NANOBOTZ IN CANCER DETECTION & TREATMENT

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ABSTRACT

According to World Health Organization, today cancer is a leading cause of death. There are two commonly used treatments for cancer, radiotherapy and chemotherapy. There are many side effects of these cancer treatments. With the help of Nanorobots we can completely cure cancer without any side effects. In the past few decades many research scientists have tried to develop lot many alternatives to chemotherapy and also the varieties of the actuators, energy supply to the mini drones. But the nanoscience and the nanotechnology research has come up with an excellent idea of using the nano robots that uses the bodily heat and chemicals as their fuel and based on the cadherin signal they kill the tumor cells . thus it is a revolution in terms of medicinal field and an alternative to the chemo and radio therapy to cure the cancer cells. It is demonstrated how nanotechnology can help solve one of the most deadly and the challenging problem without any pain or further mutagenic side effects.

KEYWORDS: Cancer, Diamondoid, Folate Receptor, Hyperthermia Method, Nanoparticle, Melanoma, Nanocrystal, Nanobiotechnology, Nanotechnology, Quantum Dot

INTRODUCTION

World health organization estimates that cancer is a leading cause of death and because of this 7.6 million peoples died last year. In the US, men have a 1 in 2 lifetime risk of developing cancer, and for women the risk is 1 in 3. Lung cancer is the most common cancer related cause of death among men and women.

Radiation therapy is one of the major treatment modalities for cancer.

Approximately 60% of all people with cancer will be treated with radiation therapy during the course of their disease. Radiotherapy is the treatment of cancer and other diseases with ionizing radiation. Ionizing radiation programs cells for death in the area being treated (“the target tissues”) by damaging their DNA structure, making it impossible for these cells to continue to grow(mitotic death). Although normal cells can also be affected by ionizing radiation, they are usually better able to repair their DNA damage. Radiations affect on individual cells is probabilistic process.

However, the effects of radiation on a large set of cells are more deterministic. The primary aim of radiotherapy is to deliver a high dose to maximize the probability of tumor of tumor control with risk to normal tissue within the tolerable level. In certain areas, the radio sensitivity of surrounding normal tissue becomes the dominant factor (e.g. optic chiasm for brain tumor treatment, or the spine for lung tumor treatment), thus limiting the maximum amount of dose that can be delivered. Some tissues such as in the lung have a low dose threshold for permanent radiation effects. Stereotactic technology, which has been applied to neurosurgery since the early nineties, recently has been applied to radiation
treatment of tumors, particularly brain tumors. Stereotactic radiotherapy involves varying the angle of a radiation treatment beam in 3-D together with varying beam intensities to achieve very precise delivery of radiation to target tissue.

The key problem with current chemotherapy is not that the drugs are not effective, existing cancer treatment drugs do successfully kill growing tumor cells, but that the rest of the body cannot tolerate the drug concentrations required to eliminate the cancer cells. Drug concentration high enough to destroy the tumors can kill the patient first, the aggressiveness of chemo-therapy treatment is usually determined by doses the patient can withstand rather than doses needed to eliminate all cancerous cells.

Another major method to eliminate cancer is through surgical procedures. Cancer can be successfully treated with current stages of medical surgery tools. However, a decisive factor to determine the chances for a patient with cancer to survive is: how precise can surgeon eliminate malignant tissues from the patient’s body.

Nanorobotics is emerging as a demanding field dealing with miniscule things at molecular level. Nanorobots are extremely small nano electromechanical systems designed to perform a specific task with precision at nanoscale dimensions. Its advantage over conventional medicine lies in its size. Particle size has effect on serum lifetime and pattern of deposition. This allows drugs of nanosize to be used in lower concentration and has an earlier onset of therapeutic action. It also provides materials for controlled drug delivery by directing carriers to a specific location. The typical medical nanodevice will probably be a microscale device assembled from nanoscale parts.

Nanorobots that can be compared size of bacteria could provide many novel capabilities through their ability to sense and act in microscopic environments. Particularly interesting are biomedical engineering applications, where in the nanorobots and nanoscale structured materials inside the body provide significant improvements in diagnosis and treatment of disease.

The various components in the nanorobot design comprises of onboard sensors, motors, manipulators, power suppliers and molecular computers. The best known biological example of such a molecular machine is the ribosome which is the only freely programmable nanoscale assembler already in existence.

**NANO ROBOT**

![Figure 1](image)
So with the help of chemotactic sensors nanorobots detects the tumor cell. Because chemotactic sensors have different affinity for each kind of molecule. After sensing the tumor nanorobots inject the antidote of cancer into the tumor and it will destroy the tumor cell. With the help of nanorobot control design simulator scientists designed the nanorobot, which consists of sensors, rotors, fins and propellers and rotors.

