Curtain is a concern – A multicenter Study

Dr Viola Chow 3rd Nov 2017



Contaminated surfaces contribute to the transmission of hospital pathogens

Table 1

Survival of hospital pathogens on dry hospital surfaces

Organism	Survival time
Clostridium difficile (spores)	≫5 Months
Acinetobacter spp	3 Days to 11 months ⁷⁹
Enterococcus spp including VRE	5 Days to >46 months ³²
Pseudomonas aeruginosa	6 Hours to 16 months
Klebsiella spp	2 Hours to >30 months
Staphylococcus aureus, including MRSA	7 Days to >12 months ⁸⁰
Norovirus (and feline calicivirus)	8 Hours to >2 weeks ⁸¹

NOTE. Adapted from Kramer et al.³¹

Table 2

Transfer of pathogens from surfaces to the hands of health care personnel

Direct patient contact	Contact with environmental surfaces only
	52% of 44 HCP acquired VRE on their hands or gloves ¹⁰
45% of 50 HCP acquired MRSA on their gloved hands ³⁹	40% of 50 HCP acquired MRSA on their gloved hands ³⁰
50% of 30 HCP acquired Clostridium difficile on their gloved hands ⁴⁰	50% of 30 HCP acquired C difficile on their gloved hands ⁴⁰
Compliance with hand hygiene: 80%***	Compliance with hand hygrene: 50%

HCP, Health care personnel.



Fig 1. Chart showing the increased risk associated with the prior room occupant. The figures of difference in risk are unadjusted based on raw data. Several of the studies included adjusted measures of risk, but these were not included because of differences in study design. * Any patient infected or colonized with VRE in the two weeks prior to admission. ¹ The immediate prior room occupant was known to be infected or colonized with VRE.

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Curtain is a potential important site of environmental contamination

- commonly touched by patients and HCWs
- cleaned or changed infrequently
- Difficult to disinfect between patients use
- HCWs may be less likely to disinfect their hands after contact with inanimate objects than after direct contact with patients



Trillis et al. Contamination of hospital curtains with healthcare associated pathogens. Infect Control Hosp Epidemiol 2004;25:164-7

Curtain is a common high touch item

Table II

Analysis of the top 10 high-touch items^a including patient's bodies by different categories of persons

Rank	Items	Medical staff	Nursing staff	Allied health staff	Supporting staff	Patients	Visitors
		(699 contact-episodes)	(2717 contact-episodes)	(375 contact-episodes)	(1757 contact-episodes)	(470 contact-episodes)	(126 contact-episodes)
1	Bedside rail	83 (11.9%)	377 (13.9%)	64 (17.1%)	235 (13.4%)	111 (23.6%)	29 (23.0%)
2	Bedside table	141 (20.2%)	361 (13.3%)	45 (12.0%)	170 (9.7%)	77 (16.4%)	18 (14.3%)
3	Patient body	81 (11.6%)	253 (9.3%)	51 (13.6%)	221 (12.6%)	2 (0.4%)	15 (11.9%)
4	Patient file	110 (15.7%)	335 (12.3%)	48 (12.8%)	107 (6.1%)	15 (3.2%)	2 (1.6%)
5	Linen	56 (8.0%)	135 (5.0%)	34 (9.1%)	123 (7.0%)	31 (6.6%)	23 (18.3%)
6	Curtain	23 (3.3%)	114 (4.2%)	9 (2.4%)	113 (6.4%)	22 (4.7%)	6 (4.8%)
7	Bed frame	23 (3.3%)	104 (3.8%)	20 (5.3%)	62 (3.5%)	24 (5.1%)	5 (4.0%)
8	Locker	3 (0.4%)	22 (0.8%)	4 (1.1%)	25 (1.4%)	27 (5.7%)	13 (10.3%)
9	BP cuff	1 (0.1%)	38 (1.4%)	1 (0.3%)	48 (2.7%)	1 (0.2%)	0
10	Syringe	11 (1.6%)	69 (2.5%)	1 (0.3%)	0	1 (0.2%)	0
≥11	Other items ^b	167 (23.9%)	909 (33.5%)	98 (26.1%)	653 (37.2%)	159 (33.8%)	15 (11.9%)

BP, blood pressure.

