New spray fights infections and antibiotic resistance

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The antibacterial material, with peptides bound to hydrogel particles, works even in contact with body fluids such as blood. It can be sprayed directly into wounds without impairing healing or applied as a coating to catheters and implants to prevent infection, and to fight even multi-resistant bacteria. Credit: Chalmers University of Technology, Anna-Lena Lundqvist

The World Health Organization (WHO) ranks antibiotic resistance as one of the top ten threats to global health. There is therefore a great need for new solutions to tackle resistant bacteria and reduce the use of antibiotics. A group of researchers at Chalmers University of

Technology in Sweden are now presenting a new spray that can kill even antibiotic-resistant bacteria, and that can be used for wound care and directly on implants and other medical devices.

"Our innovation can have a dual impact in the fight against antibiotic resistance. The material has been shown to be effective against many different types of bacteria, including those that are resistant to antibiotics, such as Methicillin-resistant Staphylococcus aureus (MRSA), while also having the potential to prevent infections and thus reduce the need for antibiotics," says Martin Andersson, head of research for the study and professor at the Department of Chemistry and Chemical Engineering at Chalmers.

It is already estimated that antibiotic-resistant bacteria cause nearly 1.3 million deaths a year worldwide. As part of the effort to slow down the spread and development of drug resistance, researchers at Chalmers are developing a new antibacterial material that can be used in health care and become an effective tool to fight antibiotic resistance.

The material consists of small hydrogel particles equipped with a type of peptide that effectively kills and binds bacteria. Attaching the peptides to the particles provides a protective environment and increases the stability of the peptides. This allows them to work together with body fluids such as blood, which otherwise inactivates the peptides, making them difficult to use in health care. In previous studies, the researchers showed how the peptides can be used for wound care materials such as wound dressings.

They have now published two new studies in which the bactericidal material is used in the form of a wound spray and as a coating on medical devices that are introduced into our bodies. This new step in the research means that the innovation can be used in more ways and be of even greater benefit in health care.

The studies are published in the *International Journal of Pharmaceutics* and *ACS Applied Bio Materials*.

Kills bacteria without adversely affecting wound healing

The wound spray, which can reach into deep wounds and other open areas on the body where bacteria can enter, is flexible and very useful for treating and preventing infection. The new material has many advantages over existing sprays and disinfectants

"The substance in this wound spray is completely non-toxic and does not affect human cells. Unlike existing bactericidal sprays, it does not inhibit the body's healing process. The materials, which are simply sprayed onto the wound, can also kill the bacteria in a shorter time," says Edvin Blomstrand, an industrial doctoral student at the Department of Chemistry and Chemical Engineering at Chalmers University of Technology and one of the lead authors of the scientific article.

Reduces the risk of infection from materials introduced into the body

For treatments in which materials such as implants and catheters are inserted into our bodies, infections are a major problem. Therefore, there is great need for new antibacterial biomaterials, i.e., materials that treat, replace or modify organs, tissue or functions in a biological body. One of the major sources for hospital-acquired infection comes from the usage of urinary catheters. The Chalmers researchers' new coating can now be an effective new tool for reducing this risk and preventing infections.

"Although the catheters are sterile when unpacked, they can become

contaminated with bacteria while they are being introduced into the body, which can lead to infection. One major advantage of this coating is that the bacteria are killed as soon as they come into contact with the surface. Another is that it can be applied to existing products that are already used in health care, so it is not necessary to produce new ones," says Annija Stepulane, a doctoral student at the Department of Chemistry and Chemical Engineering at Chalmers and one of the lead authors of the article.

In the study, the researchers tested the coating on silicone materials used for catheters, but they see opportunities to use it on other biomaterials.

Research in parallel with product development

The research on the antibacterial materials is being conducted in collaboration with the spin-off company Amferia AB, which is also commercializing the technology. Chalmers and Amferia have previously presented the antibacterial material in the form of hydrogel wound dressings, which are presently under clinical investigation for both human and animal wound care.

More about the research and the new materials

The beneficial properties of antimicrobial peptides have been known for many years. They exist in thousands of different variants in the natural immune systems of humans, animals and plants, and researchers have long sought to mimic and harness the peptides to prevent and treat infection.

In their natural state, these peptides are rapidly broken down when they come into contact with body fluids such as blood, which makes their direct clinical use difficult. In the materials the researchers are

developing, they have solved this problem by binding the peptides to particles. For both the spray and the coating, they have been able to measure that the bactericidal effect of the materials lasts for up to 48 hours in contact with body fluids and as long as a few years without contact with body fluids.

The researchers have shown that 99.99% of bacteria are killed by the material and that the bactericidal capacity is active for approximately 48 hours, enabling its use in a wide range of clinical applications. Since the materials are non-toxic, they can be used directly on or in the body, preventing or curing an infection without adversely affecting the natural healing process.

More information: Edvin Blomstrand et al, Cross-linked lyotropic liquid crystal particles functionalized with antimicrobial peptides, *International Journal of Pharmaceutics* (2022). DOI: 10.1016/j.ijpharm.2022.122215

Annija Stepulane et al, Multifunctional Surface Modification of PDMS for Antibacterial Contact Killing and Drug-Delivery of Polar, Nonpolar, and Amphiphilic Drugs, *ACS Applied Bio Materials* (2022). DOI: 10.1021/acsabm.2c00705

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