Novel microneedle bandage could save lives by stopping blood loss from wounds

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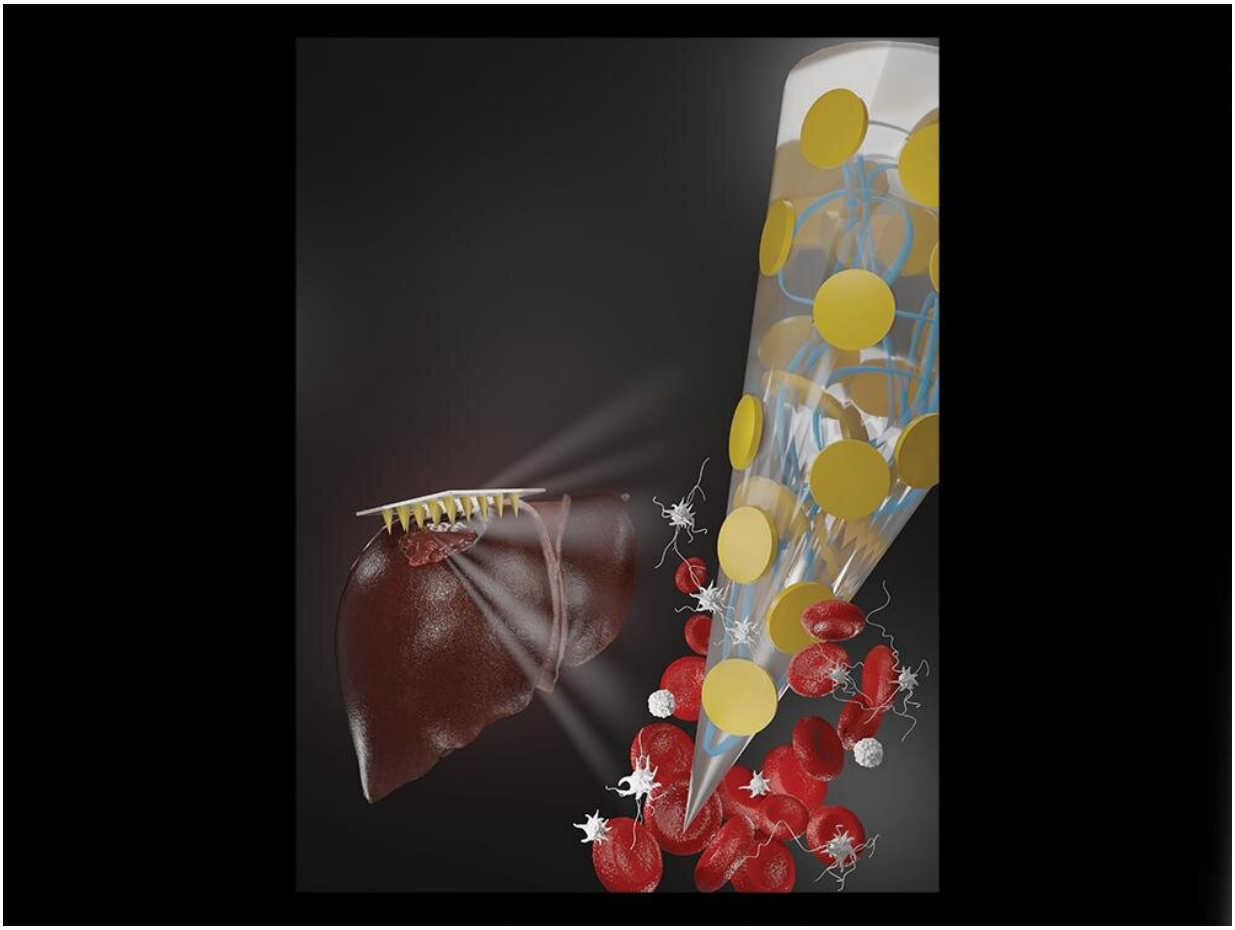

Hemostatic microneedle technology can be applied like a typical adhesive bandage to quickly stop bleeding. The biocompatible and biodegradable microneedle arrays (MNAs) on the patch increase its surface contact with blood to accelerate the clotting process and also increase the adhesive properties of the patch via mechanical interlocking to promote wound closure. Credit: Designed by Amir Sheikhi and Reihaneh Haghniaz/Executed by Natan Barros

A soldier suffers a serious gunshot wound on a remote battlefield or a machinist has a work accident and gets stuck in traffic on the way to the hospital. Secondary, uncontrolled bleeding from traumatic injury is the leading cause of death of Americans from ages 1 to 46.

Amir Sheikhi, assistant professor of chemical engineering and of biomedical engineering at Penn State, has a plan to change that with a novel microneedle patch that can immediately stop bleeding after injury.

He laid out his prototype in a new paper that will be published in the May issue of *Bioactive Materials*. The work will be featured on the journal's cover.

"Excessive bleeding is a serious challenge for human health," Sheikhi said. "With hemorrhaging injuries, it is often the loss of blood—not the injury itself—that causes death. There is an unmet medical need for ready-to-use biomaterials that promote rapid blood coagulation."

The hemostatic microneedle technology developed by Sheikhi can be applied like a typical adhesive bandage to quickly stop bleeding. The biocompatible and biodegradable microneedle arrays (MNAs) on the patch increase its surface contact with blood and accelerate the clotting process. The needles also increase the adhesive properties of the patch via mechanical interlocking to promote wound closure.

"In vitro, the engineered MNAs reduced clotting time from 11.5 minutes to 1.3 minutes; and in a rat liver bleeding model, they reduced bleeding by more than 90%," Sheikhi said. "Those 10 minutes could be the difference between life and death."

The MNA patch can be compared with the hydrogel technology that is

currently used to treat bleeding wounds in hospitals, but hydrogel applications require preparation and medical expertise. The microneedle patch is pre-engineered for immediate application that anyone can use to stop bleeding, Sheikhi said, much like a typical over-the-counter adhesive bandage.

Microneedles—which are already in use to deliver biologics, such as cells or drugs, through the skin or for cosmetic procedures to stimulate collagen production—are tiny, making their application pain-free, according to Sheikhi.

The researchers are now working to translate the patch from the lab to the market, with plans to further test the technology.

More information: Reihaneh Haghniaz et al, Tissue adhesive hemostatic microneedle arrays for rapid hemorrhage treatment, *Bioactive Materials* (2022). DOI: 10.1016/j.bioactmat.2022.08.017

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