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Review: Nanorobotics Used in Cancer Therapy

Pratiksha Vinchurkar[1], V. M. Waghulkar[1], A.W.Baitule[1]

[1]Vidyabharti College of Pharmacy, C.K. Naidu Road, Amravati, Maharashtra, India

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ABSTRACT:

Now a days, much research work has been on going in the mission to find an ideal system for drug delivery within the human body. Drug delivery may be a important side of medical treatment. As consequence of Nanotechnology, new technique consisting of devices coming into the market among these Nanorobots finds opportunity in cure of human illness. Nanorobots have many uses such as it has ability to find out and destroy the cancer cell. nanorobots are so tiny that they can easily traverse the human body. Oncologists around the world are working tirelessly to develop accurate methods for detecting and treating cancer while minimizing adverse effects on healthy tissue. The rapid development of nanotechnology research over the past decade holds great promise for realizing every oncologist's dream. Nanorobots (or nanorobots) are typical devices, ranging in size from 0.1 to 10 μm and composed of nanoscale or molecular components. The robots will complement the motor performance, diagnostic capabilities and senses of the surgeon through touch and augmented reality. These embrace additional bioavailability, targeted medical aid, fewer physician mistakes; reach remote areas in human anatomy, giant surface space for mass transfer, non-invasive technique, this review focuses on description of nanorobots including its parts, application and use of nanorobots in cancer.

KEYWORDS: nanorobots, cancer therapy.

Introduction:

Nanotechnology is commonly referred to as small science, or scientifically, the art of developing materials and structures in the size range of 1-10 nm. Oncologists around the world are constantly researching how to detect cancer and pinpoint the location of cancer drugs while minimizing side effects on healthy tissue. Over the past decade, rapidly expanding research in nanotechnology has presented a promising opportunity to realize every oncologist's dream [1]. Nano-robots are the emerging technology of this century. It manufactures machines or robots with parts up to 1 nanometer (10-9 meters). Specifically, nanorobotics refers to the engineering science and engineering discipline of designing and building nanorobots, devices made of nanoscale elements or molecular. Nanomachines are mostly in the research and development phase, but some primitive molecular machines and nanomotors have already been tested. An example is a detector with a switch of about 1.5 nm capable of counting specific molecules in highly chemical samples.[2]

Nanorobots are expected to provide advances in medicine through the miniaturization from microelectronics to nanoelectronics. The aim of this article is to present the future use of nanorobots to combat cancer. Cancer can be successfully treated with current stages of medical technologies and therapy tools. However, a decisive factor to determine the chances for a patient with cancer to survive is: How earlier it was diagnosed; what means, if possible, cancer should be detected at least before the metastasis has begun. Another important aspect to achieve a successful treatment for patients is the development of efficient targeted drug delivery to decrease the side-effects from chemotherapy. Considering the properties of nanorobots to navigate as blood-borne devices, they can help on such extremely important aspects of cancer therapy.[3] The first useful application of nanomachines could be nanomedicine. For example, biological machines can be used to recognize and destroy cancer cells. Another potential application is the detection of cyanogenic chemicals to determine their concentrations in the environment. Other definition could be an automaton that allows precise interaction with nanoscale objects or will operate with nanoscale resolution. Such devices are also relevant for research or scanning probe studies rather than demonstrating nanorobots as molecular machines. When the device recognizes a target cell supporting its surface proteins, the two halves split open like clams to deliver small, deadly drugs or nanoparticles. These are molecules that can force cancer cells to destroy themselves by interfering with their growth,

- Destroying cancer cells in the body
- Removing blockages in blood vessels.
- Replace DNA Cells [2]

Nanorobots with embedded chemical biosensors can be used to perform detection of tumor cells in early stages of development inside the patient's body.[4 5] Integrated nanosensors can be utilized for such a task in order to find intensity of E-cadherin signals.[6] According to current theories, nanorobots will possess at least rudimentary two-way communication; will respond to acoustic signals and will be able to receive power or even reprogramming instructions from an external source through sound waves. Physicians can not only monitor a patient's progress, but also change the instructions given to the nanorobot in vivo to transition to a different phase of healing. Once the task is completed, the nanorobots are flushed from the body [7].

