Application of nanotechnology based on drug delivery system in therapy

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Abstract: Technology has been of great assistance in each industry. Medicine technology has been used to guarantee accuracy where nanomedicine plays an important part in the medics as correctly carry out diagnosis, monitoring and drug delivery to cancer patients effectively. In this study, we will be looking at how nanomedicine has helped medics in the easy and fast diagnosis of diseases. The study also discusses the basic understanding of nanomedicine development and its current application. How nanoparticles help in the delivery of drugs to tissues that are affected by the illnesses and diseases and how nanoparticles play the important role as ensuring that it leaves the patient with a therapeutic effect that helps in recovery of the patient will be included in the paper as well. We will also look at how to tackle drug resistance and how to ensure to prevent drug measures. Nanomedicine makes the production of drugs to achieve low cost, high efficiency, automation and large-scale possible, while the role of drugs will achieve revolutionary breakthroughs such as organ targeting, high efficiency and low toxicity. In recent years, nanomedicine is used to treat cancer patients. Based on the article, we can clearly understand the principle of nanomedicine, the basic applications and the challenges of the future. The readers can get a clearer picture of the unlimited potential of nanomedicines from this paper.

1. Introduction

Due to the changing world and evolving technology, nanotechnology plays a role in our daily routine. The new technology has been used as an alternative approach in various fields hence resulting in the increased number of applications and products that contain nanomaterials. It has also resulted in the production of new medicine that helps in curing diseases. Nanotechnology has been identified as the main technology that is capable of producing new innovative medical solutions that help in unmet medical needs [1]. Nanomedicine refers to the application of nanotechnology for the medical purpose by use of nanomaterials to diagnose, monitor, control, prevent and treat diseases [2]. In the following passage, we will summarize the application of nanoparticles as drug delivery system in therapy for curing diseases.

2. Nanomedicine

2.1 Nanomdicine for tumors

With the help of nanotechnology, it helps in carrying out of chemotherapy which helps in reducing adverse effects by directing drugs to the targeted cells. It also helps in guiding surgical resection of tumors that require high levels of accuracy to enhance efficiency of radiotherapies and other treatment options. The treatment has low possible risks to the cancer patients and high chances of survival.

The main use of nanotechnology in cancer treatment is oncology which refers to the delivery of drugs in cancer patients. Research has shown that nanotechnology has been used in several cases and the applied systems for drug delivery have turned out to be successfully. [3] It has also been used to design systems that help in the improvement of the pharmacokinetics of pharmaceuticals that reduce toxicities. The systems are found to help in limiting unexpected events of the drugs hence increasing

the chances of patient survival. Nanotechnology has also allowed chemotherapies to be more selective as they help in delivering drugs to specific areas of the human tissues that are affected by the tumor. There are a number of these systems that have been developed. Results have shown that one of these systems has been used to increase the efficiency of chemotherapy drugs which is used to treat bowel cancer. [4] This was a result of various clinical trials suggesting that nanoparticle delivery of drugs helps in increasing survival rates of cancer patients by delivering drugs directly to the affected tissues.

