Nanoparticles Toxicology Studies

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ABSTRACT

Commercial production of nanoparticles which are less than 100 nm in size has been rapidly increasing. These nanoparticles are major driving force in creating a revolution in industrial sector. Nanoparticles have a physiochemical and electrical properties different from other. These characteristics have made their usage in various fields like that of biotechnology, medical, electronics and many engineering departments has employed in work. Medical field are using these particles and many novel methods are being generated to use nanoparticles in many ways. These are used for delivery of drugs, antibodies, proteins and DNA.

INTRODUCTION

Metals, non-metals, bio-ceramics, and many polymeric materials are used to produce nanoparticles of the respective materials [1]. These are functional in producing liposomes, PEG and many more. Due to their small size nanoparticles has found to be interacting with human bodies same like of gases. After entering into our bodies [2-6] with ease their reach many vital parts of body like heart, brain, and liver. Once reaching these organs there can disrupt normal biochemical environment and can hamper their functionality.

Studies have shown that these nanoparticles trigger immune response against them. Since physical properties of these nanoparticles seems to be different so as the toxicity when compared to large size particles. Nanoparticles normally found in human lungs will be having half-life of 700 days, during their stay in lungs these nanoparticles poses a constant threat to respiratory system and human’s life [7-15]. When compared to large size companion of these nanoparticles these show different physiochemical properties in different biological systems. There is huge gap of knowledge relating to toxicity effect of nanoparticles. Because of this gap many scientist are divided for the extensive usage of these nanoparticles [16-19].

To understand the toxicity caused by nanoparticles one should have an understanding what and how nanoparticles are coming in contact with our cells. After interaction how these are causing toxicity. What kind of disruption is caused to cells? Key important understanding one should have is dosage of nanoparticles considered as lethal, most of nanoparticles are used in daily purposes [20-22]. Likes of silver nanoparticles, Fe nanoparticles are used in many different methods exposing human to these nanoparticles on regular basis. We all know these have many advantages, although research has revealed about their toxic effect. By having the knowledge of function, mode of transfer, and amount of dosage safe for humans, and one can use these nanoparticles effectively, rather than getting effected more compared to benefitted from it. It has found the toxicity is inversely proportion to the size, the smaller the size greater is the toxicity of the nanoparticle. 2.5 nm of nanoparticles are more dangerous and toxic compared to same molecule of 100 nm size [23-25].
However there are many studies made on these nanoparticles for assessing the toxicity, but there are no proper guidelines followed in conducting the studies. High concentration of Nanoparticles will cause cytotoxicity, for making sure toxicity is induced high concentration of nanoparticles used, these results are not appropriate for making guidelines. There are many discrepancies in in vitro and in vivo results. Basing on these results one single protocol cannot be proposed [26].

There are many types of nanoparticles to which humans are exposed constantly, these are nanoparticles exposure from dust storms, volcanic ash, our bodies has adapted to these harmful nanoparticles, our immune system can neutralize and destroy these nanoparticles entering into our body [27,28]. Since these nanoparticles have existed from very very long time, our bodies got adapted perfectly to these nanoparticles generated from smoke, ash of volcano eruptions etc., however the recently many new sources of nanoparticles are emerged these generate nanoparticles and release into air mainly industries smoke, vehicular smoke, combustion of fossil fuel [29,30].

These new technology are releasing new generation of nanoparticles. Advancement in technology has led to generation of smaller and smaller nanoparticles. Many studies have shown the capability of pollutant nanoparticles from air leads to many cardiovascular and respiratory diseases including cancer and mortality also in some cases [31-33].

Types of Nanoparticles Available

**Aluminum oxide**

Among all available nano sized chemicals, aluminium based nanoparticles are 20% of them. These Al-nanoparticles are used in textiles, paints, coating, polymers etc. toxic nature of these Al-nanoparticles are been studied by Chen et al [34]. Results have shown that AL-nanoparticles can disrupt cells, alter mitochondrial structure and function, oxidative stress, capable of disrupting blood brain barrier protein expression. Radzium et al [35] studied the toxic effect basing on concentrations of 10 µg/mL, 50 µg/mL, 100 µg/mL, 200 µg/mL and 400 µg/mL and found that all these concentrations doesn’t show any effect cell viability, however mitochondria has not been checked in those cells. Genotoxic properties of Al-Nanoparticles studied by Balasubramanyam et al [36] proved to have effect on cell, these studies are carried out by comet assay.

**Gold**

Gold nanoparticles are inert and non-toxic in nature, there have unique physiochemical properties, their react with amine and thiol groups [37-48], due to this reacting property gold-nanoparticles are used for surface modifications and used as drug carriers in cancer therapy. Studies have done looking for cytotoxicity against leukaemia cell line using 4, 12 and 18 nm size gold nano particles. Spherical gold nanoparticles are non-toxic at any concentration [49-53].

**Copper-oxide**

Copper-oxide nanoparticles are utilized as anti-microbial reagent, intrauterine contraceptive devices, semiconductors and heat transfer fluids. Studies have revealed toxic effect of copper oxide on kidney and liver [54,55]. During the study copper oxide nanoparticles has been orally administrated into experimental animals, and found that these nanoparticles interact with gastric juices causing severe impairment of kidney, spleen and liver in the animals. In-vivo studies found genotoxic and cytotoxic effects leading to cell membrane integrity disturbance and causing oxidative stress [56-59].

**Silver**

Since old times many civilizations widely used silver as anti-bacterial substance. Silver nanoparticles have found its important role in different commercial products. Wound dressing, surgical instruments are coated with silver nanoparticles [60-70]. These nanoparticles reach different organs once it enters human body, brain, kidney, liver, and spleen any many organs seen with silver nanoparticles deposits in them [70-80]. More and more studies are coming on silver nanoparticles toxicity, they have effect on cell viability, reactive oxygen species (ROS) are produced, leakage of lactate dehydrogenase (LDH) [80-90].

**Titanium Oxide**

Although titanium oxide are inert compounds, but usage of titanium oxide nanoparticles has shown toxicity effects in experimental animals such as DNA damage, lung inflammation and genotoxicity as well. Titanium oxide of size range 5 to 200 nm has shown effect on immune system also. Experimental animal’s lipid homeostasis is disrupted [91,98].

**CONCLUSION**
Although the usage of nanoparticles is increasing exponentially, care should be taken against the usage. Most of the nanoparticles need to studied, although there are many types of studies can be done in-vivo studies should be done on priority, since these studies will helps us in understanding it effects on our health [99,100].
There should be few guidelines which all research and industrial organizations should follow, such that there should not be any varying results. These results can be utilized for general purpose.

REFERENCE


