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The Strategic Role of Nanoparticles in the Biological System Dealing with Complex Diseases and Medication

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Abstract: Nanoparticles belong to a class of materials that range from 10nm to 100nm. In the modern time of advancement, nanoparticles are playing a significant role in the therapeutic sector. Nanoparticles are now being used not only in medicine but also in the medical instrument applications. Nanoparticles increase the efficiency of the medicines, reduce the number of medicines needed, and, subsequently, their side effects. Quantum Dots made of components that can emit intense fluorescent light under UV light can be used in optical imaging. Superparamagnetic iron oxide (SPIO) nanoparticles are a viable alternative of Gadolinium (Gd) in a magnetic image processing (MRI) system. Abundant Polymeric nanoparticles (such as metallic nanoparticles, solid lipid nanoparticles, dendrimers, and liposomes) are rudimentary for drug & gene delivery systems to fight against different inflammatory diseases. It makes a revolutionary change in the drug & gene delivery system, and some treatments are impossible without nanoparticles nowadays. Some of the application of nanoparticles results in shifting the properties of conventional medicines for the better. In this brief review, we will discuss the overall contribution of nanoparticles in the health system.

Keywords: nanomaterial; medicine; optical imaging; gene delivery.

1. Introduction

Human civilization has always been affected by different diseases caused by viruses, bacteria, and fungi or by some other means which didn't correspond with their bodily function. Sometimes human existence was threatened by the outbreak of such diseases, like Spanish flu. It was estimated that around 30 million to 100 million people died during the 1918 outbreak of this deadly disease [1]. That is why humans are always trying to come up with new ways to encounter these diseases. We have always mitigated these unknown enemies in different ways, like using medicinal herbs, homemade remedies, conventional medicines, physiotherapy, and many more. Even though they have led us to the other

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side of every crisis, there were some exceptional diseases against whom these remedies were deemed inefficient. There is always some limitations in all of these techniques for complicated diseases. As we are becoming more and more advanced in science & technology, we are exploring many ways to overcome these problems & to find better ways to prepare against them for a longer time, if not possible, to prevent them forever. Among the many different technologies currently in the testing and on trial, nanotechnology holds the most potential.

Nanoparticles mainly originated from the Greek word "nano". Nanoparticles are defined as a particle that is between 1 to 100 nanometer in diameter. This term is also sometimes used for particles that are larger up to 500 nanometers in diameter [2]. These nanoparticles play an essential role in medical technology, which is mainly used for detecting and curing various diseases. Nanoparticles are used for a long time in medical technology. In recent years these nanoparticles have played a vital role in parasitic diseases like malaria, leishmaniasis, and trypanosomiasis treatment [3]. In the past, a lot of people died because of various diseases. Some of these were impossible to cure without the help of nanotechnology. In various forms of cancer, such as in breast cancer treatment, nanoparticles are now used extensively.

Polymer–Lipid Nanoparticles are used to transport mRNA to the Lungs systemically [4]. Due to the invention of nanotechnology now a day's various viruses can be eradicated. Most importantly, in cancer treatment, angiogenesis is regarded as one of the imprints of cancer. Many confirmations are indicating that the vascular endothelium growth factor (VEGF) is one of the dominant factors for the development of angiogenesis. It becomes active when it comes in contact with tyrosine kinase receptors (TKRs). It can be prevented by new therapeutic initiatives by targeting angiogenesis that opens a new opportunity for the therapy of cancer. Among them, nanotechnology has been the confirmed approach for curing different types of cancers. These nanoparticles can be very useful for targeting various therapeutic agents. Today chemotherapy is mainly used for cancer treatment, but this technology has many disadvantages; for example, chemotherapy badly affects typical cell detachment and imitation. These kinds of limitations can be overcome by utilizing nanoparticles [5]. mRNA vaccine delivery by liquid nanoparticles is currently in recent clinical trials for cancer immunotherapy applications. Furthermore, it has a massive prospective in the prophylactic vaccines [6].

Nowadays, in medical technology, there are various types of treatment available where nanoparticles are used. Many applications of various vital hydrophilic medicines limit the treatment of the brain related diseases due to the blockade between the blood and the brain within the body. However, a bipolymer drug termed as dextran-spermine is extensively used for this purpose. By inspection, we can observe that after 1 to 7 days of post-injection. The increase in drug transport across BBB and pH-triggered cellular uptake of TDS-NPs makes these theranostic nanocarriers a very good option for the treatment of brain malignancy [7].

