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Nanotechnology Based Drug Delivery Systems in Cancer Treatment - A Review

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Abstract

Cancer is caused by damage of genes which control the growth and division of cells. In the fight against cancer, early detection is a key factor for successful treatment. However, the detection of cancer in the early stage has been hindered by the intrinsic limits of conventional cancer diagnostic methods. Nanotechnology provides high sensitivity, specificity, and multiplexed measurement capacity and has therefore been investigated for the detection of extracellular cancer biomarkers and cancer cells, as well as for in vivo imaging. These advances will improve the survival rate of cancer patients by enabling early detection. In addition, it could be used to monitor cancer progress in response to treatment, which may contribute to the development of better strategies for cancer treatment. In fact it holds tremendous potential as effective drug delivery systems. Nanoparticles based drug delivery and targeting systems under development aim to minimize harmful side effects and increase the bioavailability of drugs for action at the specific site of cancer. This review paper is an overview of nanotechnology based drug delivery systems for cancer treatment.

Keywords: Nanotechnology, nanoparticles, cancer diagnosis, cancer biomarker.

1. Introduction

Cancer is a disease caused when cells divide uncontrollably and spread into surrounding tissues .It is one of the major health concerns of the 21st Century which does not have any boundary. The rate at which cancer is honouring is only increasing as time goes on due to such factors as increases pollution, radiation, lock of exercise and a balanced diet, among other variables such as genetics. Anyone of these factors can lead to a mutation in the DNA of our cells like oncogenes and develop into cancer [1, 2]. The immortalization at astonishing rates, overtake all the healthy functional cells and eventually lead to death. A variety of approaches are being practiced for the treatment of cancer which has some significant sight effects. Cancer treatment includes surgical removal chemotherapy radiation and hormone therapy. In recent years, significant efforts enhance the delivery of anticancer drug to tumor tissue.

The role of nanotechnology has come in many aspects and is radically changing the treatment pattern of various diseases and cancer in particular. It recognizes the cancerous cells very selectively and targets the drug delivery. It ensures enhanced permeability and retention to localize in solid tumors and not in healthy tissues. Cancer nanotechnology is rising very enthusiastically as a major advancement in detection, diagnosis, and treatment of the disease. Nanotechnology holds tremendous potential as an effective drug delivery system.

Drug delivery systems include liposomes, polymeric micelles, dendrimers, nanospheres, nanocapsules, and nanotubes as reported by Praetorius and Mandal (2007) and Park (2007). Nanomaterials and nanoscale devices for diagnosis, treatment and monitoring diseases is a fast developing area of biomedical research. It involves the understanding and control of matter on a scale of 1 to 100 nanometres. On nana scale, there is vastly increase in ratio of surface area to volume. Due to this, materials at nanometre -scale exhibit unusual properties. When you change the size of a particle, it can change colour that's because in nanometre-scale particles, the arrangements of atoms reflects light differently. Nanotechnology offers great visions of improved, personalized treatment of disease. The hope is that personalized medicine will make it possible to develop and administer the appropriate drug, at the appropriate dose, at the appropriate time to the appropriate patient. The benefits of this approach are accuracy, efficacy, safety and speed. Some techniques are only imagined, while others are at various stages of testing, or actually being used today. While some researchers use the term nanomedicine to refer to applications of nanoparticles currently under development, other researchers reserve the term nanomedicine to refer to longer range research that involves the use of manufactured nano-robots to make repairs at the cellular level. While nanomedicine potentially offers promising new value propositions and revenue streams, it also could completely displace certain classes of drugs [5]. For example, currently-employed chemotherapeutic agents are being substituted with novel nanoparticle reformulations. Today, commercial nanomedicine is at a nascent stage of development and its full potential years or decades away. Currently, the most advanced area of nanomedicine is the development and use of nanoparticles for drug delivery. Smart suparparamagnetic iron

oxide particle conjugates can be used to target and locate brain tumors earlier and more accurately than reported methods. It is known that folic acid combined with polyethylene glycol can further enhance the targeting and intracellular uptake of the nanoparticles. Therefore, nanomaterial holds tremendous potential as a carrier for drugs to target cancer cells.

