Nanoparticles against Radiation
Abstract

With cancer being one of the top diagnosed disease in the United States of America, it makes sense that many doctors across the world are trying to find the cure for this dangerous disease. Radiation therapy, which is one of the few therapies that actually helps kill the cancerous cells is said to also cause danger to healthy cells in the human body. Doctors across the country have discovered that certain nanoparticles, when inserted into the human body, could actually help kill the cancerous cells faster, as well as protect the healthy cells from the radiation. Having this in mind, our investigation is trying to prove how prostate cancer (PC3) cells would react under x-ray radiation when inserted with Cerium Fluoride (CeF3) and Zinc Oxide (ZnO) nanoparticles.

Introduction:

Over 14 million people worldwide were diagnosed with cancer this year. About 8 million people around the world died of cancer in previous years. It's also estimated that the number of cancer cases reported around the world will increase about 80 percent by the year 2030 in low and middle-income countries. Being amongst the most diagnosed cancers, Prostate cancer is slowly but surely coming to a rise. In 2014, about 233,000 new cases of Prostate cancer will be diagnosed (1 in 7 men will be diagnosed with Prostate cancer during his lifetime)\(^1\), and about 29,480 men will die of Prostate cancer\(^2\). With so many cases coming forward, new medical advances are being developed each year; coming closer and closer to finally finding the cure. Meanwhile, many hospitals around the world are providing patients with treatments that slow down the cancer cell growth and keep it from spreading to other organs in the body. A good example of a popular treatment being used today is radiation therapy. With radiation therapy, doctors are now able to use either UV or X-ray radiation to enter the body and kill the cancerous
cells. The radiation kills the infected cells with a certain level of concentration depending on which stage of cancer the patient is at. However, recent studies have shown that radiation therapy will not only kill the cancerous cells but will also start to damage many of the healthy cells within the body. With that in mind, if radiation therapy is actually damaging tissues of the body, then why are so many doctors, hospitals and patients still using this method? To provide an alternate method, we are conducting this research to be able to provide evidence of better and safer ways of killing the cancer cells using radiation therapy. In recent years, many doctors and medical researchers around the world have found that by adding nanoparticles into a cancerous cell, the radiation will have some kind of chemical reaction with the nanoparticles, making the infected cell easier and faster to kill. At the same time, the nanoparticles will also protect the surrounding healthy cells from getting damaged from the overexposure of radiation from UV and X-rays give off.

It wouldn’t be the first time that nanoparticles are used for radiation protection. Many products including sunblock, use nanoparticles to prevent harmful UV and X-ray radiation from penetrating the skin and causing serious damage like skin cancer. With other products already using nanoparticles to help them protect against radiation damage, it’s now time to take these particles into the next level of use. With this research, the nanoparticles we will be using are Cerium Fluoride (CeF3) and Zinc Oxide (ZnO); later inserting them into cancer cells to view the reactions and final results. With the final result, we will be able to determine whether or not nanoparticles can actually protect us from the one method that can successfully diminish the cancer cells. In this report, we will show how we discovered Cerium Fluoride to be the ultimate nanoparticle and why Zinc Oxide didn’t quiet meet our expectations for our research.
Methods for this Experiment:

We mixed components Zinc Oxide (ZnO) and Cerium Fluoride (CeF3) separately with water to make the nanoparticles that would be used in the experiment. To properly mix the substances with water we had to place them into small tubes, later placing them into the sonication machine, which shook them with sonic waves to properly dissolve the powdery substance. This machine shakes the particles and water very fast and hard in order for the particles to breakdown and turn into the solution we need. It look about 3-5 minutes until the solution was completely mixed and broken down. We then had to take the Prostate Cancer Cells (PC3) out of the refrigerator, place the PC3 cells into a new dish and later placed the nanoparticles into the cells. After adding the nanoparticles, we added a few drops of medium, F12K into the dish, so the cells wouldn’t die while resting. Once we did that we put the plates which had the PC3 cells, as well as the nanoparticles aside for 24 hours. We had to wait 24 hours until we would get our results because we needed to give the cells and nanoparticles time to take effect and react with each other after which we could obtain the results. One of the many things we had to deal with was the fact that the medium we had to use was getting old. We had to change the medium and replace it with fresh medium. We change this by throwing old and used medium in the waste container underneath the vent hoods and replace it with the new medium from the refrigerator where it was sored. We placed new medium into 6 plates. These plates had to be cleaned very well because they had old medium and cells in them already. Due to the lack of time and resources available to complete this research we were unable to repeat this procedure. Unfortunately we experienced issues and minor defects when performing the research
while trying to resolve them as best as possible at the time. However, we were fortunate that no major conflict arose while completing the research.

**Materials used for Experiments**

We used Ethanol water Alcohol to disinfect the things we were using as well as our hands before we touched any other materials or instruments. We used different liquids such as F12K, (the media), Trypsin, and Penicillin. The F12K was in the larger tubes because we needed more F12K than any other substance. The Trypsin was in the smaller tubes because it is far more concentrated and a smaller amount was required. One key component of our research was the PC3 cells, which would have hinder our progress; why you may ask, well you see, with the help of the prostate cancer cells, we were able to witness how the cancerous cells would react under radiation. These PC3 cells were what we were testing our experiments in. What we needed was Clear Media to get accurate results. When the Media is cloudy or similar to when you mix glitter and water together, the media is considered contaminated. This is not good because then we have all kinds of trash in our important testing materials. This will alter our findings in a major away and not only can it be harmful, it is a waste of good cells and materials and it will take a long time to be able to re-create the mixture again.

We placed these cells and nanoparticles into what we call 6 welled plates. These are an arrangement of 6 plates that are all attached to one platform and are used to hold substances such as the ones we are using. Penicillin is another material we used. This was used to keep the cells from going into places they weren’t supposed to go into. We performed these chemical mixtures under two kinds of vent hoods, one for toxic and harmful substances and one for non-harmful and nontoxic substances. We needed all these materials to make this research as accurate and
sufficient as possible. We also could have used more materials but we made it happen with the minimum materials required.

**Discussion:**

The significance to our research is to determine whether or not adding nanoparticles such as Zinc Oxide and Cerium Fluoride to the body would hurt the healthy cells while killing the cancerous cells. Radiation is extremely harmful to the body in general and we are trying to find a way we can get the same effect from the radiation but by placing these nanoparticles in body. Chemotherapy is what cancer patients have to go through to get rid of most cancerous cells but along with that comes many disadvantages and damages. The radiation in this process is so strong that it makes these cancer patients lose their hair, lose a lot of weight, and feel really sick most of the time in addition to that therapy is not fun nor is it exciting. What we did in the lab was we mixed 9.93 mg of Zinc Oxide into .25 ml of water. We also added 95.6 mg of Cerium Fluoride into 1 ml of water. We used a very sensitive scale called (we will put these details later) to measure the exact amount of substance we needed. We had to take much caution when using this scale because a very small movement and even the slightest breeze could affect the weight. With the usage of a scapula we were able to scoop small amounts of Zinc Oxide and Cerium Fluoride onto a piece of wax-like paper until we reached the exact weight amount we needed. When we finished we placed both Zinc Oxide and Cerium Fluoride into labeled plastic tubes.

These two chemicals were what we used to preform our experiment and find if human cells would be affected if placed under direct radiation with cancerous cells. We had to use a Sonication machine to turn our substance mixed with water into a solution. These particles mixed with water turned a milky color once they were turned into a solution. When we placed the ZnO and the CeF3 that were mixed with water into the PC3 cells and the Media we used had
some discoloration. It turned a pink-purple color and that was because the PH (Potential Hydrogen) was too high for what we were mixing.

