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Mini Review

Gold Nanoparticles Are Medically More Precious Than Pretty Gold

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Abstract

Noble metals and their compounds have a long and distinguished history as therapeutic agents in medicine. Recent years have seen tremendous progress in the design and study of nanomaterials geared towards biomedical applications. Gold nanoparticles particularly have attracted intensive interest, because they are easily prepared, have low toxicity and can be readily attached to molecules of biomedical interest. The gold nanoparticles have become more precious than pretty gold because of their wide use and applications. The present mini review article gave a critical view of the biomedical uses of gold nanoparticles in diagnostics, medicine and surgery.

Keywords: Gold; Nanoparticle; Biomedical; Medicine; Surgery

Introduction

The progress in design and study of nanomaterials geared towards biological and biomedical applications have seen tremendous progress in recent years. For centuries, man has searched for miracle cures to end sufferings caused by disease and injury. Many researchers believe nanotechnology applications in medicine may be mankind's first 'giant step' towards this goal. Nanotechnology is the study of extremely small structures, having size of 0.1 to 100nm. The word "nano" means very small or miniature size. Nanotechnology is the treatment of individual atoms, molecules or compounds into structures to produce materials and devices with special properties. Recent years have seen tremendous progress in design and study of nanomaterials geared towards biomedical applications including diagnostics, medicine, surgery and other diseases [1,2].

Biomedical

In China gold was used in the treatment of ailments such as smallpox, skin ulcers and measles. In Japan, thin gold foils placed in tea, sake and food were seen as beneficial to health. In Bangladesh-Pakistan- India, traditional ayurvedic medicines are still used widely with gold taken as a 'rejuvenator' by millions of people each year. A typical daily dose includes 1-2mg of gold incorporated into a mixture of herbal. As medical science and medicine have advanced, so too the biomedical uses and applications of gold. Over the years, the gold nanoparticles have become more precious than pretty gold. Most important reason for this has been their wide uses and applications in the fields of diagnostics, medicine and surgery [3-5]. Ability to integrate metal, particularly gold and silver, nanoparticles into biological systems has had greatest impact in biology and medicine. Some investigators reported the wide spread use of gold nanoparticles in four areas of biology, i.e. labeling, delivering, heating and sensing [3,6]. Most applications are largely related to the excellent biocompatibility and inertness of gold as a material and resistance to bacterial infection. Nanoparticles, such as quantum dots, with quantum confinement properties, such as size-tunable light emission, can be used in conjunction with magnetic resonance imaging, to produce exceptional images of tumor sites. Nanowires are used to prepare sensor test chips, which can detect proteins and other biomarkers left behind by cancer cells, and detect and make diagnosis of cancer possible in the early stages from a single drop of a patient's blood. Nanoparticles are used to deliver the drug with enhanced effectiveness for treatment of head and neck cancer.

Medicine

More recently, new technologies have used the ability of tiny gold nanoparticles to collect specifically in a cancerous tumor by passing through the inherently leaky blood vessels attached to a tumor. Thus, when injected into a patient, there is a way by which a potent anticancer compound attached to a gold nanoparticle can be delivered directly and accurately to a tumor while avoiding surrounding healthy tissues. Such an effective drug delivery mechanism with reduced toxicity is considered to be a major step forward for cancer treatment, limiting side effects such as reduced immunity and hair loss [3,7,8]. Even today various diseases like diabetes, cancer, Parkinson's disease, Alzheimer's disease, cardiovascular diseases and multiple sclerosis as well as different kinds of serious inflammatory or infectious diseases (e.g.

HIV) constitute a high number of serious and complex illnesses which are posing a major problem for the mankind. With the help of nano-medicine, early detection, improved diagnosis, proper treatment, follow-up and prevention of diseases is possible; one of the most important applications of nanotechnology is in the treatment of neurodegenerative disorders due to which treatment of diseases such as Alzheimer's disease, Parkinson's disease, Brain tumors, HIV encephalopathy, acute ischemic stroke, etc has become possible. Alzheimer's disease: The early diagnosis and treatment are made possible by designing and engineering of a plethora of nanoparticulate entities with high specificity for brain capillary endothelial cells. Parkinson's disease: Nanotechnology could provide devices to limit and reverse neuro-pathological disease states, to support and promote functional regeneration of damaged neurons, to provide neuro-protection and to facilitate the delivery of drugs and small molecules across the blood-brain barrier (BBB). lt may be possible to use nano-scale diamond particles, which in principle may operate at much higher resolution, allowing new kinds of brain implants and brain stimulating devices; Many other conditions such as Tuberculosis, Antibiotic resistance and brain disorders can be treated in a better way with nanoparticles/ pharmaceuticals. A nanotechnology is one of the most promising approaches for the development of more effective and complaint medicines.

Surgery

A resistance to bacterial infection has led to a long tradition of gold being used in microsurgery of the ear and other procedures which require implants that are at risk of infection, including in the eye. In addition to gold's resistance to bacteria, the radiopacity of the metal means that gold-plated stents offer the best visibility under X-ray enabling them to be positioned accurately during surgery. In 2001, Boston Scientific produced the Niroyal stent, one of the first gold-plated stents, largely in response to the need for stents that could be placed more accurately. The biological inertness of gold was found to be important in this application and gold- plated stents have been found to produce the least number of macroscopic changes in surrounding intravascular tissue [3,4]. A new surgical procedure for prostate cancer involves the insertion of three gold grains into the prostate. The position of the gold grains can be detected using X-rays, allowing doctors to target the position of the prostate within one or two millimeters and thereby allow a more precise dose of radiation to be administered to a more targeted area for the treatment of the tumor. While this is a relatively new application, radioactive gold was used in some of the very first treatments of cancer dating back to 1955 [4,8,9].

Conclusion

In conclusion further research in nanotechnology can be useful for every aspect of human life in the very near future. Nanotechnology, as it advances, will also bring with it a need for greater understanding of the body systems that we are tempering with, as well as an appreciation of the ethics that go along with it. As diseases evolve, so too does the need for the robust and versatile metal 'gold' to aid in the treatment of a range of conditions, now and into the future. That is why gold nanoparticles are medically more precious than pretty gold. Currently, the World Gold Council's Gold Research Opportunities Worldwide (GROW) program supports research in new uses for the precious metal 'gold'.

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