Designing nanoparticles loaded with recognition proteins can target specific cancer cell. The advantages of such targeting include the significantly reduced as well as the drug concentration on the cancer site can be increased without any lead effect on healthy cells. The physicochemical characteristics of nanotechnology platforms, such as composition, particle size, surface change, surface functionalization with hydrophilic polymers, and inclusion of tissue –recognition ligands, will conduct their bio distribution and pharmacokinetics.

2. Background

Nanomedicine is the medical application of nanotechnology. It covers areas such as nanoparticle drug delivery and possible future applications of Molecular Nanotechnology (MNT) and nanovaccinology. Current problems for nanomedicine involve understanding the issues related to toxicity and environmental impact of nanoscale materials. Some of the examples where nanotechnology shows promise include multifunctional nanoparticles for imaging and therapy (in diseases such as cancer), nanochannel implants for controlled release of drugs, nanoscale devices for evaluation of proteomics and genomics, and diagnostic techniques that take advantage of physical changes in diseased tissue. Recent advances in nanotechnology have made possible the design and development of tubular nanoscale particles called nanotubes [10-15, 19]. The tubular shape of such particles is highly attractive since it is possible

to differentially functionalize the inner and outer surfaces to facilitate drug loading, biocompatibility, and bio recognition. Novel synthetic strategies allow the fabrication of tubular structures with well-defined diameters and lengths. This can have important implications in bio distribution, sub cellular trafficking, and drug release. Magnetic nanoparticles with appropriate surface coatings are increasingly being used clinically for various biomedical applications, such as magnetic resonance imaging, hyperthermia, drug delivery, tissue repair, cell, and tissue targeting and transfection. This is because of the nontoxicity and biocompatibility demand that mainly iron oxide-based materials are predominantly used, despite some attempts to develop 'more magnetic nanomaterials' based on cobalt, nickel, gadolinium, and other compounds. The first use of the distinguishing concepts in 'nanotechnology' was in "There's Plenty of Room at the Bottom," a talk given by physicist Richard Feynman at an American Physical Society meeting at Caltech on December 29, 1959. This idea has been expanded tremendously in biomedical field. Nanotechnology and nanoscience got started in the early 1980s with two major developments; the birth of cluster science and the invention of the scanning tunnelling microscope (STM). This development led to the discovery of fullerenes in 1986 and carbon nanotubes a few years later. In another development, the synthesis and properties of semiconductor nanocrystals was studied. This led to a fast increasing number of metal oxide nanoparticles of quantum dots. The atomic force microscope was invented five years after the STM was invented. The AFM uses atomic force to see the atoms. Nanotechnology has the potential to have a revolutionary impact on cancer diagnosis and therapy. It is universally accepted that early detection of cancer is essential even before anatomic anomalies are visible. A major challenge in cancer diagnosis in the 21st Century is to

be able to determine the exact relationship between cancer biomarkers and the clinical pathology, as well as, to be able to non-invasively detect tumors at an early stage for maximum therapeutic benefit. For breast cancer, for instance, the goal of molecular imaging is to be able to accurately diagnose when the tumor mass has approximately 100-1000 cells, as opposed to the current techniques like mammography, which require more than a million cells for accurate clinical diagnosis. In cancer therapy, targeting and localized delivery are the key challenges. To wage an effective war against cancer, we have to have the ability to selectively attack the cancer cells, while saving the normal tissue from excessive burdens of drug toxicity. However, because many anticancer drugs are designed to simply kill cancer cells, often in a semi-specific fashion, the distribution of anticancer drugs in healthy organs or tissues is especially undesirable due to the potential for severe side effects [25-30, 39]. Consequently, systemic application of these drugs often causes severe side effects in other tissues (e.g., bone marrow suppression, cardiomyopathy, neurotoxicity), which greatly limits the maximal allowable dose of the drug. In addition, rapid elimination and widespread distribution into non-targeted organs and tissues requires the administration of a drug in large quantities, which is often not economical and sometimes complicated due to non-specific toxicity. This vicious cycle of large doses and the concurrent toxicity is a major limitation of current cancer therapy. In many instances, it has been observed that the patient succumbs to the ill effects of the drug toxicity far earlier than the tumor burden. Recent developments in nanotechnology can address these challenges. In the following section we have discussed implication of nanotechnology and nanomedicine in cancer detection and treatment.