Nanorobots:

Nanorobots are theoretical microscopic devices that measure in the nanometer range (1 nm is one millionth of a mm). If fully realized from the hypothetical stage, it can function at the atomic, molecular and cellular level, accomplishing tasks in both medical and industrial fields that have hitherto been science fiction. Nanomedicine's nanorobots are so small that they can easily cross the human body. Scientists report that the nanorobot's exterior is likely made of carbon atoms with a diamond-like structure due to its inert properties and strength.

The extremely smooth surface reduces the chances of triggering the body's immune system, allowing the nanorobots to go about their work unhindered. Glucose or natural sugars and oxygen could be the power source, and nanorobots have other biochemical or molecular moieties depending on their task. Nanomachines are mostly in the research and development stage [8], but some primitive molecular machines are being tested. I have a sensor. The first useful application of nanomachines may be in medical technology that can be used to identify and destroy cancer cells.

STRUCTURE AND DESIGN OF NANOROBOTS:

Component of Nanorobots:

The main component of nanorobots is surface unit carbon, due to its inertia, adaptable resistance, diamond or C type. The other components hydrogen, oxygen, nitrogen, sulphur, silicon and fluorine, etc. for the nanoscale. [9]

Nanobot Room:

Medicine Chamber:

This is a hollow part inside the Nanobot that holds small doses of medicine. The robot is able to deliver the drug directly to the site of injury or infection. Nanorobots could also carry chemicals used in chemotherapy to treat cancer. Although the number of drugs is relatively small, applying them to cancerous tissue can also be more convenient than older treatments, which rely on the body's cardiovascular system to keep chemicals moving through the patient's body.

Probes, cutters and chisels:

These probes, cutters and chisels are used to remove plaque and clogs. These components help nanobots grasp and break down matter. They may also need a tool to crush the clumps into very small objects. If part of the clot breaks off and enters the bloodstream, it should cause many other problems for the cardiovascular system.[10]

Microwave Transmitter and Ultrasonic Signal Generator:

Doctors need a way to destroy cancer cells without tearing them apart. Ruptured cancer cells release chemicals that help cancer spread. By harnessing precisely tuned microwave or supersonic signals, nanorobots can break chemical bonds inside cancer cells and kill cancer cells without disrupting cell membranes. Alternatively, the mechanism could trigger microwave or ultrasonic signals to heat the cancer cell enough to destroy it.

Electrodes:

Nanobots use electrodes to generate an electric current that heats the cells until they are destroyed.

Laser:

The power laser can burn harmful substances such as cancer cells, blood clots and plaques. These lasers vaporize the tissues. Vaporizing cancer cells is a difficult task using a powerful laser that does not damage surrounding tissue. Teams around the world are currently working on developing medical nanobots that are small and enter the bloodstream. Nanorobots from a few millimetres to two centimetres long have been developed, but they are not yet used in the health field and they are in the test phase. It can take a long time for nanobots to enter the medical market.

Power supply for nanobots:

Power is available for outdoor and indoor nanobots. Harvesting energy directly from the bloodstream, the nanorobots use the patient's body heat to generate electricity. It's like a navigation system [11]

Nanorobots in Cancer Detection and Treatment:

The development of nanorobots could bring significant advances in cancer diagnosis and treatment. Nanoparticles (NPs) play an important role in developing new methods for cancer detection. Detecting cancer early is an important step in improving cancer treatment. Various NPs used are cantilevers, nanopores, nanotubes, and quantum dots. These are briefly described in the literature [12].

Nanospores:
Another interesting device is the nanopore. Better ways to read the generic code can help researches spot genetic errors that can cause cancer. The nanopore contains tiny holes that hallow deoxyribonucleic acid (DNA) to pass through her one well at a time, thus making DNA sequencing more efficient.[12]

Cantilever:

When cancer cells secrete their molecular products, antibodies coated on the cantilever fingers selectively bind to these secreted proteins. The physical properties of the cantilever change in real time, providing information on the presence and concentration of various molecular expressions [12].

Nanotubes:

Carbon rods about half the diameter of a nanotube DNA molecule not only detect the presence of altered genes, but also pinpoint the precise location of these alterations. A multidisciplinary team at the Massachusetts Institute of Technology has developed carbon nanotubes (CNTs) that can be used as sensors for anticancer drugs and other DNA-damaging agents in living cells.[12]

Dendrimers:

These are spherical, highly branched and synthetic macromolecules with adjustable size and shape.[13] A single dendrimer can carry a molecule that recognizes cancer cell, a therapeutic agent to kill those cells, a molecule that recognizes the signal of cell death. Dendrimer NPs have shown promise as drug delivery vehicles capable of targeting tumours with large doses of anti-cancer drugs.[12]

Quantum Dots:

Quantum dots are tiny crystals that glow when excited by ultraviolet light. Once injected into the body, it drifted until it encountered cancerous tissue. Deadly cells adhere to a special coating of glowing dots. Particles of light act as beacons to show doctors where the disease has spread [12]. Nanorobots could be very useful in treating patients, as current treatments such as radiation and chemotherapy often destroy more healthy cells than cancer cells. From this perspective, it offers a non-depressive therapy for cancer patients. Nanorobots can switch between different cell types. H. Distinguish between malignant and normal cells by examining their surface antigens. This can be achieved by using chemotactic sensors that are tailored to specific antigens on target cells. Chemical sensors can be used to program her to detect varying concentrations of E-cadherin and beta-catenin during early and metastatic stages. Medical nanorobots only destroy cancer cells [14]. Attempts to build microelectromechanical systems [MEMS]-based microrobots for in vivo use are underway. For example, his MR sub-His project at Ecole Polytechnic's Nanorobotics Laboratory in Montreal uses a magnetic resonance imaging system to drive micro-His robots in blood vessels. First-generation prototype applications may include targeted drug delivery, recanalization of occluded arteries, or biopsy. The project will collect the information needed to define the design rules for this type of microrobot, with the long-term goal of "making the system even smaller and creating robots out of nanometer parts." This allows the procedure to be performed in vessels that are not yet accessible. [15] Nanorobots can deliver medicines and carry therapeutic chemicals to stop cancer progression.

Liposomes:

Liposomes have a long history as drug carrier systems because of their easy preparation, acceptable toxicity and biodegradability profiles. Drug loading in liposomes can be achieved through: (1) Liposome formation in an aqueous solution saturated with soluble drug; (2) the use of organic solvents and solvent exchange mechanisms; (3) the use of lipophilic drugs; and (4) pH gradient methods.[13]

Nanoshells:

Nanoshells have a core of silica and a metallic outer layer. By manipulating the thickness of the layer, scientist can design beads to absorb near infra-red light, creating an intense heat that is lethal to cancer cells. The physical selectivity to cancer lesion site occurs through a phenomenon called enhanced permeation retention.[12]

Micelles:

Polymeric micelles are biodegradable spherical nanocarriers with a typical size range of 10–200 nm. Micelles are considered ideal vehicles for drug delivery because they offer many important advantages. Hydrophobic cores can be used to carry pharmaceuticals, especially lipophilic drugs. These drugs are solubilized and physically entrapped inside with high loading capacity. Polymeric micelles can deliver two or more therapeutic agents simultaneously and release the drugs in a controlled manner. Encapsulated drugs may be released by erosion of biodegradable polymers, drug diffusion through the polymer matrix, or swelling of the polymer following drug diffusion. External conditions such as pH and temperature changes can also induce drug release from micelles. Furthermore, surface modification of micelles with ligands such as antibodies, peptides, or other small molecules can be used to target the delivery and uptake of these nanocarriers, thereby reducing systemic toxicity and increasing specificity. and improve effectiveness. [16]

Polymeric NPs:

These are delivery devices made from biodegradable polymers and are an attractive option as carriers of therapeutic drugs in cancer therapy. Polymeric NPs, including nanospheres and nanocapsules, are solid supports 10–1000 nm in diameter, made of natural or artificial polymers, are generally biodegradable, and can adsorb, dissolve, trap, and encapsulate therapeutic agents., or covalently bonded. The polymers become backbones via simple ester or amide linkages and are hydrolysed in vivo by pH changes. NPs are generally more stable than liposomes when administered systemically, but are hampered by poor pharmacokinetic properties. H. Uptake, restriction of the reticuloendothelial system [RES]. Similar to liposomes, nanoparticles can be coated with molecules on their surface, intercalated into their structure to improve pharmacokinetics, or even targeted for delivery or imaging purposes.[17]