In total, 6144 contact-episodes of items, including direct contact with patient's bodies, by 1107 person-episodes were observed for 33 working days (19th November 2013 to 18th March 2014). In total, 4143/6144 (67.4%) episodes of contacts were observed in the top 10 items.

^a Rank based on the contacts of all persons.

^b In total, 222 categories of hospital items were included.

Sixth most common high-touch items Mutually touched by HCWs, patients and visitors (5-6% of all observed episodes)

V.C.C. Cheng et al. / Journal of Hospital Infection 90 (2015) 220-225

Curtains are frequently contaminated with pathogenic bacteria

- Trillis et al cultured samples collected from 50 standard curtains in a point-prevalence study and found that 42% were contaminated with VRE, 22% with MRSA, and 4% with *C. difficile*
- Klakus et al cultured samples collected in 1 week from 200 curtains and found that 15.5% were contaminated with MRSA

 Klakus et al. MRSA contamination of hospital curtains. J Hosp Infect 2008;68:189-90.
 Trillis et al. Contamination of hospital curtains with healthcare associated pathogens. Infect Control Hosp Epidemiol 2004;25:164-7

Major article

Hospital privacy curtains are frequently and rapidly contaminated with potentially pathogenic bacteria

Michael Ohl MD, MSPH^{a,b,*}, Marin Schweizer PhD^{a,b}, Maggie Graham MS^b, Kristopher Heilmann BS^c, Linda Boyken BS^c, Daniel Diekema MD^{a,c}

- 30 locations including medical wards, surgical and medical ICU
- 180 samples taken on 43 curtains over 3 week period
- 92.3% showed contamination within 1 week
- MRSA is present on 9 (20.9%) curtains at least once
- VRE was present on 18 (41.9%) curtains in separate occasion
- Various types of VRE were present on each curtain over time

Table 1	
Frequency of contamination	on privacy curtains

	Individ	lual cultures, 1 == 180	Indiv	idual curtains, n = 43
	n	% (SE)	n	% (SE)
Any growth	119	66.1 (3.2)	41	95.3 (3.2)
S aureus	47	26.1 (3.2)	27	62.8 (7.4)
MRSA	12	6.7 (1.8)	9	20.9 (6.2)
Enterococcus spp	79	43.9 (3.5)	34	79.1 (6.2)
VRE	31	17.2 (2.6)	18	41.9 (13.8)
Gram-negative bacilli*	40	22.2 (3.1)	27	62.8 (7.4)

SE, standard error.

*Gram-negative organisms included 3 Enterobacter spp, 5 Pseudomonas spp, 2 Klebsiella spp, Acinetobacter spp, Pantoae agglomerans, Bordetella bronchoseptica, and Pasteurella multocida.

Location	Day 1	Day 3	Day 9	Day 14	Day 16	Day 18
Bed 1					A	
Bed 2						A
Bed 3				В	P	В
Bed 4		н			6	
Bed 5	A		A		A	A
Bed 6	J					
Bed 6						C
Bed 7	В		к			
Bed 8		U		0		
Bed 9	5					
Bed 10			м	D		
Bed 11	A					
Bed 12	E.	A				
Bed 13	F					
Bed 14	1	L, N	1			
Bed 15	E					
Bed 16					T	<u>(</u>
Bed 17					Q	
Bed 18	R					

We found 21 VRE PFGE types in the 3-week study period, labeled A-R. Beds 1, 6, 7, 9, 10, 11, 14, 16, and 17 had curtain changes during the 3-weeks, as indicated by gray areas.

Fig 1. Visual display of persistence of VRE types on privacy curtains at 18 locations.

