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NANOTECHNOLOGY CANCER TREATMENT

Justin Thomas (jxt1@pitt.edu)

ENGINEERING NEW WAYS TO DELIVER MEDICINES

As technology advances, the desire for things to get, faster, smaller and more efficient increases. These advancements have also had major impacts on the medical industry and has allowed them to solve problems that they couldn't have in the past. For example, a specific problem facing today's medicine is finding ways to transport drugs throughout the body. Often drugs meant to attack something specific affect surrounding healthy tissue resulting in side effects.

Medicine has been used to help "improve health and extend lives" for a long time, however, the process of delivering this medicine to the correct part of the body is difficult [1]. Due to our understanding of "the physiological barriers to efficient drug delivery" biomedical engineers have been able to develop new ways to transport medicine throughout the body [1]. However, even with all the progress that biomedical engineers have made in understanding how to efficiently deliver medicine, many drugs, still have severe side effects. These side effects are due to the "drug interacting with healthy tissues and cells that are not the target of the drug [1]." In some cases, these side effects can be avoided by treating the disease "locally rather than systemically [1]". Treating an infection locally means to apply medication directly to the spot of infection instead of letting the medicine circulate throughout the entire body. For instance, using an antibacterial cream on an infection is a way to locally treat something, or injecting the treatment directly into the affected part of the body. However biomedical engineers are coming up with other ways of treating diseases locally and that is through the use of nanotechnology.

Nanotechnology is combination of physics, chemistry, biology and engineering concepts applied at the nanoscale [2]. This technology is being used to efficiently administer medicine to the correct parts of the body and reduces the amount of damage done to healthy cells. Because this technology can target abnormalities within the body more precisely and efficiently than traditional technology, it makes it very useful in fighting against very serious diseases such as cancer.

NANOTECHNOLOGY DELIEVERY SYSTEMS FOR CANCER FIGHTING DRUGS

Cancer is the leading cause of death worldwide [3]. According to the National Cancer Institute, there are more than 1.5 million new cases of cancers diagnosed in the United States each year, and more than 700,000 people will die from the disease [4]. With all of these cases of cancer there must be some type of treatment available to help.

Traditional cancer treatment includes chemotherapy which "is designed to slow or stop the growth of rapidly dividing cancer cells in the body" [5]. These treatments are designed to "destroy cancer cells, to shrink an existing tumor, or relieve symptoms of advanced cancer." [5]. However, cancer treatment often comes with severe side effects. These side effects are because the treatment not only kills cancerous cells, but it also affects living, healthy tissue. Some side effects include "bleeding and bruising, memory issues, and nerve problems" [4]. Since cancer treatment often affects surrounding cells, biomedical engineers are trying to discover ways to use nanotechnology to deliver the medicine directly to the cancerous cells.

Nanotechnology provides a way for scientists, doctors and bioengineers to interact with biological molecules. Because of their small size, nanoparticles have the potential to detect disease sooner and deliver treatment in newer ways. Also, nanotechnologies allow researchers to "study and manipulate macromolecules in real time and during the earliest stages of cancer progression" [6]. These nanotechnologies can be programed to target cancerous cells and destroy them without affected the surrounding healthy tissue. This precision in releasing the anticancer medicine reduces the amount of healthy exposed to the treatment.

Research and experiments are being done to perfect the use of nanotechnology in cancer treatments. Scientists at the Massachusetts Institute of Technology are conducting research to "increase the levels of drugs delivered to tumors by using two different types of nanoparticles." [7]. One type of nanoparticle would

locate the cancer tumor while the other one carries the “therapeutic drugs” and releases them, which attacks the cancerous cells, but it avoids damaging the healthy cells, tissues and organs [7].

Engineers at the Institute of Bioengineering and Nanotechnology are developing new ways to shape the nanotechnology so that they can more effectively deliver the cancer treatment. For example, research has proven that “a disk shaped nanoparticle can stick to tumors longer than a spherical shaped nanoparticle” which makes it more efficient in transferring therapeutic cancer drugs into the tumor [7]. Also, scientists are developing rod shaped nanoparticles which are effective in delivering chemotherapy drugs to breast cancer cells [7]. These new developments in the machinery help improve their ability to locate the cancer and increase effectivity in fighting and destroying the infected cells.

