# The Application of Nanotechnology in Medicine

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PASS

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Abstract
Nanotechnology involves the manipulation of matter on an atomic scale to make material with structures that have special properties. These materials can be used to make everyday objects more efficient and smaller. This paper will discuss the potential treatments for osteoporosis, motor neurone disease and coronary heart disease, using nanotechnology, and also the ethics involved in using this technology.

## Introduction

My paper will discuss various uses of nanotechnology to treat different diseases and conditions of the human body such as osteoporosis and motor neurone disease, and coronary heart disease. Nanotechnology such as carbon nano tubes, made in the university of Cincinnati in 2007, can be used to treat conditions and maybe in some cases with certain conditions, even cure them.

For example carbon nanotubes have been developed to replace certain parts of an electric circuit board, to reduce the size of the. Other examples are self-cleaning glass where nano particles have been used to fill the gaps in between glass molecules so water droplets don't cling onto the windows, and so the glass does not require cleaning. As there are applications of nanotechnology in these aspects of life, so can there be these kinds of advances in medicine also. Nanotechnology will allow doctors and surgeons to manipulate matter at a really small scale, however the knock on effects will be large.

# Discussion

Osteoporosis: This condition occurs in elderly people, where the bone become porous and less dense, and so therefore it will be more easy for that person to break their bones, and also their posture will change. As figure 1 shows the bone becomes more porous, and this can affect any bone in the body. In terms of medication, there is no such medication for curing this condition; only medication is available to prevent it. However studies show that regular exercise and a healthy diet will prevent the disease, however this is the case also for many other ailments.

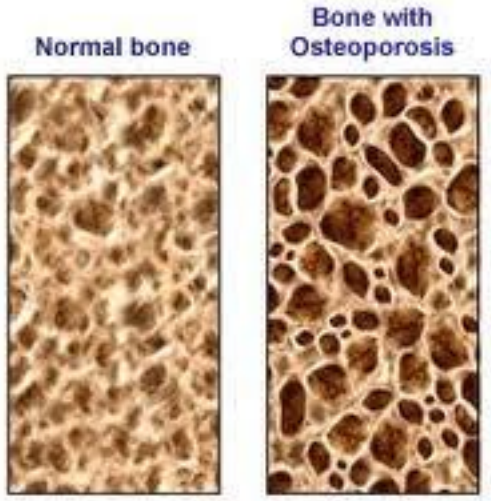


Figure 1

The normal bone density has a T score of -1.0 or higher, the score for Osteoporosis will be -2.5 or lower (the T score is a number determining how far away from the average you are). For the application of nanotechnology this score could be used to the surgeons advantage when treating the patient. The main form of treatment would be the used of bucky balls (see Smalley 1966). These are balls of carbon, which would be a viable substance to use to fill in some of the pores in the bone, which would be weakening the bone. Bucky balls would be the perfect solution to this problem as they would be strong and light enough to be able to fill in the gaps of the bone itself. However if the bone should become too dense due to the excess number of bucky balls the person would find it difficult to move.

This is where the real aspect of nanotechnology comes into play as scientists have created bucky balls of varying sizes. This would be extremely useful as surgeons and doctors would be able to use the T score to see what size of bucky ball would be needed to fill in the bone. The balls would have to be injected into the bone and from then on they would work their way into the small pores of the bone. This would increase the density of the bone, therefore making it stronger and less likely to break. If injected into the spine the bucky balls would also be able to improve the posture of people suffering

from osteoporosis. The bucky balls (figure 2) are strong due to the covalent bonding between the atoms and it is this aspect of these balls that would be able to support the forces exerted on the bone without breaking, and since there are very small they shouldn't increase the weight of the bone too much.

