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New treatment pairs blue light with food-safe plant oil to safely wipe out surface bacteria

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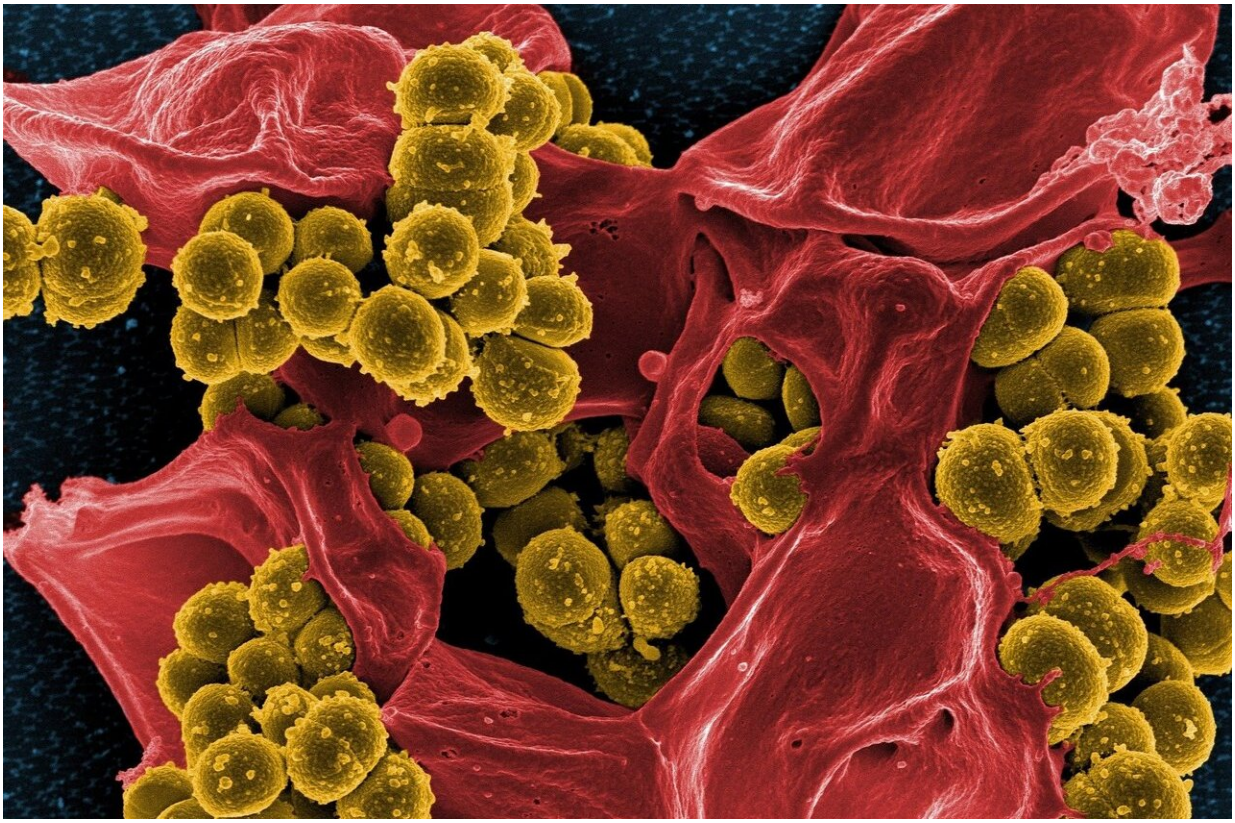

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A new treatment for eliminating surface bacteria using blue light and carvacrol, a phenol derived from edible oils, creates a photoxic, bacteria-specific reaction that does not contribute to antibiotic resistance. The

technique, developed by researchers from Harvard Medical School and Shanghai Jiao Tong University School of Medicine, is described in *Science Translational Medicine*.

Oral and topical antibiotics have been in wide use since the 1940s, when they saved the lives and limbs of thousands of soldiers and injured civilians in WWII. It is difficult to overstate how many lives have been saved or improved through antibiotic pharmacology, but the efficacy of many standby treatments is now rapidly declining as bacteria mutates to withstand our common treatments.

"Multidrug-resistant (MDR) bacteria have become one of the biggest threats to the public healthcare of our time and we are fast running out of treatment options because fewer and fewer antibiotics are available to treat these infections. The infections are associated with high mortality, leading to approximately 35,000 deaths each year in the United States alone," says Dr. Mei X. Wu, Associate Professor at Harvard Medical School and corresponding author of the research. But loss of life is not the only factor contributing to damages from antibacterial resistance. "An estimated cost of antibiotic resistance is in excess of 55 billion dollars annually when loss of productivity is included in the estimate," Dr. Wu adds.

While multiple methods for treating internal infection are in development, this two-step treatment is perfectly suited for effective, easy treatment of surface wound infections. Dr. Wu describes the process: "We combine carvacrol, an ingredient of edible oils, with blue light to safely and quickly kill multiple MDR bacterial pathogens quickly without incurring any resistance. ... This modality may be an alternative for patients, especially, diabetic patients with skin wound infections which cannot be treated effectively with antibiotics." Such wounds are difficult to treat and cause considerable discomfort and secondary infections.

Carvacrol is a phenol compound long used as a preservative in food production; it is derived from thyme and oregano essential oils, occurs naturally in many edible plants, and is safe for topical and internal use. The therapy entails treating a surface wound with carvacrol and then applying blue light to create a bacteria-specific phototoxic reaction. The treatment "may be used at home conveniently as carvacrol is edible and blue light has been safely used in clinics for treatment of acne and neonatal jaundice," explains Dr. Wu.

The study focused on Acinetobacter baumannii and methicillin-resistant Staphylococcus aureus, two prevalent pathogenic bacteria that are notoriously difficult to treat with currently approved methods. Additionally, mice infected with lethal Pseudomonas aeruginosa were saved using the new strategy.

From the research: "Mechanistic studies revealed that carvacrol was photocatalytically oxidized into a series of photoreactive substrates that underwent photolysis or additional photosensitization reactions in response to the same blue light, forming two autoxidation cycles that interacted with each other resulting in robust generation of cytotoxic reactive oxygen species." With one application, researchers found that substantial or complete eradication of biofilm bacteria with few or no adverse reactions in the patient. After 20 repeat applications, the researchers found no antibacterial resistance. Neither carvacrol nor blue light alone produced comparable results.

"A study with a large animal like swine is needed to verify the efficacy prior to clinical study," Dr. Wu explains, in order to obtain FDA approval. If the treatment is found effective, it will be relatively low cost and easy enough to self-administer at home.

More information: Min Lu et al. Bacteria-specific phototoxic reactions triggered by blue light and phytochemical carvacrol, *Science*

Translational Medicine (2021). DOI: 10.1126/scitranslmed.aba3571