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EDITORIAL

Current developments in nanosafety research

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Analyzing the most intensively studied fields of research based on the articles published in our journal, it becomes clear that nanotoxicology remains one of the most popular topics (Gebel et al. 2013; Cadenas et al. 2012; Hoelting et al. 2013; Bolt et al. 2012; Kroll et al. 2012; Nohynek and Dufour 2012; Marchan 2012; Hengstler 2011; Haase et al. 2012; Landsiedel et al. 2012a, b; Klein et al. 2012; Kim et al. 2012; Hadrup et al. 2012; Creutzenberg 2012; Stewart and Marchan 2012). Publications in recent years focused on the influence of size (Xiong et al. 2013a), shape (Zhao et al. 2013; Xiong et al. 2013b), the corona (Böhmert et al. 2012), report about uptake by endocytosis (Kasper et al. 2013) and confirm generation of oxidative stress, release of cytokines and apoptosis as well as autophagy as mechanisms triggered by exposure to nanoparticles (Guo et al. 2013; Xu et al. 2013; Trpkovic et al. 2012; Morishige et al. 2012). However, the articles published in the past 2 years do not report basically new mechanisms of action of nanoparticles (Donaldson and Poland 2013; Safe Work Australia 2009; Donaldson et al. 2010; NIOSH 2013). Also comprehensive reviews on kinetics, particle translocation, and systemic toxicity (Landsiedel et al. 2012a, b), genotoxicity (Magdolenova et al. 2014; Singh et al. 2009; Shi et al. 2013; Kumar and Dhawan 2013), material characterization (Warheit 2008, 2010), physico-chemical features (Fubini et al. 2010; Rivera et al. 2010) and concepts of risk assessment (Dankovic et al. 2007; Sayes et al. 2013; Stone et al. 2014; Kuempel et al. 2012) have already been published. Considering this background, it may be questioned whether we really need so many further studies showing again that nanoparticles may induce oxidative stress, release pro-inflammatory cytokines and show size-dependent differences. What are the key questions that should be preferentially addressed by nanotoxicology? Recently, it has been reported that despite of intensive research, not a single nano-specific toxic mechanism has been discovered (Donaldson and Poland 2013). Nanoparticles act by the chemicals released, reactions catalyzed by their surface or by mechanisms already known from particle toxicology for materials with a primary particle diameter higher than 100 nm. A recent review systematically compared rat inhalation studies performed with respirable granular biodurable particles with diameters of smaller and larger than 100 nm (Gebel 2012). The difference in carcinogenic potency between nano- and micromaterials was relatively small ranging between two and five depending on the individual study. Although size and shape of particles have been shown to be influential, the factor of the size effect may be smaller than hitherto expected. It is also no longer particularly helpful to illustrate in vitro that, e.g., neuronal cells can be compromised by certain nanoparticles. A critical question for risk assessment is whether toxic concentrations can really be reached in human target tissues (Henrich-Noack 2012). Further, it would be of high practical relevance if groups of nanoparticles can be defined to facilitate risk evaluation. It might occur that in some years, nanotoxicology will no longer be seen as a specific subdiscipline in toxicity, since toxic effects of nanoparticles may be sufficiently explained by already well-established mechanisms of chemical and particle toxicology.

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