Using drugs and surgery, doctors can only encourage tissues to repair themselves. With nanorobots, there will be more direct repairs. Cell repair will utilize the same tasks that living systems already prove possible. Access to cells is possible because biologists can insert needles into cells without killing them. Thus, nanorobots 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 operations needed to perform molecular-level cell repair, in the future, nanorobots will be built that are able to enter cells, sense differences from healthy ones and make modifications to the structure.

Nanocomputers will be needed to guide these machines. These computers will direct machines to examine, take apart, and rebuild damaged molecular structures. Nanorobots will be able to repair whole cells by working structure by structure. Then by working cell by cell and tissue by tissue, whole organs can be repaired. Finally, by working organ by organ, health is restored to the body. Cells damaged to the point of inactivity can be repaired because of the ability of nanorobots to build cells from scratch. Therefore, cell nanorobots will free medicine from reliance on self repair alone.

Properties of Nanorobots

The extreme concept of nanotechnology is the "bottom up" creation of virtually any material or object by assembling one atom at a time. Although nanotech processes occur at the scale of nanometers, the materials and objects that result from these processes can be much larger. Robots will respond to acoustic signals and will be able to receive power or re-programming instruction from an external source via sound waves. A network of special stationary nanorobots will be strategically positioned throughout the body, logging each active nanorobot as it passes, and then reporting those results, allowing an interface to keep track of all of the devices in the body. A doctor could only monitor a patients progress but change the instructions of nanorobots in vivo to progress to another stage of healing.

We treat the nanorobots as cylinders, 1μm in length and 0.5μm in diameter. Most of the cells are red blood cells, with diameter 6μm. On the inside payloads of up to 2000 siRNA molecules required for a 70nm diameter tumor. SiRNA is a small interfering Ribonucleic acid, it deactivates the protein production of ant RNA, so because of this cancer cells will die due to starvation. So each nanorobot is having siRNA protein which is injected in the tumor cell after being detected. We can also use Taxol which is a anticancer drug which react with the lower pH of tumors. This nanorobots consists of sensor element, power supply circuitry, motors or actuators, container, and nanochip. As a sensor we can use here biosensors or chemical sensors as chemical properties of cancer tumors are different than normal cells. Motors or actuators gives the proper motion to nanorobot in blood fluid. Nanorobot container consists of cancer antidote element. Nanochip takes input signal from sensor and according to the input signal it performs its task. Manufacturing better sensors and actuators with nanoscale sizes makes them find the source of release of the chemical. Nanorobot Control Design (NCD) simulator was developed, which is software for nanorobots in environments with fluids dominated by Brownian motion and viscous rather than inertial forces. These nanorobots can work together in response to environment stimuli and programmed principles to produce macro scale results.
Replication is a critical basic capability for molecular manufacturing. Replication in the body is dangerous because it might go out of control. If even replicating bacteria can give humans so many diseases, the thought of replicating nanorobots can present unimaginable dangers to the human body.

Nanorobot Architecture

The medical nanorobot for tumor defense should comprise a set of integrated circuit block as an application-specific integrated circuit. The architecture has to address functionality for common medical applications. The main parameters used for the nanorobot architecture and its control activation, as well as the required technology background that can advance manufacturing hardware for molecular machines, are described next.

![Nanorobot Architecture Diagram](image_url)

Figure 2

Chemical Sensor

E-cadherin (uvomorulin, cell-CAM120/80) is a calcium dependent cell adhesion molecule expressed...
predominantly in epithelial tissues. It plays an important role in the growth and development of cells via the mechanisms of control of tissue architecture and the maintenance of tissue integrity. The nanorobot sensing for changes on Ecadherin protein signals. Several studies have shown that E-cadherin expression is significantly reduced in cancer tissues. So this will affect on pH level of the cell and with the help of pH responsive sensor i.e. phosphatidic acid nanorobot can distinguish healthy cells and cancer cells. Thus, the response is improved by having the nanorobots maintain positions near the vessel wall instead of floating throughout the volume flow in the vessel. A key choice in chemical signaling is the measurement time and detection threshold at which the signal is considered to be received. Due to background concentration, some detection occurs even without the target signal.

**Actuator**

There are different kinds of actuators, such as electromagnetic, piezoelectric, electrostatic, and electrothermal. Which can be utilized, depending the aim and the workspaces where it will be applied.

CNTs can be used as materials for commercial applications on building devices and nanoelectronics such as nanotweezers and memory systems. SOI technology has been used for transistors with high performance, low heating and low energy consumption for VLSI devices. CNT selfassembly and SOI properties can be combined to addressing CMOS high performance on design and manufacturing nanoelectronics and nanoactuators. Owing to the maturity of silicon CMOS technology, as well as the unique properties of CNTs, the integration of CNT and the CMOS technology can make use of the advantages of both. For a medical nanorobot, applying CMOS as an actuator based on biological patterns and CNTs is proposed for the nanorobot architecture as a natural choice.