3. Nanoparticles- Drug Delivers

The applications of nanoparticles for drug delivery provide the potential for enhanced treatments with targeted delivery and fewer side effects. Here I have highlighted some important kinds of Nanoparticles.

3.1 Polymeric Nanoparticles

Polymer based nanoparticles involve various natural or biocompatible synthetic polymers. They include rationally designed macromolecular drugs, polymer drug and polymer-protein conjugates, polymeric micelles containing covalently bounded drugs and polyplexes for DNA delivery. Polymer nanoparticles can be divided into nanospheres, which build a continuous polymer matrix and can be referred as "drug sponges" and nanocapsules, which consist of a polymer layer enclosing a fluid-filled cavity and mimic liposomes.

Nanoparticles, including nanospheres and nanocapsules, can be amorphous or crystalline. They are able to absorb or encapsulate a drug, thus protecting it against chemical and enzymatic degradation. In nanocapsules, the drug is confined to a cavity surrounded by a polymer membrane, while nanospheres are matrix systems within which the drug is dispersed physically and uniformly. Biodegradable polymeric nanoparticles have attracted considerable attention in the controlled release of drugs in targeting particular tissues, as carriers of DNA in gene therapy and in their ability to deliver proteins peptides and genes by the oral route.

3.2 Lipid – Based Nano Particles

Lipid based nanoparticles, combining the advantages but avoiding the disadvantages of other colloidal carriers, have

attracted increasing attention in recent years and regarded as alternative carrier systems to traditional colloidal systems, such as emulsions, liposomes and polymeric micro particles and nanoparticles.

3.3 Biological Nanoparticles

The conjugation of biological molecules and synthetic polymers is an efficient means of improving control over the Nanoscale structure formation of synthetic polymers that can be used as drug delivery systems. The conjugation of suitable synthetic polymers to pepside or proteins can reduce toxicity, prevent immunogenic side reactions, enhance blood circulation times and improve drug solubility.

3.4 Metallic Nanoparticles

Metal-based nanoparticles is the generic term for several nanoparticles, for example metal oxide and non-oxide ceramics, metals, calcium phosphate, gold, silicate and magnetic nanoparticles. So called "nanoshells" combine various inorganic elements or materials. They have attractive properties like high surface Plasmon resonance, optical properties which can be tuned from visible to infra-red range. They possess large surface energy and have the ability to absorb small molecules. Gold, silver and platinum are some of the metallic nanoparticles that have been used for cancer diagnosis and therapy [33, 38]. The Gold nanoparticles have already been used as a vehicle for the delivery of anti-cancer drugs such as paclitaxel. Properties of gold nanoparticles including small size, bio-compatibility, high atomic number and ability to bind targeting agents gives an advantage over other nanoparticles to be used as contrast agents. The formation of bubble around the overheated gold nanoparticles in liquid environment followed by generation of acoustic

and shock waves protein inactivation has become a profound area of research. The Gold has also been used together with magnetic materials to improve the photo thermal effect to accelerate the death of cancer cells. Platinum nanoparticles act as prominent radiation sensitizers in radiotherapy cancer treatment showed improvements in biological efficiency of radiations, leading to amplified damage in DNS from tumor cells when compared to metal atoms. Silver nanoparticles can be used for both active and passive targeting of drugs [26, 30]. It has been emerged as an attractive candidate for delivery of various small drug molecules or large biomolecules like proteins, DNA or RNA.