Curtains have been implicated in outbreaks

Carbapenem-resistant Acinetobacter and role of curtains in an outbreak in intensive care units

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Summary: Multiple-antibiotic-resistant *Acinetobacter baumanii*, including meropenem resistance, was first isolated from a patient in the general intensive care unit of a tertiary-referral university teaching hospital in Birmingham in December 1998. Similar strains were subsequently isolated from 12 other patients, including those on another intensive care unit within the hospital. The outbreak followed an increase in the use of meropenem in both the units. Environmental screening revealed the presence of the multiple-resistant *Acinetobacter* species on fomite surfaces in the intensive care unit and bed linen. The major source appeared to be the curtains surrounding patients' beds. Typing by pulsed field gel electrophoresis demonstrated that the patients' isolates and those from the environment were indistinguishable. Rigorous infection control measures including increased frequency of cleaning of the environment with hypochlorite (1000 ppm) and twice-weekly changing of curtains were implemented, along with restriction of meropenem use in the units. Isolation of the multiple-resistant *Acinetobacter* spp. from the UK. This outbreak also highlights environmental sources, particularly dry fabrics such as curtains, as an important reservoir for dissemination of acinetobacters.

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| Hosp Infect 2002;50:110-114

Keywords: Acinetobacter; intensive care units; meropenem resistance.

Outbreak of invasive group A streptococcus infection: contaminated patient curtains and cross-infection on an ear, nose and throat ward

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SUMMARY

Background: Outbreaks of group A streptococcus (GAS) infections may occur in healthcare settings and have been documented in surgical, obstetrics and gynaecology, and burns units. The environment may serve as a reservoir and facilitate transmission via contaminated equipment.

Aim: To describe the investigation and control of an outbreak of healthcare-associated GAS infection on an ear, nose and throat (ENT) ward in a tertiary referral centre.

Methods: Two patients with laryngeal cancer developed invasive GAS infection (bacteraemia) with associated tracheostomy wound cellulitis within a 48 h period. The outbreak team undertook an investigation involving a retrospective review of GAS cases, prospective case finding, healthcare worker screening and sampling of patient curtains. Immediate control measures included source isolation, a thorough rolling clean with a chlorinebased disinfectant and hydrogen peroxide decontamination of patient equipment.

Findings: Prospective patient screening identified one additional patient with carriage of GAS from a tracheostomy wound swab. Staff screening identified one healthcare worker who acquired GAS during the outbreak and who subsequently developed pharyngitis. Environmental sampling demonstrated that 10 out of 34 patient curtains on the ward were contaminated with GAS and all isolates were typed as emm-1.

Conclusion: This is the first outbreak report to demonstrate patient curtains as potential source for GAS cross-transmission, with implications in relation to hand hygiene and frequency of laundering. Based on this report we recommend that during an outbreak of GAS infection all patient curtains should be changed as part of the enhanced decontamination procedures.



Figure 2. Curtain sweep plate from side-room 10.



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HA Guideline on Environmental Decontamination in Clinical Areas

Clinical setting	Changing frequency
Ward: inpatients	4 weeks
Ward: inpatients on Contact Precautions	2 weeks and upon discharge#
Accident & Emergency Department	2 weeks
Out-patient Clinic	4 weeks

[#]In accordance with prevailing MDRO guidelines

CAN ANTIMICROBIAL CURTAIN REDUCE RISK OF CONTAMINATION?

Advantages of antimicrobial curtain

- Reduce bacterial contamination
- Reduce costs related to curtain changing and laundering
- Reduce risk of injury to supporting staff



ORIGINAL ARTICLE

Novel Hospital Curtains with Antimicrobial Properties: A Randomized, Controlled Trial

Marin Schweizer, PhD;^{1,2} Maggie Graham, MS;^{1,2} Michael Ohl, MD, MSPH;^{1,2} Kris Heilmann, BS;³ Linda Boyken, BS;³ Daniel Diekema, MD^{1,3}

- Double-blinded RCT in a 36-bed surgical ICU and 20-bed medical
- Curtains are randomly placed on day 0 with 15 rooms received the curtain containing complex element compound (CEC) with antimicrobial properties and 15 received standard curtains with identical appearance
- The median time to first contamination for CEC curtains was 14 days (range 6–20)and standard curtains was 2 days (IQR 1-6)
- overall adjusted rate of contamination was 29% lower among CEC curtains (adjusted RR, 0.71; 95% CI, 0.48–1.07)
- risk of VRE contamination was 8 times higher among standard curtains compared with CEC curtains (unadjusted relative risk [RR], 8.0; 95% CI, 1.14–56.18; P <0.01)
- The CEC curtains were significantly less contaminated compared with the standard curtains at time points 1, 2, and 3, which correspond to days 2–10

