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Persistent issues associated with monitoring, measuring, and assessing risk of engineered nanomaterials

Gregory Nichols, Jason Davis, Wade Ivey and **Jason Lee**
ORAU, USA

The global use of engineered nanomaterials has increased rapidly over the past decade.Nanotechnology is being used in a variety of sectors including medicine, defense, materials, energy production and storage, electronics, and environmental applications. More than 700 companies in 30 countries have self-identified as being involved in nanotechnology-related activities of some kind. More than 1,600 commercially available products are manufacturer-identified as containing engineered nanomaterials. Even with the widespread use of nanomaterials, there continues to be a lack of regulation, partly because there are no clearly agreed-upon methods of assessing for risk or monitoring their activity via standardized testing procedures. Either currently available techniques must be adapted in order to accommodate the unique properties of engineered nanomaterials, or new methodologies must be developed in order to adequately measure engineered nanomaterials. A literature review was conducted to determine existing methods of testing that could be used to assess the risk of nanomaterial exposure. Given the proliferation of nanotechnology usage in many different applications, this testing spanned both health and environmental sampling. Five major issues were identified with the current testing methods of nanomaterials:

1. Interactions of engineered nanomaterials with experimental background
2. Adaptation of cytogenetic techniques for assessing geno- and cytotoxicity
3. Interpretation of non-specific biomarkers of exposure
4. Distinguishing engineered nanomaterials from background bulk elements
5. Accounting for and tracking biomagnification

These issues remain largely unresolved and compound the difficulties associated with the development of uniform testing procedures for engineered nanomaterials. It is important to understand the nature of each of these challenges, what is being done to overcome them, and the gaps that still remain. Although experimental testing is available on a limited basis in areas where advanced research facilities exist, a much greater challenge exists in areas where laboratory testing is unavailable or facilities are minimal. If some or all of these challenges could be overcome, then currently available testing methodologies, including ICP-MS, micronucleus test, and QSAR, might be feasible with adaptations and would be available to regulators and personnel involved in risk management. The alternative is to develop new methods for assessing engineered nanomaterials that would circumvent the aforementioned limitations. As a result of our research, we offer some suggestions for dealing with current challenges and limitations regarding nanomaterials exposure testing (e.g., radioisotope tagging with neutron activation and utilizing ROC models for non-specific biomarkers of inflammation like acute-phase proteins or micro-RNAs). As the field grows, new scientific discoveries should aid in the ability to assess engineered nanomaterials better. Whatever the future may hold, it is clear that improved techniques are desired and will improve the efficiency and viability of assessing nanotechnology safety risks.

Gregory.Nichols@orau.org

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