3.5 Hyperthermia Magnetic Nanoparticles

The Magnetic nanoparticles have been used in biomedical field including cancer treatment. One of the most widely used nanoparticle of this kind are the Super magnetic iron oxide nanoparticles (SPIONs). One of the distinguishing features of SPIONs for drug deliver is their applicability for both magnetic properties and anti-body attachment which will improve targeting capability [31, 06]. Magnetic iron oxide particles offer a huge advantage over the other particles since they are highly bio-compatible. Magnetic nanoparticles are currently in development as a promising new type of cancer treatment which selectively heat tumor cells to temperatures high enough to kill cancer cells without harming normal ones. This destroys tumors and leads to the activation of immune system to attack other cells throughout the body. In this process, the heat produced can kill the cancer cells and releases the drug from the nanoparticles directly inside the cancer cells. Magnetic radiated hyperthermia can be used for local tumor treatments. It also ramps up the immune system to find and destroy distant cells. This is because cancer cells

produce more heat shock proteins (HSPs). When cancer cells are heated to high temperatures, they produce HSPs in high quantities which in turn binds to antigens (molecules or proteins that trigger and immune response) [16, 17]. When some cells are destroyed by the heat, their HSPs and antigens are released into the body that attracts cells from the immune system which then interact with the HSP antigen complex and used them to hunt down other cancer cells that were not damaged by the initial heating. Magnetic nanoparticles used as nano-heaters can be activated by an external magnetic field, through the magnetic coupling between the magnetic component of the field and their magnetic moment. Magnetic nanoparticles absorb the energy from this coupling phenomenon, and dissipate it as heat. For these magnetic fields, biological tissues are "transparent" with no significant energy deposition, thus this technique is safe for cancer treatment.

4. Drug Delivery Systems

Drug delivery system can be designed to improve the pharmacological and theraptic properties of drugs. The strength of drug delivery system is their ability to alter the pharmacokinetics and distribution of the drugs. Nanoparticles have unusual properties that can be used to improve drug delivery where large particles would have been cleared from the body; cells take up these particles because of their size. Complex drug delivery mechanisms are being developed, including the ability to get drugs through cell membranes and into cell cytoplasm.

Colloidal systems such as micellar solutions, vesicle and liquid crystal dispersions as well as nanoparticles dispersions consisting of small particles of 10-400 diameter show great

promise as carriers in drug delivery system. Some important carriers are discussed below.

4.1 Quantum Dots

The Quantum dots are nano-crystals ranging from 2-10nm which have extensively attracted great interest in the field of biology and medicine because of its unique optical and electrical properties. They have a distinct advantage over conventional biomarkers because of their high photo stability and size tenable excitation [12, 19]. Use of quantum dots has been extended in the NIR wavelength range as an imaging probe. The main advantage of the technique is that it increases the depth of tissue penetration which will lead to more accurate detection in-vivo. Materials best suited in building up quantum dots are cadmium sulphide and cadmium selenide. However, based on factors like toxicity and bio-compatibility, Zinc Sulfide is preferred. Applications of quantum dots include in-vivo and in-vitro imaging, live cell imaging and single molecule tracking [22, 28]. It is used for the detection of lung cancer, breast cancer, prostate cancer and pancreatic cancer, detection of primary tumor in vitro, prostate cancer, targeting and imaging melanoma and also detection of thyroid carcinoma antigen.

4.2 Carbon Nanotubes

The Carbon Nanotubes belong to the family of fullerenes and are formed of coaxial graphite sheets (<100 nm) rolled up into cylinders. Structurally there are two types: single-walled carbon nanotubes (SWCNTs) and multi-walled carbon nanotubes (MWCNTs). It possesses properties such as high aspect ratio, ultralight weight, tremendous strength and high thermal conductivity. In the field of cancer, diagnostic and therapeutic, three main properties have been exploited i.e.,

small size, high surface area to volume ratio and their ability to contain chemicals [26, 29]. Surface of carbon nanotubes can be modified with proteins for cellular uptake which are then heated up upon absorbing near-IR light wave. When exposed to near-IR light, carbon nanotubes quickly release excess energy as heat (~70°C) which can kill cancerous cells. Due to their unique properties, they have wide ranging applications in cancer diagnosis and therapy. Some of the notable applications in cancer diagnosis are molecular imaging with single-walled carbon nanotubes and cancer biomarker detection. It is also used for drug delivery and thermal therapy. The CNTs have proposed as a promising tool for detecting cancer at early stages with high sensitivity, selectivity and low detection limit.

