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Brief Report

Efficacy of a multi-purpose high level disinfection cabinet against *Candida auris* and other health care-associated pathogenJessica A. Kumar DO, MPH^{a,b}, Jennifer L. Cadnum BS^c, Annette L. Jencson CIC^c, Curtis J. Donskey MD^{a,b,*}^a Geriatric Research, Education, and Clinical Center, Cleveland Veterans Affairs Medical Center, Cleveland, OH^b Case Western Reserve University School of Medicine, Cleveland, OH^c Research Service, Cleveland VA Medical Center, Cleveland, OH

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Portable equipment and other small devices used in health care are a potential source for dissemination of pathogens. We demonstrated that a high-level disinfection cabinet using ultrasonic submicron droplets of peracetic acid and hydrogen peroxide was effective against methicillin-resistant *Staphylococcus aureus*, *Clostridioides difficile* spores, the nonenveloped virus bacteriophage MS2, and *Candida auris* on steel disk carriers. The device also eliminated *Candida auris* inoculated on real-world items of portable equipment.

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Portable equipment and other shared items are a potential source for transmission of health care-associated pathogens.¹ For example, a recent outbreak of the emerging multidrug-resistant fungal pathogen *Candida auris* was linked to contamination of shared temperature probes.² Although it is recommended that reusable portable equipment that contacts intact skin be cleaned and decontaminated after each patient use, decontamination of equipment is often suboptimal in practice.^{1,3} Moreover, some equipment may be difficult to clean manually due to presence of irregular surfaces (eg, vital signs equipment, keyboard) or may not be amenable to application of liquid disinfectants (eg, electronic equipment).¹

Devices that generate an aerosol (hydrogen peroxide or peracetic acid) or vapor (hydrogen peroxide) have been shown to be highly effective for decontamination of surfaces in patient rooms.^{1,4,5} These technologies could potentially be useful for decontamination of difficult to disinfect equipment as the disinfectant gas or aerosol may provide thorough coverage of aerated surfaces with relatively little risk for damage to equipment. This method also has the advantage of eliminating the variability inherent in manual cleaning. In the current study, we examined the efficacy and safety of a new portable decontamination

cabinet that generates submicron droplets of aerosolized peracetic acid and hydrogen peroxide for decontamination of medical equipment.

METHODS

The Multi-Purpose High-Level Disinfection Cabinet (Altapure, Mequon, WI) is a portable enclosed cabinet on wheels that contains ultrasonic fogging and air scrubber devices. The outside dimensions of the cabinet are 72 by 36 by 24 inches and the dimensions of the disinfection chamber are 54 by 27.7 by 12 inches. The device is computer operated with a wireless data reporting system which is plugged into a standard electrical outlet. Upon activation, the ultrasonic fogging device converts a concentrated disinfectant solution (22% hydrogen peroxide and 4.5% peracetic acid) into 0.69-micron droplets containing 0.88% hydrogen peroxide, 0.18% peracetic acid, and 0.36% acetic acid that disseminate throughout the disinfection chamber. The complete operation cycle requires 21 minutes, including 1 minute of fogging, 5 minutes of dwell time, and 15 minutes of scrubbing and dehumidification during which peracetic acid, hydrogen peroxide, and acetic acid are removed by passing through activated charcoal filters. The cost of the concentrated solution is approximately \$0.20 per cycle. The manufacturer recommends that personnel using the device wear gloves and goggles while filling the device with the concentrate.

