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# A Systematic Review on Nanomedicine

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**Abstract:** Nanomedicine is used to cure cancer of many tissues such as ovarian cancer and multiple myeloma. With the help of nanotechnology, the probability of failure or rejection of a transplant, an organ is reduced. Nanomedicine is one of the latest and better fields which is used for the treatment of tumors. Some of the methods used to produce nanoparticles are discussed here. Many nanoparticles are used for the benefit of humans. The solvent is subsequently dispersed in a surfactant's aqueous media, resulting in the formation of a film in an instant colloidal suspension called solvent displacement. This method can be used to achieve a pharmacological payload. Supersaturation and precipitation are required for the assembly and stability of drug nanoparticles. Shear and cavitation forces are also used to produce nanoparticles. The milling media is generating shear forces on impact, resulting in nanoparticles, the principle of size reduction. Extrusion is also used to generate nanoparticles. Hydrophobic drugs are converted directly into nanoparticles. The capacity to build nanocores with a wide range of functionalities is another key advantage of the HAylation process (a method to make nanoparticles). Determine medication, metabolism and hepatotoxicity in these models in nanomedicine have the potential to have a significant influence in the field. Red blood cells (RBCs), for example, are sensitive to substantial external flow pressures, and their inherent formability can be used as a biomarker to identify a range of RBC diseases. It is concluded that different nanoparticles are made to treat different kinds of diseases and to make different therapies for cancer etc. Now a day's nanotechnology is the method that uses nanoparticles to cure diseases and provide a significant treatment approach to humans.

**Keywords:** Nanomedicine, Nanoparticles, Nanotherapeutics, Production of Nanomedicine, Nanotechnology, Theranostic Nanoparticles



## INTRODUCTION

'Nano' is a Greek word that means 'small to billionth level'. The Medical application of nanotechnology is called Nanomedicines, also called nanocarriers, nano constructs, nanoparticles, nanotherapeutics, nanosystems, nanomaterials. These are used for different medicinal purposes such as to diagnose, monitor, prevent, control and treatment of disease. Nanorobots and nanoparticles are used for sensing purposes in living organisms e.g Doxil ( commonly used for breast cancer and ovarian cancer cells) and Abraxane etc(Ma and Sanchez 2017). The ultimate goal is to raise the standard of living organisms. Different nanoparticles (1-1000nm range) are used for different purposes such as for the treatment of cancer; Doxil is common while for diagnostic purposes, carbon nanotubes are common. Whereas some nanoparticles are used for both diagnostic and therapeutic purposes called theranostics e.g, DOTA-TATE(d'Angelo *et al.,* 2019).

Nanoparticles guide drugs to reach the desired destination and control action. They can penetrate deep into the body. They can scan very fast. But they can`t detect and treat at the DNA level. They are specific, not selective in nature. They are not able to treat bone marrow cancer. It is a little bit expensive treatment. Some nanoparticles show plasma resonance properties, i.e. They attach to cancerous cells and make them visible(Dong *et al.,* 2022). Nanorobots are also used to clean teeth; collecting harmful terms. Lung cleaning robots are also used, they collect all foreign particles like the fibre of asbestos and smoking toxic particles. Extra fats and proteins that block the arteries are also used to remove them.

In ancient times, nanoparticles were known as gold collide. Ehrlich and Metchinkov both worked on phagocytosis by using nanoparticles. (they received the Nobel prize in 1908). Most nanomedicines are neither target specific nor water-soluble. They can cause a problem. Some nanocarriers are also not specific so they are dissolved in water and as a nanovector, they reach the desired target and release an appropriate drug. Nanovectors are designed to raise benefits and lower the ratio of risk. Tumour targeting drugs are specifically used in nanotechnology(Caron *et al.,* 2014). Such as Polysomes, Conjugates, Radiopharmaceuticals, and Nanoparticles.

There are two main mechanisms to use nanomedicines; the Active way (drugs attach to the receptor) and the Passive way (Enhance permeation and retention affect). Major

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approaches to use nanoparticles in body fluids are using MRI, PET, and gamma cameras. Carbon nanotubes are used that have C-60 (single-wall coated or multi-wall coated). These are insoluble in water so a mix in polyethylene glycol, and then reach a target and image get by cameras. Nanoparticles are much smaller than light particles and used in photothermal therapies such as gold nanoparticles and used in anticancer clinical trials. As a safety measurement Gold nanoparticle are used.