The important part is getting accurate results, so to do that we left our PC3 cells unattained for 24 hours. It is not good to leave them there for more than that amount of time because those cells would be over processed and our results including the research would be completely inaccurate. Some extra information to know about the nanoparticles is that they have the ability to absorb light. Nanoparticles can also convert to heat and as those temperatures rise, they will die. The way the doctors would get these particles into the body is by injecting them into the direct place that they need them. This is an advancement because this puts the nanoparticles that kill the cells right where they need to be and that way it won’t harm the rest of the body as much as if the particles were everywhere.

Results:

As the results come in we notice that the dishes containing ZnO had many dead PC3 cells and the dishes containing CeF3 had a lower count of dead PC3 cells. The ZnO nanoparticle killed most of the PC3 cells and the CeF3 nanoparticle only killed less cells but it was still able to do the things we suspected it would do, which was to reduce the cancerous cells. We were able to view these result through oh Bright Field and Fluorescent microscopes. We noticed that almost all the cells in the ZnO nanoparticle were circular shape, and floating, meaning that they were dead. Looking at the cells that didn't contain any kind of nanoparticle but were exposed to the X-ray radiation, we saw that the majority of the cells were dead to. With further investigation we were able to determine that the concentration level of the Zinc Oxide wasn't correct for this experiment; the level was more suited in radiation detection for security purposes. With the cells
containing the Cerium Fluoride, we noticed that there were more living cells than dead. When comparing it with the cells that didn’t contain the Cerium Fluoride, we noticed that there were more dead cells. Figure 1 shows which are the treated PC3 cells and which are the untreated cells as well as which are the alive and dead cells. So for best results in protecting the healthy cells within the body and killing the cancerous cells not using radiation, the Zinc Oxide would have to be the nanoparticles used.

**Conclusion:**

Knowing that cancer is the second leading disease that causes death in the United States is terrifying. Also seeing family members, friends, or important people, losing the battle to cancer is something that many people seems to fear the most. When people hear the few words from their doctor saying that you might have a small tumor or worse that you have cancer, it can really be daunting, but people need to understand that there are many medical advances being created every day to come closer to the cure. When looking at all the research that my partner and I have done, we have found that there is a lot more to discover and learn about the use of nanoparticles in cancer treatments. Further work that could be done to improve on this experiment is to find new nanoparticles that could serve the same purpose as the Zinc Oxide and the Cerium Fluoride did in our experiment and research. Also, using these nanoparticles on other cancer cells besides Prostate Cancer will further advance the research. The idea of using nanoparticles to eliminate the usage of radiation when treating cancer was one of the best ideas because not only does it help create new ways to cure specific diseases, but save the lives of many people around the world.
**Figure 1.** The image on the top left shows the Bright Field image of CeF3 after it was placed in the Prostate cancer Cells. The image on the top right corner was taken with the Fluorescent Microscope and that one shows the cells that are still alive a lot more clearly. The image on the bottom left corner was taken with the Bright Field Microscope and that shows the untreated CeF3 30 uL, however, the image on the bottom right corner was taken by the Fluorescent Microscope and that one shows red dots which indicate the presence of
Figure 2. On the side labeled Untreated CeF3 30 uL the Bright Ground image (gray image) shows that a vast variety of the cells are dead, the more oval shaped cells and the cells that are alive, the cells that are more circular before they were places under the x-ray radiation. The Fluorescent image right under the Bright Ground image is the same picture but you are able to differentiate between the dead and live cells a little bit more. On the side labeled X-ray treated CeF3 30uL the Bright Ground image and the Fluorescent image are the same. However, there are a lot more dead cells in those images rather than in the images that were not treated.
Citations

i [http://www.cancer.org/cancer/prostatecancer/detailedguide/prostate-cancer-key-statistic](http://www.cancer.org/cancer/prostatecancer/detailedguide/prostate-cancer-key-statistic)


www.ncbi.nlm.nih.gov/pmc/articles/PMC2924765/

www.wallstreetdaily.com/2014/08/12/nanoparticles/