Study shows quantum dots can penetrate skin through minor abrasions

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Researchers at North Carolina State University have found that quantum dot nanoparticles can penetrate the skin if there is an abrasion, providing insight into potential workplace concerns for healthcare workers or individuals involved in the manufacturing of quantum dots or doing research on potential biomedical applications of the tiny nanoparticles.

While the study shows that quantum dots of different sizes, shapes and surface coatings do not penetrate rat skin unless there is an abrasion, it shows that even minor cuts or scratches could potentially allow these nanoparticles to penetrate deep into the viable dermal layer - or living part of the skin - and potentially reach the bloodstream.

Dr. Nancy Monteiro-Riviere, professor of investigative dermatology and toxicology at NC State's College of Veterinary Medicine, tested the ability of the quantum dots to penetrate rat skin at 8 and 24 hour intervals. The experiment evaluated rat skin in various stages of distress - including healthy skin, skin that had been stripped using adhesive tape and skin that had been abraded by a rough surface. The researchers also assessed whether flexing the skin affected the quantum dots' ability to penetrate into the dermal layer. Monteiro-Riviere co-authored the study with doctoral student Leshuai Zhang.

While the study indicates that acute - or short-term - dermal exposure to quantum dots does not pose a risk of penetration (unless there is an abrasion), Monteiro-Riviere notes "there is still uncertainty on long-term exposure." Monteiro-Riviere explains that the nanoparticles may be able

to penetrate skin if there is prolonged, repeated exposure, but so far no studies have been conducted to date to examine that possibility. Quantum dots are fluorescent nanoparticles that may be used to improve biomedical imaging, drug delivery and diagnostic testing.

This finding is of importance to risk assessment for nanoscale materials because it indicates that skin barrier alterations - such as wounds, scrapes, or dermatitis conditions - could affect nanoparticle penetration and that skin is a potential route of exposure and should not be overlooked.

The study found that the quantum dots did not penetrate even after flexing the skin, and that the nanoparticles only penetrated deep into the dermal layer when the skin was abraded. Although quantum dots are incredibly small, they are significantly larger than the fullerenes - or buckyballs - that Monteiro-Riviere showed in a 2007 study in *Nano Letters* can deeply and rapidly penetrate healthy skin when there is repetitive flexing of the skin.

Additionally, Monteiro-Riviere's laboratory previously showed quantum dots of different size, shape and surface coatings could penetrate into pig skin. The anatomical complexity of skin and species differences should be taken into consideration when selecting an animal model to study nanoparticle absorption/penetration. Human skin studies are also being conducted, but "it is important to investigate species differences and to determine an appropriate animal model to study nanoparticle penetration," Monteiro-Riviere says. "Not everyone can obtain fresh human skin for research."

Nanoparticles are generally defined as being smaller than 100 nanometers (thousands of times thinner than a human hair), and are expected to have widespread uses in medicine, consumer products and industrial processes.

Source: North Carolina State University

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