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Tiny particles have big hazard potential

Nanotechnology will be viewed as both hero, villain for next 20 years

In the 1980s, the *Mork and Mindy* TV series featured a comedic space alien played by Robin Williams who said "nanu-nanu" which loosely meant "hello." The mere mention of nanoparticles inevitably leads to someone referring to the space alien Mork. Today, however, the terms "nano" and "nanotechnology" have seriously different meanings.

Nanotechnology is the branch of technology that deals with structural dimensions and tolerances of less than 100 nanometers. The term "nanotechnology" was coined in 1974 by professor Norio Taniguchi of the Tokyo University of Science. In 1981, with the development of the scanning tunnelling microscope that could resolve actual individual atoms, modern nanotechnology began.

Perhaps without anyone really noticing, nanoparticles have infiltrated everyday life in North America. Innovation, Science and Economic Development Canada lists thousands of producers and users of nanotechnology in Canada. Every major university has a research group or department with a nanoparticle focus.

Some of the high-technology uses of nanoparticles include: carbon nanofibres used as a flame-retardant coatings or used to build super strong, super light-weight structural components; computer hard drives; flexible, nanoparticle based solar cells; protective and glare-reducing coatings for eyeglasses and car windshields; and nano-enhanced drug delivery systems used in advance chemotherapy for cancer patients.

Nanotechnology-enabled products are also quietly proliferating our store shelves in products we use, wear and even eat. Examples of every day uses of nanoparticles are Elmer's glue, cottage cheese, sunscreen, powered coffee creamer, many cosmetics and even your favourite stain-repellent Khakis pants.

Nanoparticles and nanotechnology will be seen as both the heroes and villains of technology for the next 20 years, depending on who you ask. They are viewed with great hope by engineers, scientists and the medical community, and they are an undefined health risk to workers and the community at large. As nanotechnology moves from research laboratories to industrial and commercial settings, employers should be aware of the potential hazards posed by nanomaterials in their workplaces and take appropriate measures to control worker exposure.

One would think before boldly venturing forward with nanoparticles that a careful assessment of the health risks associated with exposure would have been undertaken. History should have taught us that man-made molecules, although they may appear to be of great benefit at first, may be more dangerous than first thought. Recall our foray into the manufacture of super synthetic pesticides in the 1940s with the "invention" of dichloro-diphenyl-trichloroethane (DDT). It did not end well for us or for the environment, almost single-handedly causing the extinction of the bald eagle. From 1930 until the 1970s, super high-heat capacity liquids for transformers called polychlorinated biphenyls (PCBs) were put into use and into the environment. PCBs continue to be a ubiquitous contaminant of concern.

Teachings in risk assessment and control suggest that in the absence of strong evidence that a substance does not cause a significant health risk, we should not use it. This approach to risk management is referred to as the precautionary principle. Despite nagging questions about the safety of synthetic nanoparticles and the products that contain them in the regulation of food and most consumer products, the precautionary principle is ignored.

So what are the health impacts associated with exposure to nanoparticles? What is known and where are there gaps in knowledge? We know exposure to such substances can create a real health risk, occurring through inhalation, skin absorption and ingestion. The health risks associated with exposure could range from simple irritation, allergy and sensitization to cancer. Ultimately, the health risk is related to the nature or toxicity of the type of nanoparticle, the concentration of exposure, the duration of exposure and individual susceptibility.

There is some evidence that certain types of nanoparticles and levels of exposure may be harmful to human health. Scientific studies indicate that at least some of these materials are biologically active, may readily penetrate intact human skin and have produced toxicological reactions in the lungs of exposed experimental animals. Nanoparticles have been linked to mesothelioma (a cancer of the lung lining and gut lining) in exposure studies with white mice. Employees in the nanotechnology industry are potentially exposed to uniquely engineered materials. The uniqueness is related to the novel size, shape and physical and chemical properties of the particles. The occupational health risks associated with manufacturing and using nanomaterials are not yet clearly understood. It has been hard to link exposure to health effects, partly due to the challenge of measuring exposure.

Exposure monitoring requires the development of specially designed detectors. Professor Warren Chan and his team at the University of Toronto have developed the first test for exposure to nanoparticles. His team developed a skin test based on the observation that fluorescence in the skin may appear after exposure to increasing levels of different kinds of nanoparticles. Until this or some other methods are refined "there is no way to determine how much nanoparticles you've been exposed to," said Chan in an interview with CBC.

Chan's research continues and others need to join the effort. There is a legislated responsibility to protect employees and a social responsibility to protect the public from exposure to harm from this potential hazard. Sensible and appropriate control strategies can only be developed once the health impacts, mechanisms and exposure levels associated with ill-health or disease are identified.

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