

THE POTENTIAL USE OF NANOTECHNOLOGY  
AS A METHOD OF TREATING AND DIAGNOSING  
CANCER AND SPECIFICALLY  
PANCREATIC CANCER.

BY

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PASS

RESEARCH PAPER  
BASED ON  
PATHOLOGY LECTURES  
AT MEDLINK 2010 or MEDISIX 2011

## ABSTRACT

10 or 15 years ago, the mere concept of nanotechnology was the stuff of science fiction. Today, it is a reality. In addition to examining nanotechnology commercially and for its uses in almost all fields of industry, including manufacturing and cosmetics, scientists have been able to explore and develop methods of applying this technology to medicine, and in particular to previously incurable diseases.

This paper studies the potential of nanotechnology in diagnosing, treating, and possibly even curing pancreatic cancer, a form of cancer that is virtually untreatable by current methods due to its aggressive nature and almost imperceptible symptoms.

This paper also evaluates some of the alternative treatments and potential cures currently in development, such as the use of stem cell transplantation, in comparison to the potential application of nanotechnology, in terms of economic and ethical issues as well as medical.

## INTRODUCTION

Pancreatic cancer accounts for 5% of all cases of cancer, with 7800 people being diagnosed with it every year, and is the fifth most common cause of death by cancer. In comparison to other cancers, such as cancers of the lung, breast or prostate, these figures seem relatively small. However, the nature of pancreatic cancer makes the need to find a cure for it essential.

Most pancreatic cancers begin in the ducts that contain the pancreatic juices, although there is a rare form of pancreatic cancer which forms in the islets of Langerhans, the cells that are responsible for the production of insulin and other hormones. A pancreatic tumour often becomes metastatic and usually spreads to the stomach, small intestine, liver, lymph nodes and occasionally the lungs or bones.

The symptoms of pancreatic cancer are difficult to detect, as many of those which are noticeable are not associated with pancreatic cancer or indeed cancer of any kind. Nausea and vomiting, as well as weight loss, feverishness, jaundice and sometimes stomach and back pains are some of the symptoms of pancreatic cancer, and these may well be misinterpreted by the sufferer as symptoms of common illnesses. These symptoms often do not become apparent until the cancerous tumour is of a significant size. Diabetes may also be a symptom, as a tumour of the pancreas will restrict insulin production.

The organ is difficult to image by CT or MRI scans due to its location in the body, and the tumour is almost always resistant to chemotherapy and radiotherapy; the only hope for most patients is surgery, and by the time the symptoms of pancreatic cancer have manifested, the cancer has usually metastasised.

The potential of nanotechnology in treating cancer is phenomenal; the refinement and application of this technology will result in efficient drug delivery systems and more precise imaging through nanovectors (transportation devices such as nanoparticles which can be loaded with drugs or imaging agents), and the ability to detect the biological signatures of cancer through nanosensor devices. When directed to the tumour, these technologies will lead to earlier diagnosis of cancer and more effective treatment. This is vital in the search for a cure for pancreatic cancer; it is more than likely that the future use of nanotechnology to create an effectual and precise system of tumour imaging will save thousands of lives every year, before the cancer has a chance to metastasise, as well as considerably improving the standard of tumour imaging in other forms of cancer, particularly those

which, like pancreatic cancer, manifest in tissues that are difficult to view via current imaging techniques.

The size and shape of nanoparticles is what makes them essential in the progression of developing cancer treatments. Richard Smalley is one of the scientists credited with the discovery of buckyballs, tiny spheres made up of 60 carbon atoms, measuring only 1 nanometre in diameter; that's just 0.000001mm. However, it is a relative of the buckyball that is central to research into drug delivery systems for treating pancreatic cancer. The carbon nanotube is made up, like buckyballs, of carbon atoms forming hexagons and pentagons. However, the carbon pentagons in nanotubes are found at each encapsulating end, with the hexagons forming a cylindrical body, ideal for the transportation of cancer drugs and imaging agents to the tumour. Carbon nanotubes can also be as small as 1 nanometre in diameter, making them ideal for use within the body and at a cellular level.