In contrast, lately, the world is more serious about originating contaminants from hospitals. Medical devices, reuse of contaminated equipment, through contact, and air are predominantly circulating the contaminants. Thereupon researchers are newly bringing nanoparticles grounded on auto sanitizing products to reduce health concerned issues [8].

Bacteria-induced wound infection is one of the vital challenges for medical institutes all over the world. Multidrug-resistant bacteria, precisely gram-negative MDR bacteria, are inflicting human health significantly since there are no new antibiotics currently to terminate gram-negative MDR. Thus gold nanoparticles(for having low-toxicity, photothermal effects, large specific surface area, versatile surface modification, and polyvalent effects) are effective in emerging therapeutic strategies that can be used as antibiotics for killing gram-negative MDR [9].

In this era, nanotechnology brought a considerable way for new applications in nanomedicines and nano-biotechnology, for example, drug delivery systems, biosensing, and bio-detection, discovering the latest remedies for intimidating diseases like cancers, etc. [10].

In recent times, with the improvement of the drug delivery system, nanoparticles technology become a trending site. Pharmaceutical industries have expanded interest in Nano-technology because of their excellent physical & optical properties. It has a significant influence on applications to detect and manage biological systems in health and diseases. High powered implement for biological and medical research; this development involves drug delivery systems, medical imaging, and the element of different drugs.

This review is accommodating a comprehensive overview of the role of nanoparticles in medical science rather than an exhaustive notion. Furthermore, we will be highlighting here the latest technologies that have already proceeded to the medical application or in vivo experimentation. The effect on the environment and society will be discussed lastly.

2. Types of Nanoparticles

Different types of nanoparticles are available, depending on various aspects they are fabricated and chosen. Metallic nanoparticles, solid lipid nanoparticles, dendrimers, and liposomes are widely accredited (as shown in Figure 1) [11].

2.1. Polymeric nanoparticles: Polymer nanoparticles are composed of natural and biodegradable and biocompatible polymers, representing an encouraging drug delivery formula [12]. They are used for controlling the drug release and targeting a specific location. Generally, their diameters are extending from 10 to 1000 nm, with varying their composition structural organization [11].

2.2. Solid lipid nanoparticles: Solid-liquid nanoparticles (SLNs) are mainly composed of lipids, also contain highly purified triglycerides. SLNs are a colloidal carrier. They can provide the combined benefit of other colloidal systems like liposome and polymeric nanoparticles in their biodegradability, biocompatibility, and low toxicity [13]. SLNs possess a particle size ranging from 50 to 1000 nm and are used in the pharmaceutical field for the purpose of drug delivery [11].

2.3. Liposome: Liposomes are small size vesicles made up of natural or synthetic lipid bilayers, divided by an aqueous medium in their core [11][14]. Hydrophilic substances are encapsulated inside the aqueous compartment, while the lipophilic substances are integrated into the lipid bilayers. Liposomes have assisted in minimizing the side effects of various types of drugs and increasing their effectiveness [14].

2.4. Metallic nanoparticles: The group of materials that are prepared from metals (such as titanium, gold, and platinum) is referred to as metallic nanoparticles. They have a great utility in the clinical field because of their extraordinary optical and electronic properties [15]. Their size is ranging from 10 to 100 nm.

2.5. Dendrimers: A dendrimer is synthetic polymers with repetitively branched molecules, which are usually 1 to 100 nm in size [16]. Dendrimers are homogeneous and symmetrical tree-like branches structure [17]. They have a vast application in the biomedical field due to their high stability and the large surface area.

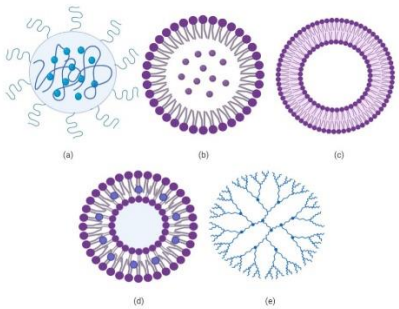

Figure 1. Different types of nanoparticles used in the medical sector (a. Polymeric nanoparticles, b. Solid lipid nanoparticles, c. Liposomes, d. Metallic nanoparticles, e. Dendrimers).

3. Nanoparticles in medical imaging

Nanoparticles can arrange for a noteworthy improvement in imaging of cell and tissue of human anatomical parts using fluoresce microscopy along with magnetic resonance imaging (MRI).

