Significant role of nanotechnology in cancer and molecular genetics: An overview

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Abstract
Nanotechnology is the understanding and control of matter at the Nano scale, at dimensions between approximately 1 and 100 nanometres, where unique phenomena enable novel applications. 1 nanometre is equal to 1 * 10^ -9. Nanotechnology offers the means to target chemotherapy directly and selectively to cancerous cells and neoplasm, guide in surgical resection of tumours, and enhance the therapeutic efficacy of radiation-based and current treatment modalities. All of this can add up to decreased risk to the patient and an increased probability of survival. As cancer is becoming the leading cause of deaths day by day so we need a proper treatment for that severe situation. We have many way of cancer treatment like surgeries, chemotherapy, hormone and immunotherapy's cell transplant etc. But nanotechnology have the ability to raise the strength and selectivity biological physical and chemical approaches to obtain cancer cell death as well as decreasing the collateral toxicity to non-malignant cells. In this process the cancer cells are increasingly targeted by the material on nanoscale by active and passive targeting with great accuracy. Here we will discuss about the nanotechnology for cancer treatment by target drug delivery.

Keywords: Oncogene, Nanoparticles, Endoscopy

Introduction

With the increasing rate of risk of cancer, the need for advanced technology for cancer treatment is increasing. Mortality rate is increasing per year due to cancer. It became one of the top causes of deaths around the world. Estimated 70% of deaths because of cancer occur in LICs and MICs. Around 10 million deaths due to cancer in 2020 in terms of new cases where lung, colon and rectum, liver, stomach and breast cancers are the main causes [1]. Cancer is not one disease but a combination of multiple diseases where every organ develops a set of distinct disease or disorder. There are many causes of cancer which includes genetic factor, other lifestyle factors foreign agents like physical carcinogens like ultraviolet and ionizing radiation, chemical carcinogens like asbestos, tobacco smoke, aflatoxin and arsenic and biological carcinogens like infections from viruses, bacteria or parasites [3-4]. In 2018 almost 13% of cancer treatments were based on Epstein-Barr virus, carcinogenic infections, HPV, hepatitis B and C virus including Helicobacter pylori, etc. Many causes can be minimised by simple change in daily lifestyle like smoking and dietary practices. But most of the causes cannot be dodged by just small changes that cause the requirement of the advance and innovation technology to improve the outcome. There is a noticeable success in cancer caused by viral infection (HPV). The noticeable achievement we have acquired for diagnose in viral cancer (e.g. HPV) can be enhanced by the use of current vaccine technology with the help of nanotechnology to improve the efficiency of vaccine, and as well as nanoparticles are able to distinguish between malignant and non-malignant cells and delivering a lethal payload increased as nanotechnology is the science that deals with the few nm to hundred of nm. Now it has been practiced for a few decades to develop new dimensions in this technology.

Nanotechnology is the technique to control the material less than 100 meu size and when we include this technology to medicine it becomes nanomedicine [5]. It has a vast variety of applications in medicine ranging from diagnostic devices, contrast agents, tools for analysis, and most importantly in the field of drug delivery for vulnerable diseases like cancer. Nanotechnology is the concept that revolves around the delivery of nanoparticles incorporating drugs which are originally engineered technology and used for targeted delivery and controlled release of curative agents. It is becoming the regular routine in dental clinics as it is gaining popularity nowadays. Saying that, with the use of nanotechnology the noticeable achievement has been attained by treating and detecting the variety of malignancies (like colon cancer, lung cancer, prostate cancer, breast cancer, head cancer, neck cancer, etc.).

Tumour Targeting

For cancer treatment tumor targeting is one the potential fundamental advantage of nanotechnology. In this process it shows the ability to differentiate malignant cells from non-malignant cells and says the central target of nanotechnology is malignant cells. There are two processes involved in differentiating malignant and non-malignant cells that are active and passive targeting. In passive targeting EPR (enhanced permeability and retention) gives the advantage to increase the concentration of nanoparticles (NPs) in tumors. In active targeting it shows the selective molecular recognition of antigens, frequently proteins which are present on the surface of the cancer cells to locate the NP to malignant cells, and on the other hand exploits biochemical properties associated with malignancy such as matrix metalloproteinase secretion. Both processes may work independently and also can be combined.

