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Opinion

Nanotechnology as an Alternative to Chemotherapy

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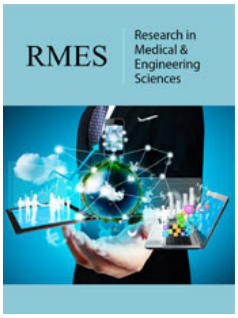

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Introduction

"I would better die than lose my hair", said one of my close relatives. She had cancer and she was advised chemotherapy. She has seen bald heads of men and women having gone through chemotherapy. Not only this; they were found fatigued, feeling and being sick, getting frequent Infections, anaemia, bruising and bleeding, sore mouth, loss of appetite, memory loss, concentration problem, sleep problem, sex and fertility issues, diarrhoea and constipation, emotional problems and much more. Being a learned woman; she knew that the drugs used for chemotherapy are powerful, highly toxic and they can still cause damage to healthy cells. This damage causes the side effects as do all the sulpha drugs.

Most chemotherapy (chemo) drugs are strong medicines that have a narrow range for dose safety and effectiveness. Chemo drugs kill fast-growing cancer cells. Even normal, healthy cells that are fast-growing too, affected because these drugs travel throughout the body. Damage to healthy cells causes side effects. The normal cells most likely to be damaged by chemo are Blood-forming cells in the bone marrow, hair follicles, Cells in the mouth, digestive tract, and reproductive system. Some chemo drugs can damage cells in the heart, kidneys, bladder, lungs, and nervous system.

Drug will not treat the cancer if it is taken too little but life-threatening side effects can be caused if it taken in large quantities. It is also not sure that even after chemotherapy the cancer patient would survive. There are many in her neighbourhood who died after chemotherapy treatment. "I dread this most inhuman treatment. Please find some alternative for it", she said. Bathinda is a hotbed for cancer. You will find cancer patient in every alternative village. Train goes to Bikaner daily taking cancer patients to Government Cancer Hospital and is known as cancer train.

Alternative Treatments to Chemotherapy

As I studied the material available on net and books and found that alternative therapies to chemotherapy include photodynamic therapy, laser therapy, immunotherapy, targeted therapy, and hormone therapy. There were 10 other options to consider but it was also mentioned that the alternative cancer treatments can't cure your cancer, but they may provide some relief from signs and symptoms. Alternative cancer treatments may help you cope with signs and symptoms caused by cancer and cancer treatments, but they may not play a direct role in curing your cancer. Alternative treatments may lessen anxiety, fatigue, nausea and vomiting, pain, difficulty sleeping, and stress the common signs and symptoms. Alternative cancer treatments may offer some feeling of control, but many alternative cancer treatments are unproved as these may be turned out to be dangerous. Ten alternative cancer treatments generally found safe as these may provide some benefit. To get her some relief, I read out to her: "If you are feeling anxiety try hypnosis, massage, meditation or relaxation techniques.

If you feel fatigued do exercises, massage, relaxation techniques and yoga. If you feel nausea and vomiting try acupuncture, aromatherapy, hypnosis and music therapy. If you have pain, try acupuncture, aromatherapy, hypnosis, massage and music therapy. If you have sleep problems do exercise, relaxation techniques, yoga and if you feel stressed try aromatherapy, exercise, hypnosis, massage or, meditation." I researched further to find an answer to her questions and found that: "The majority of cancers cannot be avoided by simple exercises, yoga or behavioural changes. They require technological innovation to improve outcomes".

As I was discussing this with her, she told me, "These all-alternative treatments appear to be for the aftereffects of chemotherapy which I said I do not want. Why not try your Nano medicine? You used to talk about your research on burning the cancerous cells directly through heated gold nanoparticles without affecting any other part of the body. Why not elaborate on that?" I remembered our discussions with Director Cancer Hospital, Muktsar whenever he came to teach M.Tech classes in nanotechnology from 2006-2011. This lady was the professor in Biology who also participated in discussion. We tried in laboratory firing of heated gold-headed nano-arrows on to the dummy cancer cells and burning these. This was an effort to localise cancer cell burning rather than chemotherapy treatment which had many problems for the patients.

Imaging tests like X-rays, CT scans, and MRIs are ofter orders by doctors to help diagnose cancer these days. However, these tests are only when the tumours are big enough to be seen. But by that time the cancer cells would have copied themselves many times and spread to other parts of the body. These scans also can't show whether a tumour is cancer or not for which biopsy is the answer. Being of nanoscale, Nanotechnology can detect very minute changes in cells and difference between normal and cancer cells can be found. Getting at the cancer cells at the earliest stages, while cells just start dividing, cure of cancer is easier.

Seeing tumours on Nanotechnology imaging tests makes these cells easier to identify. Nanoparticles with antibodies or other substances coatings help them find and stick to the cancer cells. When signals about cancer are received, nanoparticles can be coated with substances. As an example of this, iron oxide nanoparticles bind to cancer cells sending off a strong signal that lights up the cancer on MRI scans. Doctors can be helped by nanotechnology to locate cancer in blood or tissue samples. Pieces of cancer cells or DNA that are too small for current tests to pick up can also be spotted. Cancer treatments can be made safer and more precise by nanotechnology. Medicines like chemotherapy can be delivered straight to the tumour by specially designed nanoparticles. On reaching the target only, they release the medicine and not before that. Healthy tissues around the tumour are saved from drugs from damaging the harming. Side effects which otherwise occur from this damage are thus avoided [1].