3.1. Optical imaging.

By loading samples into the dyes, conservative imaging of cells and tissue sections is accomplished. Fluorescein isocyanate (FITC) and rhodamine, which are used as dyes, frequently are tethered to biomolecules that particularly in the chain to the cell or cell component by sensory receptor interchange. It has a couple of problems. The first one is the low fluorescence intensity, and the second one is photobleaching. Falling of fluorescence intensity is habitually noticed over a period because of having an irreversible change in the molecular structure of the dye molecules that have rendered them non-fluorescent; this phenomenon is referred to as photobleaching.

Quantum dots are tiny semiconductor particles that are in nanometer size. They emit powerful fluorescent light underneath UV light. The wavelength (of emitted wave) dependences the sensitivity of particle size. The bandgap is the reason for these properties of Quantum dots. The amount of energy released can be calculated by the following equation:

$$E = \frac{hc}{\lambda} \quad (1)$$

Energy is inversely related to the wavelength. That means with the increasing size of Quantum dots, the wavelength of the emitted light is decreasing. Comparing with the traditional dyes, the Quantum dots emanate more significant & stable light against photobleaching. It is the key advantage of 3-D tissue imaging, where photobleaching is a prime issue over the possession of z-directional successive sections.

Quantum dots are indissoluble in aqueous conditions, so a thin coated layer of water-soluble material is usually obligatory for biological and medical applications. This coating is done with the materials which are preferential to a particular cell or cell component[18]. These Quantum dots were made of CdTe capped with CdSe, a composition which can emit light under the UV excitation range[19]. Quantum dots can be delivered to the specific body organs containing the Quantum dots surface with appropriate molecules. Zn-S capped CdSe Quantum dots can be focused near the lungs to mica by a peptide sequence coating, CGFECVRQPERC., which binds to the endothelial cells in lung blood vessels [20]. Quantum dots were made of CdSe capped with ZnS, which are encapsulated within an amphiphilic copolymer and modified the polymer surface with targeting ligands. This is protecting the Quantum dots from aggregation in solution by a correlating ligand (tri-n-octyl phosphine oxide) [TOPO] [21].

3.2. Magnetic resonance imaging.

Magnetic resonance imaging (MRI) is a method where 3-D imaging can be done. It is a very advanced and widely used technique in modern medicine. MRI working method is dependent on magnetic resonance spectroscopy to study the hydrogen atoms that are naturally present in the tissue. When the specimen is employed under a powerful static magnetic field and transverse radiofrequency (RF) signal, the magnetic dipoles inside hydrogen nuclei present in the specimen get excited. The spinning nuclei are oriented with the applied field during RF pulse. This RF signal gives the spinning dipole extra energy and makes them spin in different frequencies and different directions. The hydrogen nuclei return to the equilibrium position in alignment with the static magnetic field following the RF pulse, which is called relaxation. Relaxation is of two types. They are T1 and T2. The time needed for the restoration of nuclear spin in orientation with the static field is referred to as T1. On the other hand, T2 is the time for vanishing the transverse magnetization. Depending on the difference between T1 and T2 relaxation times, several types of tissue can be differentiated [22].

In many cases, natural relaxation time is minimal, so there needs a contrast agent to overcome this problem. The contrast agent is naturally paramagnetic, which can alter the relaxation times between regions of the body.

Gadolinium (Gd) has been successfully used as a contrast agent for several years [23].

Right now, Superparamagnetic iron oxide (SPIO) nanoparticles are employing as per contrast agents for T2-weighting, as the replacement of gadolinium-based agents. To image the liver, lymph nodes, and bone marrow, T2-weighting is essential. The relaxation time of SPIO is much compared to the gadolinium-based particles [23].

SPIO nanoparticles are recently used for detecting cancer in vivo with the help of a mouse xenograft model. In this process, SPIO nanoparticle is conjugated with a cancer antibody named Herceptin. Largely, the SPIO nanoparticles were produced by the thermal decomposition of iron acetylacetonate and made them water-soluble over binding with 2,3-dimercaptosuccinic acid. After this, it can be conjugated with Herceptin. The MRI signal from a tumor situated in an animals' thigh has typically observed a quick difference during T2-weighted. Antibody binding is quantified through an organized experiment, whereas the same iron oxide nanoparticles bonded with a nonspecific antibody. No change in MRI signal is produced by these controls nanoparticles [24]. In some imaging applications, SPIO nanoparticles are required; otherwise, the feature can't be visualized by conventional MRI [25].