However there might be some problems with the use of bucky balls as some people might find it un-natural injecting artificial substances into the human body. Also while no evidence has been found that buck balls are toxic to the human body, it is unsure whether the body might react to the presence of these nanoparticle in an adverse way, thus creating more problems for the patient. Also another problem arises, since the bucky balls are very small they might be able to pass through the bone and into other parts of the body and could cause damage. This problem could be solved by only using bucky balls of a certain size. Another issue of this procedure is cost, bucky balls aren't easily made and so a problem could arise where only the more well off would be able to afford the treatment, which does not seem right as all should have the chance to be cured what ever the disease or condition, if there is a cure.

Overall I feel that the benefits of using the bucky balls to treat and cure Osteoporosis outweigh the problems that it could potentially create.

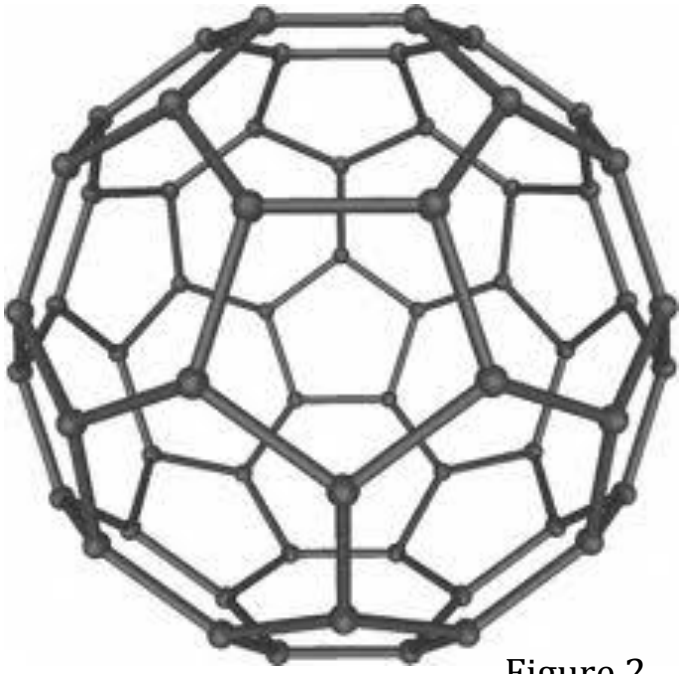


Figure 2

Motor Neurone Disease: This is a neurological disorder where the neurones, involved in the movement of muscles and their activity, do not function properly(Figure 4, next page). The problem lies in the fact that electrical impulses cannot pass between one motor neurone and another, and so therefore reflexes and movements are reduced and the muscles become weaker and weaker. There are two areas of the body that MND (motor neurone disease) affect. There is upper and lower MND, which involves spasticity, and brisk muscle reflexes in upper MND and muscle weakness and muscle atrophy, which is the decrease in muscle mass, due to the lack of muscle use in the lower body. Currently there is no cure for MND. Only drugs are available to prolong the life of the sufferer by a few months. Stem cells seem to be an obvious solution as they could replace the damaged neurones with fully functioning ones. However the use of stem cells has caused much controversy in the eyes of the public, as many do not agree with the use of cells to grow organs, as it could eventually lead to cloning.

Therefore another treatment must be found. The answer lies in graphite, an amazing material not just because of its layer like structure but also because of it conducting properties. Graphite has a free electron on each of its carbon atoms and so therefore it will be able to carry a charge. This means that even when there is only one layer of graphite it will still be able to conduct electricity. This means that it can be used to make really small materials. This is where it comes into the use of curing MND. Graphite nanofibers (Figure 3) have been formed and are used to coat materials to protect them, but they could also be used to transmit electrical impulses between the brain and muscles using neurones as a pathway. The electrical properties of graphite make it the perfect candidate for this material used to transmit the electrical impulses.

