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Brief report

Effectiveness of improved hydrogen peroxide in decontaminating privacy curtains contaminated with multidrug-resistant pathogens

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We tested the ability of an improved hydrogen peroxide solution to decontaminate privacy curtains in inpatient and outpatient areas. The microbial contamination of the curtains was assessed before and after the curtains were sprayed with improved hydrogen peroxide. The disinfectant reduced the microbial load on the privacy curtains by 96.8% in 37 patient rooms.

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Hospital curtains that surround patients' beds to provide privacy have been shown to become contaminated and can be a source of pathogens on the hands or gloves of health care personnel.¹⁻³ It has been reported that health care personnel are less likely to perform hand hygiene after contact with inanimate objects such as curtains than after direct contact with patients; thus, the pathogens on curtains could travel to patients via the contaminated hands of health care personnel.⁴ Because privacy curtains are normally not changed until visibly contaminated or using an infrequent routine (eg, 3-6 months), they may represent a reservoir for health care-associated pathogens such as methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococcus* (VRE), *Clostridium difficile*, or other multidrug-resistant pathogens.

The purpose of our study was to evaluate the ability of an improved hydrogen peroxide (IHP) solution to decontaminate privacy curtains that were potentially contaminated with MRSA, VRE, and other pathogens.

METHODS

A convenience sample of privacy curtains in 27 inpatient rooms (18 rooms following contact precaution guidelines recommended by the Centers for Disease Control and Prevention for reducing the

risk of transmission of epidemiologically important microorganisms by direct or indirect contact [8 MRSA, 6 VRE, 3 other multidrug-resistant pathogens, and 1 MRSA plus VRE], 4 rooms following contact enteric precautions guidelines for *C difficile*, and 5 nonisolation rooms), and 10 outpatient areas (10 emergency department rooms [3 of which were isolation rooms]) were cultured using replicate organism detection and counting (Rodac; BD, Franklin Lakes, NJ) plates containing D/E Neutralizing Agar (BD), which is effective in neutralizing hydrogen peroxide. Before culturing the 100% flame retardant privacy curtains (Designtex, New York, NY), a black marker was used to place 10 dots along the grab area of the curtain approximately 3 in apart, starting at a height of approximately 6 ft (roughly 3-6 feet above the floor). Rodac plates were used to sample each area indicated by a dot by positioning the dot at the center of each plate. Once the Rodac surface (~25 cm²) made contact with the curtain area to be sampled, the plate was gently turned upright while keeping the surface of the curtain in place, and ~1 lb pressure was uniformly applied over the Rodac plate surface. Five Rodac plate samples were collected before curtain disinfection, starting with the highest dot and then culturing alternating dots thereafter. Then the curtain was disinfected by spraying the grab area 3 times, from a distance of 6-8 in, with an Environmental Protection Agency-registered 1.4% IHP (Clorox Healthcare Hydrogen Peroxide Cleaner Disinfectant; The Clorox Company, Oakland, CA). After a contact time of 2 minutes, 5 additional postdisinfection cultures were collected in the manner described above using the alternate dot sites that had not previously been sampled. Following collection, samples were incubated at 37°C for 48 hours, then total colony forming units (CFU) counts were determined. Based on colony morphology, isolates were

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Conflicts of interest: W.A. Rutala is a consultant for The Clorox Company, Oakland, CA, and Advanced Sterilization Products, Irvine, CA. D.J. Weber is a consultant for The Clorox Company, and Johnson & Johnson, New Brunswick, NJ.

Table 1

Evaluation of improved hydrogen peroxide to decontaminate hospital privacy curtains in contact precaution patient rooms (for methicillin-resistant *Staphylococcus aureus* [MRSA] or Vancomycin-resistant *Enterococcus* [VRE]) in an intensive care unit

Contact precaution status (organism)	Before disinfection CFU/curtain*		After disinfection CFU/curtain*		
	Total CFU	MRSA/VRE	Total CFU	MRSA/VRE	Reduction %
MRSA	330	10 MRSA	21 [†]	0 MRSA	93.6
MRSA	186	24 VRE	4 [†]	0 VRE	97.9
MRSA	108	10 VRE	2 [†]	0 VRE	98.2
VRE	75	4 VRE	0	0 VRE	100
VRE	68	2 MRSA	2 [†]	0 MRSA	97.1
VRE	98	40 VRE	1 [†]	0 VRE	99.0
MRSA	618	341 MRSA	1 [†]	0 MRSA	99.8
MRSA	55	1 VRE	0	0 MRSA	100
MRSA, VRE	320	0 MRSA, 0 VRE	1 [†]	0 MRSA, 0 VRE	99.7
MRSA	288	0 MRSA	1 [†]	0 MRSA	99.7
Mean	2,146 CFUs/10 curtains = 215 CFU/curtain	(432 MRSA or VRE/10 curtains = 43 MRSA or VRE/curtain)	33 CFU/10 curtains = 3 CFU/curtain	0 MRSA, 0 VRE/curtain	98.5

CFU, colony forming units.

*Five replicate organism detection and counting (Rodac) plates were used to sample each curtain before and after disinfection; thus, a mean of 43 MRSA or VRE per curtain represents 43 CFU/5 Rodac plates per curtain (or on average, 8.6 CFU/Rodac) or (215 CFU/curtain represents 43 CFU/Rodac).

[†]Represents *Bacillus* species; 100% of the isolates recovered after disinfection were *Bacillus* species.

Table 2

Evaluation of improved hydrogen peroxide to decontaminate hospital privacy curtains in patient rooms in selected locations

Area or pathogen	Rooms n	Before disinfection CFU/curtain*		CFU/curtain before disinfection*	After disinfection CFU/curtain*		CFU/curtain after disinfection*	Reduction %
		Total CFU	Pathogens, n		Total CFU	Pathogens, n		
CP (<i>C difficile</i>), non-ICU	4	86	0	22	0	0	0	100
CP (2 MRSA, 3 VRE), non-ICU	5	806	0	161	21 [†]	0	4	97.4
CP (<i>E coli</i> ESBL) 2 ICU, 1 non-ICU	3	376	0	125	6 [†]	0	2	98.4
ED (7 non-isolation; 3 isolation), outpatient	10	5,623	(7 MRSA, 5 VRE isolated from non-isolation patient rooms)	562	160/153 [†]	0	16	97.2
Inpatient rooms, non-ICU	5	604	0	121	82 [†]	0	16	86.4

C diff, *Clostridium difficile*; CFU, colony forming units; CP, contact precautions; *E coli* ESBL, *Escherichia coli* extended spectrum beta lactamase; ED, emergency department; ICU, intensive care unit; MRSA, methicillin-resistant *Staphylococcus aureus*; VRE, vancomycin-resistant *Enterococcus*.

*Five replicate organism detection and counting (Rodac) plates were used to sample each curtain before and after disinfection; thus, 562 CFU/curtain represents 562 CFU/5 Rodac plates per curtain (or on average 112.4 CFU/Rodac).

[†]Represents *Bacillus* species; 97.5% of the isolates recovered after disinfection were *Bacillus* species; of the other 7 other isolates, 6 were fungi and 1 was *Micrococcus* sp.

selected and identified as MRSA, VRE, and epidemiologically important gram-negative rods using standard techniques.

In addition we also performed a wipe procedure on curtains in 10 intensive care unit (ICU) patient rooms following isolation precautions for MRSA and/or VRE. A 6.75-in × 9-in large IHP wipe (Clorox Healthcare Hydrogen Peroxide Cleaner Disinfectant Wipes) was applied to the front of the curtain (ie, the patient side) using a gloved hand placed on the back of the curtain as support. This was repeated on the opposite side but in no case were sites cultured that had just had gloved hand contact. After allowing a 2-minute contact time with the disinfectant, the postdisinfection samples were collected.

Confidence intervals (95% CIs) were calculated based on a Poisson distribution.

RESULTS

The IHP was found to reduce 96.8% (95% CI, 96.6-97.1) of the pathogens on the privacy curtains (Tables 1 and 2) in 37 patient rooms. In the ICU rooms of patients subject to contact precautions, the microbial contamination of the curtains ranged from 0-341 CFU with an average of 43 MRSA and/or VRE per curtain (median, 7 MRSA and/or VRE per curtain) (Tables 1 and 2). Postdisinfection, MRSA and VRE were completely eliminated (100% reduction) (95%

CI, 99.2-100). In 3 cases, VRE was found on the curtains of a patient subject to MRSA contact precautions and in 1 case MRSA was found on the curtain of a patient subject to contact precautions for VRE. In all 4 of these rooms, a patient with the same pathogen occupied that room during the previous 8-60 days.

