

## LETTERS TO THE EDITOR

## Effectiveness of an Electrochemically Activated Saline Solution for Disinfection of Hospital Equipment

*To the Editor*—Hospital equipment that touches patients (eg, blood pressure cuffs, bedside commodes) frequently becomes contaminated with pathogens such as *Clostridium difficile*, methicillin-resistant *Staphylococcus aureus* (MRSA), and vancomycin-resistant enterococci (VRE).<sup>1–6</sup> Because equipment is often shared among patients, there is a need for simple and effective disinfection methods that include activity against *C. difficile* spores.

Electrochemically activated saline solutions are broad-spectrum disinfectants with sporicidal activity that are generated by passing saline solution through an electrolytic cell, resulting in production of hypochlorous acid and free radicals.<sup>7–9</sup> They are commonly used for disinfection of dental equipment and endoscopes, washing fruits and vegetables, and swimming pool sanitation. One formulation (ie, Vashe, PuriCore) is approved for wound care,<sup>9</sup> suggesting that these solutions may have a low propensity for skin and mucous membrane irritation. Here, we tested the hypothesis that spraying equipment with electrochemically activated saline containing 0.05% hypochlorous acid (Sterilox HG, PuriCore) would reduce bacterial contamination, including *C. difficile* spores, on equipment.

The study protocol was approved by the Cleveland Veterans Affairs Medical Center's Institutional Review Board. The in vitro efficacy of Sterilox HG was compared with a 1 : 10 dilution of household bleach (ie, ~5,000 ppm free chlorine) for killing spores of 3 strains each of *C. difficile* (a restriction endonuclease analysis type BI isolate and American Type Culture Collection strains 43593 and 43601), VRE (C68, a VanB-type isolate, and C37 and C25, VanA-type isolates), and MRSA (pulsed-field gel electrophoresis types USA300 and USA800 and ATCC strain 43300). *C. difficile* spores were prepared as previously described.<sup>10</sup> Ten-microliter aliquots containing ~6 log<sub>10</sub> colony-forming units (CFUs) of the organisms suspended in deionized water with or without simulated organic load containing bovine serum albumin, tryptone, and mucin (0.5 : 5 : 0.4% w/v) were spread to cover 1-cm-diameter polystyrene cell culture wells (nest cell culture plate, Denville Scientific). After the suspensions air dried, 300 µL of deionized water, Sterilox HG, or 10% household bleach (Clorox) was added. After 10 minutes of contact time, 1 mL of Dey-Engley neutralizer (Remel) was added, and viable organisms were quantified by plating on media selective for each pathogen.<sup>10</sup> Although the complete experiments included only a 10-minute contact time, preliminary experiments with the 3 *C. difficile* strains did demonstrate equivalent killing of spores at 5 and 10 minutes for both bleach and

Sterilox HG, respectively. The experiments were repeated 3 times.

On hospital wards, we evaluated Sterilox HG for disinfection of wall-mounted equipment in patient rooms (ie, blood pressure cuffs, thermometer handles, and pulse oximetry finger probes), portable vital signs equipment units, intravenous medication pumps, and bedside commodes. Cultures were collected from half of the surface area of each set of objects, using sterile swabs (BD BBL CultureSwab, Becton Dickinson) followed by sterile gauze, both premoistened with Dey-Engley neutralizer (Remel). The equipment was sprayed with Sterilox HG in sufficient quantities to thoroughly wet the surfaces (~6 sprays at one time). The surfaces were allowed to air dry (~15–30 minutes for complete drying), and the other half of the surface area was cultured. Cultures for *C. difficile* were processed as previously described.<sup>10</sup> The swabs were also plated onto 5% sheep blood tryptic soy agar plates (Becton Dickinson) to quantify total aerobic and facultative bacteria. A Fisher exact test was used to compare the percentages of positive cultures, and paired *t* tests were used to compare mean CFUs recovered before versus after application of Sterilox HG.

Sterilox HG or 10% household bleach resulted in a 5 log<sub>10</sub> or greater CFU reduction of *C. difficile* spores, VRE, and MRSA in 10 minutes, but effectiveness of both disinfectants

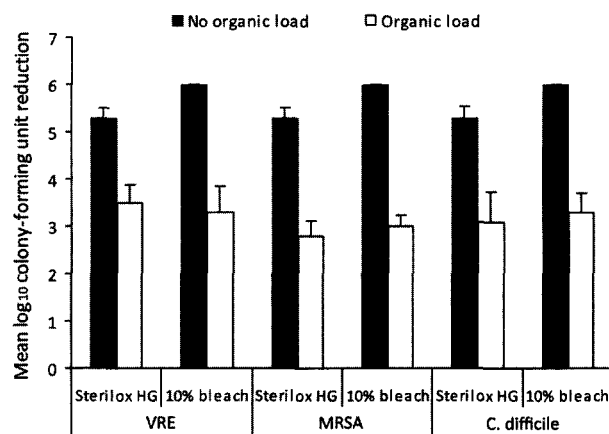


FIGURE 1. Mean log reduction in recovery of 3 strains each of *Clostridium difficile*, methicillin-resistant *Staphylococcus aureus* (MRSA), and vancomycin-resistant *Enterococcus* (VRE) from polystyrene surfaces after application of Sterilox HG or 10% household bleach solution. Ten-microliter aliquots containing ~6 log<sub>10</sub> colony-forming units of the organisms were spread to cover a 1-cm<sup>2</sup> area and allowed to air dry. The surfaces were sprayed with Sterilox HG or 10% household bleach. After 10 minutes of contact time with the solutions, 1 mL of Dey-Engley neutralizer was added, and serial dilutions were cultured on selective media. Log reductions were calculated. Error bars show standard error.

