2020)] A variety of stem cell types, particularly bone marrow stem cells, have now been proposed to be used in heart rehabilitation. Endothelial progenitor cells (EPCs), marrow-derived stem cells (BMSCs), and induced pluripotent stem cells. Musculoskeletal myoblasts, mesenchyme stem cells (MSCs), especially cardiovascular stem cells (CSCs). Multipotent bone marrow have currently been demonstrated (PSCs), Embryonic stem cells (ESCs) and induced pluripotent stem cells (iPSCs) were developed are promising sources of bone marrow [Kehl, D. et al. (2019)]. Prospective resource for heart therapeutic applications that has also demonstrated to be effective. Possibility for recovering a circulation that has been harmed. Methodologies allowing efficiently differentiating human (h)iPSCs becoming cardiac myocytes (CMs) have indeed been created during the last twenty years, paving the way for medical implementation stage. Furthermore, investigations have shown that the essential processes of heart healing as well as the potential health benefits of hiPSC-CMs in larger and smaller model organisms. Numerous transcriptional elements (biologically active compounds, for example) are secreted by stem cells. [Bose, R. et al. 2021] proteins, lipids, DNA, and RNA) that are discharged as available particles into the intercellular space stem cell-derived hydrophilic soluble compounds or transferred into proteolipid membranes (vesicles) (SCDVs).

Nanoparticles	Stem cells	Imaging modality	Modals
SNPs	hMSCs	Ultrasound imaging	In vitro
Au@BSA@PLL	hMSCs	CT	rat
USPIO	MSCs	MRI	IHD patients
PANPs	hESCs-CMs	Photoacoustic image	rat
Iron oxide NPs	hESCs-CPCs	MRI	pig
PFCE NPs	CPCs	MRI	rat
SiO2-NPs	hMSCs	IFA of tissue clices	rat

In recent studies, different types of NPs have been applied in stem cell tracking for cardiac repair in vivo and in vitro (Table 3).

IV. CONCLUSION AND FUTURE PERSPECTIVES

Nanomaterial's technique is now being aggressively used to the creation of enhanced prophylactic and treatment approaches, as it has found to be successful in those other disciplines of biotechnology. The capacity to effectively enclose operational contents like as medications and diagnostic agents, localize these cargoes to diseased locations, and distribute these throughout time as needed are all advantages of Nano delivery. The sensible application of biomaterials ideas in the construction process for novel Nano composites became more frequent in recent years. The substrates which have resulted have shown to be fully functioning, easy to build and construct, and also have unique characteristics that make them well enough for CVD operations. There are numerous prospects for further improvement all along lines of bio inspired nanomaterial's for CVD in the potential. It will be able to develop successfully carry mechanisms that really can identify particular sickness phases when we get a deeper understanding of the numerous morphological alterations involved with disease development. These substrates can also be made more sensitive to the surroundings, allowing payloads discharge to be controlled by disease-related signals. Numerous cell categories that are important to CVD pathophysiology can be employed to supply Tran's membrane coatings for cell membrane-coated nanomaterials. This may be mixed with innovative micro particles cores to create one-of-a-kind compositions customized to particular purposes. Biomaterials nanomaterial's can be used to improve the usefulness of recently found bioactive chemicals or diagnostics biomarkers. MiRNA-based therapeutics, for instance, has showed promise in reversing atherosclerotic and might considerably profit from of the protections offered by microencapsulation. The processes of stem cell-based cardiovascular rehabilitation now have to be better explored in future researchers. Throughout examination of the putative impacts of NPs factors like as size, charge, shape, and surface properties, and also its assimilation, dispersion, and biochemical functions in vivo, would require more research. NPs have showed potential advantages for usage in therapy as compared to standard therapies. Their physicochemical properties have an impact on stem cell function, such as when they are used as non-viral gene delivery techniques. NPs possibilities are prospective as genetic engineering for CVD becomes more widespread. Smart small and medium enterprises (MNPs) can respond to environmental stimulation in a predicted and particular fashion in tumour treatment. The data given in this study shows that nanomaterial has the possibility to be used in the management of cardiovascular disease, as evidenced by translation clinical studies. It's just a matter of how long until Nano carriers, Nano composites equipment, and perhaps other associated technology actually complete the difficult clinical research procedure and reach the market, thanks to increased investments in the domain of nanomaterials and appropriate infrastructures throughout the globe. Nanoparticles has the potential to improve patient healthcare including well, as well as any advancements in existing medicines will have a significant influence on consumers' lives throughout the world. More in vivo investigations and new treatments will be needed to completely understand the physiological characteristics of active suspension in order to make the largest likely consequences in healthcare. In terms of expectations, Nanoparticles could be ideally positioned to meet the stated objective of tailoring medication to particular disease conditions as the direction of treatments shifts forward into targeted therapies. Additionally, rising healthcare expenses need the search for substitutes to current pharmaceutical and surgical therapy in order to keep expenditures from spiraling out of control. There's really, nonetheless, sufficient evidence to support the claim that nanomaterials has yet to fully revolutionized healthcare.