4. Nanoparticles in drug delivery

The drug delivery system is of the most advantageous application of nanoparticles. Different kinds of inflammation diseases like cancer, HIV/AIDS, ocular disease, respiratory disease, etc. treatment applications are associated with nanoparticles [15].

4.1. Inflammation.

When the body is infected by bacteria, viruses, or fungi, the immune system becomes active and forms inflammation to resist the invaders. Inflammation is a natural mechanism of the body which shields the body by giving response to stimuli to repair and cure any indications of defected cell or tissues. If the inflammatory process does not work efficiently, it results in infection. Inflammatory diseases can cause plenty of disorders and complications [26].

4.2. Rheumatoid arthritis.

Rheumatoid arthritis (RA) is a very natural inflammatory disease results in joint disability. Progressive disability, systematic complications, socioeconomic costs are associate with this disease. The drug delivery to the targeted cell is still the major problem of this disease treatment. The conventional treatment for RA includes three groups: modifying anti-rheumatic drugs (DMARDs), steroids, and anti-inflammatory drugs like NSAIDs. The contribution of nanoparticles to these three groups are discussed below:

RGD-attached gold (AU) half-shell nanoparticles containing methotrexate (MTX) are developed for treating rheumatoid arthritis (RA). For the treatment of RA, MTX is frequently used as disease modified anti-rheumatic drug (DMARD), and RGD peptide is a targeting moiety for inflammation. Heat is generated by AU half-shells, and the rate of drug release is increased, transporting the drug to the targeted cell under the near-infrared (NIR) radiation. With the combination of NIR irradiation, these nanoparticles possess a small amount of MTX, which shows grater therapeutic effects compared to the conventional treatment by MTX solution in collagen-induced arthritic mice. This nanoparticles based drug delivery system increased the efficiency of the drug doge with a small amount, which is also responsible for minimizing the side-effects [27,15].

For many years doctors are using a storied based drug for the treatment of chronic inflammatory disease[28]. As a result of the rapid clearance from the body, it is necessary to give a high dose of steroid in the blood for reaching efficient concentration in the cell. Several side effects, like osteoporosis, hypertension, and weight gaining, are associated with the chronic use of corticosteroids. So corticosteroids needed nanoparticles as delivery vehicles for active targeting, controlled release, and retention in the inflamed tissue [28].

4.3. Dermatitis

Dermatology therapy is the branch of medicine where inflammation in the skin is mainly

discussed. In this study, the main aim is to decrease the inflammation. For the various inflammatory condition and their treatment, topical corticosteroids are the keystone weapon. Though corticosteroids are widely used, they have serious side effects, as stated before.

SLN corticosteroid formulations showed enhanced penetration compared to the traditional counterparts and penetrated beyond the epidermis and into the dermis[29]. SLN brought the advantage of sustained-release, which play a vital role in managing the concentration of drug in tissue over times and improve side-effect profiles.

NSAIDs are another drug that is used for inflammatory disease for their excellent anti-inflammatory and analgesic actions [30]. But NSAID has adverse effects. Topical ointments that contain NSAID nanoparticles show significant penetration into the skin compared to the conventional ointment [30].

Another primary dermatological product is the sunscreen that is used for the precaution against the inflammation caused by the ultraviolet (UV) rays in the skin. UV filters are necessary for the prevention of sunburn and UV-induced mutations that may result in skin cancer. Inorganic UV filter titanium oxide (TiO_2) and zinc oxide (ZnO_2) are utilized for a very long period, and they are essential in protecting against UVA and UVB rays. But both of these two materials creating a filmy white residue on the skin, which is the limiting factor for their widespread use [29]. This problem can be solved by using nanoparticles of TiO_2 and ZnO_2, which are translucent without weaving UVA and UVB protection. Usually, for useful properties, the size of the nanoparticles ranging for this is ranging from 40 nm to 60 nm [31].

4.4. Asthma.

Asthma is a chronic inflammatory condition. In asthma, the patients' airway is narrowing and swelling due to the extra production of mucus, making difficulties in patients breathing [32]. For many years theophylline is the most widely used drug for treating allergic asthma[33]. This drug has inhaled glucocorticoid instead and many side effects like nausea, headache, and cardiac arrhythmias that are limiting the application of this medicine. Chitosan nanoparticles adsorption in theophylline modified by adding thiol groups was examined in vivo with the help of mouse models of allergic asthma [32].