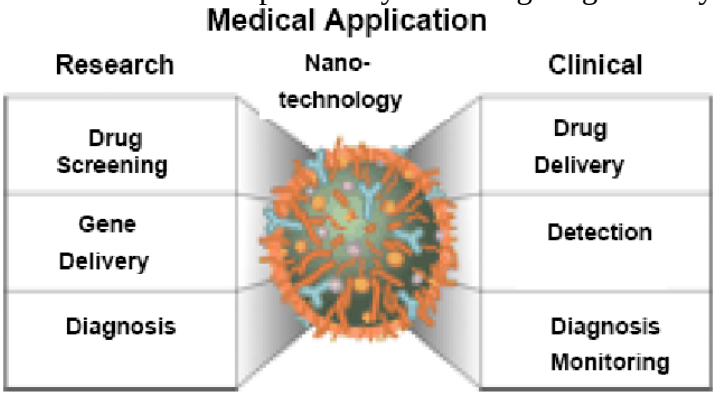

Figure 1. Medical Application of Nano technology

2.2 Nanomedicine for drug screening

In the delivery of drugs in the context of nanomedicine, it should be viewed as a practice of science and technology using a nanometer in its complex scale of (10-1000nm) which consists of two components to form the nanoparticle formulations of the drug desired to be produced. This system results in a special function related to treating, preventing or diagnosing disease. The main aim of the nanoparticles in drug delivery is to specifically target and deliver the drugs to the areas of the human body that are affected by the tumor. It also reduces toxicity in the human body. According to research carried out by [5], the main issues that may occur in search for appropriate carriers of the drug delivery include drug incorporation and release, formulation and shelf life of the drug, biocapacity, targeting capacity and functionality. Besides, when nanoparticles are used in drug delivery, they are the sole carrier since the limited life span and there should have well monitoring strategies once they are administered to the patient.

Table 1. overview of nanoparticles and their application.

Particle class	*Materials*	*Application*
Natural materials	Chitosan Dextrane Gelatin Liposomes	Gene / drug delivery
Dendrimers	Branched polymers	Drug delivery
Fullerness	Carbon based carriers	Photo dynamics
Polymer carriers	Polylactic acid	Drug delivery

The main aim of nanoparticles is to ensure that it traps the drug that is being delivered or taken by the specific cell that needs the drug or reducing toxicity in the tissue, both situations result in enhancement of therapeutic index which is usually the end goal of the drug delivery.

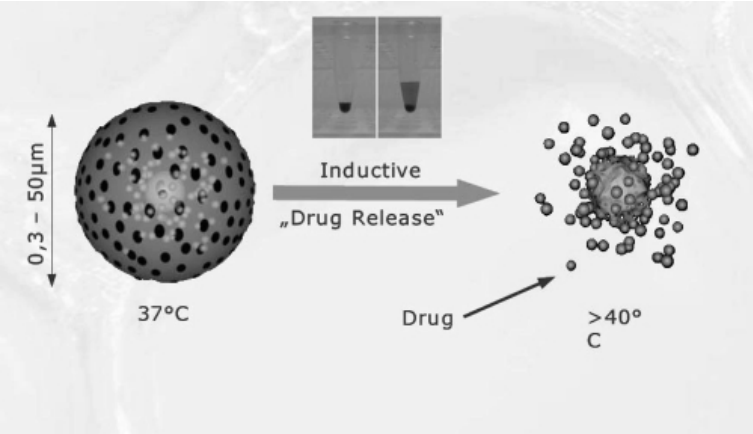

Figure 2. Contactless controllable drug carrying system based on thermosensitive magnetic nano- and micro particles. The insert shows the application of the system with Rhodamine B encapsulated beads that are released after heating up to 45°C.

2.3 Nanotechnology in disease diagnosis

The development of nanotechnology has brought about positive impacts in the world. This is by ensuring that there is diagnosis, treatment and prevention of diseases and most importantly detecting diseases in their early stages. It has also helped in giving hope to millions around the world because of its better and effective healthcare giving solutions to many diseases.

2.4 Targeting specificity and releasing mechanism of nanomedicine

NPs are meant to target drug therapies that aim to take the drug to the specific site that needs the drug. The desired moved of the NP is then limited by various psychological barriers. These barriers are found to be biological significant, and they are essential components of the body's defense system which is designed to limit the passage of foreign materials in the body. One barrier that affects the administration of NP is the reticuloendothelial system which consists of both the liver and the spleen which aid in removing the particles from the circulation. Under normal circumstances, NOs cannot be able to cross the endothelium of the blood capillaries when the patient is healthy. However, in certain pathological conditions such as inflammation or cancer, the endothelial cells tend to lose cellular integrity because of the activation of pro-inflammatory cytokines hence the gap between the endothelial cells expands. As a result, NPs extraverts from vascular systems to the diseased site through the abnormal endothelial gaps.