TABLE 1.	Summary	of Relativ	e Risk	of Co	ontaminati	on (Rate	Ratio)	Comparin	g Comp	lex
Element C	Compound	Curtains (CEC)	with	Standard (Curtains	(S)			

		Proportion of contaminated curtains				
Visit	Test day	CEC	Standard	Rate ratio (CEC:S)	Confidence interval	Р
0	1	1/15	2/15	0.54	0.06, 5.14	50
1	2 or 3	1/15	8/15	0.12	0.02, 0.86	.03
2	7 or 8	5/15	11/15	0.42	0.19, 0.93	.03
3	9 or 10	2/15	12/15	0.15	0.04, 0.59	.01
4	4 or 15	12/15	9/15	1.24	0.63, 2.44	.53
5	16 or 17	4/14	5/14	0.82	0.22, 3.05	.77
6	21 or 22	13/14	8/14	1.80	0.76, 4.22	.18
7	23 or 24	5/14	3/14	1.92	0.44, 8.39	.38

NOTE. Results are from a repeated-measures Poisson model and are adjusted for type of intensive care unit, contact precautions, number of beds, and room occupancy.

Major article

The silver lining of disposable sporicidal privacy curtains in an intensive care unit Despina Kotsanas BSC (Hons), MCHINEDI^{a,*}, W.R.P.L.I. Wijesooriya MB, BS, MD, MPhil^b, Tracy Sloane RN, MAdvPrac (Hons), CICP^b, Rhonda L. Stuart MB, BS, FRACP, PhD^{a,b,c}, Elizabeth E. Gillespie BN, MPH^b

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In vitro testing

- Unused standard and sporicidal curtain consisting of 100% polypropylene, impregnated with antibacterial and nanometer silver samples (5 x 5-cm) were tested against a range of microorganisms and repeated in at 1, 2, 3, and 6 months
- Zones (ZOI) and CI were detectable for 12 out of the 14 microorganisms up to 6 months
- Scanty growth of C difficile spores was seen growing beneath the swatch after 1 month, which increased to moderate growth by six months
- Light growth of S maltophilia was found to occur at 3 months and increased to moderate by 6 months



In Field testing in ICU

- 14 sporicidal privacy curtains were hung in each bed area in the ICU
- 15 cm x 20 cm on each leading edge were swabbed monthly over 6 month for total bacterial count and significant pathogens including MRSA, VRE, CRE and C diff
- Cultures grew low number of environmental organisms (0-83 cfu, median 3 cfu)
- No MRSA, CRE, C diff detected while VRE was grown on 3 occasions from 2 curtain sites (known VRE patient located in each bed prior to sampling)

Table 2

Costs associated with changing ICU privacy curtains for the 6 months: January-June 2013

	Standard (SAUD)	Sponcidal (SAUD)
Curtains laundered and changed at 3 months and 6 months ($n = 14$)	421,40	0
Curtains laundered after discharge of patient with significant pathogen ($n = 147$)*	2,212.00	0
Time to replace sponcidal curtains every 6 months (2.3 hours)	0	92.00
Initial cost to purchase and install 14 pairs of sponcidal curtains every 6 months	0	1,100.00
Total	2,633.40	1,202.00

NOTE. There is no capital outlay shown for standard curtains because these were purchased when the hospital was established. At time of submission \$AUD 1 = \$USD 0.93. *MRSA, VRE, C difficile, or CRE.

In vitro test of another brand of antimicrobial privacy curtain



Fig 1. Images from 24-month testing for (A) *Clostridium difficile* (zone of inhibition), (B) *Clostridium difficile* (contact inhibition), (C) methicillin-resistant *Staphylococcus aureus* and vancomycin-resistant *Enterococcus faecium* (zone of inhibition), and (D) methicillin-resistant *S aureus* and vancomycin-resistant *E faecium* (contact inhibition).

