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Toxicity of Nanoparticles and an Overview of Current Experimental Models

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ABSTRACT

Nanotechnology is a rapidly growing field having potential applications in many areas. Nanoparticles (NPs) have been studied for cell toxicity, immunotoxicity, and genotoxicity. Tetrazolium-based assays such as MTT, MTS, and WST-1 are used to determine cell viability. Cell inflammatory response induced by NPs is checked by measuring inflammatory biomarkers, such as IL-8, IL-6, and tumor necrosis factor, using ELISA. Lactate dehydrogenase (LDH) assay is used for cell membrane integrity. Different types of cell cultures, including cancer cell lines have been employed as *in vitro* toxicity models. It has been generally agreed that NPs interfere with either assay materials or with detection systems. So far, toxicity data generated by employing such models are conflicting and inconsistent. Therefore, on the basis of available experimental models, it may be difficult to judge and list some of the more valuable NPs as more toxic to biological systems and vice versa. Considering the potential applications of NPs in many fields and the growing apprehensions of FDA about the toxic potential of nanoproducts, it is the need of the hour to look for new internationally agreed free of bias toxicological models by focusing more on *in vivo* studies.

Keywords: Cytotoxicity, *in vitro*, Metal nanoparticles, Toxicology, Review

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INTRODUCTION

Engineered nanoparticles (NPs) are commercially produced materials having at least one dimension less than 100 nm[1]. Nano-technology has brought a great revolution in the industrial sector. Due to their distinctive physicochemical and electrical properties, nano-sized materials have gained considerable attraction in the field of electronics, biotechnology, and aerospace engineering. In the field of medicine NPs are being employed as a novel delivery system for drugs, proteins, DNA, and monoclonal antibodies[2-4]. So far, NPs have been prepared from metal and non-metal, polymeric materials and bioceramics. The majority of NPs having medical applications are liposomes, polyethylene glycol, and dendrimers[5]. Humans are exposed to various nano-scale materials since childhood, and the new emerging field of nanotechnology has become another threat to human life[6]. Because of their small size, NPs find their way easily to enter the human body and cross the various biological barriers and may reach the most sensitive organs[7]. Scientists have proposed that NPs of size less than 10 nm act similar to a gas and can enter human tissues easily and may disrupt the cell normal biochemical environment[8]. Animals and human studies have shown that after inhalation and through oral exposure, NPs are distributed to the liver, heart, spleen, and brain in addition to lungs and gastrointestinal tract[9-11]. In order to clear these NPs from the body, the components of the immune system are activated. The estimated half life of NPs in human lungs is about 700 days posing a consistent threat to respiratory system. During metabolism, some of the NPs are congregated in the liver tissues[6-12]. NPs are more toxic to human health in comparison to large-