Now it is a decade since the doctors have used nanotechnology to treat cancer. Abraxane and Doxil are the two approved treatments which help chemotherapy drugs work better. Nanoparticle made from the protein albumin Abraxane is attached to the chemo drug docetaxel which stops cancer cells from dividing. Breast and pancreatic cancers that have spread, and non-small-cell lung cancer are treated by Abraxane. Wrapped inside a liposome, a fatty sack, Doxil is the chemo drug doxorubicin which disrupts cancer genes so the cancer cells can't divide [2]. Ovarian cancers, multiple myeloma, and Kaposi's sarcoma are treated by Doxil. Other nanotechnology treatments in clinical trials include the treatments wrap toxic drugs in nanoparticles to make them safer. They may also help the drug survive the trip through the bloodstream. Nanoparticles might also be able to deliver radiation to cancer after some time.

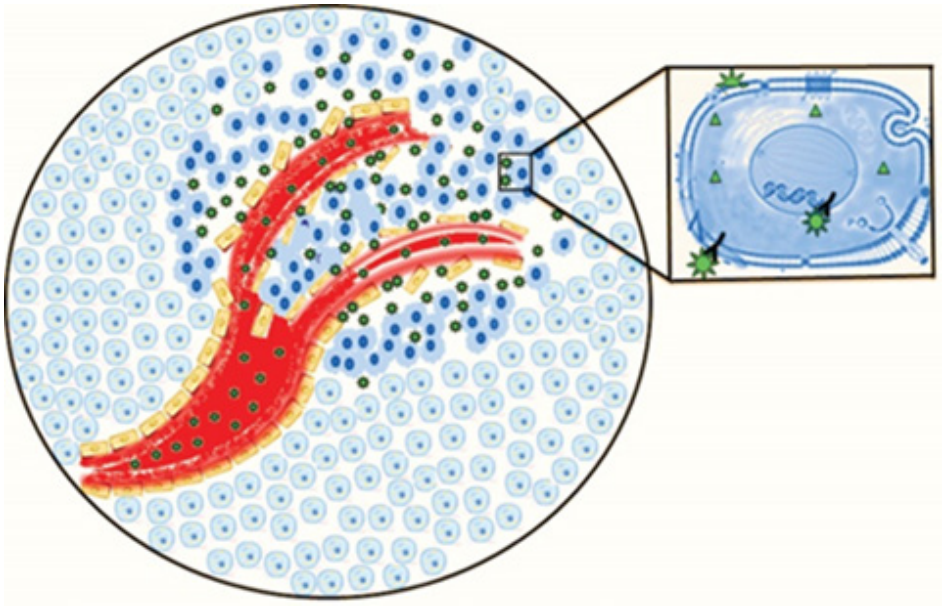

Figure 1

Abraxane and Doxil the current nanotechnology-based treatments do cause some side effects like weight loss, nausea, and diarrhoea which may be from the chemotherapy drugs which they contain. Side effects of these treatments need further research through clinical trials [3]. Cancer caused by viral infections [e.g., Human Papilloma Virus (HPV) has been limited successfully [4–6]. Using more widespread implementation of existing vaccine technologies, by using nanotechnology and other technologies for improving vaccination efficiency this success could be further enhanced [7]. Early diagnose through improved imaging through nanotechnology may increase the percentage of treatred cancers. This can be further developed in conjunction with more aggressive implementation of existing screening technologies leading to improved outcomes for cancer patients [8,9]. Types of cancer are stated to be of over 700 types for which new approaches for treating established disease are required. For this, nano-sized molecular tools capable of distinguishing between malignant and non-malignant cells and for delivering a lethal payload should be developed. Tumour targeting is the most studied for cancer treatment (Figure 1). Both active and passive targeting of NP targeting of malignant cells are depicted above [10]. NPs (green stars) accumulate in tumour tissue via the EPR – a form of passive targeting. Inset – shape-specific interaction of the NPs with cell-surface receptors is indicated by "Y-star" interactions that represent active targeting of NPs to cancer cells based upon specific molecular interactions.

In this first the malignant cancer cells are detected and then selectively eradicated. Passive and active targeting is done to detect the malignant cells. To increase the concentration of Nanoparticles (NPs) in the tumour, advantage of the Enhanced Permeability and Retention (EPR) effect helps passive targeting [11,12]. Selective molecular recognition of antigens, frequently proteins that are expressed on the surfaces of cancer cells to localize NPs to malignant cells helps Active targeting [13]. It may involve or, alternatively, exploit biochemical properties associated with malignancy such as matrix metalloproteinase secretion [14]. The two approaches may be combined, or Passive and Active targeting may be deployed independently. Both strategies minimize uptake by the Macrophage Phagocytic System (MPS) and maximizing time in circulation there by giving the benefit from surface modifications of NPs that [15].

Review

For more than a decade now doctors have used nanotechnology to treat cancer with Abraxane and Doxil, the two approved treatments. The active and passive targeting techniques have been tested only in laboratory and are available for treatment hence may take some time to be effectively used at medical level globally. Thus, alternative to chemotherapy has been provided by nanotechnology.

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