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IMPORTANCE OF NANOTECHNOLOGY IN PHARMACEUTICAL FORMULATIONS -A REVIEW

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ABSTRACT

Nanotechnology has brought a revolution in manufacturing materials, creating a vast number of new devices, drug delivery systems and monitoring and diagnosing systems, but the implications if this technology are very diverse, impacting consumers, clinicians and the practice of informatics. A major area of concern for health care providers is the ethical use of nanomaterials. Nanotechnology is manipulation of matter on an atomic, molecular, and supramolecular scale. The earliest, widespread description of nanotechnology referred to the particular technological goal of precisely manipulating atoms and molecules for fabrication of macroscale products, also now referred to as molecular nanotechnology. Drugs with high toxic potential like cancer chemotherapeutic drugs can be given with a better safety profile with the utility of nanotechnology. These can be made to act specifically at the target tissue by active as well as passive means. Other modalities of therapy such as heat induced ablation of cancer cells by nanoshells and gene therapy are also being developed. This review discusses the various platforms of nanotechnology being used in different aspects of medicine like diagnostics and therapeutics. The potential toxicities of the nanoparticles are also described in addition to hypothetical designs such as respirocytes and microbivores. The safety of nanomedicine is not yet fully defined. However, it is possible that nanomedicine in future would play a crucial role in the treatment of human diseases and also in enhancement of normal human physiology.

Key words: Nanotechnology, nanoparticles, namomedicine

INTRODUCTION:

Nanomedicine is the medical application of nanotechnology [1]. Nanomedicine ranges from the medical applications of nanomaterials, to nanoelectronic biosensors, and even possible future applications of molecular nanotechnology. Current problems for nanomedicine involve understanding the issues related to toxicity and environmental impact of nanoscale materials. Nanomedicine involves utilization of nanotechnology for the benefit of human health and well being. The use of nanotechnology in various sectors of therapeutics has revolutionized the field of medicine where nanoparticles of dimensions ranging between 1 - 100 nm are designed and used for diagnostics, therapeutics and as biomedical tools for research. It is now possible to provide therapy at a molecular level with the help of these tools, thus treating the disease and assisting in study of the pathogenesis of disease. Conventional drugs suffer from major limitations of adverse effects occurring as a result of non specificity of drug action and lack of efficacy due to improper or ineffective dosage formulation (*e.g*., cancer chemotherapy and antidiabetic agents).

Designing of drugs with greater degree of cell specificity improves efficacy and minimizes adverse effects. Diagnostic methods with greater degree of sensitivity aid in early detection of the disease and provide better prognosis. Nanotechnology is being applied extensively to provide targeted drug therapy, diagnostics, tissue regeneration, cell culture, biosensors and other tools in the field of molecular biology. Various nanotechnology platforms like fullerenes, nanotubes, quantum dots, nanopores, dendrimers, liposomes, magnetic nanoprobes and radio controlled nanoparticles are being developed [2].

Current status of therapeutics: The major factors influencing the treatment outcome in a patient are the efficacy and safety profile of the drug more so when used for cancer chemotherapy. These drugs have poor cell specificity and high toxicity like bone marrow suppression, gastric erosion, hair loss, renal toxicity, cardiomyopathy, and several effects on other systems. Similarly treatment for diabetes faces challenges with the route of delivery and inadequate glycaemic control. Availability of non-parenteral dosage forms of insulin would be a breakthrough and development of a suitable drug delivery device can aid in this approach. In many cases, the sensitivity and specificity of various diagnostic methods as in radio imaging and various assays for detection of malignancy are not sufficient enough for early detection and treatment[4].

Nanotechnology and medical applications: Development of newer drug delivery systems based on nanotechnology methods is being tried for conditions like cancer, diabetes, fungal infections, viral infections and in gene therapy. The main advantages of this modality of treatment are targeting of the drug and enhanced safety profile. Nanotechnology has also found its use in diagnostic medicine as contrast agents, fluorescent dyes and magnetic nanoparticles [5].

