How are nanoparticles used in medicine and research?

Uses of Nano technology in Medicine:

Nano medicine and the use of nanoparticles to deliver drugs to specific cells in the body are being researched and developed for a wide variety of uses. This may include chemotherapy drugs being delivered directly to the cancer cells, leaving surrounding cells unaffected. A research facility is also designing nanoparticles that can be taken orally. These nanoparticles are designed to pass through the intestinal wall and get to the bloodstream from there, thus providing drugs that are not being absorbed in the intestine. Professor Chenzong Yu and a team of researchers are currently studying ways in which delivery of oral medications can be improved by the use of nanoparticles. Injections medications are subjected to changes in depth (P1) levels and their enzymatic break down in the patients mouth and stomach before they have a chance to act on the target tissue. The main aim for Professor Yu and his team is to develop new and cost effective nanoparticles to improve the delivery of drugs and vaccines for human and animal healthcare.

Nanomedicines are becoming one of the difficulties experienced by traditional medical approaches; sometimes drugs have poor solubility in the human body and not enough is absorbed to provide a benefit, sometimes the body removes the drugs before it is effective in the treatment and due to poor delivery drugs have side effects. Nanomedicine can ensure that drugs are delivered to the right area of the body, they stay in the body for an appropriate time and enough of the drug is absorbed for them to be effective.

Nano materials are being researched to be used to detect and diagnose diseases and damage. Gold nanoparticles, for example, are being used to detect kidney damage. A damaged kidney generates a protein that the gold nanoparticles attach to, as the protein accumulates on the gold nanoparticle's a visible color change which allows for early detection. Researchers at the University of Michigan are currently developing a sensor to detect very low levels of cancer cells (3–5 cells) in one milliliter of blood, this is done by growing graphene oxide sheets, and these are then attached to molecules containing gold nanoparticles which are attached to cancer cells. This ‘tags’ the cancer cells with a fluorescent molecule, making them stand out in a sample under a microscope. This means nanomedicine can be used to detect diseases before the body shows obvious sign of them, which in turn can improve the prognosis of patients. The British Society for Nanomechanical therapy claims that, "Over the coming years, the benefits of nanomedicine and new diagnostic tools will be felt by an increasing number of people with considerable impact on global health." Medical Revenue Imaging (MRI) is a primary example of how nanomedicine is being used in current health care practices, the MRI image is enhanced using nanoparticles, usually based on gadolinium or iron oxide which each exhibit strong magnetism when reduced to 2nm or less, this improving, areas of damage within the body. Nanoparticles can also be involved with therapy of diseases and diseased tissue, nanoparticles for example absorb and remove toxins from the blood stream, nanoparticles are polymeric nanoparticles coated in a red blood cell membrane which allows them to travel freely while attracting and removing them as they themselves pass out of the blood stream. Researchers have shown that the use of carbon nanoparticles containing polyethylene, glycol and hydrophobic carbon (PEC-HCC) are much more effective in absorbing free radicals than the protein’s own body cells for the same function which results in local effects from these free radical related cell events such as a brain injury. Targeted heat therapy is also being developed to destroy breast cancer tumours, this method uses antibodies that are specifically attracted to proteins produced by one type of breast cancer cell, these are attached to a nanoamine causing the nanomole to accumulate at the tumour, infrared light from a laser is absorbed by the nanotubes, this process produces heat that then increases the tumour.

Social, Economic, Environmental and Social Factors and Bias within Research:

Often overlooked are the ethical issues associated with existence in creating nanomedicine, even though unexpected impacts of the environment has occurred with current medicines. Although targeted drug delivery is desirable in a patient due to biologically active components, once the drug has passed out of a patients system, these active ingredients may have undesirable effects on the environment. Economic factors to be considered are the fact that governments and governing bodies are setting aside hundreds of millions of dollars to develop and produce nanotechnologies for medicinal use. Governments see the health of the population as primary so are willing to invest in costly research from improved treatments. Ethical and social factors and concerns are also highly debated within the development of nanomedicine. Informed consent, risk assessment, toxicity and human enhancement are just a few of the ethical concerns surrounding nanotechnology. Bias and Limitations in article, web.com, for example. "Nanotechnology in Medicine" was good in providing information and evidence about nanomedicine, however the evidence that is provided is skewed in the way they only presented studies that had been successful and indicating a positive outcome for the field of nanomedicine. However, Cancer nanomedicine: Challenges and Opportunities, was very objective in the way it showed both sides of the story and it went very in depth about the way nanomedicine works in regard to cancer treatment. It required in depth investigation to produce a objective and unbiased report.

Applications of Nanomedicine:

Traditional treatments for cancer struggle to localize treatments for tumours and cancer drugs have a short circulation time in the body. Ontology based Therapies have shown clear benefits compared to traditional drugs as they improve retention, improve efficacy and have fewer side effects. When treating cancer with nanomedicine there are two types of tumor targeting approaches that can be used, passive or active. Passive targeting relies on tumour vascularization, it means that the tumour will develop from these gaps and reach tumour cells, achieving an enhanced permeability and retention due to the larger gaps in the tumour and does not only occur in areas around fast growing tumours. Active targeting on the other hand involves nanoparticles being used in conjunction with other targeting agents, such as, antibodies that are specific to proteins that are exclusively expressed by certain tumours. Nanotechnology for cancer is still being studied and developed by researchers, the number one problem researchers face is clinical translation, even though most nanomedicines for cancer have not passed their Phase II clinical trials and very few have achieved approval by the United States Food and Drug Administration. Clinical translation is so challenging due to the difficulty in controlling the size of nanoparticles and preventing nanoparticle aggregation in vivo, which is critical for clearance by the kidney or liver. Other challenges include biocompatibility, blood circulation time, and the ability to dilute the immune system for long enough to release the drug it is carrying, practical challenges that need to be overcome for clinical translation include cellular uptake and localization and controlled release and functionality of the cancer drug.

Conclusions:

From this research it was learned that nanomedicine can revolutionize the way diseases are diagnosed and treated as this new medical field works on the cellular level and changes the way drugs interact with the human body. Nanomedicine is being developed and researched to diagnose and treat, change of diseases improving the prognosis of patients worldwide. However, it must overcome many practical difficulties such as cost effectiveness and delivery to become widely available in the society. The evolving field of nanomedicine could make treatment easier and more comfortable for patients.

Literature cited: