Biodistribution of metal and metal oxide nanoparticles and of short CNT (preliminary)

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The production rate of engineered nanoparticles (NP) will increase over the next years. Therefore, humans will come more and more into contact with NP. In the field of nanomedicine it is discussed to use e.g. gold NP or short carbon nanotubes (CNT) as a nanoparticulate drug delivery system. A direct injection of these particles into the blood stream could be the consequence. In addition, during production, transport or application in consumer products these NP could become airborne which may lead to inhalation. Furthermore, NP are daily ingested as food additives. To evaluate an ideal drug delivery system and to estimate the hazard which originates from internalized NP it is important to investigate the mechanisms and characteristics which lead to maximum translocation across biological barriers as well as to accumulation in secondary organs.

We administered radio labeled metal and metal oxide NP into healthy adult female rodents. Furthermore, in a preliminary study, we injected radio labeled CNT into the tail vein of mice. The particles were measured in organs, tissue, and excretion after various time points. Thereby, a complete quantitative biodistribution analysis was performed in each animal.

NP are able to cross biological barriers. In this regard, size and surface charge seem to be the major determinants. In addition, NP, inclusive CNT, are able to reach each secondary organ. Over time, only little clearance out of the organs occurred. As for the translocation across biological barriers size and surface charge are key factors for accumulation in secondary organs. However, a smaller size does not necessarily lead to a higher accumulation; e.g. 18nm gold NP accumulated more in the brain of rats after intestinal uptake compared to smaller sized NP.

To conclude, no general rule of uptake and accumulation can be made so far. Therefore, for each NP used in industrial applications and leading to human exposure, a quantitative biokinetics study should be conducted. This will be part of a reasonable toxicological risk assessment as well as innovative and safe designs of nanoparticulate drug delivery systems.