Overview: Nanomedicine seeks to deliver a valuable set of research tools and clinically useful devices in the near future [6, 7]. The National Nanotechnology Initiative expects new commercial applications in the pharmaceutical industry that may include advanced drug delivery systems, new therapies, and in vivo imaging [8]. Neuro-electronic interfaces and other nanoelectronics-based sensors are another active goal of research. Further down the line, the speculative field of molecular nanotechnology believes that cell repair machines could revolutionize medicine and the medical field.

Medicinal use: Drug delivery: Nanomedical approaches to drug delivery center on developing nanoscale particles or molecules to improve drug bioavailability. Bioavailability refers to the presence of drug molecules where they are needed in the body and where they will do the most good. Drug delivery focuses on maximizing bioavailability both at specific places in the body and over a period of time. This can potentially be achieved by molecular targeting by nanoengineered devices [7, 8]. It is all about targeting the molecules and delivering drugs with cell precision. More than $65 billion are wasted each year due to poor bioavailability.

In vivo imaging is another area where tools and devices are being developed. Using nanoparticle contrast agents, images such as ultrasound and MRI have a favorable distribution and improved

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contrast. The new methods of nanoengineered materials that are being developed might be effective in treating illnesses and diseases such as cancer. What nanoscientists will be able to achieve in the future is beyond current imagination. This might be accomplished by self assembled biocompatible nanodevices that will detect, evaluate, treat and report to the clinical doctor automatically.

Protein and peptide delivery: Protein and peptides exert multiple biological actions in human body and they have been identified as showing great promise for treatment of various diseases and disorders. These macromolecules are called biopharmaceuticals. Targeted and/or controlled delivery of these biopharmaceuticals using nanomaterials like nanoparticles and Dendrimers is an emerging field called nanobiopharmaceutics, and these products are called nanobiopharmaceuticals.Nanotechnology as defined by size is naturally very broad, including fields of science as diverse as surface science, organic chemistry, molecular biology,semiconductor physics, microfabrication, molecular engineering, etc. The associated research and applications are equally diverse, ranging from extensions of conventional device physics to completely new approaches based upon molecular self-assembly, from developing new materials with dimensions on the nanoscale to direct control of matter on the atomic scale.

Scientists currently debate the future implications of nanotechnology. Nanotechnology may be able to create many new materials and devices with a vast range of applications, such as in nanomedicine, nanoelectronics, biomaterials energy production, and consumer products. On the other hand, nanotechnology raises many of the same issues as any new technology, including concerns about the toxicity and environmental impact of nanomaterials, and their potential effects on global economics, as well as speculation about various doomsday scenarios. These concerns have led to a debate among advocacy groups and governments on whether special regulation of nanotechnology is warranted.

Nanotechnology is the engineering of functional systems at the molecular scale. This covers both current work and concepts that are more advanced. In its original sense, nanotechnology refers to the projected ability to construct items from the bottom up, using techniques and tools being developed today to make complete, high performance products[9-12].

One nanometer (nm) is one billionth, or 10^{-9}, of a meter. By comparison, typical carbon-carbon bond lengths, or the spacing between these atoms in a molecule, are in the range 0.12–0.15 nm, and a DNA double-helix has a diameter around 2 nm. On the other hand, the smallest cellular life-forms, the bacteria of the genus Mycoplasma, are around 200 nm in length. By convention, nanotechnology is taken as the scale range 1 to 100 nm following the definition used by the National Nanotechnology Initiative in the US. The lower limit is set by the size of atoms (hydrogen has the smallest atoms, which are approximately a quarter of a nm diameter) since nanotechnology must build its devices from atoms and molecules. The upper limit is more or less arbitrary but is around the size below which phenomena not observed in larger structures start to become apparent and can be made use of in the nano device. These new phenomena make nanotechnology distinct from devices which are merely miniaturised versions of an equivalent macroscopic device; such devices are on a larger scale and come under the description of microtechnology.