was reduced in the presence of organic load (Figure 1). On patient wards, application of Sterilox HG resulted in significant reductions in total aerobic and facultative bacterial counts (mean CFU, 39 vs 0.73;  $P = .0003$ ) and in positive *C. difficile* cultures (8/66 [12%] vs 0/66;  $P = .006$ ). Spraying of Sterilox HG on sets of equipment was simple and required only approximately 15 seconds per application. Application of Sterilox HG did not result in production of noticeable noxious fumes but was described as producing an odor similar to that of swimming pool water. There were no reported complaints from nursing staff or patients.

Our results demonstrate that spraying equipment with an electrochemically activated saline solution is a simple and effective means to reduce contamination with *C. difficile* and other healthcare-associated pathogens. The potential advantages of this method for equipment disinfection include efficiency, ability to maintain sufficient disinfectant contact time when surfaces were thoroughly sprayed, thorough application of disinfectant on objects with irregular surfaces that might be difficult to reach with a cloth, relatively low risk for skin or respiratory irritation, and ability to perform disinfection in patient care areas. Potential disadvantages of this method include lack of mechanical removal of pathogens and organic material, dependence on the operator to apply sufficient disinfectant to thoroughly wet the surfaces, and infeasibility of leaving sprayed surfaces to air dry for 15–30 minutes if equipment is needed for immediate reuse.

Our study has some limitations. A small number of strains were tested, and only 1 disinfectant was tested as a comparator to Sterilox HG. We did not perform a complete assessment of materials compatibility and did not determine the effect of different surfaces on effectiveness of Sterilox. Finally, only a 10-minute contact time was used in the complete set of laboratory studies.

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#### REFERENCES

1. Manian FA, Meyer L, Jenne J. *Clostridium difficile* contamination of blood pressure cuffs: a call for a closer look at gloving practices in the era of universal precautions. *Infect Control Hosp Epidemiol* 1996;17:180–182.
2. Walker N, Gupta R, Cheesbrough J. Blood pressure cuffs: friend or foe? *J Hosp Infect* 2006;63:167–169.
3. Porwancher R, Sheth A, Remphrey S, Taylor E, Hinkle C, Zervos M. Epidemiological study of hospital acquired infection with vancomycin-resistant *Enterococcus faecium*: possible transmission by an ear-probe thermometer. *Infect Control Hosp Epidemiol* 1997;18:771–774.
4. Livornese LL, Dias S, Samuel C, et al. Hospital-acquired infection with vancomycin-resistant *Enterococcus faecium* transmitted by electronic thermometers. *Ann Intern Med* 1992;117:112–116.
5. Brooks SE, Veal RO, Kramer M, et al. Reduction in the incidence of *Clostridium difficile*-associated diarrhea in an acute care hospital and a skilled nursing facility following replacement of electronic thermometers with single-use disposables. *Infect Control Hosp Epidemiol* 1992;12:98–103.
6. Jernigan JA, Siegman-Igra Y, Guerrant RC, Farr BM. A randomized crossover study of disposable thermometers for prevention of *Clostridium difficile* and other nosocomial infections. *Infect Control Hosp Epidemiol* 1998;19:494–499.
7. Shetty N, Srinivasan S, Holton J, Ridgway GL. Evaluation of microbicidal activity of a new disinfectant: Sterilox 2500 against *Clostridium difficile* spores, *Helicobacter pylori*, vancomycin resistant *Enterococcus* species, *Candida albicans* and several *Mycobacterium* species. *J Hosp Infect* 1999;41:101–105.
8. Selkon JB, Babb JR, Morris R. Evaluation of the antimicrobial activity of a new super-oxidized water, Sterilox, for the disinfection of endoscopes. *J Hosp Infect* 1999;41:59–70.
9. Niezgoda JA, Sordi PJ, Hermans MH. Evaluation of Vashe Wound Therapy in the clinical management of patients with chronic wounds. *Adv Skin Wound Care* 2010;23:352–357.
10. Nerandzic MM, Donskey CJ. Effective and reduced-cost modified selective medium for isolation of *Clostridium difficile*. *J Clin Microbiol* 2009;47:397–400.

## Peripheral Venous Catheter and Bloodstream Infection Caused by *Pseudomonas aeruginosa* after a Contaminated Preoperative Shower

*To the Editor*—*Pseudomonas aeruginosa*, a ubiquitous gram-negative bacillus frequently involved in healthcare-associated infections, is usually found in water-related environmental reservoirs—such as pipes, taps, or showers—where it develops in a naturally resistant and adherent biofilm.<sup>1</sup> Several *P.*