Hydrogel with potent antibacterial activity promises to protect hospital patients from difficult-to-treat infections

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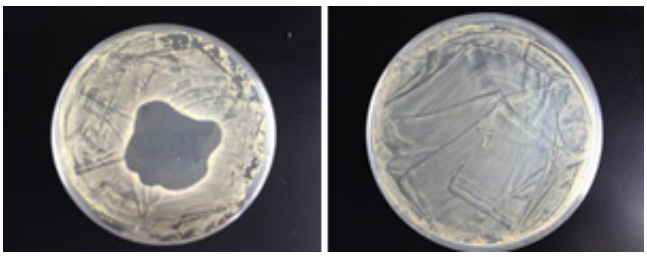

An antibacterial hydrogel coated onto the center of a Petri dish (left) prevents bacterial growth, whereas an untreated Petri dish (right) is completely covered with bacteria. Credit: 2012 Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim

Coating medical supplies with an antimicrobial material is one approach that bioengineers are using to combat the increasing spread of multidrug-resistant bacteria. Multidrug-resistant Staphylococcus aureus (MRSA) and related pathogens, for example, can lengthen hospital stay and even cause death. A research team at the A*STAR Institute of Bioengineering and Nanotechnology in Singapore has now developed a highly effective antimicrobial coating based on polymers. The coating can be applied to medical equipment, such as catheters, explains Yi-Yan Yang, who led the research.

Yang's coating was inspired by a well-known family of antimicrobial materials called cationic polymers. On contact, these materials kill

microbes by attaching to, infiltrating and ultimately rupturing their cell walls. When these polymers are modified to form a coating, however, their antimicrobial activity is usually compromised. They also tend to accumulate a layer of dead microorganisms on their surface. "This can trigger an immune response and inflammation in the patient, and may also block the antimicrobial function of the coating," Yang explains.

To overcome these limitations, Yang and her team developed their polymer-based hydrogel coating to have antifouling as well as potent antimicrobial properties. They made the coating by combining a 'block' of poly(ethylene glycol) (PEG)—which is known for its fouling resistance—with a polycarbonate. They then made the polycarbonate block functional by adding two components: cationic groups to capture passing pathogens; and water-repellent hydrophobic units to puncture their lipid-rich cell membranes and kill the cell.

Yang and her team showed that their gel coating was highly effective at killing a range of multidrug-resistant bacteria and fungi and preventing pathogens from growing on surfaces (see image). A simple rinse with a buffer solution was sufficient to remove the dead cells, confirming the coating's antifouling capabilities. The team also confirmed that the coating is harmless to red blood cells and does not irritate the skin.

Furthermore, the researchers showed that the hydrogel could be added to the surface of a standard hospital catheter, preventing microbial growth. As the coating can be formed under mild, physiological conditions, the hydrogels can also be used as a wound dressing, Yang notes. "For example, hydrogel dressings could form after spraying the gel precursor solution onto wounds," she says.

According to Yang, the research team's next step will be to investigate wound healing using these gels in animal studies. "At the same time, we will also seek industry partners to help commercialize these hydrogels,

especially for medical device coating applications," she says.

More information: Liu, S. Q., Yang, C., Huang, Y., Ding, X., Li, Y. et al. Antimicrobial and antifouling hydrogels formed in situ from polycarbonate and poly(ethylene glycol) via Michael addition. *Advanced Materials* 24, 6484–6489 (2012). onlinelibrary.wiley.com/doi/10 … a.201202225/abstract

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