IMPACT ON HUMAN HEALTH: EFFECTS BY INHALED ULTRAFINE PARTICLES

PD Dr. Marianne Geiser, Institute of Anatomy, University of Bern, Bern, Switzerland

In recent years, substantial evidence has been obtained from comprehensive epidemiological studies that ambient particulate matter exposure is associated with adverse health effects, including increased pulmonary and cardiovascular morbidity as well as increased short and long term mortality. There is also increasing evidence that ultrafine particles, i.e., particles with diameters < 100 nm, have effects on mortality, even at ambient concentrations. Their environmental burden is characterized by high number concentrations of up to $10^5/cm^3$, but low mass concentration (< 25 $\mu g/m^3$). Interestingly, fine particle number concentration seems to be constant or to even slightly increase, while mass concentration decreased by a factor of three in Erfurt, Germany, over the last decade. Increasingly, new ultrafine particles are also produced by the growing field of nanotechnology, and with them an additional great demand for health risk assessments from inhaled particles emerges. Therefore, it is most important to further investigations to clarify the fate of inhaled ultrafine particles.

Due to their small size, ultrafine particles have unique properties: Relatively large surface areas per unit mass are available for the adsorption of various organic compounds from the ambient air and for the interaction with biological molecules. Ultrafine particles were implicated to have increased toxicity relative to larger particles composed of the same materials in experimental studies in rats. Particle deposition in the respiratory system is caused by diffusional displacement and mainly occurs in small conducting airways and in the alveoli. In the human lung, particles are distributed over a large surface area of about 140 m^2, separated from the blood by a thin tissue barrier of about 2 µm thickness only. While particles with diameters > 1 µm usually remain on the surfaces of the epithelial cells upon their deposition and are subjected to clearance by macrophages from the peripheral lungs, there is evidence that ultrafine particles are translocated into the lung tissue and even beyond the lung into other organs. Hence, inhaled and deposited ultrafine particles may show distinct lung-distribution patterns and clearance pathways, which are still poorly described. In addition, besides local also systemic effects or health effects in organs distant from the lungs might occur.

To understand any adverse (toxicologic) effects observed and to assess health risks from inhaled ultrafine particles, their interaction with lung cells upon their deposition, the further pathway of particles in the lung and beyond, as well as the cellular responses along these pathways need to be clarified.