Abstract Book

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Talk 33. Options in the biomonitoring approach for assessing exposure and health effects of engineered nanomaterials (ENM): Challenges and perspectives

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Biological monitoring (BM) has been used in environmental and occupational toxicology as a powerful tool to assess both exposure and early effects of xenobiotics, thus allowing the identification of groups at risk before the manifestation of clinical outcomes. It is thought that for the ENM with known mechanisms or that share similar injury mechanisms (i.e., oxidative stress and inflammation, DNA damage) with environmental and occupational ultrafine particles (UFP), it is theoretically feasible to conduct biomarker studies [1], by assessing the early biochemical changes indicative of local and systemic oxidative stress, systemic inflammation, and inflammatory response in target organs.

Already validated biomarkers are now available for BM studies in ENM workers [2, 3]. Abnormalities in exhaled breath condensate (EBC) chemistry reflect intrinsic changes in the airway lining fluid and lung inflammation; moreover, pilot studies suggest the possibility to use EBC to assess the target dose (*see Peclova D. - present session*). Circulating soluble molecules, antioxidant capacity by the Cu/Zn-superoxide dismutase and glutathione peroxidase-1, peroxidated lipids and carbonyl groups in serum proteins can help reveal systemic inflammation; vascular adhesion molecules (e.g., ICAM) can detect endothelial activation/damage and prothrombotic changes. DNA oxidation products, such as 8-oxo-7,8-dihydroguanine or the corresponding deoxynucleoside 8-oxo-7,8-dihydro-2´-deoxyguanosine measured in biological fluids can be regarded as biomarkers of effective dose**.** The functional integrity of lung epithelial barrier can be assessed by pneumoproteins. Besides conventional genotoxicity tests, DNA methylation as well as other epigenetic biomarkers could reveal new mechanisms of action of NM.

Although inflammation represents the main mechanism of injury for several nanoparticles, specific physico-chemical properties of ENM can trigger unusual pathophysiological events. Advances in the system biology and “-omic” techniques should allow to assess whether specific biological pathways are activated or perturbed by specific ENM, and to identify fingerprints of selected ENM. Provided that biochemical or functional parameters are supported by consistent pathophysiological mechanisms, practical considerations suggest to focus now on the sensitivity instead of the specificity of biomarkers, to assess the association between exposure scenarios and hazards. To evaluate if quantitative modifications in these biomarkers can reflect relevant health changes predicting long-term outcomes or simple adaptive phenomena, validation studies on well characterised groups of exposed workers are needed which also consider the likelihood of combined exposure, organ specificity and disease specificity, background levels in not exposed people as well as inter-individual variability in biomarkers pattern [2].

[1] Li, N. and Nel, A.E. 2011. Feasibility of biomarker studies for engineered nanoparticles: what can be learned from air pollution research. JOEM 53(6): S74–S79
[2] Bergamaschi, E. and Magrini, A. 2012. Biomonitoring. In: Fadeel, B., Pietroiusti, A. and Shvedova, A. (Eds): Adverse Effects of Engineered Nanomaterials - Exposure, Toxicology, and Impact on human health. Academic Press - Elsevier, pp. 45-62
[3] Liou, S.H. et al. 2012 Epidemiological study of health hazards among workers handling engineered nanomaterials. J Nanopart Res 14: 878-93