REFERENCES

[1] Jimei Duan, Jiuju Du, Rongrong Jin, Wencheng Zhu, Li Liu, Li Yang, Mengye Li, Qiyong Gong, Bin Song, James M Anderson, Hua Ai, Iron oxide nanoparticles promote vascular endothelial cells survival from oxidative stress by enhancement of autophagy, *Regenerative Biomaterials*, Volume 6, Issue 4, August 2019, Pages 221–229, https://doi.org/10.1093/rb/rbz024

[2] Wang S, Sun X, Jiang L et al. 6-Gingerol induces autophagy to protect HUVECs survival from apoptosis. Chem Biol Interact 2016;256:249–56.

[3] Zheng XT, Wu ZH, Wei Y et al. Induction of autophagy by salidroside through the AMPK-mTOR pathway protects vascular endothelial cells from oxidative stress-induced apoptosis. Mol Cell Biochem 2017;425:125–38

[4] Jin R, Liu L, Zhu W et al. Iron oxide nanoparticles promote macrophage autophagy and inflammatory response through activation of toll-like receptor-4 signaling. Biomaterials 2019; 203:23–30.

[5] Li, Y., Li, F., Zhang, L., Zhang, C., Peng, H., Lan, F., Peng, S., Liu, C., & Guo, J. (2020). Zinc Oxide Nanoparticles Induce Mitochondrial Biogenesis Impairment and Cardiac Dysfunction in Human iPSC- Derived Cardiomyocytes. International journal of nanomedicine, 15, 2669–2683. https://doi.org/10.2147/IJN.S249912

[6] Kielbik P, Kaszewski J, Rosowska J, et al. Biodegradation of the ZnO:Eu nanoparticles in the tissues of adult mouse after alimentary application. Nanomedicine. 2017;13(3):843–852. https://doi:10.1016/j.nano.2016.11.002

[7] Liu J, Feng X, Wei L, Chen L, Song B, Shao L. The toxicology of ion-shedding zinc oxide nanoparticles. Crit Rev Toxicol. 2016;46(4):348–384. https://doi:10.3109/10408444.2015.1137864

[8] Bi, X., Bian, P. & Li, Z. Synaptic Acid Encapsulated with Selenium-Mesoporous Silica Nanocomposite: A Potential Drug in Treating Cardiovascular Disease. J Clust Sci 32, 287–295 (2021). https://doi.org/10.1007/s10876-020-01787-7

[9] R. Seyedebrahimi, S. Razavi, and J. Varshosaz (2020). J. Clust. Sci. https://doi.org/10.1007/s10876-019-01621-9

[10] M. C. Llinàs, G. Martínez-Edo, A. Cascante, I. Porcar, S. Borrós, and D. Sánchez-García (2018). Drug Deliv. 25, 1137–1146.

[11] A. U. Rahman, Y. Wei, A. Ahmad, A. U. Khan, R. Ali, S. Ullah, W. Ahmad, and Q. Yuan (2019). J. Clust. Sci. https://doi.org/10.1007/s10876-019-01680-y.

[12] H. Vahidi, H. Barabadi, and M. Saravanan (2019). J. Clust. Sci. https://doi.org/10.1007/s10876-019-01671-z.

[13] X. Wang, X. Zhong, H. Lei, Y. Geng, Q. Zhao, F. Gong, Z. Yang, Z. Dong, Z. Liu, and L. Cheng (2019). Chem. Mater. 31, 6174–6186.