2.5 Nanotechnology against bacteria

Nanomaterials are known to have at least a common measurement when weighed in the nanometer which is 1-100nm which makes it have a physical characteristic [6]. In the wide range of nanomaterials, nanoparticles are considered to have many features which make them favorable as vectors for drugs to conquer a disease that causes pathogens. These refer to their ability to be soluble and stable [7]. The biocompatibility with the targeted tissues can be easily controlled by stimuli such as light, pH and heat. Their specific function in drug delivery is often achieved through their size and the vast surface-to-volume ratios. This results in its competitiveness over other therapies in the treatment of infections that are caused by the intracellular pathogens.

Poor membranes are known to transport limits; the portability of antibiotics loaded with NPs possesses the ability to enter the host's cell via the endocytosis which facilitates the entry of the nanoparticles. The penetration of the membranes can also be easily achieved of NPs when interacting with lipids on the surface such as the use of gold the administration of protein-based drugs [8]. The therapeutic appeal of NPs is brought about by their ability to offer physical protection against resistant mechanism.

Therefore, NPs can carry out their antibacterial activities through varied mechanisms such as interacting directly with the bacterial cell wall, inhibiting biofilm formations, generating reactive

oxygen species and the inducing of intracellular effects of NPs in the interaction with DNA proteins. The NPs are also known to engage in bacterial threats through long-term drug retention at the specific infection site actively through the combination with active molecules that play a role in targets binding [6]. The balance found between the modification in the interaction strength, the compound release rate and its stability to conjugate should be considered carefully with the design of an effective delivery strategy.

2.6 More to be used

In the current practice of medicine, there is a difference from the last century. New medications have been formulated to help in Treating complicated health conditions but some take part in producing severe side effects that the benefit of the medicine does not particularly out di the risks that come with the medication. On the contrary, some drugs have not been found to be effective but cannot be able to withstand the endogenous enzymes which are found in the Gastrointestinal tract. Nanotechnology has resulted in identifying drugs targets, designing and making better drug molecules, there is still a huge room for improvement of the drug delivery systems and the delivery of the drugs as well [9].

Through the application of nanotechnology to medicine, nanoparticles have been created particularly to mimic or alter biological processes. Nanoparticles are usually solid particles however for nanomedical application; the preferred size of the particles should be less than 200nm. The most important areas involve the application of nanoparticles drug delivery systems.

The use of nanoparticles for the therapeutic and diagnosis of diseases is very effective in medicine as well as the ability to deliver drugs. Traditional drugs that are available at this time are either taken orally or through injection and are not produced as an optimal formulation of the product. Medicine that contains proteins or nucleic acids are known to require a more innovative type of carrier system that plays a role in preventing them from unwanted degradation [10].

The effectiveness and efficiency of most drug delivery systems is directly related to the size of the nanoparticles. Their small size and large surface area enhance solubility as well as bioavailability, assigns additional ability to penetrate through the blood-brain-barrier, enters the pulmonary system and easily absorbed through the tight endothelial cells of the skin [11]. Nanoparticles made from natural and synthetic polymers have received more attention because they can be easily customized case by case. The involvement of technology in the production of the new drug delivery systems has provided an added advantage to the pharmaceutical sales to consider branching out. It has pushed pharmaceutical companies to develop new formulations of an existing drug which is very essential to patients.

2.7 Multifunctional therapies

Study results have shown that multifunctional nanoparticles particles have a greater ability compared to conventional nanoparticles to perform activities such as the delivery of multiple bioactive with imaging agents, targeting specific delivery through surface ligands and simulation of attainment of cancer therapeutics and diagnosis [12]. There are different advantages of multifunctional nanoparticles. For instance, multifunctional particles have been found to be important to targeted cancer therapeutics and imaging [13].

