Predicting the inflammatory potential of nanoparticles

New methods to screen nanoparticles for potential toxicity to humans are needed to test the growing number of engineered nanoparticles being developed. A battery of simple tests has been developed that can be used to investigate the potential of nanoparticles to cause lung inflammation and also avoids the need for animal testing.

Despite the many benefits of using nanomaterials, concerns have been raised about the effects of these particles on human health. Of particular concern is the potential of some of these particles to cause inflammation in the lungs if they are inhaled. Inflammation is the immune system’s response to irritants. The researchers therefore wanted to determine the most efficient way of testing nanoparticles of metal oxides for their potential to cause inflammation of the lungs without using live animals.

Until now, researchers have largely relied on animal tests to test whether nanoparticles could cause inflammation. This new research explored the potential of a range of simple in vitro tests (not conducted in a living organism, i.e. a ‘test tube’ test) to replace animals as a means of screening nanoparticles for toxicity. The researchers compared the set of tests with findings in rats, to determine whether the in vitro tests produced similar findings.

In this study, rats were exposed to a panel of metal oxides which are used extensively in industry, to determine the inflammatory response of the lungs to each of the nanoparticles. In addition, four separate tests were conducted on tissue cultures exposed to the different nanoparticles. The results of these tests were compared with the actual inflammatory response detected in the rat lungs.

Only two nanoparticles, nickel oxide and alumina 2, showed significant inflammation of the lungs in the rats. The inflammatory potential of nickel oxide had been anticipated but not that for alumina 2. Three types of alumina nanoparticles had been tested, from different sources and of different sizes. As only one of the three (alumina 2) had the potential to cause lung inflammation, the researchers suggest that testing one variant of a nanoparticle might not give a representative result for all the variants of that nanomaterial.

Overall, the research found that the tests could be used to predict the inflammatory potential of metal oxides, though single tests alone were not sufficient. This suggests that in vitro tests could be developed for use in screening metal oxide nanoparticles for potential toxicity, allowing particles to be identified that might need further testing.

The results also suggest the nanoparticles tested have low toxicity. This indicates there is little potential to cause lung disease in people working with these materials. While inflammation is an indicator of irritation, it does not necessarily indicate or cause disease.

The researchers suggest it would be unlikely that these tests could be extended to different shapes of nanoparticles - such as fibrous types. Nevertheless, this research could be extended to design models to predict the toxicity of untested nanoparticles from the chemical and structural characteristics of the particles.


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