[14] G. Deng, C. Chen, J. Zhang, Y. Zhai, J. Zhao, A. Ji, Y. Kang, X. Liu, K. Dou, and Q. Wang (2018). Artif. Cells Nanomed. Biotechnol. 46, 112–121.

[15] Nenna, Antonio, Francesco Nappi, Domenico Larobina, Emanuele Verghi, Massimo Chello, and Luigi Ambrosio. 2021. "Polymers and Nanoparticles for Statin Delivery: Current Use and Future Perspectives in Cardiovascular Disease" Polymers 13, no. 5: 711. https://doi.org/10.3390/polym13050711

[16] Ou, L.C.; Zhong, S.; Ou, J.S.; Tian, J.W. Application of targeted therapy strategies with Nano medicine delivery for atherosclerosis. Acta Pharmacology. Sin. 2021, 42, 10–17.

[17] Fukuhara, N.; Honda, Y.; Ukita, N.; Matsui, M.; Miura, Y.; Hoshina, K. Efficient Suppression of Abdominal Aortic Aneurysm Expansion in Rats through Systemic Administration of Statin-Loaded Nano medicine. Int. J. Mol. Sci. 2020, 21, 8702

[18] Shaker, M.A.; Elbadawy, H.M.; Al Thagfan, S.S.; Shaker, M.A. Enhancement of atorvastatin oral bioavailability via encapsulation in polymeric nanoparticles. Int. J. Pharm. 2021, 592, 120077.

[19] Shaker, M.A.; Elbadawy, H.M.; Shaker, M.A. Improved solubility, dissolution, and oral bioavailability for atorvastatin-Pluronic(R) solid dispersions. Int. J. Pharm. 2020, 574, 118891.

[20] Huang J, Wang D, Huang L-H, Huang H. Roles of Reconstituted High-Density Lipoprotein Nanoparticles in Cardiovascular Disease: A New Paradigm for Drug Discovery. International Journal of Molecular Sciences. 2020; 21(3):739. https://doi.org/10.3390/ijms21030739

[21] Tsujikawa, L.M.; Fu, L.; Das, S.; Halliday, C.; Rakai, B.D.; Stotz, S.C.; Sarsons, C.D.; Gilham, D.; Daze, E.; Wasiak, S.; et al. Apabetalone (RVX-208) reduces vascular inflammation in vitro and in CVD patients by a BET-dependent epigenetic mechanism. Clin. Epigenetics 2019, 11, 102

[22] Hung, A.M.; Tsuchida, Y.; Nowak, K.L.; Sarkar, S.; Chonchol, M.; Whitfield, V.; Salas, N.; Dikalova, A.; Yancey, P.G.; Huang, J.; et al. IL-1 Inhibition and Function of the HDL-Containing Fraction of Plasma in Patients with Stages 3 to 5 CKD. Clin. J. Am. Soc. Nephrol. 2019, 14, 702–711

[23] Ebtehaj, S.; Gruppen, E.G.; Bakker, S.J.L.; Dullaart, R.P.F.; Tietge, U.J.F. HDL (High-Density Lipoprotein) Cholesterol Efflux Capacity Is Associated with Incident Cardiovascular Disease in the General Population. Arter. Thromb. Vasc. Biol. 2019, 39, 1874–1883.

[24] Marinko, J.T.; Huang, H.; Penn, W.D.; Capra, J.A.; Schlebach, J.P.; Sanders, C.R. Folding and Misfolding of Human Membrane Proteins in Health and Disease: From Single Molecules to Cellular Proteostasis. Chem. Rev. 2019, 119, 5537–5606.

[25] Sun Y, Lu Y, Yin L and Liu Z (2020) The Roles of Nanoparticles in Stem Cell-Based Therapy for Cardiovascular Disease. Front. Bioeng. Biotechnol. 8:947. https://doi.10.3389/fbioe.2020.00947

[26] Yun, C. W., and Lee, S. H. (2019). Enhancement of functionality and therapeutic efficacy of cell-based therapy using mesenchymal stem cells for cardiovascular disease. Int. J. Mol. Sci. 20:982. https://Doi.10.3390/ijms20040982

[27] Bose, R. J., Ha, K., & McCarthy, J. R. (2021). Bio-inspired nanomaterials as novel options for the treatment of cardiovascular disease. Drug Discovery Today, 26(5), 1200–1211. https://doi:10.1016/j.drudis.2021.01.035

[28] Kehl, D. et al. (2019) Proteomic analysis of human mesenchymal stromal cell secretomes: a systematic comparison of the angiogenic potential. NPJ Regener.