In recent cases, generic material-based anti-cancer approaches have been seeking much attention in which the plasmid DNA or therapeutic oligonucleotides can suppress gene expression by RNA interface or interruption of the transcriptional DNA. Multifunctional nanoparticles are bioactivity use for the delivery of targeted cancer treatment which is carried in two ways as whether being active or passive in the delivery of drugs. In cases of active tumor targeting, functional macro-biomolecules such as peptides, proteins, antibodies and proteins are decorated on the surface of the nanoparticle in order to target specific tumor cells. To add on that, multifunctional nanoparticles are labeled with imaging agents like magnetic resonance for live monitoring. The nanoparticles provide advantages to cancer theranostics through localizing themselves in disease tumors more than normal sites. The

multifunctional nanoparticles systems owe to the multimodal abilities to offer an opportunity for the delivery of bioactivities [14].

2.8 Measurements of nanomedicines in vivo

In vivo studies have shown that magnetic iron oxide nanoparticles hence demonstrating utility in biomedical diagnosis and therapy since they display favorable biocompatibility and various responses to the magnetic fields. Successful strategies involve the development of different targeted structures of the nanoparticles which requires biological activities between the physicochemical properties of the nanoparticles.

When nanoparticles are injected into the circulation of blood, they encounter a new environment which includes the living and non-living biological matters that vary with the physical conditions. The interaction of the nanoparticles with the dynamic environment can easily modify the surface of the particle to having a molecular signature that produces specific interactions with the patient's body.

Studies clearly show that the pilot trials using healthy micro in the vivo organs distribution of the iron oxide Magnetic Nanoparticles construct are used in cancer hyperthermia studies. The coating of nanoparticles varies with polymer materials. Polymer-coated particles are often characterized by their size, surface and heat generation. On the other hand, iron contents are most frequently used in nanoparticles to treat the lung diseases.

2.9 Safety concern and drug resistance

Nanostructures are known to stay in the blood for a long period of time and enable the release of amalgamated drugs as per the specified dose hence causing the plasma fluctuations in the system of the patients' body's nanoparticles should be of the right dimensions to ensure that they care easily soluble in the body of the patients. The uptake of nanoparticles results to cells that are much higher than larger particles with sizes that range from 10mm-100mm as discussed earlier.

In all stages of clinical practices, the nanoparticles have been found to play key roles in getting information owed to the various diagnoses of diseases. The main benefits of the nanoparticles are to ensure that various proteins can be fixed at the surface.

Drug resistance is defined as the reduction of the effectiveness of medication when treating a patients' diseases or conditions. There are various ways in which patients may incur drug resistance such as antibiotics. Global campaigns awareness is important in ensuring that societies are well educated in the danger behind the overuse of drugs which commonly causes resistance to drugs. Prevention is said to be better than cure. Patients should be fully understood that their medication plan would not cause prone to certain unhealthy condition which often cause the body to require the drugs thus leading to drug resistance. Limitation of the rate of the supply of mutations is also another way to ensure that the patients' body does not resist the drug that is being issued to the patient. This should be done through ensuring that the drugs cannot develop resistance once it is used regularly by a management system that plays an important role reducing the chances of drug resistance.

Clearly informing society on the possible risks of the drug is essential. This means that the patients should be warned against buying drugs over the counter without the doctor's prescription will highly cause drug resistance when the body needs the drug for a different purpose.

3. Conclusion

In conclusion, technology has played an important role in ensuring that patients have hope in the circumstances of healing tumors. In today's world, an increase in tumors has become the most challenging disease that is affected human beings in the world. Nanotechnology has brought about early diagnosis of tumors and diseases. This helps in starting early treatments for the patients which helps to save patients' lives. It also enabled the ease of ensuring that when drugs are delivered to the human body, they are easily directed to the tissues that the drug has been designed for. Lastly, nanotechnology is important in the medical industry. It enables the medics to have an easy time in ensuring that patients are diagnosed drug delivery is done effectively. They also play a remarkable

role in reducing undesirable resistance since chemotherapy is a long-term process. They also help inaccuracy of diagnosis whereby the medics are sure about the diseases that they are treating and can easily monitor the disease progress with more confidence.

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