Chitosan is a polymer that is derived from chitin. Because of having advantages like biocompatibility, biodegradability, and bio-adhesiveness, it is used for nano-drug delivery[34]. The mica was treated with theophylline adsorbed to nanoparticles show a significant effect on cellular infiltration, histopathology of lung sections, and apoptosis of lung cells. Thus, the clinical effectiveness of theophylline can be enhanced by the adsorption of chitosan nanoparticles as drug delivery vehicles[32]. The nasal drug delivery system is becoming a perfect option for the drug delivery system because of the large surface areas in the nose. So with the nasal drug delivery associated with nanoparticles as drug carriers enhance the effectiveness[35].

4.5. Inflammatory bowel disease

Inflammatory bowel disease (IBD) is a group of intestinal disorders that cause prolonged chronic inflammation of the gastrointestinal tract. IBD are generally two types, and they are Ulcerative colitis (UC) and Crohn's disease (CD)[36]. When inflammation is limited to the colon, it is referred to as UC, while CD is referred to as inflammation in any areas of the gastrointestinal tract. The primary symptoms of IBD are facing abdominal pain, diarrhea, and rectal bleeding[36]. Corticosteroids, aminosalicylates, and immune suppressants are generally used medicine for the IBD disease. These drugs possess various side-effects because of having unspecific targeting characteristics upon application. Selectively targeting the inflamed colonic tissue for reducing the side-effects and increasing the therapeutic efficiency of the drug administered would be a promising strategy towards IBD treatment.

One study shows that mesalamine, a conventional anti-inflammatory medicine used for the UC treatment, is used with nanoparticles formulation [37]. Free mesalamine is rapidly and quietly absorbed entirely in the intestine causing side effects and colossal drug loss with the low therapeutic effect of the medication.

As this drug causes excessive metabolism, delivering the mesalamine locally to the colon for decreasing the drug absorption and metabolism is very important. The drug was covalently bonded with NP matrix polymer, which able to deliver the drug to the selective cell that reduces the side-effects and enhances the therapeutic effect of the medication [37].

Nano-drug delivery conveys new hope for the treatment of inflammatory disorders as they can aggregate in the inflamed regions. Scientists are using the sensitivity of the polymer to pH in gastrointestinal (GI) transit. To supply specific aggregation in the inflamed tissue and selective drug release in the colon, PLGA nanoparticles are bonded with a pH-triggered polymer. They used curcumin (C) for the treatment of IBD because of its excellent anti-inflammatory, antioxidant, antimicrobial, anticarcinogenic, and hepatoprotective effects. But some problems associated with raw C like low solubility and thus low bioactivity, high metabolism rate, and rapid elimination. So, it is necessary to save C from rapid degradation during IBD treatment. To solve this problem, C is filled with polymeric pH-sensitive nanoparticles for IBD treatment. The positively charged ulcerated tissues are attracted by the negatively charged surface of nanoparticles. In vitro study showed that encapsulated C could cross the epithelial barrier a significant amount [36].

4.6. Alzheimer's disease.

Alzheimer's disease (AD) is a low-level inflammatory that mainly attacks the elderly, which progressively and devastating neurodegenerative disorder that is identified by cognitive deterioration and decreases the patient's lifestyle quality [38]. There are many Vivo and Vitro research on the influence of NPs on AD treatment. The examples of some nanoparticles that aim the brain for the treatment of AD are bellowed:

To circumvent the first-pass metabolism of the drug and to deliver it quickly to the brain, albumin NPs filled with tacrine are produced and administered through the intranasal route of sheep. Because of having a small size and large surface area, albumin NPs tacrine can be effectively delivered through the mucosa to the brain [39].

The use of dendrimers can prevent the aggregation of Amyloid β (Aβ), which is one of the causes of AD. They are bonded to the protofibrils and fibrils, which prevents the cytotoxic effect of Aβ plaques [40].

To resist further aggregation of the Aβ aggregates, Gold (Au) NPs were dissolved in it by the use of local thermal energy at a molecular level. After being attached to the Aβ aggregate, Au NPs create a local week microwave field producing thermal energy, which dissolves the aggregation and prevents from reforming [41].

Polymeric NPs, such as PLGA, can be used for encapsulating the drug to deliver it to the brain with the help of surface modification. A study found that curcumin can bind to the Aβ plaques to disaggregate them. So encapsulated the curcumin by the polymeric NPs can be used for the AD treatment [41].

