Does Improving Surface Cleaning and Disinfection Reduce HAI?
Prof. William Rutala, University of North Carolina
A Webber Training Teleclass

AD Russell Memorial Teleclass
Does Improving Surface Cleaning and Disinfection Reduce Healthcare-Associated Infections?

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Hosted by Prof. Jean-Yves Maillard
Cardiff University, Wales

The A. Denver Russell Memorial Teleclass Lecture (2013)

Professor Allan Denver Russell
(1936-2004)

Does Improving Surface Cleaning and Disinfection Reduce Healthcare-Associated Infections?
Objectives

- Role of the environment in disease transmission
- Adequacy of room cleaning and monitoring thoroughness of room cleaning
- Methods for room decontamination
- Does improved surface disinfection reduce HAIs

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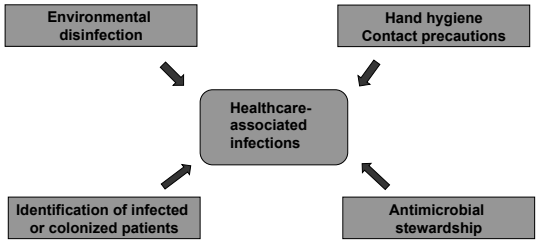
HEALTHCARE-ASSOCIATED INFECTIONS IN THE US: IMPACT

- 1.7 million healthcare-associated infections (HAIs) per year
- 98,987 deaths due to HAI
  - Pneumonia 35,967
  - Bloodstream 30,665
  - Urinary tract 13,088
  - Surgical site infection 8,205
  - Other 11,062
- 6th leading cause of death (after heart disease, cancer, stroke, chronic lower respiratory diseases, and accidents)[1]

[1] National Center for Health Statistics, 2004

Multiple Factors Influence Infection Rates



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ENVIRONMENTAL CONTAMINATION LEADS TO HAIs

- There is increasing evidence to support the contribution of the environment to disease transmission
- This supports comprehensive disinfecting regimens (goal is not sterilization) to reduce the risk of acquiring a pathogen from the healthcare environment/equipment

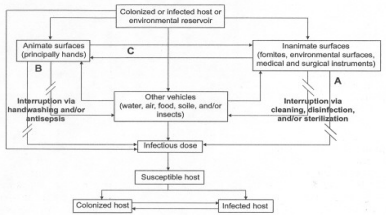
KEY PATHOGENS WHERE ENVIRONMENTIAL SURFACES PLAY A ROLE IN TRANSMISSION

- MRSA
- VRE
- *Acinetobacter* spp.
- *Clostridium difficile*
- Norovirus
- Rotavirus
- SARS

ENVIRONMENTAL CONTAMINATION LEADS TO HAIs

- Frequent environmental contamination
- Microbial persistence in the environment
- HCW hand contamination
- Relationship between level of environmental contamination and hand contamination
- Transmission directly or on hands of HCPs
- Housing in a room previously occupied by a patient with the pathogen of interest is a risk factor for disease
- Improved surface cleaning/disinfection reduces disease incidence

TRANSMISSION MECHANISMS INVOLVING THE SURFACE ENVIRONMENT



Rutala WA, Weber DJ. In:"SHEA Practical Healthcare Epidemiology" (Lautenbach E, Woeltje KF, Malani PN, eds), 3rd ed, 2010.

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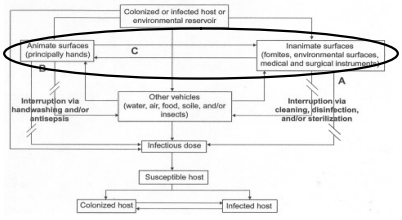

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ENVIRONMENTAL CONTAMINATION ENDEMIC AND EPIDEMIC MRSA

	Outbreak	Endemic				Site estimated mean§
	Rampling et al[†,**]	Boyce et al[‡,**]	Sexton et al[†,†]	Lemmen et al[†,**,‡]	French et al[**,¶]	
Floor	9%	50–55%	44–60%	24%	..	34·5%
Bed linen	..	38–54%	44%	34%	..	41%
Patient gown	..	40–53%	..	34%	..	40·5%
Overbed table	..	18–42%	64–67%	24%	..	40%
Blood pressure cuff	13%	25–33%	..	..	..	21%
Bed or siderails	5%	1–30%	44–60%	21%	43%	27%
Bathroom door handle	..	8–24%	..	12%¶	..	14%
Infusion pump button	13%	7–18%	..	30%	..	19%
Room door handle	11%	4–8%	..	23%	59%	21·5%‖
Furniture	11%	..	44–59%	19%	..	27%
Flat surfaces	7%	..	32–38%	..	..	21·5%
Sink taps or basin fitting	..	..	..	14%	33%	23·5%
Average quoted**	11%	27%	49%	25%	74%	37%