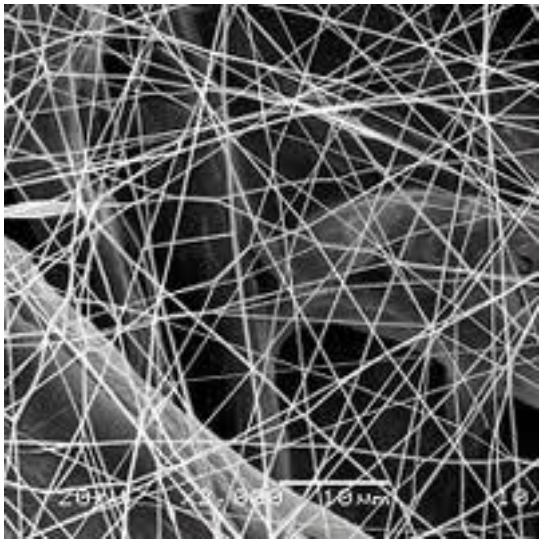


Figure 3

The procedure would take a very long time, but with electron microscopes surgeons could be able to repair and

replace motor neurones allowing MND suffers to use their muscles and have an increased life expectancy.

Again however there would be certain problems with this treatment as it would be very difficult to persuade people to under go hours of operations. Also some people might object with the use of these materials and putting them in the human body e.g. Rastafarians, who believe that the body should be whole and pure. Also people might find it un-natural to have inorganic materials in their body, especially due to their size and overall effect that they have. Some people might not even believe that nano materials could be used to such an extensive effect in the field of medicine. Another problem would be cost as the nanofibers would be expensive to produce.

However once again I believe that the benefits outweigh the problems to this potentially life changing procedure. Another feature of the graphite nanofibers is that they are flexible and so this is another reason for using them to treat MND as they will not break easily and will be easily placed in the human body.

This treatment could also be used to people who suffer from nerve damage, replacing the neurones with graphite nanofibers, and once again this would completely change the sufferer's life as they would no longer be dependant on other people or machines.

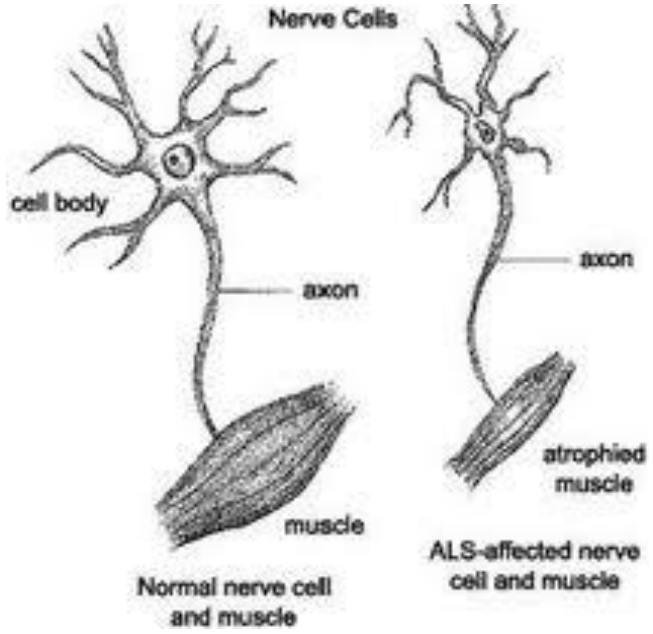



Figure 4

Coronary Heart Disease: This condition is where the coronary arteries located in the heart are narrowed by low density lipoproteins, which cling onto the artery wall, this makes it more difficult for blood to pass through the narrowed gap (Figure 5), and if this gap is completely blocked then the muscle, being supplied oxygen by that artery will die and this is a myocardial infarction. Normally stents (Figure 6) are used the prop the artery open as a solution however this procedure would seems very complicated and finding the particular artery might seem harder than thought before. The stents used in the heart are made of stainless steel because this is the most biocompatible substance with the body where corrosion will not occur. Stents however tend to recoil after being enlarged due to the different densities of the plaque and the atheromas creates and odd shape. The artery also needs to recoil to maintain blood pressure and flow. The stent does not allow this to happen as it is designed to keep the artery open.

