Increased markers of oxidative stress in exhaled breath of workers exposed to TiO2 nanoparticles

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The potential adverse health effects of nanoparticles are very little understood, nevertheless, nano-TiO2 have been increasingly commercially manufactured for use in medical, cosmetic, and industrial applications. Experimental studies suggest that these particles can be distributed in the important organs and may induce body damage for biological systems. No biological exposure tests have been identified to monitor workers’ exposure.

In the year 2012 and 2013, the spatial distributions of total particle number and mass concentrations were determined in the workplace air in TiO2 production plant using particle number concentration monitor (P-TRAK) and monitor of particle mass concentrations (DustTRAK DRX). Particle number size distributions were monitored by aerosol spectrometers SMPS and APS, covering the overall size range 15 nm-10 μm.

In 2012, both pre-shift and post-shift samples of exhaled breath condensate (EBC) were collected in 20 workers (mean age 34 years) and 19 controls (35 years). In 2013, post-shift samples were harvested in 14 workers (34 years) and 25 controls (34 years). Malondialdehyde (MDA), 4-hydroxy-trans-nonenale (HNE), 4-hydroxy-trans-hexenale (HHE), C6-C12, 8-isoprostaglandin F2α (8-isoprostane), 8-hydroxy-2-deoxyguanosine (8-OHdG), 8-hydroxyguanosine (8-OHG), 5-hydroxymethyl uracil (5-OHMeU), o-tyrosine (o-Tyr), 3-chloro-tyrosine (3-Cl-Tyr), nitro tyrosine (NO-Tyr), and leukotriene’s (LTs) were analyzed by LC-ESI-MS/MS. In addition, Ti concentration was measured in EBC by X-ray diffraction method.

Total aerosol concentrations in the production plant varied greatly in both space and time; median number concentrations were 38,000 and 14,900 particles/cm3 and mass concentrations 1.9 and 0.9 mg/m3 in 2012 and 2013, respectively. In the workshops, 70% of the particles were smaller than 100 nm in diameter.

The pre-shift and both post-shift EBC markers of oxidative stress were significantly higher in the workers then controls, in addition LTB4 was increased. All markers of lipid oxidation were elevated (p<0.001): MDA, HNE, HHE, C6-C12, and 8-isoprostane. Also all markers of oxidation of nucleic acids and proteins: 8-OHdG, 8-OHG, 5-OHMeU, 3-Cl-Tyr, NO-Tyr, o-Tyr; and LTB4 (p<0.001). The elevation of cysteinyl LTs was lower.

Mean Ti in EBC of workers was 20.05 ng/ml. In the controls, it was under the detection limit.

Conclusions: This 2 years study in workers suggests adverse effects of exposure to TiO2 aerosol containing a high proportion of Nano-sized fractions. To our knowledge, this is the first study of this kind. Markers of oxidative stress in the EBC appear a suitable non-invasive method to monitor exposure to Nano TiO2 in the preventive examinations of the workers.

Biography
Pelclova Daniela, M D, PhD is Professor and has been working since 1995 as a Head of Department of Occupational Medicine and Toxicology at 1st Faculty of Medicine of the Charles University in Prague and General University Hospital in Prague. She is a Fellow of Collegium Ramazzini.

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