Superparamagnetic iron oxide is also used with nanoparticles to cure brain cancer and hyperthermia, intact, and they also have toxicity in them(Kenzaoui *et al.,* 2012). Nanomaterials also have physicochemical properties that differ from chemical bulk due to their small size. Its small size expands the development of the medicinal field and safety measures.

Cancer is one of the most life-threatening diseases. Surgery and Chemotherapy are used to cure but these do not eradicate cells and also have some side effects. Nanomedicine is also used to cure this fatal disease. Photochemical therapy is used with nanoparticles in nanomedicines that is valid and show fewer side effects as compared to previous treatment.

Nanotechnology i.e. nanomedicines are used as an attractive tool for cardiovascular diseases. Controlled drug delivery of active ingredients is carried out through a safe and effective platform of nanomedicines. In the treatment of cardiovascular disease, the supply of NO improves through gold and silica nanoparticles. A magnetic field is used that retain the medicine in the body. Cerium dioxide nanoparticles have antioxidant potential(Jain 2005).

Paul Ehrlich put
forward the concept of a "magic bullet"
around a century ago: An entity that can recognize a target and act therapeutically on that target. Prec ise medicine focuses on
specific tissue, cell type, or disease marker.
The concept of a magic bullet currently involves th ree components: drug, targeting moiety, a pharmaceutical carrier that is used as nanomedicines.

Nanomedicines have a large surface-to-volume ratio because of so small size which allows for the fine-tuning of nanomedicines' surfaces. They have the ability to change the organs and tissues at the molecular and cellular levels, nanomedicines have the potential to alter medicine(Soares *et al.,* 2018). Nanotoxicology is known as any malfunctioning in nanomedicines that harms the living body. If they have a little number of steroids then they can also badly affect living tissues.

## METHODS TO PRODUCE NANOMEDICINES

Different nanoparticles are used for the benefit of humans. Different technologies have been applied to synthesize the nanomedicines like nanoprecipitation, microfluidizer technology, milling method, extrusion technology, supercritical fluid technology, ionic gelation technique, high-pressure-homogenization etc. Nanoprecipitation is a straightforward method for preparing polymers. To conclude, the polymer is dissolved in a water-miscible organic solvent, yielding a water-miscible organic solvent.(Tosi *et al.,* 2021) The solvent is subsequently dispersed in a surfactant's aqueous media, resulting in the formation of a film in an instant colloidal suspension. This technique is also known as solvent displacement. The procedure can be used to prepare a variety of foods. At a high level, nanocapsules are a reservoir type of nanosystem. This approach can be used to achieve a pharmacological payload. However, its utility is limited to water-miscible nanocapsules. It cannot be used with water-insoluble solvents (this is inefficient) to encapsulate medicines that are hydrophilic.

Supersaturation and precipitation are required for the assembly and stability of drug nanoparticles. The following are the regulating factors for the nanoprecipitation method. The dynamics of nucleation and growth determine the final particle size and the distribution of sizes. Similarly, the drug's phase is important.

In microfluidizer technology, when two vehicles cool, a frontal collision occurs under high pressure. At the same time, shear and cavitation forces are also used to produce nanoparticles. This technique also generates nanoparticles that are made from lipids(Ottonelli *et al.,* 2021). It is the most common method used to create nanoparticles. The milling method is also used to generate nanocrystals. A bead or pearl mill is typically used to obtain drug nanoparticles. A ball

mill can be used to make ultra-fine medication suspensions. The milling media is generating shear forces on impact, resulting in nanoparticles, which is the principle of size reduction.

The Milling media, dispersion media, and stabilizers are all elements that affect the size and physical stability of nanoparticles. However, product contamination due to milling material degradation, a comparatively long milling time in the case of crystalline medicines, and scaleup limitations are some of the disadvantages of this technology(Hajialyani *et al.,* 2018).