To put that scale in another context, the comparative size of a nanometer to a meter is the same as that of a marble to the size of the earth. Or another way of putting it: a nanometer is the amount an average man's beard grows in the time it takes him to raise the razor to his face

Two main approaches are used in nanotechnology. In the "bottom-up" approach, materials and devices are built from molecular components which assemble themselves chemically by principles of molecular recognition. In the "top-down" approach, nano-objects are constructed from larger entities without atomic-level control. Areas of physics such as nanoelectronics, nanomechanics, nanophotonics and nanoionics have evolved during the last few decades to provide a basic scientific foundation of nanotechnology[13-17].

Nanomaterials

- The nanomaterials field includes subfields which develop or study materials having unique properties arising from their nanoscale dimensions.
- Interface and colloid science has given rise to many materials which may be useful in nanotechnology, such as carbon nanotubes and other fullerenes, and various nanoparticles and nanorods. Nanomaterials with fast ion transport are related also to nanoionics and nanoelectronics.
- Nanoscale materials can also be used for bulk applications; most present commercial applications of nanotechnology are of this flavor.
- Progress has been made in using these materials for medical applications; seeNanomedicine.
- Nanoscale materials such as nanopillars are sometimes used in solar cells which combats the cost of traditional Silicon solar cells.
- Development of applications incorporating semiconductor nanoparticles to be used in the next generation of products, such as display technology, lighting, solar cells and biological imaging; see quantum dots.
- Recent application of nanomaterials include a range of biomedical applications, such as tissue engineering, drug delivery, and biosensors.

Cancer: The small size of nanoparticles endows them with properties that can be very useful in oncology, particularly in imaging. Quantum dots (nanoparticles with quantum confinement properties, such as size-tunable light emission), when used in conjunction with MRI (magnetic resonance imaging), can produce exceptional images of tumor sites. These nanoparticles are much brighter than organic dyes and only need one light source for excitation. This means that

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the use of fluorescent quantum dots could produce a higher contrast image and at a lower cost than today's organic dyes used as contrast media. The downside, however, is that quantum dots are usually made of quite toxic elements.

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Surgery: At Rice University, a flesh welder is used to fuse two pieces of chicken meat into a single piece. The two pieces of chicken are placed together touching. A greenish liquid containing gold-coated nanoshells is dribbled along the seam. An infrared laser is traced along the seam, causing the two sides to weld together. This could solve the difficulties and blood leaks caused when the surgeon tries to restitch the arteries that have been cut during a kidney or heart transplant. The flesh welder could weld the artery perfectly.

Visualization: Tracking movement can help determine how well drugs are being distributed or how substances are metabolized. It is difficult to track a small group of cells throughout the body, so scientists used to dye the cells. These dyes needed to be excited by light of a certain wavelength in order for them to light up. While different color dyes absorb different frequencies of light, there was a need for as many light sources as cells. A way around this problem is with luminescent tags. These tags are quantum dots attached to proteins that penetrate cell membranes. The dots can be random in size, can be made of bio-inert material, and they demonstrate the nanoscale property that color is size-dependent. As a result, sizes are selected so that the frequency of light used to make a group of quantum dots fluoresce is an even multiple of the frequency required to make another group incandesce. Then both groups can be lit with a single light source.

Nanoparticle targeting: It is greatly observed that nanoparticles are promising tools for the advancement of drug delivery, medical imaging, and as diagnostic sensors. However, the biodistribution of these nanoparticles is mostly unknown due to the difficulty in targeting specific organs in the body. Current research in the excretory systems of mice, however, shows the ability of gold composites to selectively target certain organs based on their size and charge. These composites are encapsulated by a dendrimer and assigned a specific charge and size.

Positively-charged gold nanoparticles were found to enter the kidneys while negatively-charged gold nanoparticles remained in the liver and spleen. It is suggested that the positive surface charge of the nanoparticle decreases the rate of Opsonization of nanoparticles in the liver, thus affecting the excretory pathway. Even at a relatively small size of 5 nm, though, these particles can become compartmentalized in the peripheral tissues, and will therefore accumulate in the body over time. While advancement of research proves that targeting and distribution can be augmented by nanoparticles, the dangers of nanotoxicity become an important next step in further understanding of their medical uses .

