Safety assessment of multiwalled carbon nanotubes: present status and futureresearch needs

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A thorough evaluation of desirable vs. adverse effects is required for the safe use of engineered nanomaterials, and major challenges lie ahead to answer key questions of nanotoxicology. Foremost are the assessment of human and environmental exposure, the identification of potential hazards, and the biopersistence in organs, cells and subcellular structures in order to perform meaningful risk assessments. A specific example that is discussed are multiwalled carbon nanotubes (MWCNT). MWCNT are produced in large amounts by different methods and therefore different physico-chemical properties. Several studies in mice and rats have found that certain MWCNT cause asbestos-like effects (mesothelioma and granuloma formation) of the mesothelium following intracavitary injection of high doses. Although the important question of whether inhaled MWCNT will translocate to these sensitive pleural sites has not been studied yet, results of new studies using dosing by oro-pharyngeal bolus aspiration of MWCNT in mice show dose-dependent penetration into the alveolar and subpleural interstitial space and into the pleural space. It is conceivable that some MWCNT may turn out to induce fibrotic and tumorigenic effects like asbestos in long-term rodent inhalation studies. There is an urgent need to design such inhalation studies in rodents in order to determine the biokinetics and effects of MWCT following realistic exposure conditions. For example, clearance pathways in the lung and the pleural cavity of inhaled MWCNTs may differ from those after bolus-type administration to the lung. Of high importance is to obtain information about exposure levels and airborne size distributions so that the inhalation studies can be appropriately designed and risk assessments can be performed. Furthermore, parallel in vitro studies should be considered so that in vivo – in vitro correlations can be assessed with the goal to develop predictive toxicity studies. Important questions that need to be addressed include the use of dispersants, impact of agglomeration/aggregation state, impurities and surface defects, and generally the identification of physico-chemical characteristics that are associated with oxidative stress and inflammation. Other questions are: Is there a dose-dependent translocation to the pleura? Can a NOAEL be identified? The reactivity of different MWCNT can differ widely, yet the ultimate goal is to design “safe” MWCNTs.