Dancer SJ et al. Lancet ID 2008;8(2):101-13

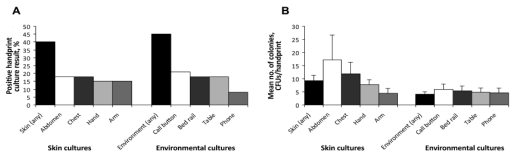
ENVIRONMENTAL SURVIVAL OF KEY PATHOGENS ON HOSPITAL SURFACES

Pathogen	Survival Time
S. aureus (including MRSA)	7 days to >12 months
Enterococcus spp. (including VRE)	5 days to >46 months
Acinetobacter spp.	3 days to 11 months
Clostridium difficile (spores)	>5 months
Norovirus (and feline calicivirus)	8 hours to >2 weeks
Pseudomonas aeruginosa	6 hours to 16 months
Klebsiella spp.	2 hours to >30 months

Adapted from Hota B, et al. Clin Infect Dis 2004;39:1182-9 and
Kramer A, et al. BMC Infectious Diseases 2006;6:130

FREQUENCY OF ACQUISITION OF MRSA ON GLOVED HANDS AFTER CONTACT WITH SKIN AND ENVIRONMENTAL SITES

No significant difference on contamination rates of gloved hands after contact with skin or environmental surfaces (40% vs 45%; p=0.59)



Stiefel U, et al. ICHE 2011;32:185-187

ACQUISITION OF MRSA ON HANDS AFTER CONTACT WITH ENVIRONMENTAL SITES

ACQUISITION OF MRSA ON HANDS/GLOVES AFTER CONTACT WITH CONTAMINATED EQUIPMENT

TRANSFER OF MRSA FROM PATIENT OR ENVIRONMENT TO IV DEVICE AND TRANSMISSON OF PATHOGEN

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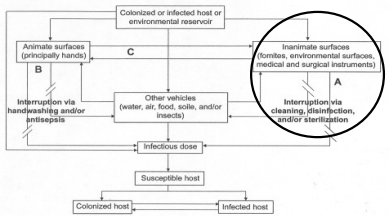

Rutala WA, Weber DJ. In:"SHEA Practical Healthcare Epidemiology" (Lautenbach E, Woeltje KF, Malani PN, eds), 3rd ed, 2010.

ACQUISITION OF *C. difficile* ON PATIENT HANDS AFTER CONTACT WITH ENVIRONMENTAL SITES AND THEN INOCULATION OF MOUTH

Does Improving Surface Cleaning and Disinfection Reduce Healthcare-Associated Infections?
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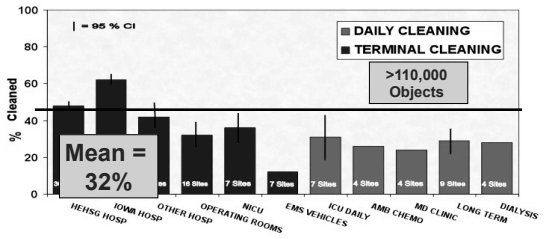
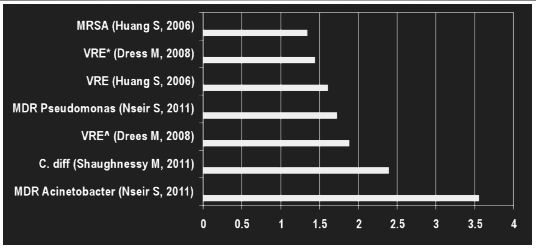
Thoroughness of Environmental Cleaning
Carling PC et al. ECCMID, Milan, Italy, May 2011



