New Approach To Wound Healing May Be Easy On Skin, But Hard On Bacteria

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Source: University of Wisconsin-Madison

Summary: Researchers describe an experimental approach to wound healing that could take advantage of silver's anti-bacterial properties, while sidestepping the damage silver can cause to cells needed for healing.

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In a presentation to the American Chemical Society meeting, Ankit Agarwal, a postdoctoral researcher at the University of Wisconsin-Madison, described an experimental approach to wound healing that could take advantage of

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silver's anti-bacterial properties, while sidestepping the damage silver can cause to cells needed for healing.

Silver is widely used to prevent bacterial contamination in wound dressings, says Agarwal, "but these dressings deliver a very large load of silver, and that can kill a lot of cells in the wound."

Wound healing is a particular problem in diabetes, where poor blood supply that inhibits healing can require amputations, and also in burn wards. Agarwal says some burn surgeons avoid silver dressings despite their constant concern with infection.

Using a new approach, Agarwal has crafted an ultra-thin material carrying a precise dose of silver. One square inch contains just 0.4 percent of the silver that is found in the silver-treated antibacterial bandages now used in medicine.

In tests in lab dishes, the low concentration of silver killed 99.9999 percent of the bacteria but did not damage cells called fibroblasts that are needed to repair a wound.

Agarwal builds the experimental material from polyelectrolyte multilayers — a sandwich of ultra-thin polymers that adhere through electrical attraction. To make the sandwich, Agarwal alternately dips a glass plate in two solutions of oppositely charged polymers, and finally adds a precise dose of silver.

"This architecture is very easily tuned to different applications," Agarwal says, because it allows exact control of such factors as thickness, porosity and silver content. The final sandwich may range from a few nanometers to sev-

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eral hundred nanometers in thickness. (One nanometer is one-billionth of a meter; a human hair is about 60,000 nanometers in diameter.)

Nicholas Abbott, a professor of chemical and biological engineering who advises Agarwal, says during the past decade, "about a bazillion papers have been published on polyelectrolyte multilayers. It's been a tremendous investment by material scientists, and that investment is now ripe to be exploited."

The project was supported by seed funding from the Wisconsin Institutes of Discovery — a new unit devoted to advancing technology in five targeted areas, including tissue engineering — and benefited from contributions by Christopher Murphy, Jonathan McAnulty and Charles Czuprynski of UW-Madison's School of Veterinary Medicine; Ronald Raines of the Department of Biochemistry; and Michael Schurr, a burn surgeon at the School of Medicine and Public Health.

Although both mammalian cells and bacteria are sensitive to silver, bacteria are much more sensitive, leaving a sweet spot — a concentration of silver that can kill bacteria without harming cells needed for healing. In tests using mouse cells and sample bacteria, Agarwal has tuned the dose to find the sweet spot where the silver bullet destroys 99.9999 percent of the bacteria, but does not harm fibroblasts.

Indeed, the system is so sensitive that increasing the silver dose from 0.4 percent to 1 percent of the level used in a commercial dressing severely damaged the fibroblasts.

To kill bacteria, silver must take the form of charged particles, or ions, and the tiny silver nanoparticles that Agarwal embeds in the sandwich can be designed to release ions for days or weeks as needed. In contrast, Agarwal says, commercial wound dressings contain a large dose of silver ions, which are released faster and with less control.

The required dose of silver can also be reduced because the new material would be designed to stay in close contact with the wound, Abbott says. "In a commercial dressing, the silver is part of the bandage that is placed on the wound surface. We envision this material becoming incorporated into the wound; the cells will grow over it and it will eventually decay and be absorbed into the body, much like an absorbable suture."

Tests on animals will be needed to before the new material can be tested on humans, says Abbott. "A commercial dressing needs to have a large quantity of silver so it can diffuse to the wound bed, and that quantity turns out to be toxic to mammalian cells in lab dishes. We are putting the silver where we need it, so we can use a small loading of silver, which does not exhibit toxicity to mammalian cells because the silver is precisely targeted."

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