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Major article

The silver lining of disposable sporicidal privacy curtains in an intensive care unit

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Background: The environment is a well-known source of health care-acquired infection. Because of the known risk of contamination, patient privacy curtains require frequent changes to decrease the risk of spread from patients to curtain and visa versa.

Methods: Fourteen disposable sporicidal privacy curtains were tested from December 2012 to June 2013 while hanging in a busy intensive care unit. Significant bacterial pathogens were identified and total bacteria enumerated as colony-forming units. Antimicrobial activity of curtain swatches was also tested against a range of bacteria in the laboratory. Measurements were recorded as zone of inhibition and contact inhibition. A cost analysis to replace standard curtains with disposable sporicidal curtains was also undertaken.

Results: Cultures grew low numbers of skin and environmental microorganisms with no methicillin-resistant *Staphylococcus aureus*, carbapenem-resistant Enterobacteriaceae, or *Clostridium difficile* detected. Vancomycin-resistant enterococci were recovered in very low numbers from 2 curtains where vancomycin-resistant enterococci-infected patients had been located. Privacy curtains demonstrated antimicrobial activity against *C difficile* and 13 additional bacterial pathogens.

Conclusion: We conclude that disposable sporicidal privacy curtains are cost-effective and best replaced at 6 months in a high-risk area such as an intensive care unit.

The environment is known to contribute to health care-acquired infection, and patient privacy curtains are no exception. Recent studies have found that standard (nonantimicrobial) curtains are rapidly contaminated by microorganisms that can be transferred to, or from, health care workers (HCW) hands, the patient, or the environment.[1-4] Most curtains are irregularly changed and thus may act as yet another environmental vehicle for transmission of potential pathogens. In our health service, patient privacy curtains are changed whenever a patient is discharged who has had diarrhea or colonized with a significant pathogen such as vancomycin-resistant enterococci (VRE).

Recently, a number of disposable antibacterial privacy curtains have been marketed as sporicidal and recommended to remain hanging in situ for 6 to 12 months. This appears to be despite the potential for contamination with *Clostridium difficile* and other significant pathogens.[5]

We sought to investigate the clinical use and persistence of antimicrobial activity on disposable sporicidal privacy curtain in a busy intensive care unit (ICU) over a 6-month period. Our study examined antimicrobial curtain performance against an extensive range of nosocomial and environmental microorganisms under laboratory conditions. Finally, we aimed to calculate the costs involved in replacing standard curtains with sporicidal privacy curtains in the ICU.

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Conflicts of interest: None to report.

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Table 1
Antimicrobial activity for sporicidal curtain swatches against a range of microorganisms

	ZOI detected (0-6 months)	CI day 0	CI 1, 2, 3 months	CI 6 months
Spores				
C difficile (spores)*	Y	NVG	SG, SG, LG	MG
Gram-positive bacteria				
Enterococcus faecium (van B gene) (LSS)	Y	NVG	NVG	NVG
Methicillin-resistant *Staphylococcus aureus* (ATCC BAA 1026)	Y	NVG	NVG	NVG
Staphylococcus aureus (ATCC 25923)	Y	NVG	NVG	NVG
Staphylococcus epidermidis (ATCC 14990)	Y^L	NVG	NVG	NVG
Gram-negative bacteria				
Eschericia coli (ESBL) (ATCC 51446)	Y	NVG	NVG	NVG
Pseudomonas aeruginosa (ATCC 27853)	N	NVG	NVG	NVG
Stenotophomonas maltophilia (ATCC 17666)	N	NVG	NVG, NVG, LG	MG
Acinetobacter baumanii (LSS)	Y	NVG	NVG	NVG
Klebsiella pneumoniae (bla_{NDM1} gene) (LSS)	Y	NVG	NVG	NVG
Serratia marcesens (bla_{IMP4} gene) (LSS)	Y	NVG	NVG	NVG
Yeast				
C albicans (ATCC 14053)	Y^L	NVG	NVG	NVG
Environmental				
Aspergillus fumigatus (LSS)	Y	NVG	NVG	NVG
Micrococcus spp (LSS)	Y^L	NVG	NVG	NVG

ATCC, American Type Culture Collection; *CI*, contact inhibition; *cfu*, colony-forming units; *ESBL*, extended-spectrum β-lactamase; *LG*, light growth (10-99 cfu); *LSS*, laboratory-specific strain; *MG*, moderate growth (100-200 cfu); *NVG*, no visible growth; *SG*, scanty growth (<10 cfu); *Y*, yes; Y^L, largest zones of 4 and 5 mm detected; *ZOI*, zone of inhibition detected.
*M7047 supplied by Monash University.