RELATIVE RISK OF PATHOGEN ACQUISITION IF PRIOR ROOM OCCUPANT INFECTED



* Prior room occupant infected; ^Any room occupant in prior 2 weeks infected

EVALUATION OF HOSPITAL ROOM ASSIGNMENT AND ACQUISITION OF CDI

- Study design: Retrospective cohort analysis, 2005-2006
- Setting: Medical ICU at a tertiary care hospital
- Methods: All patients evaluated for diagnosis of CDI 48 hours after ICU admission and within 30 days after ICU discharge
- Results (acquisition of CDI)
  - Admission to room previously occupied by CDI = 11.0%
  - Admission to room not previously occupied by CDI = 4.6% (p=0.002)

Shaughnessy MK, et al. ICHE 2011;32:201-206

TABLE 3. Multivariate Analysis of Risk Factors for Acquisition of *Clostridium difficile* Infection (CDI)

Risk factor	HR (95% CI)	*P*
Prior room occupant with CDI	2.35 (1.21–4.54)	.01
Greater age	1.00 (0.99–1.01)	.74
Higher APACHE III score	1.00 (1.00–1.01)	.06
Proton pump inhibitor use	1.11 (0.44–2.78)	.83
Antibiotic exposure		
Norfloxacin	0.38 (0.05–2.72)	.33
Levofloxacin	1.08 (0.67–1.73)	.75
Ciprofloxacin	0.49 (0.15–1.67)	.23
Fluoroquinolones	1.17 (0.72–1.91)	.53
Clindamycin	0.45 (0.14–1.42)	.17
Third- or fourth-generation cephalosporins	1.17 (0.76–1.79)	.48
Carbapenems	1.05 (0.63–1.75)	.84
Piperacillin-tazobactam	1.31 (0.82–2.10)	.27
Other penicillin	0.47 (0.23–0.98)	.04
Metronidazole	1.31 (0.83–2.07)	.24
Vancomycin		
Oral	1.38 (0.32–5.89)	.67
Intravenous	1.55 (0.88–2.73)	.13
Aminoglycosides	1.27 (0.78–2.06)	.35
Multiple (≥3 antibiotic classes)	1.28 (0.75–2.21)	.37

NOTE. APACHE, Acute Physiology and Chronic Health Evaluation; CI, confidence interval; HR, hazard ratio.

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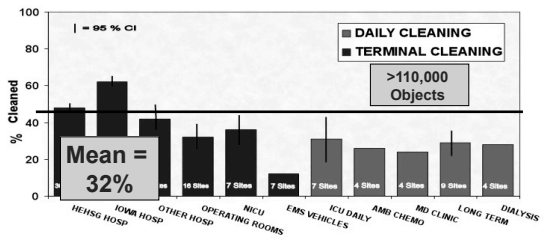
Thoroughness of Environmental Cleaning

Carling PC et al. ECCMID, Milan, Italy, May 2011



Mean proportion of surfaces disinfected at is 32%

Terminal cleaning methods ineffective (products effective practices deficient [surfaces not wiped]) in eliminating epidemiologically-important pathogens

MONITORING THE EFFECTIVENESS OF CLEANING

Cooper et al. AJIC 2007;35:338

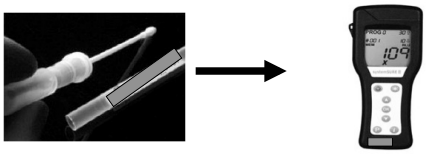
- Visual assessment-not a reliable indicator of surface cleanliness
- ATP bioluminescence-measures organic debris (each unit has own reading scale, <250-500 RLU)
- Microbiological methods-<2.5CFUs/cm^2-pass; can be costly and pathogen specific
- Fluorescent marker-transparent, easily cleaned, environmentally stable marking solution that fluoresces when exposed to an ultraviolet light (applied by Infection Preventionist unbeknown to EVS, after EVS cleaning, markings are reassessed)

Target After Marking

Target Enhanced

SURFACE EVALUATION USING ATP BIOLUMINESCENCE

Swab surface → luciferace tagging of ATP → Hand held luminometer



Used in the commercial food preparation industry to evaluate surface cleaning before reuse and as an educational tool for more than 30 years.