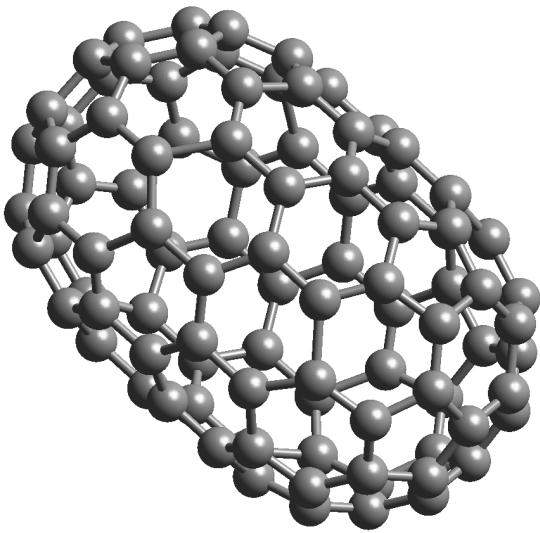


figure 1: a carbon nanotube.

In terms of treating pancreatic cancer, nanotechnology could represent a major breakthrough in the near future. The different methods in which this disease could be diagnosed, treated, or even cured will be explored in the discussion of this paper, along with a consideration of other cancer treatments currently in development and their relative potential, both economically and ethically as well as medically.

## DISCUSSION

Currently, the main treatments for cancer are surgery, chemotherapy and radiotherapy. All of these carry a significant risk and are usually stressful and sometimes psychologically damaging to patients. Chemotherapy is perhaps the most emotionally damaging of all the current treatments available, due to its side effects, including severe fatigue and hair, nail and tooth loss. An important application of nanotechnology to cancer is the delivery of drugs via nanoparticles specifically to the cancerous area, and not to the healthy cells of the body. Essentially, nanovectors could be loaded with chemotherapy drugs and transported to only the tumour, killing the cancerous growth without causing significant damage to other organs and tissues. CytImmune Sciences is a company currently developing gold nanoparticles to administer drugs directly to a cancerous tumour. With a tumour killing agent (tumour necrosis factor alpha) attached, and molecules of Thiol-derivatized polyethylene glycol (to

mask the nanoparticles from the immune system of the patient), the nanoparticles are able to make their way to the cancerous growth and kill it without being detected by the body.

Unfortunately, tumours in the pancreas are usually resistant to chemotherapy and radiotherapy, although it is possible that the use of nanotechnology as a system of transporting drugs to the affected area could improve the success rate of chemotherapy on pancreatic cancer. Of course, this is merely speculation and until drugs that are specifically aimed to destroy pancreatic cancer cells are developed there is little that can be achieved through nanovectors. The use of nanosensor devices, on the other hand, could provide a series of detailed images of a tumour in its early stages and after surgery, reducing the amount of tissue that needs to be removed and increasing the chances of survival of the patient significantly. A combination of cancer treatment techniques involving nanotechnology has the potential to tackle most cancer cases, including pancreatic cancer, particularly in this case through advanced medical imaging techniques to spot the signs of cancer early. The tumour can then be almost entirely removed by surgery whilst it remains in its early stages of growth, and the remaining few cancerous cells could potentially be killed by specific cancer drugs transported by nanovectors. Of course, a single cancerous cell left behind has the potential to start a new malignant tumour in the body, but the use of nanotechnology drastically lowers this risk.

Although new drug delivery systems may not be of great use currently in treating pancreatic cancer, there is potential for their use in the future, and certainly in the near future they may prove an excellent treatment technique for other forms of cancer that are not as frequently resistant to chemotherapy drugs.

