NAU team invents patented technology that speeds wound healing, prevents infection

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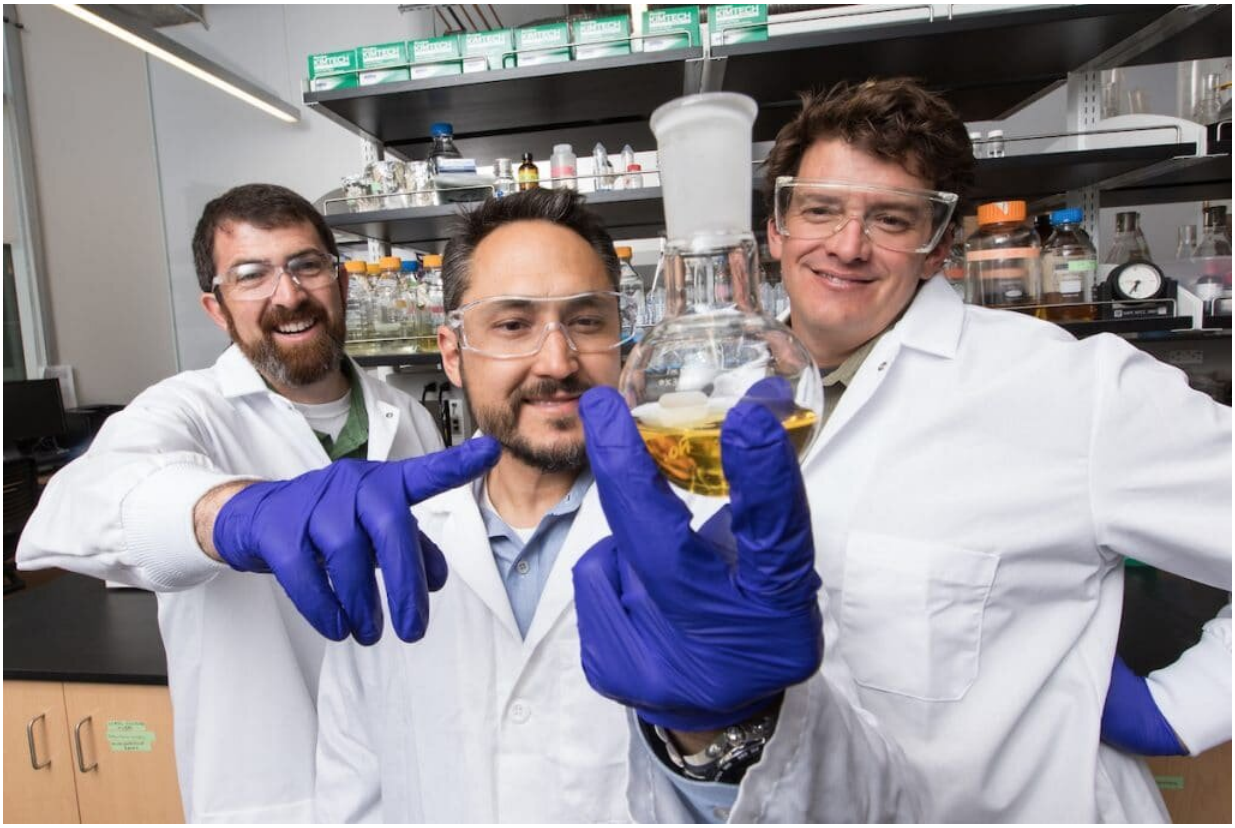

Credit: Northern Arizona University

The American population is aging, and conditions such as diabetes and cardiovascular disease are on the rise. With those factors in place, the medical community has growing concerns about wound treatment.

According to the American Professional Wound Care Association, about 15 percent of Medicare recipients suffer chronic, nonhealing wounds with an annual cost of about $30 billion.

One challenge physicians repeatedly face in treating wounds is the threat of bacterial infection. Closing the wound helps reduce the risk, but if pathogens infect the compromised tissue, they can readily form biofilms, hardy communities of cells covered by a protective biopolymeric layer. This layer is difficult for conventional antibiotics to penetrate, and as a consequence, biofilm-mediated infections require long treatment regimens. Microbial biofilms can result in chronic infection and often cause havoc in hospitals, where they can spread.

Recently, scientists have been exploring tissue engineering to treat wounds and promote better healing. One new approach is to use three-dimensional skin substitutes formed from native skin proteins through a process called electrospinning. These electrospun protein "scaffolds" guide cell adhesion and growth, and can be used to deliver cells, drugs and even genes into the body. Research is shifting from using synthetic materials for scaffolds to degradable, porous materials that can provide a more natural, effective and aesthetic healing environment.

Three Northern Arizona University researchers—Robert Kellar, associate professor of practice of biology, Nathan Nieto, associate professor of biology and Andy Koppisch, associate professor of chemistry, along with Rico Del Sesto of Dixie State University—have invented a technology that speeds healing and reduces the risk of infection.

The scientists developed this technology, which was recently awarded a patent, by incorporating antimicrobial materials known as ionic liquids into skin wound-healing scaffolds. Incorporation of the ionic liquid sterilizes the wound-healing device and enables the resultant scaffold to

resist colonization by a wide variety of microbial pathogens. The researchers envision that these properties of the scaffold will similarly reduce the risk of infection during the process of wound closure.

"The unique chemical properties of ionic liquids offer significant biochemical advantages as a therapeutic to combat biofilm development," Koppisch said.

Ionic liquids are formally salts, but unlike table salt, they are fluid at room temperature and at a wider range of temperatures relevant to living systems. Consequently, ionic liquids are often described as molten organic salts. Because they are temperature stable and adaptable, ionic liquids can serve a variety of applications. One such application is the disruption of the protective biopolymer covering microbial biofilms and neutralization of the underlying cells, which many ionic liquids have proven uniquely suited to do.

The team identified choline geranate, an ionic liquid that not only serves as a vehicle for tissue-generating cells and medications, but also has powerful biofilm-killing properties of its own. It can attack established infections as well as prevent new ones from developing. The researchers see a two-fold application for the solution—it can be added to dressings commonly used in treating wounds and it can be incorporated into wound-healing scaffolds.

Through their work, the researchers established a protocol for formation of the ionic liquid-containing scaffolds and demonstrated that choline geranate can prevent the scaffolds themselves from becoming contaminated, even with high concentrations of pathogens. The researchers are hopeful the scaffolds will ultimately improve outcomes for patients with healing difficulties, such as diabetics with chronic wound-based infections. The technology the team uses to create scaffolds uses native skin proteins that closely align to skin, facilitating

the natural healing process.

"This novel technology represents a co-development effort from multiple disciplines to create a game-changing therapeutic in the space of combating chronically infected wounds," Kellar said.

The researchers have identified several other potential healing applications for the technology:

- Surgical incisions
- Burns
- Skin conditions such as acne
- Traumatic injuries from military-grade weaponry
- Wounds animals may suffer in a variety of contexts

"We are encouraged by our early discoveries and the speed at which the university was able to secure patent protection for our ideas," Kellar said. "Our plans moving forward include seeking additional grant funding to support continued development and investigations into opportunities to spin out the technology for commercialization."

Provided by Northern Arizona University