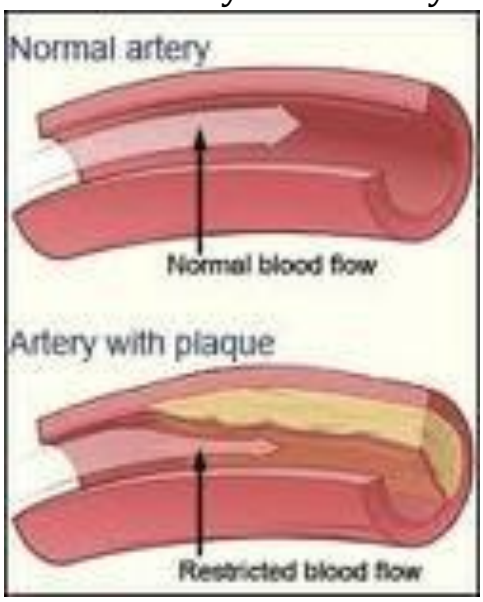
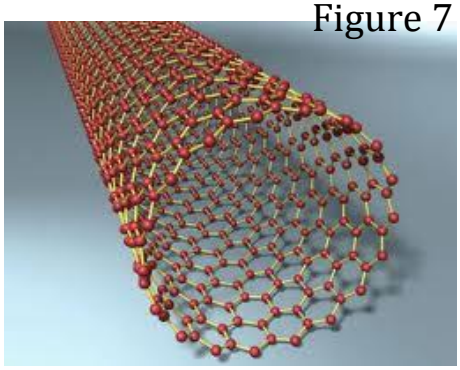



Figure 5

Figure 6

Figure 7



This is where nanotechnology comes into play as the idea of a stent is okay but the materials it is made with are not really advanced enough. Nanotechnology presents a solution for the fallbacks of the modern day stent, with elastic nanotubes (Figure 7). These are tubes made of carbon, which could be linked together to make a stent. The stent will then not only keep the artery open but it will be able to

recoil with the artery walls which will allow the arteries to maintain blood flow and pressure. These stents made from nanofibers would not be hard to synthesise as they have already been made, and would only need to be linked together. This new stent would not only aid in the recovery of the patient but it may put them at ease to know that the device keeping their artery open could not harm the body and won't be rejected by the body.

There is also another use of nanotechnology in CHD (Coronary Heart Disease), this could be the use of bucky balls to clear blockages in the arteries of the heart. A simple injection of the bucky balls into the blood would suffice as the balls would go around the body and then reach the heart where they would be pumped into the artery where the blockage would occur. The nano particles would be so small that the body would naturally filter them out. Without any damage caused to the person. The use of the bucky balls would also not trigger a release of white blood cells by the body, as they would be too small to detect.

However as always there will be ethical issues with the use of this technology, as people might not accept the fact of injecting people with unnatural substances into the body. Also since this technology is new, the tests to see whether the substance is safe in the human body may also be deemed wrong and unethical by the public.

Conclusions

As with all new technologies in medicine there will always be ethical an issue surrounding the topic, and this is what the use of nanotechnology will have to overcome also. However there will be other problems to overcome also. Like in the treatment for MND how will the surgeon be able to see where he is placing the nanofibers to replace the neurons. The solution also lies in the use and manipulation of particles. Electron microscopes would developed be used allowing the surgeon to see at a highly precise scale. Also the nanofibers could be synthesised to last for a long time so they would not need to be replaced. All of these achievements would not only develop how future doctors might treat patients, but it would also affect how we might live our lives, as the advances in nanotechnology would not only affect medicine, it would affect all aspects of life.

References:


- Jones and Jones, (1997) Advanced Biology, Cambridge.
- Toole. G. and S. (2006) AQA biology, Cheltenham, Nelson Thornes Ltd.
- Elastic nanofibers http://physicsworld.com/cws/article/news/31683/1/nano1
- Bucky balls http://en.wikipedia.org/wiki/buckyballs
- Stents http://en.wikipedia.org/wiki/Stent