Neuro-electronic interfaces: Neuro-electronic interfacing is a visionary goal dealing with the construction of nanodevices that will permit computers to be joined and linked to the nervous system. This idea requires the building of a molecular structure that will permit control and detection of nerve impulses by an external computer. The computers will be able to interpret, register, and respond to signals the body gives off when it feels sensations. The demand for such structures is huge because many diseases involve the decay of the nervous system (ALS and multiple sclerosis). Also, many injuries and accidents may impair the nervous system resulting in dysfunctional systems and paraplegia.

If computers could control the nervous system through neuro-electronic interface, problems that impair the system could be controlled so that effects of diseases and injuries could be overcome.

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Two considerations must be made when selecting the power source for such applications. They are refuelable and nonrefuelable strategies. A refuelable strategy implies energy is refilled continuously or periodically with external sonic, chemical, tethered, magnetic, or electrical sources. A nonrefuelable strategy implies that all power is drawn from internal energy storage which would stop when all energy is drained.

One limitation to this innovation is the fact that electrical interference is a possibility. Electric fields, electromagnetic pulses (EMP), and stray fields from other *in vivo* electrical devices can all cause interference. Also, thick insulators are required to prevent electron leakage, and if high conductivity of the *in vivo* medium occurs there is a risk of sudden power loss and "shorting out." Finally, thick wires are also needed to conduct substantial power levels without overheating. Little practical progress has been made even though research is happening. The wiring of the structure is extremely difficult because they must be positioned precisely in the nervous system so that it is able to monitor and respond to nervous signals. The structures that will provide the interface must also be compatible with the body's immune system so that they will remain unaffected in the body for a long time . In addition, the structures must also sense ionic currents and be able to cause currents to flow backward. While the potential for these structures is amazing, there is no timetable for when they will be available[18-22].

Medical applications of molecular nanotechnology: Molecular nanotechnology is a speculative subfield of nanotechnology regarding the possibility of engineering molecular assemblers, machines which could re-order matter at a molecular or atomic scale. Molecular nanotechnology is highly theoretical, seeking to anticipate what inventions nanotechnology might yield and to propose an agenda for future inquiry. The proposed elements of molecular nanotechnology, such as molecular assemblers and nanorobots are far beyond current capabilities.

Nanorobots: The somewhat speculative claims about the possibility of using nanorobots [20], in medicine, advocates say, would totally change the world of medicine once it is realized. Nanomedicine [1, 16] would make use of these nanorobots (e.g., Computational Genes), introduced into the body, to repair or detect damages and infections. According to Robert Freitas of the Institute for Molecular Manufacturing, a typical blood borne medical nanorobot would be between 0.5-3 micrometers in size, because that is the maximum size possible due to capillary passage requirement. Carbon could be the primary element used to build these nanorobots due to the inherent strength and other characteristics of some forms of carbon (diamond/fullerene composites), and nanorobots would be fabricated in desktop nanofactories specialized for this purpose.

Cell Repair Machines: Using drugs and surgery, doctors can only encourage tissues to repair themselves. With molecular machines, there will be more direct repairs.[22] Cell repair will utilize the same tasks that living systems already prove possible. Access to cells is possible because biologists can stick needles into cells without killing them. Thus, molecular machines are capable of entering the cell. Also, all specific biochemical interactions show that molecular systems can recognize other molecules by touch, build or rebuild every molecule in a cell, and can disassemble damaged molecules. Finally, cells that replicate prove that molecular systems can assemble every system found in a cell. Therefore, since nature has demonstrated the basic

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operations needed to perform molecular-level cell repair, in the future, nanomachine based systems will be built that are able to enter cells, sense differences from healthy ones and make modifications to the structure.

The healthcare possibilities of these cell repair machines are impressive. Comparable to the size of viruses or bacteria, their compact parts would allow them to be more complex. The early machines will be specialized. As they open and close cell membranes or travel through tissue and enter cells and viruses, machines will only be able to correct a single molecular disorder like DNA damage or enzyme deficiency. Later, cell repair machines will be programmed with more abilities with the help of advanced AI systems.