Applications:

1) Nanorobots in blood clots.
2) Nanorobots in the diagnosis and treatment of diabetes.
3) Nanobots in kidney stones.
4) Nanorobots in cancer treatment
5) Nanorobots in arteriosclerosis
6) Nanorobots in nerve regeneration
7) Nanorobots that help in the elimination of parasites
8) Nanorobots in healing skin diseases [18]

Manufacturing technology:

The ability to create nanorobots may result from current trends and new methods in manufacturing, computation, transducers, and manipulation. In some cases, different temperature gradients, concentrations of chemicals in the bloodstream, and electromagnetic signatures are some of the relevant parameters for diagnostic purposes.[19] Complementary metal-oxide-semiconductor (CMOS) very high-level integrated system design using deep-UV lithography provides a high-precision and commercial route to fabricate nascent nanodevices and nanoelectronic systems. The CMOS industry could successfully pioneer the assembly processes required to manufacture nanorobots, and the combination of nanophotonics and nanotubes could further accelerate practical resolution levels from 248 nm to 157 nm devices. [20].

Chemical Signaling in the Body:

The interaction between chemical signaling and blood flow is an important aspect of nanorobot applications in cancer therapy. His Nanorobot detection of a simulated architecture that detects slope changes in the E-cadherin signal is investigated. To improve the reaction and biosensing capabilities, the nanorobot maintains a position close to the vessel wall rather than floating inside the vessel throughout the volume flow. A key choice in chemical signaling is the measurement time and detection threshold at which a signal is considered received. Due to the background concentration, some detection occurs even in the absence of target signal. After discovering a therapeutic tumor, the first nanorobots can be programmed and attached to the tumor. Then, beyond attracting a predefined number of other nanorobots to help for incisive chemotherapeutic action with precise drug delivery above the tumor, the architecture permits it to use wireless communication to send accurate position for the doctors informing that a tumor was found.[21]

Chemical sensor:

Chemical nanosensors can be embedded in nanorobots to monitor the E-cadherin gradient. Nanorobots programmed for such tasks can therefore perform detailed whole-body screening of patients. Various medical nanorobotics architectures use mobile phones to obtain information about patient conditions. To do this, we use electromagnetic waves to control and detect the current state of the nanorobot within the patient. [22 23]

Power supply:

The use of CMOS for active telemetry and power supply is the most effective and secure way to ensure energy as long as necessary to keep the nanorobot in operation. The same technique is also appropriate for other purposes like digital bit encoded data transfer from inside a human body.[21] Thus, nanocircuits with resonant electric properties can operate as a chip providing electromagnetic energy supplying 1.7 mA at 3.3 V for power, allowing the operation of many tasks with few or no significant losses during transmission.[24] Radio frequency (RF)-based telemetry procedures have demonstrated good results in patient monitoring and power transmission with the use of inductive coupling using well-established techniques already widely used in commercial applications of radio frequency identification (RFID). The energy received can be also saved in ranges of ~1 µW while the nanorobot stays in inactive modes, just becoming active when signal patterns require it to do so.[25]

System Implementation:

The nanorobot architecture involves the use of mobile phones for, e.g., the early diagnosis of E-cadherin levels for smart chemotherapy drug delivery and new cancer tumor detection for cancer treatments. The nanorobot uses a RFID CMOS transponder system for in vivo positioning using well-established communication protocols, which allow track information about the nanorobot position.[22] This information may help doctors on detecting tiny malignant tissues even in initial stages of development. The nanorobot exterior shape consists of a diamondoid material [26] to which may be attached an artificial glycocalyx surface that minimizes fibrinogen (and other blood proteins) adsorption and bioactivity, ensuring sufficient biocompatibility to avoid immune system attack. Different molecule types are distinguished by a series of chemotactic biosensors whose binding sites have a different affinity for each kind of molecule. For instance, chemical detection can be very selective, e.g. for identifying various types of cells by markers.[27]

Data Transmission:

The application of implanted devices and sensors to transmit data about a patient's health could bring enormous benefits to ongoing medical surveillance. Chemical signals are very useful for close communication between nanorobots, allowing some coordination of teamwork.[3] Recently, electroencephalography (EEG) has been successfully tested using RFID for in vivo data collection and transmission. [25] For communication in fluid workspaces, depending on the application, acoustic, optical, RF and chemical signals can be considered as possible options for communication and data transmission. [28] Data transfer using embedded sensors is a better solution for reading and writing data in implantable devices.