Dr. Robert Langer said recently in a podcast, 'You could take nanoparticles and put an anticancer drug in them, and by decorating the nanoparticle with the right substances, have it go to the cells that you want, the cancer cells, for example, rather than other cells in the body.'

Promising as nanotechnology may appear in the field of medicine, and particularly in cancer, it is a technology that is yet to be tested extensively on human patients. Until enough research has been conducted on patients suffering with diseases such as cancer, the progress this science could make is limited.

There are some alternative treatments also in current development; one which will be discussed here is stem cell transplantation. The main purpose of stem cell transplantation is that it replaces the stem cells in bone marrow damaged by high doses of chemotherapy and radiation. This is important as the bone marrow is essential in making new blood cells to prevent infection and to carry oxygen. Damage to the bone marrow has many serious consequences, especially for the immune system, which is why stem cell transplantation could represent an advance in chemotherapy techniques.

In many forms of cancer, this could prove a suitable partner treatment to chemotherapy, allowing high doses of the drugs to be administered without causing as many serious long-term effects. There is even a medical potential for stem cell transplantation to be used in conjunction with nanovectors to administer chemotherapy drugs at high doses whilst causing only a small amount of damage to healthy cells. However, in relation to pancreatic cancer, this therapy is unlikely to prove successful.

Also there is an ethical issue attached to the use of stem cells, even in medical treatment. There is imperative research currently being conducted into the use of umbilical cord blood stem cells, however, there is still a great deal of controversy over the use of embryonic stem cells and their potential in medicine, in particular from a religious perspective.

Ethically, there are very few arguments against the research into nanotechnology as a treatment in comparison to stem cell research, most probably as it deals mainly with the improvement of diagnostic and drug delivery techniques, rather than the use of human cells.

Economically, nanotechnology has huge potential. Should research into the science progress to frequent testing on human patients and prove successful, the amount of investment will soar, and the number of jobs produced will prove not only extraordinarily beneficial to the scientific and medical profession, but to the economy as a whole. In fact, between 1997 and 2005, investment into nanotechnology research went from \$432 million to \$4.1 billion, with industry investment exceeding government investment by 2005. This clearly indicates a huge demand for this research to continue to develop and improve, both for industrial purposes and medical. It is predicted that by 2015, products incorporating nanotechnology will contribute roughly \$1 trillion to the global economy, with as many as 2 million workers employed in various nanotechnology industries.

## CONCLUSION

So what does nanotechnology mean for the future of pancreatic cancer? With such an enormous economic potential to back up research, it is likely that in the very near future there may be various new methods of diagnosing and treating an array of cancers and other complex and life-threatening illnesses. There is promising research into the use of nanotechnology and, with very few ethical and economical issues associated with it; this research could potentially become a medical reality in the near future.

One very clear issue with the development of nanotechnology for treating cancer is that it may undermine current cancer research projects, into which an enormous amount of funding has been placed. Huge amounts of money, raised both charitably and by government and company investment, go into cancer research every year. There are numerous research projects being developed to target almost all forms of cancer from many different fronts. Genetic research is one of the aspects currently at the forefront of cancer research, with new developments suggesting that cancer could be targeted before it even forms in people with a family history of cancer.

Another issue with nanotechnology is that it is a very young science, and much is yet to be learnt before full-scale clinical trials can be performed.

Despite this, nanotechnology has astronomical potential in relation to medicine in general and cancer. With ongoing research, and more and more becoming understood about its medical implications every day, nanotechnology could soon be used in conjunction with already practised techniques to better diagnose, treat, and in some cases even cure cancer. The potential of nanotechnology in diagnosing pancreatic cancer is particularly note-worthy, and could represent an enormous change in the way we view medical imaging of pancreatic tumours, as well as other tumours within the body.

Although we are not yet at the stage of using these techniques to diagnose pancreatic cancer, the success of ongoing research in this field is giving hope to doctors, scientists and patients alike that nanotechnology could soon have the ability to cure cancer.

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Figure 1:

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