Extrusion is also used to generate nanoparticles. Hydrophobic drugs are converted directly into nanoparticles. The use of manual pressure results in homogeneity. ( Kinast et al 2014 ) created a solid nano-suspension from a liquid nano-suspension with a pore diameter of less than 100 nm. For the integration of hydrophilic medicines into the lipid matrix of nanoparticles, a multiple emulsion technique based on solvent emulsification and evaporation has also been introduced. The particles are referred to as "liposphereS" rather than "nanoparticles" since their size is in the micrometre range. A stabiliser is added to encapsulate a hydrophilic medicine into the internal aqueous phase. To address various challenges, HAylation was proposed as a simple and all-in-one approach for nanomedicine manufacturing. HAylation requires the electrostatic attachment of HA to the positively charged NC+ nano-core. HA is a naturally occurring molecule that can be utilised as a targeting molecule. Cancer cells find it to be an excellent target.

The capacity to build nanocores with a wide range of functionalities is another key advantage of the HAylation process. As proof of a concept, NC+ containing HA nanomedicine was produced. The NC+ consisted of two treatments: CRT and PR.

The CRT nanocore is manufactured without any cars or complicated chemistry, according to PR, which eliminates any safety worries about exotic vehicles and chemical remnants. The suppression of DNA repair caused by CRT is an effective method of amplifying the clinical translation. Gold and silver liposomes also generate nanoparticles. Supermagnetism is an example of this in magnetic material (iron oxide). The magnetic moment of NPs changes and leads to a loss of energy that is called magnetic hyperthermia

**Blood Vessels on a Chip in Nanomedicines**

Endothelial cells lined the vessel chip. A photographic image is made of polydimethylsiloxane. Quantification of endothelial cells occurs in channels over time.

**Organ on a Chip in Nanomedicines**

The liver is the largest organ of the body

These detoxifying chemicals in the human organ perform drug metabolism, plasma protein synthesis, and glycogen storage. As a result of abnormal metabolism, the liver is sensitive to injury, resulting in dangerous build-up and liver diseases, which is the major cause of drug addiction(Rodrigues *et al.,* 2020). Withdrawal is induced through hepatotoxicity, which is caused by dangerous drugs. As a result, in vitro liver models that are stable are in high demand.

Determine medication, metabolism and hepatotoxicity in these models in nanomedicine have the potential to have a significant influence in the field. The clinical application of nanoparticles created as medication delivery systems. While animal models typically fail to precisely predict the effects of medications in humans. So far, several liver-on-a-chip systems have been developed, as well as 2D/3D mono- and co-cultures containing healthy and/or diseased cells. Biophysical phenomena in single cells have been studied using microfluidic devices. The behavior of blood flow in microcirculation has been intensively investigated in these studies. Red blood cells (RBCs), for example, are sensitive to substantial external flow pressures, and their inherent deformability can be used as a biomarker to identify a range of RBC diseases (for example, malaria, diabetes, sickle cell disease, and leukaemia). To gain a better understanding of the complicated NP–RBCs membrane interaction, Rodrigues and co-workers developed a microfluidic extensional technique as an indication of the haematological problems produced by MNPs in comparison to a standard haematological test.

**Limitation**

Consequently, each nanoparticle is evaluated separately because of having different traits, size is the only trait they have common

which is a fundamental limitation of nanomedicine.

Despite the benefits of utilizing NPs in applications where properties like targeting, release, and encapsulation are advantageous, such as the development of "smart" therapies or customized medicine, there are some drawbacks. Food and Drug Administration (FDA) approved a small amount of NP based treatments, medicines, and devices(Paliwal, Babu, and Palakurthi 2014).

**Development in nanomedicines**

Physical and chemical interactions can be triggered as changes in size and shape; for example, a material that is non-toxic at 100nm can become poisonous at 100nm and vice versa.

## DISCUSSION

The branch of science that deals with medicine with the help of nanotechnology is called nanomedicine. The first nanomedicine was proposed by Doxil. Nanomedicine means the use of materials for analysis, diagnosis, checking, control of a particular disease and its treatment. Nanomedicine is used to cure cancer of different tissues such as ovarian cancer and multiple myeloma. It is also used for the treatment of those peoples who had already been affected with HIV and has a weak immune system(Pai *et al.*,, 2020). With the help of nanotechnology, the probability of failure or rejection of the transplant, of an organ is reduced. Nanomedicine is one of the latest and better fields that are used for the treatment of tumors. Nanotechnology is introduced officially now and proved very beneficial in scientific areas of research. This technology is used in multiple areas of the field and has an integrated approach(Salvador-Morales & Grodzinski, 2022).

