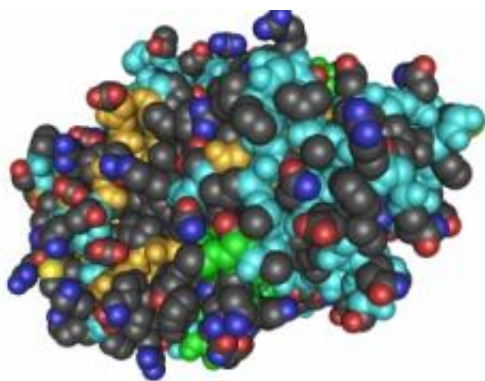


Nanoscale biological coating is a new way to stop the bleeding

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MIT researchers have developed a coating of thrombin, shown here, and tannic acid. After being sprayed onto a surface, the material can halt bleeding within seconds. Image: Wikimedia/Nevit Dilmen

MIT engineers have developed a nanoscale biological coating that can halt bleeding nearly instantaneously, an advance that could dramatically improve survival rates for soldiers injured in battle.

The researchers, led by Paula Hammond and funded by MIT's Institute of Soldier Nanotechnologies and a Denmark-based company, Ferrosan Medical Devices A/S, created a spray coating that includes thrombin, a clotting agent found in blood. Sponges coated with this material can be stored stably and easily carried by soldiers or medical personnel. The sponges could also prove valuable in civilian hospitals, says Hammond, the David H. Koch Professor in Engineering.

“The ability to easily package the blood-clotting agent in this sponge system is very appealing because you can pack them, store them and then pull them out rapidly,” she says.

Hammond and her colleagues described the technology in the Dec. 27 online edition of *Advanced Materials*. Lead author of the paper is Anita Shukla PhD '11, who is now a postdoc at Rice University.

Uncontrolled bleeding is the leading cause of trauma death on the battlefield. Traditional methods to halt bleeding, such as tourniquets, are not suitable for the neck and many other parts of the body. In recent years, researchers have tried alternative approaches, all of which have some disadvantages. Fibrin dressings and glues have a short shelf life and can cause an adverse immune response, and zeolite powders are difficult to apply under windy conditions and can cause severe burns. Another option is bandages made of chitosan, a derivative of the primary structural material of shellfish exoskeletons. Those bandages have had some success but can be difficult to mold to fit complex wounds.

Many civilian hospitals use a highly absorbent gelatin sponge produced by Ferrosan to stop bleeding. However, those sponges need to be soaked in liquid thrombin just before application to the wound, making them impractical for battlefield use. Hammond's team came up with the idea to coat the sponges with a blood-clotting agent in advance, so they would be ready when needed, for either military or civilian use.

To do that, the researchers developed a nanoscale biological coating that consists of two alternating layers sprayed onto a material, such as the sponges used in this study. The researchers discovered that layers of thrombin, a natural clotting protein, and tannic acid, a small molecule found naturally in tea, yield a film containing large amounts of functional thrombin. Both materials are already approved by the U.S. Food and Drug Administration, which could help with the approval

process for a commercialized version of the sponges, Shukla says.

A key advantage of the spray method is that it allows a large amount of thrombin to be packed into the sponges, [coating](#) even the interior fibers, says David King, a trauma surgeon and instructor in surgery at Massachusetts General Hospital who was not involved in this research.

“All of the existing hemostatic materials suffer from the same limitation, which is being able to deliver a dense enough package of hemostatic material to the bleeding site. That’s why this new material is exciting,” says King, also an Army reservist who has served in Afghanistan as chief of trauma surgery.

Once sprayed, the sponges can be stored for months before use. The sponges can also be molded to fit the shape of any wound. “Now we have an alternative that could be used without applying a large amount of pressure and can conform to a variety of wounds, because the sponges are so malleable,” Shukla says.

In tests with animals at Ferrosan, the coated sponges were applied to wounds, with light pressure (from a human thumb), for 60 seconds — and stopped the bleeding within that time. Sponges lacking thrombin required at least 150 seconds to stop the bleeding. A simple gauze patch, applied for 12 minutes (the length of the experiment), did not stop the [bleeding](#).

The researchers have filed a patent application on this technology and on similar [sponges](#) coated with the antibiotic vancomycin. Hammond’s lab is now working on combining the blood-clotting and antibiotic activities in a single sponge.

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