[29] Zhang, N. et al. (2020) Monocyte mimics improve mesenchymal stem cell–derived extracellular vesicle homing in a mouse MI/RI model. Biomaterials 120168

[30] Rafieerad, A., Yan, W., Sequiera, G. L., Sareen, N., Abu-El-Rub, E., Moudgil, M., et al. (2019). Application of Ti(3) C(2) MXene quantum dots for immunomodulation and regenerative medicine. Adv. Healthc. Mater. 8:e1900569. https://doi:10.1002/adhm.201900569

[31] Zhu, M. L., Wang, G., Wang, H., Guo, Y. M., Song, P., Xu, J., et al. (2019). Amorphous nano-selenium quantum dots improve endothelial dysfunction in rats and prevent atherosclerosis in mice through Na(+)/H(+) exchanger 1 inhibition. Vascul. Pharmacol. 115, 26–32. https://doi:10.1016/j.vph.2019.01.005

[32] Tang, J., Lobatto, M.E., Read, J.C. et al. Nanomedical Theranostics in Cardiovascular Disease. Curr Cardiovasc Imaging Rep 5, 19–25 (2012). https://doi.org/10.1007/s12410-011-9120-6

[33] Takahama H, Minamino T, Asanuma H, Fujita M, Asai T, Wakeno M, et al. Prolonged targeting of ischemic/reperfused myocardium by liposomal adenosine augments cardioprotection in rats. J Am Coll Cardiol. 2009;53(8):709–17

[34] Varna M, Xuan H, Fort E (2018) Gold nanoparticles in cardiovascular imaging. Wiley Interdiscip Rev Nanomed Nanobiotechnol 10:1–19

[35] Sherje AP, Jadhav M, Dravyakar BR, Kadam D (2018) Dendrimers: a versatile nanocarrier for drug delivery and targeting. Int J Pharm 548:7070–7720

[36] Mendes LP, Pan J, Torchilin VP (2017) Dendrimers as nanocarriers for nucleic acid and drug delivery in cancer therapy. Molecules 22:E1401

[37] Chandarana, M., Curtis, A. & Hoskins, C. The use of nanotechnology in cardiovascular disease. Appl Nanosci 8, 1607–1619 (2018). https://doi.org/10.1007/s13204-018-0856-z

[38] Wu T, Chen X, Wang Y, Xiao H, Peng Y, Lin L, Xia W, Long M, Tao J, Shuai X (2018) Aortic plaque-targeted andrographolide delivery with oxidation-sensitive micelle effectively treats atherosclerosis via simultaneous ROS capture and anti-inflammation. Nanomed Nanotechnol Biol Med 14:2215–2226

[39] El-Gendy MA, El-Assal MIA, Tadros MI, El-Gazayerly ON (2017) Olmesartan medoxomil-loaded mixed micelles: preparation, characterization and in-vitro evaluation. Future J Pharm Sci 3:90–94

[40] W. Lv, J. Xu, X. Wang, X. Li, Q. Xu and H. Xin, ACS Nano, 2018, 12, 5417–5426

[41] R. Vankayala, S. R. Corber, J. T. Mac, M. P. Rao, M. Shafie and B. Anvari, Macromol. Biosci., 2018, 18, 1700379

[42] R. J. Bose, B. J. Kim, Y. Arai, I. B. Han, J. J. Moon, R. Paulmurugan, H. Park and S. H. Lee, Biomaterials, 2018, 185, 360–370

[43] D. Dehaini, X. Wei, R. H. Fang, S. Masson, P. Angsantikul, B. T. Luk, Y. Zhang, M. Ying, Y. Jiang, A. V. Kroll, W. Gao and L. Zhang, Adv. Mater., 2017, 29, 1606209

[44] Carlander, U., Moto, T. P., Desalegn, A. A., Yokel, R. A., and Johanson, G. (2018). Physiologically based pharmacokinetic modeling of nanoceria systemic distribution in rats suggests dose- and route-dependent biokinetics. Int. J. Nanomed. 13, 2631–2646. https://doi:10.2147/ijn.s157210