**Energy Supply**

The most effective way to keep the nanorobot operating continuously is to establish the use of a continuous available source of power. The energy may be available and delivered to the nanorobot while it is performing predefined tasks in the operational environment. For a medical nanorobot, this means that the device must keep working inside the human body, sometimes for long periods, and must have easy access to clean and controllable energy to maintain efficient operation. Some possibilities to power the nanorobot can be provided from ambient energy. temperature displacements could likewise generate useful voltage differentials. Cold and hot fields from conductors connected in series may also produce energy using the well-established Seebeck effect. Electromagnetic radiation from light is an option for energy generation in determined open workspaces but not for in vivo medical nanorobotics, especially since lighting conditions in different kinds of workspaces could sharply change depending on the application. Kinetic energy can be generated from the bloodstream due to motion interaction with designed devices embedded with the nanorobot, but this kinetic process would demand costly room within the nanorobot architecture.

Another method of generating power supply is take the energy from blood itself. For this nanorobot will having chemical in a container that chemical reacts with glucose and oxygen of blood. During this chemical reaction energy production takes place and this energy is used by nanorobot to perform tasks.

**Cancer Detection and Treatment**

Many companies related with biotechnology are trying to find the correct way to manipulate the RNA (ribonucleic acid) and block genes which generate proteins associated with different diseases such as cancer, blindness or AIDS. However, this is the first mechanism which is able to enter in a cell and manipulate the RNA. The nanorobots or
nanoparticles are made with a mixture of a polymer and a protein called transferrin which has the capacity of detecting tumor cells because of its molecular particularities. Once they are in the cells the chemical sensor gives the order to dissolve; and when nanoparticles are dissolved they let free some substances which actuate on the RNA of each cell disabling the gene responsible of the cancer.

Specifically, what the nanoparticles deactivate is the ribonucleic reductasa, the protein associated with the cancer growth which is fabricated by the disabled gene. It has been probed that the therapy with nanoparticles works, but it is very early to say that this will be the definitive cure for the cancer. There is another kind of nanoparticles for the treatment of the cancer: magnetic particles. These ones are used in a different way. When they arrive to the cancer cells, microwaves are applied from outside, the particles are excited and they burn the cancer cells.

Cancer can be successfully treated with current stages of medical technologies and therapy tools. But the chance factor of the survival of patient and the early detection poses the biggest challenge. But with the help of nano based technique the drones can perform the task very well based on E-Cadherin signals and without harming the normal tissues of the body and painlessly thus the bioelectronic circuits and building up of more stable and the economic bots finds the future perspective of this nano robotic technology.

ADVANTAGES

Total Cure

More than million people in this world are affected by this cancer disease.

Currently there is no permanent vaccine or medicine is available to cure the disease without any side-effects. The currently available drugs can increase the patient’s life to a few years only if it is lately detected, so the invention of this nanorobot will make the patients to get rid of the disease.

Small Size

As we will inject the nanorobots into the patients body we require robots size as small as possible. Size of nanorobot is 0.5 to 3 micron. Upper limit of its size is 3 micron. As minimum diameter of capillary is 5 to 10 microns. So Nanorobots easily flow in the body without blocking the capillary flow.

Inexpensive(If Mass Produced)

The initial cost of development is only high but the manufacturing by batch processing reduces the cost.

Automated

Nanorobots will not require any monitoring or control system for performing the task. These are fully automated robots. When we inject nanorobots into the human body these will sense the cancer tumor and after detecting the tumor, robots will inject antidote in it.

Painless Treatment

Existing cancer treatment drugs do successfully kill growing tumor cells, but that the rest of the body cannot tolerate the drug concentrations required to eliminate the cancer cells. These treatment kills not just cancer cells but healthy human cells as well causing hair loss, fatigue, nausea, depression, and a host of other symptoms. A person undergoing a
nanorobotic treatment could expect to have no awareness of the molecular devices working inside them, other than rapid betterment of their health. As nanorobots attacks only on cancer tumor patient will not suffer any pain.

CONCLUSIONS

The development of nanorobots may provide remarkable advances for diagnosis and treatment of cancer. Using chemical sensors they can be programmed to detect different levels of E-cadherin and beta-catenin in primary and metastatic phases. Our work has shown a comprehensive methodology on tracking single tumor cell in a small venule, where nanorobots using communication techniques to increase their collective efficiency. The simulation has clearly demonstrated how better time responses can be achieved for tumor detection, if chemical signals are incorporated as part of nanorobot control strategy. As observed in the study, the follow gradient with attractant signal is a practical method for orientation and coordination of nanorobots. It has enabled a better performance for nanorobots to detect and reach cancerous targets. This approach can be useful in the treatment of many patients for a detailed examination and intervention.

REFERENCES

2. R. Hariharan, J. Manohar “Nanorobotics As Medicament” IEEE 2010
8. Adriano Cavalcanti, Bijan Shirinzadeh, Robert A. Freitas Jr. and Luiz C.