- nonwoven, extruded polypropylene impregnated with quaternary ammonium chlorides and polyorganosiloxane (a repellent negatively charged silicone)
- zone of inhibition and contact inhibition was determined against a range of microorganisms (ESBL *Escherichia coli, Stenotrophomonas maltophilia,* carbapenemaseproducing *Klebsiella pneumoniae, Pseudomonas aeruginosa;* MRSA, VRE, CNSS, *Candida albicans,* and spores of *Clostridium difficile*
- Excellent results were achieved for both zone of inhibition and contact inhibition when tested at baseline, 6, 12, 18, and 24 months

Antibacterial Hospital Disposable Curtains – Multi-Centre field study





Results of experiment

Organism / inoculum	Brand A with Silver(Mean CFU)	Brand A without silver (Mean CFU	Conventional curtain (Mean CFU)	
MRSA time 0 at 10 ⁵ cfu	6	Т	Т	
MRSA 3 months at 10 ³ cfu	0	0	15	
VRE time 0 at 10 ⁵ cfu	39.5	Т	Т	
VRE 3 months at 10 ³ cfu	7	Т	Т	
MDRA time 0 at 10 ⁵ cfu	3	Т	Т	· · · · · · · · · · · · · · · · · · ·
MDRA 3 months at 10 ³ cfu	0	28	29	

T =Too numerous to count

Aim of the In field study (Nov 16 – Aug 17)

- To compare the antibacterial effect of in use antimicrobial curtains with standard curtains:
 - total bacterial count over time
 - time of first MRSA/ Multidrug-resistant Acinetobacter (MDRA) contamination
 - percentage of MRSA/MDRA contamination
- To perform cost benefit analysis of antimicrobial curtains

Participating Hospitals / Units

Hospital	Unit / Setting	No of beds / cubicle	Existing admission screening policy e.g. MRSA
QEH	NS / Acute	6	MRSA cohort cubicle
PWH	NS /Acute	6	MRSA admission screening MDRA for patient transferred from ICU
СМС	MED /Rehab	8	Nil
UCH	SUR / Acute	4	Nil
PYNEH	MED / Acute	6	Nil
AHN	ORT / Acute	7	MDRA (for previous hospitalization in past 1 month & transferred from ICU)
ТМН	MED / Rehab	5	Nil
	Total no of beds	42	

General Ward Cubicle

 Selected cubicle in general ward (preferably with high MDRO prevalence)



Sampling Method

- Use ½ Polywipe premoistened sponge swab (Medical Wire & Equipment, Wiltshire, England)
- Sample twice weekly for first two weeks then weekly until patient discharge
- Sample area: front and back side from height 70cm – 170cm 1 m depth from curtain tie
- Front and back side using two ½ Polywipe sponge



Laboratory methods



Criteria for antimicrobial curtain removal

- MRSA > 100 cfu (i.e. 1/cm2)
- MDRA isolated from direct culture
- VRE/ CRE isolated in clinical specimens in a patient staying in the study cubicle
- Mechanical malfunction
- Grossly soiled with blood and body fluid
- Outbreak of MDRO in study ward

Conventional curtain

 Should be changed according to existing <u>hospital</u> guideline (stock take will be performed for curtain changing practice from each hospital)

Result summary

- Median time of MRSA contamination is slightly longer for antimicrobial curtain (Brand A) compared with conventional curtain.
- Percentage of MRSA contamination is higher for antimicrobial curtain (Brand A) compared with conventional curtain





Same methodology using Brand D



Results

 Antimicrobial curtain (Brand D) significantly increase time to first contamination and less contaminated compared with conventional curtain



Users' comments



- Difficulty in hanging of antimicrobial curtain as the holes of curtain and rail are not matched (N=3)
- Hocks are easily detached

Strength

- Multicenter trial with large sample size
- acute and convalescence setting
- Conventional curtain as control
- Large area of curtain sampled using polywipe sponge

Limitations

- No laboratory detection of C diff, CPE
- Admission screening of MDRO were not performed in all hospitals
- Confounding factors
 - Number of MDRO patients in cubicle
 - colonization and active infection
 - Compliance of hand hygiene and contact precautions

Conclusions

- Antimicrobial curtain (Brand D) significantly increase time to first contamination and less contaminated compared with conventional curtain
- Cost effective if used in a MDRO cohort cubicle / isolation ward /cases on contact precaution for a 6 month period
- Reduce contamination on curtains may potentially reduce cross transmission of MDRO and hence HAI