4.7. Cancer.

Nanoparticles have a considerable contribution to the treatment of cancer. Liposome and polymer are the foundation of clinical drugs and delivery systems [42]. Paclitaxel is a well-known anticancer agent used for cancer treatment. It is a water-insoluble drug, and the most common mode of its administration is dissolving ethanol (Taxol ®) in polyoxyethylated castor oil (Cremophor® EL). Hypersensitivity reactions are requiring steroids for running and antihistamines for premeditations; both are the major side effects of Cremophor® [43].

Abraxane® is a different form of paclitaxel. With the aid of the high-pressure emulsification method, the paclitaxel is packed inside the nanoparticles of a natural polymer, albumin. It reduces the side-effects associated with paclitaxel [44] and also brings some extra advantages. It improves the supply of the drug from the bloodstream to the tumor site as well as allow higher drug dosing compared with Taaxol® [45].

The interaction between chemotherapeutic and antiangiogenic agents is considered to be a noteworthy consideration in tumor treatment. Delivery of the chemotherapeutic agent impacted through the disruption of the tumor blood vessels also increases the expression of factors related to drug resistance [46]. This is composed of a core of

PLGA conjugated with doxorubicin surrounded by liposome composed of phospholipids conjugated with PEG and combretastatin where doxorubicin is the chemotherapeutic agent and combretastatin is the antiangiogenic agent. The particle size was ranging from 80-120 nm. The purpose is to release the drug slowly by the degradation of the PLGA core. The particles are rapidly taken up by tumor after administering intravenously to mica with tumor-generated by carcinoma or melanoma cell, with increasing residence time aftermath from the conjugation of PEG [47] [48].

4.8. HIV/AIDS.

Researchers investigated that pH-sensitive nanoparticles (products of a copolymer of methacrylic acid and ethyl acrylate) are used by an HIV-1 protease inhibitor (CGP 70726). The commercial name of this copolymer is Eudragit® L100-55 [49] [50].

Scientists selected Eudragit® L100-55 owing to its pH-dependent solubility. The disruption of the replication cycle of the HIV-1 CGP 70726 is another anti-viral agent. The main problem is to deliver the CGP 70726 due to its non-solubility in the water. Nowadays, nanoparticles are synthesized by the emulsification method using copolymer solution mixed with CGP 70726 and benzyl alcohol, which provides a successful drug release.

The HIV-1 Tat protein is another vaccine (either prophylactic or therapeutic) against HIV-1/AIDS[51]. Into the SLN-based system, firmly, the DNA is packed along with a tat protein were with an electrostatic force, the DNA and the Tat peptide were successively absorbed onto the surface of nanoparticles [52][53]. Either intratracheal instillation or aerosol application process is introduced to the successful transfection of the SLNs into the lungs of mice was the increase in gene expression [54].

4.9. Ocular disease.

The primary purpose of using a nano particles-based drug delivery system is its ability to hold the drug in order to extend the duration of drug residences in the ocular mucus layer [55]. This layer is the barrier to the diffusion of macromolecules, which is unconfined from the goblet cells to conjunctive and save the corner epithelial layer. Usually, eye drops (a drug solution) are medicated for most of the ocular diseases. These solutions are made highly concentrated and require high-speed applications due to the precorneal loose. To improve the drug delivery system application of nanoparticles is widely tested by the researcher.

In the rabbit eye, the drug delivery system non-steroidal and anti-inflammatory drug is delivered with a mixture of Eudragit® polymer[56]. The Eudragilt® RS and RL polymers are copolymer, which is used in this investment. The nature of insolubility and capability of swelling makes the polymers suitable for controlled release. It is also associated with ethanol solubility, and the emulsification process and particle size is around 100 nm. They improve the efficiency of the eye-drop and reduce the amount of drug concentration.

5. Conclusions

This review paper focuses on the recent technological advancements in the drug delivery system and the treatment of various diseases with the help of nanoparticles. As the advancements of new technologies are happening at a remarkable rate, which is taking us towards a hopeful future, nanoparticles are currently being majorly focused on the drug delivery system. But their prospects surpass beyond the field of not only the drug delivery system, but also replacing human organs in the future. Much remarkable development of the nanomedicines is currently being tested to determine their workability and compatibility with the human body, as we have found for treating asthma, Alzheimer's disease, cancer, HIV, etc. Thanks to the nanoparticles, treating previously thought untreatable diseases are now becoming a reality day by day.

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Conflicts of Interest

The authors declare no conflict of interest.

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