Nanonephrology: Nanonephrology is a branch of nanomedicine and nanotechnology that deals with 1) the study of kidney protein structures at the atomic level; 2) nano-imaging approaches to study cellular processes in kidney cells; and 3) nano medical treatments that utilize nanoparticles and to treat various kidney diseases. The creation and use of materials and devices at the molecular and atomic levels that can be used for the diagnosis and therapy of renal diseases is also a part of Nanonephrology that will play a role in the management of patients with kidney disease in the future. Advances in Nanonephrology will be based on discoveries in the above areas that can provide nano-scale information on the cellular molecular machinery involved in normal kidney processes and in pathological states.

By understanding the physical and chemical properties of proteins and other macromolecules at the atomic level in various cells in the kidney, novel therapeutic approaches can be designed to combat major renal diseases. The nano-scale artificial kidney is a goal that many physicians dream of. Nano-scale engineering advances will permit programmable and controllable nano-scale robots to execute curative and reconstructive procedures in the human kidney at the cellular and molecular levels. Designing nanostructures compatible with the kidney cells and that can safely operate in vivo is also a future goal. The ability to direct events in a controlled fashion at the cellular nano-level has the potential of significantly improving the lives of patients with kidney diseases.

Patients today are seeking better health care, while healthcare providers and insurance companies are calling for cost-effective diagnosis and treatments. The biomedical industry thus faces the challenge of developing devices and materials that offer benefits to both patients and the healthcare industry. The combination of biology and nanotechnology, is expected to revolutionize biomedical research by exploiting novel phenomena and properties (physical chemical and biological) of material present at nanometer length (10-9m) scale and systems through control of matter on the nm scale and the direct application of nanomaterials to biological targets. Today, nanomaterials have been designed for a variety of biomedical and biotechnological applications, including biosensors, enzyme encapsulation; neuronal nanotechnology is based on the introduction of novel nano-materials which can result in revolutionary new structures and devices using extremely biological sophisticated tools to precisely position molecules. Carbon nanotubes (CNT) and functionalized fullerenes Bucky balls with bio-recognition properties provide tools at a scale, which offers a tremendous opportunity to study biochemical processes and to manipulate living cells at the single molecule level.

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Many nanomaterials have novel chemical and biological properties and most of them are not naturally occurring. Carbon nanotubes have won enormous popularity in nanotechnology for their unique properties and applications. CNTs have highly desirable physicochemical properties for use in commercial, environmental and medical sectors. Inclusion of CNTs to improve the quality and performance of many widely used products, as well as potentially in medicine, will dramatically affect occupational and public exposure to CNT-based bionanomaterials in the near future. Even since the discovery of carbon nanotubes, researchers have been exploring their potential in bio applications. One focal point has been the production of nanoscale biosensors and drug delivery systems based on carbon nanotubes, which has been driven by evidence that biological species such as proteins and enzymes can be immobilized either in the hollow cavity or on the surface of carbon nanotubes. surface-protein and protein-protein binding and also to develop highly specific electronic biomolecule detectors.The scheme combined with the sensitivity of nanotube electronic devices provides highly specific electronic sensors for detecting clinically important biomolecules like antibodies associated with human autoimmune disease.

Biosensors: These are currently used in areas of target identification, validation, assay development, lead optimization and absorption, distribution, metabolism, excretion and toxicity (ADME-box).

(a) Nanobiosensors: The nanosensors with immobilized bioreceptors probes which are selective for target analyte molecules are called nanobiosensors. These can be integrated into other technologies like lab-on-a chip to facilitate molecular diagnostics. Their applications include detection of microorganisms in various samples, monitoring of metabolites in body fluids and detection of tissue pathology such as cancer. Their portability makes them ideal for POC applications but they can also be used in laboratory settings.

(b) Nanowire biosensors: Surface properties of these can be easily modified therefore they can be decorated with virtually any potential chemical or biological molecular recognition unit, thus making the wires themselves analyte independent. Boron doped silicon nanowires are used to create highly sensitive, real time electrically based sensors for biological and chemical species.

(c) Viral nanosensors: Essentially the virus particles are called as biological nanoparticles. Herpes Simplex Virus (HSV) and adenovirus have been used to trigger the assembly of magnetic nanobeads as a nanosensor for clinically relevant viruses[15]. By using a magnetic field, as few as five viral particles can easily be detected in a 10 ml serum sample.