CMOS with a submicron SoC design can be used for extremely low power consumption of nanorobots that collectively communicate over longer distances via acoustic sensors. For nanorobots, active sonar communication frequencies of up to 20 μW can be achieved at a resonance rate of 8 Hz with a 3 V supply. [29]

Nanorobot Simulation:

As a result of advances in nanoelectronics, nanorobots can be viewed as a promising new technology to aid in new therapeutics in medicine. The nanorobot is inside a blood vessel and can be observed in 3D real-time with or without red blood cell visualization. Glucose, which is carried through the bloodstream, is important for keeping human metabolism healthy. A simulated nanorobot prototype model incorporates CMOS (complementary metal oxide semiconductor) bioelectronics. Nanorobot computations are performed by embedded nanosensors. For pervasive computing, performance requires low power consumption. Due to their biocompatibility, nanorobots are not attacked by white blood cells. Medical nanorobot architectures can automatically transmit important measurement data to mobile phones [30].

Advantages:

- Increased bioavailability through nanorobotic drug delivery systems;
- Targeted therapy, e.g., treatment of malignant cells;
- Fewer errors due to IT control and automation;
- If the drug molecules carried by the nanorobots are square and free to move where needed, the advantage of huge surface space can be realized throughout the mass transfer process. Non-invasive technology
- Computer control knob to adjust volume, frequency, release time; More accurate;
- The drug is inactive in areas that do not require treatment, which minimizes unwanted side effects. [31]

Disadvantages:

- Initial design costs are very high
- Nanorobot design is very complex
- Electrical systems may generate stray fields that can activate bioelectrically based molecular recognition systems in biology
- Electric nanorobots are susceptible to electrical interference from external sources such as RF or electric fields, electromagnetic pulses, and stray fields from other in vivo electrical devices
- Difficult and complex to connect, adapt and design
- Nanorobots could pose a brutal risk in the field of terrorism. Nanotechnology also has the ability to destroy the human body at the molecular level, allowing terrorism and anti-groups to use nanorobots as a new form of community torture. Another potential risk. As nanorobots work to design compact and tiny devices, there are more eavesdropping possibilities than existing ones.[9]

Future Scope:

Meanwhile, Park et al from South Korea's Future Range have made a similar breakthrough called Bacteriobot, in which non-toxic bacteria (in this case Salmonella) have been genetically engineered to attract chemicals released by cancer cells. These nanobots actively search for cancer cells and deliver drugs to them. These bacteria are engineered to have receptors that can bind to biochemicals secreted by diseased tissue; this allows bacteria to diagnose cancer and use flagella to travel to cells. Currently, the technique is limited to detecting solid cancers, such as breast or colorectal cancer, but it also has the potential to treat other tumors. nanorobots were found to have high potential in in vitro experiments. The next steps will be to scale up these devices for in vivo testing in mice and human tissues. In vitro tests in a Petri dish already require 100 billion devices, devices will increase to billions for these possible cancer treatments. Yet the positive results of the nanorobot offer new hope for cancer research.

Conclusion:

Nanorobots for medical applications hold great promise, from eradicating disease to reversing the aging process (wrinkles, bone loss and age-related conditions can all be treated at the cellular level). They will personalize the treatment, improve efficiency and reduce side effects that do not seem to exist today. Nanorobots for medical applications hold great promise for everything from eradicating disease to reversing the aging process. They will provide personalized treatments, improve efficacy and reduce side effects that are not available today, and by taking joint actions - drugs and diagnostics sold, imaging agents as drugs, surgery and diagnostic return immediate. The emergence of NTM will dramatically improve the effectiveness, convenience, and speed of future medical treatments, while dramatically reducing its risk, cost, and invasiveness. The science now sounds like fiction, but nanorobotics has powerful potential to revolutionize healthcare in the future to treat disease. This opens new avenues for massive and rich research efforts in the field of oncology therapy. We are at the beginning of a new era in which many disciplines will converge, including robotics, mechanics, chemistry and biomedical engineering, chemistry, biology, physics and mathematics., so 10 will develop a fully functional system.

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