10 years of nanotoxicology research- what have we learned?

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Nanotechnology, the science of a few billionths of a meter, is today one of the fastest growing fields in engineering. The feverish development of engineered nanomaterials (NM) represents an evolving revolutionary technology that has the potential to have an impact on an incredible number of industries, markets and areas of our life. Unfortunately, in spite of the great excitement about the potential benefits offered by nanotechnology a huge health and safety questions remain unsolved, and toxicological evidences are emerging to fear that NM could have undesirable health effects, leading the scientific community to severe controversy without reaching a consensus about the health safety of NM. In this context, in 2004 a new emerging discipline, nanotoxicology, has become a new frontier in NM toxicology relevant to workplace, general environment and consumer safety (1). However, the issue of nanotoxicology is more complicated than previously thought and proactive multidisciplinary research is an urgent need for a mechanistic understanding of the interaction of NM with biological systems. Although in the last 10 years many positive lessons have been learnt more gaps and uncertainties than certainties are still existing, and few findings are conclusive about the nature and extent of the hazards of NM. In addition, the comparison of the results at international level can be done only with great difficulty and the interpretation of the biological effects cannot be done with the necessary severity.
This presentation highlights shadows and lights emerged from the last 10 years of nanotoxicology research, focusing on selected areas of emerging toxicology-based challenges presented by NM: physicochemical characterization (role of size, shape, agglomeration, surface area, crystallinity, porosity, surface modification characteristics in understanding and assessing material toxicity); metabolic pathways (uptake, translocation to other tissues, intracellular trafficking in relation to NM toxicity); biointeraction and biological responses (corona effect, inflammation and oxidative stress, systemic effects, genotoxicity and carcinogenicity, interaction with the immune system).
Although many advances have been made in improving the design of studies carried out to evaluate NM toxicity, and in developing suitable testing strategies to assess NM safety the scientific knowledge is still inadequate for a risk assessment of NM, and at present NM cannot be considered neither “angels” nor “demons”.

(1)Donaldson K, Stone V, Tran CL, Kreyling W, Borm PJ. (2004) Nanotoxicology, Occup Environ Med 61:727–728.