(d) PEBBLE nanosensors: Probes encapsulated by Biologically Localized Embedding (PEBBLE) nanosensors consists of sensor molecules which are entrapped in a chemically inert matrix by a microemulsion polymerization process that produces spherical sensors in the size range of 20 to 200 nm[16]. These are capable of real time inter and intracellular imaging of ions and molecules and are insensitive to interference from proteins.

(e) Optical biosensors: Many biosensors which are currently marketed rely on the optical properties of lasers to monitor and quantify interactions of biomolecules that occur on specially derived surface or biochips. Example: Surface plasmon.

(f) Laser nanosensors: In this laser light is launched into the fibre and the resulting evanescent field at the tip of the fiber is used to excite target molecules bound to the antibody molecules[17]. When laser falls on them, they release optical signals which are coded by photometric detection system. This system is used in analysis of proteins and biomarkers in human living cells.

Drug Delivery System

At present, 95% of all new therapeutic system have poor pharmokinetics and less developed biopharmaceutical properties. There is no such medicinal system that delivers drug and distribute therapeutically active drug molecules to the site of action or inflammation without any side effects. This problems are overcome by nanotechnology drug delivery system which possess multiple desirable attributes. Nanomedicine has a size such that it can be injected without occluding needles and capillaries which enables targeted drug delivery and medical imaging[20]. Thus nanosized liposomes, micelles, nanoemulsions, nanogels are used for this purpose.

Liposomes

Liposomes are used since 1960's. They are single phospholipid membrane organelle with aquous centre inside.They are of different shapes and sizes ranging from 30nm to several micrometer. Because of their size, hydrophobic, hydrophilic as well as biocompatibility, they are used as tool for targeted drug delivery. Liposomes size is so small such that it can cross vascular pores to reach solid tumors. Liposomes have been surface modified with active targeting ligands to improve delivery of therapautics to target cells. Recently a multicomponent liposome consisting of doxorubicin and antisense oligonucleotide targeted to MRP 1 mRNA and BCL 2 mRNA to suppress pump resistance and non pump resistance have been developed.

Micelle for drug delivery

Micelle are self assemblies of amphiphiles that form supramolecular core-shell structure in aqueous environment. When the concentration exceeds CMC i.e. critical micelle concentration, hydrophobic interactions are predominant and provides a driving force in the assembly of amphiphiles in aqueous medium. Now a days, micelle falls in the nanosize range that are formed with amphiphilic polymers. Most nanosized miceller delivery system are made up of amphiphilic polymers consisting of PEG and low molecular weight hydrophobic core forming block. Due to their low monomer concentration in equilibrium with micelles, this system has advantage of reduce toxicity and are thermodynamically stable to dilution. Micelle for drug delivery are of four types.

* Phospholipid micelles
* Pluronic micelles
* Poly (L-amino acid) micelles
* Polyester micelles

Dendrimers

It is known since 1980s, dendrimers are macromolecules constructed from the core of ABn (where n = 2 or 3) comprising a series of branches which are tree like around the core. They are well suited for targeted drug delivery because of their nanosize, ease to prepare and functionalisation and polymorphism. Their structure is such that medicinally active therapeutic agent can be embedded in it. Example: fluorouracil has antitumor activities, but also has side effects. PAMAM dendrimers after acetylation form dendrimer – 5 FU conjugates which after hydrolysis yields 5 FU., enabling the minimization of toxic effects.

Nanoemulsions for drug delivery

Nanoemulsions are dispersion of two immiscible liquids i.e. oil and water, where dispersed phase droplets are of the order of nanometeric size and is stabilized by surface -active films composed of surfactant and co-surfactant. They tremendously gain importance because of their optical transparency thermodynamic stability and ease of preparation. Structure of nanoemulsion can effect the rate of drug release at the site of action. Due to their nanosize they provide much longer oil water contact area which facilitates drug release from the dispersed phase droplets. Sonication, high and low energy emulsification using homogenizers are required for its preparation[23-25]. It has already been used in the i.v. injection of low dose amphotericin administered to mice, rats, dogs and monkeys and dose of 1.0 mg/kg.