Overall, the level of microbial contamination of privacy curtains was 260.6 CFU per curtain (9,641 CFU per 37 curtains using 5 Rodac plates per curtain), whereas the level of contamination of privacy curtains with epidemiologically important health care-associated pathogens (ie, MRSA and VRE) was 12 CFU per curtain (444 CFU per 37 curtains using 5 Rodac plates per curtain). Postdisinfection the microbial load dropped 96.9% (from 9,641 CFU to 302 CFU). Nearly all (97.7%; 295 out of 302) microbes remaining on the curtain after disinfection with the IHP were *Bacillus* spp, a spore-forming organism (Tables 1 and 2).

All of the privacy curtains tested were contaminated. Before disinfection, the curtains in the ICU isolation patient rooms were the most contaminated with epidemiologically important pathogens (36 CFU per curtain; 95% CI, 32.7-39.6), compared with in the outpatient emergency department (1.2 CFU per curtain; 95% CI, 0.6-2.1), inpatient floor isolation rooms (0 CFU per curtain; 95% CI, 0.0-0.7), and inpatient nonisolation rooms (0 CFU per curtain; 95% CI, 0-0.7).

We also evaluated a wipe technique and found an 88% reduction of microbial load (222 out of 1,878; 95% CI, 87.1-89.2) (data not

included in Tables 1 and 2). If 1 anomalous run was excluded, a 98.7% microbial reduction was found (18 out of 1,426; 95% CI, 98.1-99.2). Of note, the patient side of the curtain (129.8 CFU per curtain; 95% CI, 122.8-137.1) was more contaminated than the outside of the curtain (58.0 CFU per curtain; 95% CI, 53.4-62.8).

DISCUSSION

Substantial data have shown that contaminated surfaces (including curtains) in patient rooms are associated with hand contamination of health care personnel and risk of disease transmission to subsequent room occupants.^{5,6} For this reason, the Centers for Disease Control and Prevention recommend terminal room disinfection of environmental surfaces and equipment.⁷ Privacy curtains could serve as a source for epidemiologically important health care pathogens. Four studies have borne this out by demonstrating microbial contamination of hospital privacy curtains^{1-3,8} and 1 study assessed the decontamination of the privacy curtains using standard hydrogen peroxide.⁹ We found the level of contamination on curtains to be similar to other environmental surfaces (ie, precleaning microbial load on environmental surfaces was, on average, 44-72 CFU/Rodac and 52 CFU/Rodac for privacy curtains)¹⁰ and found IHP effective in providing decontamination of curtains as a source for hand contamination.¹¹ Based on the demonstration of contamination of curtains and our method of decontamination, we believe that curtains, as with other hand contact (ie, touchable) surfaces in a patient's room, should be decontaminated at some routine frequency (eg, discharge cleaning/disinfection).

All decontamination technologies have both advantages and disadvantages. A major advantage of IHP is that it has added constituents (eg, surfactants and chelating agents) to make it rapid-acting and with a broader antimicrobial spectrum.¹¹ At the concentration we tested the IHP would not be effective against *C difficile* spores. IHP also has low toxicity. A disadvantage is it is more expensive than a quaternary ammonium compound in ready-to-use containers. However, the cost of decontaminating a privacy curtain with IHP (product costs for 3 sprays per curtain was ~\$0.01 [2.5 mL/3 sprays]) would be far less than removing a curtain and replacing it with a new curtain between patients. We estimate that replacing curtains would cost \$4.72 per curtain based on the salary cost for an environmental service worker at University of North Carolina Health Care (~22 minutes to remove then rehang a curtain × \$12.87/hour salary). This does not include laundering costs nor increasing the turnover time from <15 seconds for

spraying to 10-20 minutes for rehangng the curtain. Other options to minimize the risk from curtains as reservoirs for health care-associated pathogens include eliminating privacy curtains for patients in private rooms (the door would be used for privacy but this would require support of nursing and medical staff), using disposable curtains, changing curtains at discharge of patients subject to contact precautions, and using an impregnated antimicrobial privacy curtain.¹²

CONCLUSIONS

IHP is an alternative to laundering privacy curtains between patients. The use of IHP could be easily integrated into health care practices where the occupancy is high and fast patient room turnaround time is critical.

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