4.3 Liposomes

Liposomes are small spheres having lipid layer that surrounds an active pharmaceutical ingredient. They can also be designed to deliver drugs. Liposomes that contain low pH can be constructed such that dissolved aqueous drugs will be changed in solution. As pH naturally neutralizes within the liposome, the drug will also be neutralized, allowing it to pass freely through a membrane. Another strategy for liposome drug delivery is to target endocytosis events [17]. Liposomes can be made in a particular size range that makes them viable targets for natural macrophage-phagocytosis. These liposomes may be digested while in the macrophage, phagosome of the thus releasing its drug. Liposomes can also be decorated with opsonins and ligands to activate endocytosis in other cell types.

4.4 Dendrimers

Dendrmers are nanometre sized polymer macromolecules. They have a high degree of molecular uniformity, narrow

molecular weight distribution, specific size and shape characteristics and a highly functionalised terminal surface. The manufacturing process is a series of repetitive steps starting with a central initial core. Each Subsequent growth step represents a new "generation" of polymer with a large molecular diameter, twice the number of reactive surface sites, and approximately double the molecular weight of the preceding generation. The core chemistry determines the solubilising properties of the cavity within the core, whereas external chemical groups determine the solubility and chemical behaviour of the dendrimer itself. Targeting if achieved by attaching specific linkers to the external surface of the dendrimer which enable it to bind to a disease site, while its stability and protection from phagocyte is achieved by "decorating" the dendrimers with polyethylene glycol chains[10].

5. Discussion and Future Directions

Nanotechnology has many advantages in cancer therapy. With small size, nanotechnology platforms can enter tumor vasculature via EPR (Enhanced Permeability and Retention). Besides, functionalization with hydrophilic polymer/ oligomer can offer a long circulation halflife and prolong the exposure time of tumor tissue to anticancer agents; Whereas inclusion of tissue recognition residues, such as antibodies, lectins and ligands which are specific for cancer cells, can help nanotechnology platforms achieve tumor cell targeting. For overcoming MDR (Multidrug Resistance) of cancer cells, a major challenge in effective cancer therapy, combinations of multifunctional nanotechnology platforms and other therapies have been developed and achieved significant successes. However, there are still challenges to the development and application of nanotechnology platforms in cancer therapy,

such as limited knowledge of the cancer cell physiology, small variety and poor functionalization of medical nanomaterials, and deficiency of clinical evaluation criteria. Nonetheless, with further advances in functionalization base on thorough understanding of the physiological features of cancer cells, nanotechnology platforms hold the promise of essentially changing the practice of oncology, allowing easy and effective targeted therapies.

In the fight against the pain, suffering, and death due to cancer, nanotechnology may allow prevention, earlier detection, diagnosis and prognosis of cancer at premalignant stages, in addition to providing multimodality treatment which is not possible with current conventional techniques. The successful clinical applications of radiolabel monoclonal antibodies for cancer detection and therapy bode well for the future of nanoscale carrier systems in clinical oncology. Several radiolabel multifunctional nanocarriers have been effective in detecting and treating cancer in animal models. Nonetheless, further preclinical, clinical, and long-term toxicity studies will be required to translate this technology to the care of patients with cancer [25-30, 33]. Super paramagnetic iron oxide nanoparticles (SPION) with appropriate surface chemistry have been widely used experimentally for numerous in vivo applications such as magnetic resonance imaging contrast enhancement, tissue repair, immunoassay, detoxification of biological fluids, hyperthermia, drug delivery, and in cell separation, et cetera. All these biomedical and bioengineering applications require that these nanoparticles have high magnetization values and size smaller than 100 nm with overall narrow particle size distribution, so that the particles have uniform physical and chemical properties. In addition, these applications need special surface coating of the magnetic particles, which has