Nanotechnology can detect cancers sooner than ever before and it also can treat cancer patients better than traditional cancer treatments. This gives patients and their families more time to come up with a plan on how they want to fight the cancer. Additionally, the use of nanotechnology in cancer screening can discover a tumor early in its progression, before it becomes cancerous. By finding the tumor quickly it gives doctors and scientists more time to fight it.

CANCER TREATMENT PROCEDURES INVOLVING NANOTECHNOLOGY

Currently, several different hospitals and cancer treatment facilities are using nanoparticles to deal with certain cancers. For instance, at the University of Copenhagen, scientists and researchers have developed a method that kills cancer cells using nanoparticles and lasers. The treatment uses the laser to shoot nanoparticles directly into the cancerous tumor and works to destroy the cancer from within [8]. This treatment has been tested on mice and has proven to considerably damage the tumor [8]. This treatment also limits the amount of exposure to the nearby tissues and organs because the laser shoots a concentrated beam of nanoparticles directly into the cancer.

Furthermore, a type of lung cancer treatment includes inhalation of nanoparticle based drugs to treat lung cancer. Lung cancer is one of the most common types of cancers and it accounts for more than 16.7 percent of all new cases in the US [9]. “Additionally, lung cancer is the most common cause of cancer related death for men and women” [9]. This led to the development of an inhalable nanoparticle based drug.

A biocompatible nontoxic polymer is used in the inhalation therapy to quickly and painlessly transport the drug to the cancer [9]. This polymer is coated with anticancer drugs which are inhaled by the patient using a

dry powder form of the nanoparticle. This treatment is more efficient than a traditional intravenous injection because the anticancer drugs remain in the lungs 13 times longer than if they were injected directly into the blood stream [9]. An intravenous injection of the cancer treatment can remain in the bloodstream for about two hours before another injection is required [9]. However, because of the inhalation therapy, the drugs are in the lungs longer, which gives them more time to attack and destroy the tumor.

HOW DOES THIS TECHNOLOGY PERTAIN TO ENGINEERING AND SOCIETY?

The use of nanotechnology in the medical field is still a relatively new idea. Engineers are still trying to perfect the idea of a nanoparticle that can seek out and destroy cancerous cells without causing damage to already healthy cells. Biomedical engineers use their knowledge of biological processes and their understanding of physics and chemical processes in the development of nanoparticles. The challenge of creating the perfect nanoparticle to attack cancers is important to engineers because nanomedicine may hold the secret to achieving cancer treatment success.

Not only are nanoparticles important to the engineering world but they are also important to society. With the use of nanomedicine, doctors can diagnose their patients sooner because the nanomachinery can locate and identify the cancer faster than before. Also, nanotechnology can accurately provide an image of the tumor and show exactly where it is [10]. Furthermore, nanomedicine reduces the severe side effects than are a product of traditional cancer treatment. Although it may not be perfect, nanomedicine is one of the more promising advances in the fight against cancer.

CONCLUSION

Nanotechnology is the newest, most efficient addition to modern medicine. A machine so small that it can't be seen with the naked eye is the best way to attack a disease because it they can infiltrate the body and specifically target the problem. I believe that nanomedicine can be used to improve treatment and improve efficiency in the medical field. In the future, maybe nanotechnology can be used to treat all diseases. A few years ago, I lost my grandfather to cancer and it was very difficult to see him undergo the chemotherapy and with all of the side effects of the treatment. If we would have known about nanotechnology therapy to treat the cancer, maybe his side effects wouldn't have been as devastating or maybe his cancer would have been

eliminated completely, all I know is that nanomedicine has the potential to help a lot of people

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ACKNOWLEDGMENTS

I would like to thank my writing instructor Dan Malakoff for commenting on previous papers which helped me write this one. I would also like to thank my friends in Forbes Hall for proofreading my essay and giving me writing tips. I would also like to thank the Pitt Excel family and all the upper classmen who helped me with this paper.