We tested the efficacy of the device against 1 strain each of methicillin-resistant *Staphylococcus aureus* (MRSA) (a clinical isolate with pulsed-field gel electrophoresis type USA400), *Clostridioides difficile* spores (American Type Culture Collection number 43598), and bacteriophage MS2 (American Type Culture Collection number 15597-B1) using a modification of the American Society for Testing and Materials standard quantitative carrier disk test method (ASTM E-2197-11).⁶ We

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also tested the device against *Candida albicans* and several species of *C. auris* (Centers for Disease Control and Prevention strain AR-BANK #0381 from Japan, #0383 from South Africa, #0386 from Venezuela, and #0389 from India) using a modification of the methods recommended by the Environmental Protection Agency (EPA) for testing liquid antimicrobials against *C. auris* (EPA MLB SOP MB-35-00).⁷ Ten microliter aliquots containing $\sim 6 \log_{10}$ colony forming units (CFU) of pathogens in 5% fetal calf serum were spread to cover 20-mm steel disk carriers and air dried. The carriers were placed on top of petri dishes inside the device cabinet and exposed to the 20-minute disinfection cycle. Additional testing was performed with carriers placed in different locations in the cabinet (top, middle, and floor). We also examined reduction of *C. auris* 0381 on carriers placed at the bottom of 20 mL polypropylene vials (Cole-Parmer, Vernon Hills, IL) and *C. auris* 0381 inoculated on a bed rail, call button, stethoscope, and blood pressure cuff. All samples were tested in triplicate.

After treatment, the steel disk carriers were neutralized with 1 mL of Lethen broth, vortexed, serially diluted, and plated onto selective media.⁸ For real-world items, premoistened rayon swabs were used to sample the area inoculated and the swabs were vortexed in 1 mL of Lethen broth and processed as described previously. \log_{10} CFU or plaque forming unit (PFU) reductions were calculated in comparison to untreated control carriers.

As an additional means to evaluate efficacy, we assessed the ability of the device to eliminate growth of 2.0×10^6 *Geobacillus stearothermophilus* spores (Apex Biological Indicators, MesaLabs, Bozeman, MT) according to the manufacturer's instructions. To assess safety of the device, badge units (Advanced Chemical Sensors, Boca Raton, FL) were worn by an operator and placed 3 feet from the device to measure acetic acid exposure during a 4-hour period when the device was filled with concentrate and operated.

RESULTS

The cabinet device eliminated all organisms tested ($\geq 5 \log_{10}$ CFU or PFU reduction) on steel disk carriers, including those placed in different locations within the disinfection chamber. *C. auris* 0381 was eliminated from carriers placed at the bottom of a polypropylene cup and from the inoculated real-world items. The device was also effective in killing the *G. stearothermophilus* biological indicator spores. Based on the air samples collected over 4 hours of device operation, the measured concentrations of acetic acid were <0.2 parts per million (ppm) and the calculated exposure was 0.2 ppm for 5 hours. These acetic acid values are below the National Institute for Occupational Safety and Health (NIOSH)-recommended permissible exposure limit of 10 ppm as an 8-hour time-weighted average.

DISCUSSION

We found that a high-level disinfection cabinet using ultrasonic submicron droplets of peracetic acid and hydrogen peroxide was

effective in reducing *C. auris*, MRSA, *C. difficile* spores, and the non-enveloped virus bacteriophage MS2 on steel carriers. The device was also effective in reducing *C. auris* on portable equipment and in killing *G. stearothermophilus* biological indicator spores. These results suggest that the device could be useful for disinfection of portable equipment used in health care facilities.

The technology has some potential limitations. The droplets will not penetrate spaces that are not aerated. Thus, enclosed areas such as drawers must be fully opened to allow entry of the disinfectant. The disinfection chamber is not large enough to accommodate larger types of equipment. Because peracetic acid and hydrogen peroxide are potential health hazards, facilities using the device must follow standardized protocols to ensure the safety of personnel. Gloves and goggles should be worn while filling the device with the concentrated solution. Although our results and the testing conducted by the manufacturer suggest that the air scrubbing process is effective in reducing concentrations of peracetic acid and hydrogen peroxide to safe levels, intermittent testing should be conducted by facilities using the device.

In summary, a high-level disinfection cabinet using ultrasonic submicron droplets of peracetic acid and hydrogen peroxide was effective in reducing pathogens on inoculated steel disk carriers and real-world equipment. Additional studies are needed to examine elimination of pathogens from devices being used in real-world health care settings. There is also a need for studies to compare the efficacy of the device with other technologies used for decontamination of equipment such as ultraviolet light.

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