Implications of nanotechnology

Implantations of nanotransmitters and nanosensors within individuals have opened gates for monitoring and treating them at the microscopic level with the use of nanodevices.But this crosses traditional bounderies of care in the hospitals as persons can get the treatment done while siting in their homes.Pateients at home could have access to date transmitted from biochips which will moniter the diseases like hypercholesterolemia, alerting them when critical levels are obtained. Education has increased individual responsibilities and provisions for safety are some of the implications of patients. Introduction of nanotechnology in daily life implies an entire role change for healthcare consumers. They will have powers of chosing their medication, but at the same time it will include responsibilities on their part. Some of the immediate implications for clinician's role include changes in decision making and clinicians productivity.[26] They may find their role changing into just participants, coordinators or coaches instead of experts. Diseases may also include those releated to softwares problems of nanodevices embedded in the human body. Highly individualized care may be needed. Patients and clinicians would need to have throughout knowledge of device interfaces as all body metabolism will be regulated by these devices. The day may not be far than insurance deny us as money due to monitoring our health at cellular level in early stages. Nanotechnology will make us over dependent on devices. Inaccurate and errors with monitoring devices will be very challenging to detect. Advocates will be needed by everyone for safe and ethical use of nanomaterials. Monitoring methods would be needed to assure that devices are checked and caliberated within safety limits. Hence if these implications can be managed nanotechnology is the biggest boon to mankind.

If this technology will be wide spread and well accepted clinicians might find their roles as experts diminished[27]. Nanotechnology has brought a new era in healthcare but the challenges is to develop it by overcoming various difficulties and implications. New opportunities have provide us with a powerful tool in the field of genomics, proteomics, molecular diagnostics and high throughout screening. Nanoparticles have the properties to become the most versatile materials for developing diagnostics. Advances in nanotechnology will provide a good inside view of our human systems. It has a bright future with the emergence of several promising approaches for delivery of therapeutics agent and imaging using the advantage of nanoscale carriers. Future studies will now be addressing a no. of challenges faced in nanomedicine application. Greater funds are being allocated for clinical and pre-clinical studies but still are studies are lacking in safety data that includes toxicity studies. Also the cost of nanomedicine should be in acceptable range so that it is successful in clinics. Nanotechnology is being applied at all stages of drug development, from formulations for optimal delivery to diagnostic applications in clinical trials. Actual utilization of nanotechnology novel drug delivery techniques lag behind because of perception that such technologies could delay products due to technical or regulatory reasons. So oral drug delivery remains a prefered option[28]. Further the

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cost factor becomes a hinderance in its daily use. This review deals with promises and uses of nanotechnology in the field of pharmacy to its wide spread application in various fields of genomics, imaging, diagnosis, drug delivery and treatment of diseases[29,30].

CONCLUSION:

Nanotechnology is widely considered to be one of the most promising technologies of the 21st century. In considering the use and potentials of emerging nanoscience techniques in nanomedicine, such as nanosurgery, tissue engineering, and targeted drug delivery, we have discussed ethical considerations related to this field. These ethical considerations are related to risk assessment in general, therapy on somatic cells versus germline cells, the enhancement of human capabilities, research into human embryonic stem cells, and the toxicity, self-assembly and uncontrolled function of nanoparticles and nanosystems.

The analysis of potential ethical problems in nanomedicine shows that even though ethical questions in nanomedicine may be more complex than ethical questions in general medicine and biotechnology, for example the toxicity of nanoparticles resulting from their nanoscale size fundamentally the same general ethical principles, such as respect for autonomy, beneficence, non- maleficence, and justice, are at stake. These ethical principles have been used for ethical assessment in biomedicine for several years and they form part of several different ethical theories, including the bioethical theory of Beauchamp and Childress. This shows that even though nanomedicine raises ethical issues that are more complex than those raised by existing technology, a reasonably sound knowledge base has already been acquired in the field of bioethics that can be extended to nanomedicine.

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