Nanotechnology in Cancer Diagnosis

In the fight against cancer, it is important that early recognition is the key for successful treatment. The recognition of cancer at the first stage is really hard. However, nanotechnology provides high sensitivity, selectivity, multiplexed measurement capacity and detection of extracellular cancer biomarkers as well as vivo imaging. The existing imaging techniques and the analysis of tissue or cell morphology helps in the early detection and diagnosis of cancer (techniques like X-ray, MRT, CT, endoscopy, etc.). But only observable changes in cancer tissues can be detected by these techniques and these techniques can not differentiate benign and malignant tumours. Therefore, it is very challenging to develop a technology for recognition of cancer at the primary stage before metastasis [25]. Although nanotechnology has not yet been developed for cancer diagnosis. But according to experiment reports there is a hope that diagnostic methods based on nanotechnology are being evolved as innovative and assuring tools for real-time, convenient for diagnosis [26-27].

1. Nanotechnology for the detection of Extracellular cancer biomarkers

When cancer is present in our body it secretes some proteins by cancerous cells and these proteins can be detected in body fluids, blood and other tissues. These proteins are called cancer biomarkers and act as measurable biological molecules. This can be done by use of nanoparticles like quantum dots, gold nanoparticles and polymer dots [38].

2. Detection of circulating tumour cells

Estimated 90% deaths from solid tumours are credited to metastasis. Early recognition of circulating tumour cells (metastatic cancer cells found in the bloodstream) can possibly affect the diagnosis and cancer prognosis. This CTC diagnosis by liquid biopsy helps us to understand the molecular organization of tumours [35-36]. High efficacy targeting ligand enabled during CTC detection by essential advantage of nanomaterials. These ligands can identify specific molecules on cancer cells. Based on experimental reports, different types of nanomaterials such as gold nanoparticles, carbon nanotube, graphene oxide, dendrimers, silicon nanopillars, nanowires, quantum dots and polymers for CTC detection [41].

Nanotechnology in Cancer Treatment

It is clearly visible that the need for advanced technology for cancer treatment is increasing per year. According to these statistics the cancer mortality rate, prevalence and incidence are rising to their high levels. Nanomedicine is good in cancer therapy. According to the National Cancer Institute, multiple nanotechnology clinical trials are currently in the progress with more advanced tools, But the cancer therapy treatment is not more rising then chemotherapy, surgery and radiation. That kind of method has a high risk of incomplete eradication of cancer/tumor or damaging healthy tissues.

1. Delivering chemotherapy

Through selective targeting traditional use of nanotechnology reduced the chemotherapy toxicity in cancer therapeutics to the toxicity. The nanoparticles designed through nanotechnology have a specificity toward their targeting site and this property stops them from releasing the medicine until they reach their targeting site and deliver the medicines directly to the targeting tumor tissue. Because of this property damage to the healthy tissues around the tumor tissue has been stopped. Even the delivery of medicine to the hardest part of the body is made possible because of the small size of nanoparticles. One example is the blood brain barrier, (stops toxic substances from entering the brain) it even blocks some medications but nanoparticles have enough small size to be able to cross this barrier and that makes an advantage for treatment of brain cancer.

2. Nano enabled immunotherapy

Immunotherapy is a promising new front in cancer treatment including cellular therapies. New technologies for molecular and functional analysis of single cells are being used to immune cells and functional response to therapy. To this end Nano enables devices and materials to be leveraged to sort, image and characterize T cells in the Nano system biology cancer centres. Additional uses of nanotechnology for immune therapy include immune depots placed in more or near tumours for in situ vaccination and artificial antigen presenting cells [39]. Nanoparticles incorporating immune modulatory agents can activate immune cells and modulate the tumour microenvironment to enhance antitumor immunity such nanoparticles-based cancer immune therapies have received considerable attention and have been extensively studied in recent years.

3. Delivering radiotherapy

Most of the cancer patients have got treated with some kind of radiation therapy during their treatment period.

Nanotechnology specific research has been conducted on radiotherapy as a treatment. Radiotherapy has been an integral treatment modality for cancer. Only nanomedicine have this ability that can impact radiation oncology. Materials on the nanoscale provide many unique properties such as enhanced permeability and retention effect that are well suited for applications in radiation oncology [41].

Molecular Genetics

Cancer is a genetic disease. Oncogenes (cancerous genes) are responsible for cell divisions, differentiation and regulation. Due to chromosomal disorder or mutation the precursor of oncogene converts into oncogene. These oncogenes are targeted by drugs or RNAi (RNA interference or RNA silencing) system to prevent proliferation of cancerous cells. Recently new techniques have been developed used to treat and diagnose cancer, including antiretroviral therapy, silencing of oncogenes, and mutations in tumour suppressor genes.

Conclusion

Thus, it is clear from this review that nanotechnology play a significant role in treatment and diagnosis.

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