*Project S.E.N.S.O.R. News

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Nanoparticle Toxicity

There was a recent article in the September 2009 issue of the European Respiratory Journal of seven women workers (ages 18-47 years) in China with shortness of breath, pleural and pericardial effusions, pulmonary fibrosis and foreign body granulomas of the pleura (1). This is the first clinical report of human toxicity from nanoparticles.

The women had worked from five to thirteen months at a print plant where polyacrylic ester particles, which were 30 nanometers in diameter, were sprayed onto polystyrene board. The ventilation unit had broke five months before the individuals became ill. Also, during this time the workplace door was kept closed because of cold weather. All seven women who became ill had worked in the same department. There was one other worker in this department, a man who had worked for three months who did not become ill. None of the members of the patients' families or workers in other departments of the facility became ill.

Abnormal laboratory or radiographic findings included: all seven had interstitial fibrosis with rapid progression in two; all seven had restrictive changes on spirometry; all seven had recurrent pleural effusions which were characterized as exudates; six had interstitial nodules; five had pericardial effusions; four had diffuse ground-glass opacities; three had lymph node adenopathy; five had monocytosis with decreased neutrophils; five had an elevated sedimentation rate; one had thrombocytopenia; and three had elevated liver enzymes. The cause of death in the two women (19 and 29 years old) who died was respiratory failure. Nanoparticles were found on biopsy in the cytoplasm of pulmonary epithelial and mesothelial cells of the chest fluid. Bacteriologic cultures and bacteriologic and viral antibodies did not identify a causal agent.

We would like to hear from you if you now have or suspect a patient in the future where nanoparticles may have caused their lung disease. We are also interested in hearing if you are aware of production facilities in Michigan using nanoparticles. Kenneth Rosenman, MD can be reached at 1-800-446-7805 to discuss individual patients or workplaces.

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The industrial application of nanotechnology is increasing (see side box on nanotechnology).

There is concern about the potential toxicity of nanoparticles. The concern is based on toxicological studies in animals of nanoparticles and the recognized human health effects of ultra fine particles from combustion.

Animal studies show that poorly soluble nanoparticles cause a greater inflammatory response in the lungs than do larger particles of the same material. Animals exposed to nanoparticles have developed pulmonary fibrosis and cardiovascular or thrombotic effects including increased platelet adhesiveness, thrombosis and increased atherosclerotic inflammation and plaques.

There is an extensive literature of the effect of ultra fine particles (<2.5 microns (2500 nanometers)) air pollution from the emission of coal burning plants and motor vehicles causing cardiovascular and pulmonary morbidity and mortality (5). There are more limited studies showing that ultra fine particles cause increased cardiovascular and lung cancer mortality in workers with exposure to welding fumes or diesel exhaust (6,7).

Whether nanoparticles have similar toxicity as ultra fine particles is not known. Nanoparticles differ from ultra fine particles. Nanoparticles (1 to 100 nanometers) are smaller than ultra fine particles which are defined as particles less than 2,500 nanometers. Also nanoparticles are engineered products with a more homogenous composition. The current understanding of the pathophysiology of ultra fine particles from combustion is that the metal contaminants of the particles may be responsible for the toxicity of ultra fine particles.

There are no human studies other than the case series highlighted in this newsletter on workers exposed to nanoparticles. Clinicians need to monitor their patients who work at jobs with potential nanoparticle exposure.

NANOTECHNOLOGY

The National Institute for Occupational Safety and Health has an excellent web site, which provides an overview of nanotechnology and toxicity (2). Nanotechnology involves creating and using particles with at least one dimension in the 1-100 nanometer range where the nanoparticles provide new properties and functions because of their small size.

There are rough estimates of 25,000 workers in the U.S. exposed to nanoparticles. In an Interim Guidance for the Medical Screening of Workers Potentially Exposed to Engineered Nanoparticles, published November 2007, NIOSH recommends considering providing a medical surveillance program to workers in this industry (3).

CURRENT USES OF NANOPARTICLES (4)

Areas producing the greatest revenue for nanoparticles reportedly are chemical-mechanical polishing, magnetic recording tapes, sunscreens, automotive catalyst supports, biolabeling, electroconductive coatings and optical fibers.

Today most computer hard drives contain giant magnetoresistance (GMR) heads that, through nano-thin layers of magnetic materials, allow for an order of magnitude increase in storage capacity. Other electronic applications include non-volatile magnetic memory, automotive sensors, landmine detectors and solid-state compasses.

ADDITIONAL PRODUCTS AVAILABLE NOW INCLUDE:

- Step assists on vans
- Bumpers on cars
- Paints and coatings to protect against corrosion, scratches and radiation
- Protective and glare-reducing coatings for eyeglasses and cars
- Metal-cutting tools
- Sunscreens and cosmetics
- Longer-lasting tennis balls
- Light-weight, stronger tennis racquets
- Stain-free clothing and mattresses
- Dental-bonding agent
- Burn and wound dressings
- Ink
- Automobile catalytic converters

FUTURE APPLICATIONS

New commercial applications of nanotechnology that are expected in two to five years in these and other industries include:

- Advanced drug delivery systems, including implantable devices that automatically administer drugs and sensor drug levels.
- Medical diagnostic tools, such as cancer tagging mechanisms and lab-on-a-chip, real time diagnostics for physicians.
- Cooling chips or wafers to replace compressors in cars, refrigerators, air conditioners and multiple other devices, utilizing no chemicals or moving parts.
- Sensors for airborne chemicals or other toxins.
- Photovoltaics (solar cells), fuel cells and portable power.

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Address service requested.

In this issue:

*P*S *Remember to report all cases of occupational disease!*

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