Nanomedicine has various applications in medical fields such as Abraxane used to cure cancer of the breast, lung and pancreas. Doxil was used to cure the HIV Kaposi sarcoma and also used for the treatment of ovarian cancer. The drug is covered by liposomes, it helps to improve the life span of a drug. Liposomes are composed of two layers of lipids that covered an aqueous space. The liposomes enhance functionality and help to decrease the damage that medicine leads to muscles of the heart specifically. Rapamune is also a nanomedicine that is used for the rejection of organs after transplantation. This nano-crystal enhances the solubility of the drug, rate of dissolution and increased absorption(Kumar and Nanda 2021). There is a new area of nanomedicine in vivo imagination in which new tools, devices and apparatus are being developed. Cardiovascular imaging the muscles of the heart where nanoparticles could visualize the pool of blood and area where inflammation or infection site is present.(Martin Gimenez, Kassuha, and Manucha 2017) Nanoparticles proved very beneficial in oncology and techniques of imaging. Quantum dots combined with MRI can make a tremendous level of resolution of images of tumour sites. The physician can see the growth of the tumor and determine the stage of infection.

Nanoparticles are brighter than organic dyes, there is a new lab chip technology in which nanotechnology on a chip is found. The nanoparticles coated with gold are tagged with fractions of DNA and it is used to find the genetic sequence in a particular sample. There is also a technology that is used to convert nucleotide strands into electronic signatures are called nanopore technology(Tan *et al.,* 2016). There are thousands of nanowires in a sensor test chip that is used to evaluate proteins and biomarkers that is residual of cancerous cells. This technique enables the physician to diagnose cancer only from some drops of blood from the patient. Nanotechnology introduces arthroscopes, which is used in surgeries and other different operations. In this way, surgery can be performed with a little incision. The little will be incision then the healing will be fast, this is good for the patient. Nanoelectronics based cancerous test is thousands of times better than a normal conventional laboratory test. By this technique, cancer performed anywhere within five minutes and results show better accuracy than other normal laboratory tests(Demming 2013). The device which is used in nanoelectronics is made up of nanowires and each nanowire is sensitive to a cancerous marker.

Nanotechnology is beginning to play a larger role in the development of new treatment procedures. Over 100 nanomaterial-based drugs are now being studied in clinical trials or have acquired FDA approval for therapeutic use. These structures are advantageous when compared to standard small molecules or biologics because of their multifunctionality, which is directly related to their comparatively large size and frequently sophisticated designs. However, because of this complexity, little thought has been devoted to how structural changes affect biological function.

Consider spherical nucleic acids, which are made by chemically arranging short RNA or DNA sequences around a nanoparticle's Centre (Egorov *et al.*,, 2021).

SNAs contain characteristics that distinguish them from the short, linear oligonucleotides that surround them, such as the ability to cross mammalian cells.

## CONCLUSION

Nanomedicine is a rapidly growing field of medical industry that has improved the efficiency of therapies for many death-causing diseases. Nanomedicines are used for the treatment of several diseases including cancer, tissues rejections in organ transplant, HIV, cardiovascular diseases and another kind of tissue damage. These medicines are prepared from different nanoparticles which help in the medicine industry by helping in the diagnosis, prevention, and treatment of such life-threatening diseases. These nanoparticles guide the drug toward the target cell. These are used in two main ways including the active and passive ways. The size of nanoparticles in the nanomedicine industry is an important factor as higher size or lower size can be damaging. In most the treatment a range of 20-100 nm nanoparticles is used. This is an emerging field in the medical industry because it causes more benefits with fewer side effects and is even use for a different kind of cancer treatment. Over 100 nanomaterial-based drugs are now being studied in clinical trials or have acquired FDA approval for therapeutic use.

**Conflict of Interest**

Authors have no conflict of interest

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