METHODS

Setting

The ICU at Dandenong Hospital (Monash Health) is a 14-bed, acute care, surgical and medical unit in Victoria, Australia. Sporicidal disposable privacy curtains (Haines Medical Australia) consisting of 100% polypropylene, impregnated with antibacterial and antimildew chemicals and nanometer silver, were used for this trial. Standard polycotton curtains currently found throughout the hospital were used as controls for laboratory testing. The study was conducted to evaluate the antimicrobial activity of disposable sporicidal curtains from December 2012 to June 2013. A cost analysis to replace standard curtains with disposable sporicidal curtains in ICU was also undertaken. The study was approved by the Monash Health Human Research and Ethics Committee.

Laboratory testing of privacy curtains

Unused standard and sporicidal curtain samples (5 × 5-cm swatches) were tested against a range of microorganisms to document baseline antimicrobial properties (Table 1). Repeat testing was undertaken on the same batch of sporicidal curtains at 1, 2, 3, and 6 months from day of inoculation to detect whether any antimicrobial deterioration occurred over time.

Tryptone soya broth agar (MPU, Melbourne, Australia) plates were inoculated with 0.5 McFarland for each of the microorganisms listed, except *C difficile* (10 μL of spores at concentration of 6.4×10^7/mL), which was cultured on ChromID *C difficile* (bioMérieux S.A., Marcy l'Etoile, France) under anaerobic conditions. Each swatch (standard control and flattest side for sporicidal swatches) was placed onto the surface of the inoculated Tryptone soya broth agar plate and incubated aerobically at 35°C for 24 hours. Swatches were then carefully removed and plates reincubated for a further 24 hours at 35°C for growth of microorganisms following direct contact with the curtain sample (contact inhibition [CI]).

Two measurements were recorded for both standard (control) and sporicidal curtain swatches:

1. Zone of Inhibition (ZOI) was recorded in millimeters for detection of diffusion beyond the sample perimeter at 24 hours,
2. CI was recorded semiquantitatively as colony-forming units (cfu) for each microorganism incubated a further 24 hours after removal of the swatch from the surface of the agar plate.

Microbial testing of sporicidal privacy curtains hanging in ICU

Fourteen sporicidal privacy curtains were hung in each bed area in the ICU in December 2012. An area 15 cm × 20 cm was marked on each leading edge of the privacy curtain for swabs to be collected for microbiology at monthly intervals. Swabs were moistened with normal saline and rubbed over the designated surface area before being sent in transport media to the laboratory for microbial culture.

Swabs were lawn cultured onto horse blood agar (MPU) aerobically for 48 hours at 35°C and plates kept for a further 3 days at room temperature for fungi. Bacterial colonies were enumerated (expressed as median/range) and described as skin, environmental, or pathogen. Swabs were also cultured onto ChromID *C difficile* anaerobically for 24 hours at 35°C. Finally, swabs were placed in Cooked Meat Media (CMM; MPU) for enrichment.

Following incubation at 35°C aerobically for 48 hours, each CMM broth was subcultured onto the following chromogenic agars (bioMérieux) at 35°C for 24 hours targeting significant pathogens that have been detected in the ICU over the last 12 months.

1. ChromID MRSA agar for methicillin-resistant *Staphylococcus aureus* (MRSA).
2. ChromID VRE agar for vancomycin-resistant enterococci (VRE).
3. ChromID CARBA agar for carbapenem-resistant Enterobacteriaceae.
4. ChromID *C difficile* agar for *C difficile*.

Identification and sensitivities were performed when required using the Vitek2 compact (bioMérieux).