to be not only non-toxic and biocompatible but also allow a targetable delivery with particle localization in a specific area. To this end, most work in this field has been done in improving the biocompatibility of the materials, but only a few scientific investigations and developments have been carried out in improving the quality of magnetic particles, their size distribution, their shape and surface in addition to characterizing them to get a protocol for the quality control of these particles. Nature of surface coatings and their subsequent geometric arrangement on the nanoparticles determine not only the overall size of the colloid but also play a significant role in biokinetics and biodistribution of nanoparticles in the body, especially in cases where specific receptors are located on the outer surface of cells. The types of specific coating, or derivatization, for these nanoparticles depend on the end application and should be chosen by keeping a particular application in mind, whether it be aimed at inflammation response, vaccine efficacy, or anti-cancer agents [11, 18]. Magnetic nanoparticles can bind to drugs, proteins, enzymes, antibodies or nucleotides and can be directed to an organ, tissue, or tumor using an external magnetic field or can be heated in alternating magnetic fields for use in hyperthermia. In the near future, advancement in nanomedicine will deliver a valuable set of research tools and clinically helpful devices. The National Nanotechnology Initiative expects new commercial applications in the pharmaceutical industry that will include advanced drug delivery systems, new therapies and in vivo imaging. Farther down the line, neuro-electronic interfaces and cell repair machines, considering their application in brain tumors, could revolutionize medicine and the medical field, but now nanomedicine is becoming one of the biggest industries in the world. In 2004, nanomedicine sales reached 6.8 billion dollars, and with over 200 companies

and 38 products worldwide, a minimum of 3.8 billion dollars in nanotechnology R&D is being invested every year. As the nanomedicine industry continues to grow, there is no doubt that it will have a significant impact on the economy. Here, it is emphasized that nanotechnology related information can be tested in one disease and then custom made for other diseases. The most important innovations are taking place in drug delivery, which involves developing nanoscale particles or molecules to improve 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 [39-43, 46]. Over 65 billion dollars is wasted every year because of 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 contrast. The new therapies and surgeries that are being developed might be effective in treating illnesses and diseases such as cancer. Finally, a shift from the possible to the potential will be made when nanorobots such as neuroelectronic interfaces and cell repair machines. The potential applications of nanotechnology, most current commercialized applications are considered for the use of "first generation" passive nanomaterials. These include titanium dioxide nanoparticles in sunscreen, cosmetics and some food products; silver nanoparticles in food packaging, clothing, disinfectants, and household appliances; zinc oxide nanoparticles in sunscreens and cosmetics, surface coatings, paints and outdoor furniture varnishes; and cerium oxide nanoparticles as a fuel catalyst. The Woodrow Wilson Center for International Scholars' Project on Emerging Nanotechnologies hosts an inventory of consumer products that now contain nanomaterials. However,

further applications that require actual manipulation or arrangement of nanoscale components await further research. Though technologies currently branded with the term 'nano' are sometimes little related to and fall far short of the most ambitious and transformative technological goals of the sort in molecular manufacturing proposals, the term still connotes such ideas. Thus, there may be a danger that a "nano bubble" will form, or is forming already, from the use of the term by scientists and entrepreneurs to garner funding, regardless of interest in the transformative possibilities of more ambitious and far-sighted work.

With this promising progress in the development of nanotherapeutic and imaging approaches to cancer detection and treatment, it is imperative to have a better understanding of the basic principles involved in designing and applying nanoparticles for diagnosis, treatment, or the combination of imaging and therapeutic in different clinical situations. There are certain critical questions that need to be addressed in the rational design and application of nanoparticles before further clinical development, such as how the association or conjugation of a therapeutic agent to ligand or carrier changes the pharmakinetics, biodistribution and side effects of the nanotherapeutic drugs; how the safety profile of nanoparticles changed after conjugation, such as coating with quantum dots; how we can minimize the potential toxicity of polymeric nanoparticles that is inherent from the accumulation of a non-biodegradable polymer with a size over the renal threshold 31; and how side effects resulting from the ability of nanoparticles to cross the blood- brain barrier (BBB) can be prevented or diminished [36, 37]. These questions are critically important and hitherto understudied. The answers will certainly lead to more rational design of optimized nanoparticles with improved selectivity, efficacy and safety. Attracted by the rapid and

