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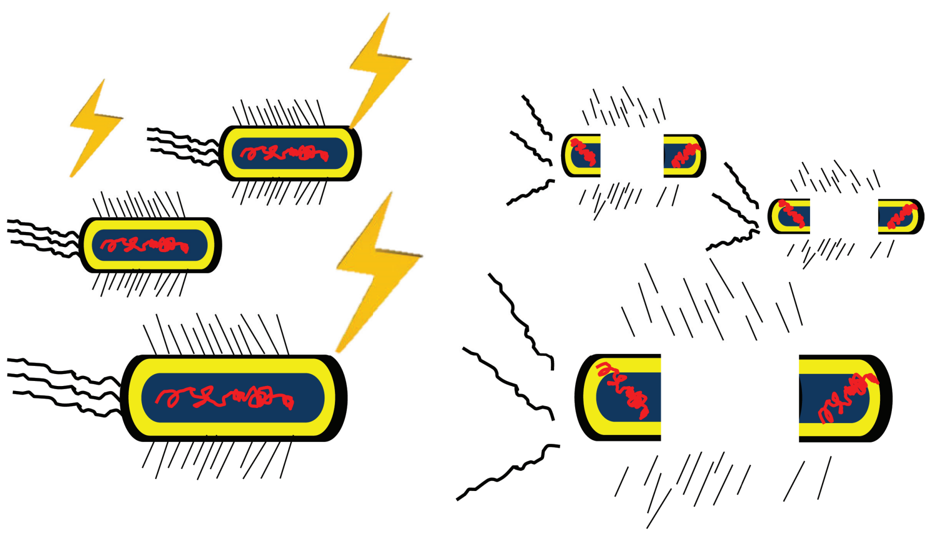
PRESS RELEASE

Pulsed electrical fields destroy antibiotic-resistant bacteria infecting burn injuries

MGH researchers test novel approach to disinfecting wounds in animal study



Pulsed electric fields kill infectious bacteria.

BOSTON — Application of a technology currently used to disinfect food products may help to get around one of the most challenging problems in medicine today, the proliferation of bacteria resistant to antibiotics and other antimicrobial drugs. In a paper appearing in the June issue of the journal *Technology* and already released online, investigators from the Massachusetts General Hospital (MGH) Center for Engineering in Medicine describe how the use of microsecond-pulsed, high-voltage non-thermal electric fields successfully killed resistant bacteria infecting experimentally induced burns in mice, reducing bacterial levels up to 10,000-fold.

"Pulsed electrical field technology has the advantages of targeting numerous bacterial species and penetrating the full thickness of a wound," says Alexander Golberg, PhD, of the MGH Center for Engineering in Medicine (MGH-CEM), first author of the paper. "This could lead to a completely new means of burn wound disinfection without using antibiotics, which can increase bacterial resistance."

About 500,000 individuals are treated for burn injuries in the U.S. each year. Standard burn treatment involves removal of burned tissue, skin grafts, and the application of antiseptic and antimicrobial dressings to prevent and treat infection. The growing prevalence of antibiotic-resistant bacteria — including strains of *Acinetobacter baumannii* and *Staphylococcus aureus* — is behind the frequent failure of antibiotic treatment, necessitating novel approaches to eliminate infecting pathogens.

Pulsed electrical fields (PEFs) have been used for decades to preserve food by destroying bacteria, presumably by causing the formation of large pores in the bacterial membrane; and more recently PEF's have been used to treat solid tumors. Members of the MGH research team, led by Martin Yarmush, MD, PhD, director of the MGH-CEM, have previously used

PEF to study scarless skin regeneration and are currently investigating use of the technology to improve wound healing. Theorizing that the procedure could improve management of wound infection, the researchers designed the current study.

The investigators applied a multidrug resistant strain of *A. baumannii* to small third-degree burns that had been made on the backs of anesthetized mice. After 40 minutes, during which imaging of the fluorescent bacteria confirmed the established infection, the burned area was treated with an electrical field generated by placing the damaged skin between two electrodes. Each animal received two 40-pulse treatments five minutes apart, one group receiving 250 V/mm pulses and another receiving 500 V/mm pulses.

Images taken right after each treatment showed pronounced drops in bacterial levels. While images taken three hours later showed some bacterial regrowth, the overall results confirmed a persistent reduction in bacterial levels, ranging from a 500-fold reduction after 80 pulses at 250 V/mm volts to a more than 10,000-fold reduction after 80 pulses at 500 V/mm. The researchers also found that increasing the number of pulses per treatment had a greater effect on bacterial reduction than did increasing the strength of the electric field. Additional investigation is needed to confirm the safety of the tested voltage levels and the treatment's effectiveness against deep infections and other species of resistant bacteria.

"Currently available technologies have not been able to solve the problem of multidrug-resistant burn wound infections, and lasers are unable to treat infections deep within a wound because of the scattering and absorption of light," says Yarmush, who is senior author of the *Technology* paper. "Pulsed electric fields are a previously unexplored technique that has the potential to provide a chemical-free way of disinfecting burns and other wound infections."

Golberg is a research fellow in the MGH Department of Surgery, and Yarmush is a faculty member in MGH Surgery and in the Harvard-MIT Division of Health Science. Golberg previously presented this work at the 46th American Burn Association conference in March, where it received the 2014 Robert B. Lindberg Award for the best scientific paper by a nonphysician.

Additional co-authors of the *Technology* paper are Felix Broelsch, MD, Saiqa Khan, MD, and William Austen, Jr., MD, MGH Division of Plastic and Reconstructive Surgery; Daniela Vecchio, PhD, and Michael Hamblin, PhD, Wellman Center for Photomedicine at MGH; and Robert Sheridan, MD, Sumner Redstone Burn Center at MGH. The study was supported by the MGH Fund for Medical Discovery and Shriners Hospitals for Children grant 85120-BOS.

Massachusetts General Hospital (www.massgeneral.org), founded in 1811, is the original and largest teaching hospital of Harvard Medical School. The MGH conducts the largest hospital-based research program in the United States, with an annual research budget of more than $785 million and major research centers in AIDS, cardiovascular research, cancer, computational and integrative biology, cutaneous biology, human genetics, medical imaging, neurodegenerative disorders, regenerative medicine, reproductive biology, systems biology, transplantation biology and photomedicine.

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