promising progress in nanotechnology, physicists, chemists, engineers, biologists and clinicians will continue to challenge themselves to develop novel and efficacious nanosystems for the diagnosis and treatment of cancer. Biodegradable polymeric nanoparticles have attracted considerable attention in the controlled release of drugs in targeting particular tissues, as carriers of DNA in gene therapy and in their ability to deliver proteins peptides and genes by the oral route. Although there is potential for use of mNPH as a non-targeted monotherapy, the greatest potential for mNPH is likely due to its ability to act as an adjuvant or targeted therapy; these possibilities must be further explored. Lipid based nanoparticles, combining the advantages but avoiding the disadvantages of other colloidal carriers, have attracted increasing attention in recent years and regarded as alternative carrier systems to traditional colloidal systems, such as emulsions, liposomes and polymeric micro particles and nanoparticles [47, 48]. At this point of studies on the effectiveness of nanobiodrugs on cancer in large animals are currently underway.

The three most common techniques being used today to treat cancer are surgery, radiation, and, of course, chemotherapy. They all involve harsh operations that entail not only killing cancer cells, but regular cells that the body actually needs. Finding alternatives to these methods has been the focus of researches since day one but the problem with most new methods is that they just aren't as effective as what we are already using. How does nanotechnology compare?

From the information that has been gathered, nanoparticle therapies vary in their efficacy and results. There is no consensus because there are so many different kinds of NP treatment techniques. It can be said, however, that most of the research being done has yielded very positive results in

the air of killing cancer while leaving healthy tissue alone for the most part. They are associated with far less side effects than that of conventional therapies as the NPs being used are mainly biocompatible, non-toxic, chemically stable materials. Efficient drug delivery means that therapeutic chemicals can be transported safely to target sites without significantly degrading and harming the body. Nanocarriers seem to do just that. Whether or not they are equal to or better than conventional treatments in regards to "treating cancer" is tough to say however further research is needed in order to make this determination. Many researchers have actually found that it is beneficial to use a mix of multiple therapies, as is already done in medicine, but incorporating nanocarriers into the mix to offer a wide range of capabilities.

6. Conclusion

In the past 10 years, many efforts have been made to develop assays for cancer diagnosis based on nanotechnology. Compared with the currently available cancer diagnostics in the clinic, a variety of nanoparticle-based assays showed improvement in terms of selectivity and sensitivity or offered entirely new capacities that could not be achieved with traditional approaches. These advances will improve the survival rate of cancer patients by enabling early detection. In addition, these advances could be used to monitor cancer progress in response to treatment, which may contribute to the development of better strategies for cancer treatment. So it can be concluded that Nanotechnology has large potential in detection and treatment of cancer in its incipient stage. The potential arises due to the ability of nanoparticle entering inside the cells and access to the chromosomes/ Flexible Nucleic Acid molecules. Certain nano structures like nanocantilevers, nanopores, nanotubes, nanoshells and

quantum dote are prospective structures that would help in detecting and treatment of cancers. Dendrimers are to serve detection, treatment and signalling that the cells are killed. Still there are many challenges that are to be met before use of Nanotechnology becomes a reality. Toxicity of the nanoparticle is an issue that is to be resolved through legislative and regulatory means.

Though progress in drug delivery by nanotechnological devices has been dramatic, however, there are some challenges that need to be addressed: (a) deeper understanding of intracellular uptake mechanisms, and the fate of nanodevices in biological tissues, (b) any negative or side-effects of the interactions between nanodevices and biological systems – production of free radicals, damage to the interacting tissue, (c) scaling up of pilot experiments to large scale production, cost of materials needed, quality control for nanodevice materials, and (d) funding support for startup companies to bring the nanodrugs to market. The challenges in targeted drug delivery systems employing nanoparticles can be prevailed over through investigating the restraints on nanoparticle approaches and maximizing the current potential of nanoparticle formulations and devices.

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