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ENVIRONMENTAL CONTAMINATION LEADS TO HAIs
Suboptimal Cleaning

- There is increasing evidence to support the contribution of the environment to disease transmission
- This supports comprehensive disinfecting regimens (goal is not sterilization) to reduce the risk of acquiring a pathogen from the healthcare environment

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DISINFECTION AND STERILIZATION
Rutala, Weber, HICPAC. 2008. www.cdc.gov

- EH Spaulding believed that how an object will be disinfected depended on the object's intended use
  - **CRITICAL - objects which enter normally sterile tissue or the vascular system or through which blood flows should be sterile**
  - **SEMICRITICAL - objects that touch mucous membranes or skin that is not intact require a disinfection process (high-level disinfection[HLD]) that kills all microorganisms but high numbers of bacterial spores**
  - **NONCRITICAL - objects that touch only intact skin require low-level disinfection**

LOW-LEVEL DISINFECTION FOR NONCRITICAL EQUIPMENT AND SURFACES

Exposure time ≥ 1 min

Germicide	Use Concentration
Ethyl or isopropyl alcohol	70-90%
Chlorine	100ppm (1:500 dilution)
Phenolic	UD
Iodophor	UD
Quaternary ammonium	UD
Improved hydrogen peroxide (HP)	0.5%, 1.4%

UD=Manufacturer's recommended use dilution

ALL "TOUCHABLE" (HAND CONTACT) SURFACES SHOULD BE WIPED WITH DISINFECTANT

"High touch" objects only recently defined (no significant differences in microbial contamination of different surfaces) and "high risk" objects not epidemiologically defined.

Effective Surface Decontamination

Practice and Product

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EFFECTIVENESS OF DISINFECTANTS AGAINST MRSA AND VRE

TABLE 2
DISINFECTANT ACTIVITY AGAINST ANTIBIOTIC-SUSCEPTIBLE AND ANTIBIOTIC-RESISTANT BACTERIA

	Log_{10} Reductions							
	VSE		VRE		MSSA		MRSA	
Product	0.5 min	5 min	0.5 min	5 min	0.5 min	5 min	0.5 min	5 min
Vesphene IIse	>4.3	>4.3	>4.8	>4.8	>5.1	>5.1	>4.6	>4.6
Clorox	>5.4	>5.4	>4.9	>4.9	>5.0	>5.0	>4.6	>4.6
Lysol Disinfectant	>4.3	>4.3	>4.8	>4.8	>5.1	>5.1	>4.6	>4.6
Lysol Antibacterial	>5.5	>5.5	>5.5	>5.5	>5.1	>5.1	>4.6	>4.6
Vinegar	0.1	5.3	1.0	3.7	+1.1	+0.9	+0.6	2.3

Abbreviations: MRSA, methicillin-resistant *Staphylococcus aureus*; MSSA, methicillin-susceptible *S aureus*; VRE, vancomycin-resistant *Enterococcus*; VSE, vancomycin-susceptible *Enterococcus*. Data represent mean of two trials (n=2). Values preceded by ">" represent the limit of detection of the assay. Assays were conducted at a temperature of 20°C and a relative humidity of 45%. Results were calculated as the log of N4/N0, where N4 is the titer of bacteria surviving after exposure and N0 is the titer of the control.

Rutala WA et al. *Infect Control Hosp Epidemiol* 2000;21:33-38.

SURFACE DISINFECTION
Effectiveness of Different Methods, Rutala et al. 2012

Technique (with cotton)	MRSA Log_{10} Reduction (QUAT)
Saturated cloth	4.41
Spray (10s) and wipe	4.41
Spray, wipe, spray (1m), wipe	4.41
Spray	4.41
Spray, wipe, spray (until dry)	4.41
Disposable wipe with QUAT	4.55
Control: detergent	2.88

Wipes
Cotton, Disposable, Microfiber, Nonwoven Spunlace

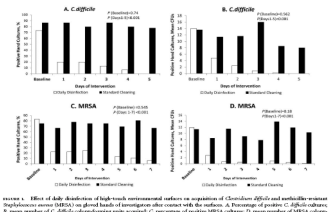
Wipe should have sufficient wetness to achieve the disinfectant contact time. Discontinue use of a disposable wipe if it no longer leaves the surface visibly wet for ≥ 1m

Surface Disinfection

- Wipe all "touchable" or "hand contact" surfaces with sufficient wetness to achieve the disinfectant contact time (≥ 1 minute).
- Daily disinfection of surfaces (vs cleaned when soiled) in rooms of patients with CDI and MRSA reduced acquisition of pathogens on hands after contact with surfaces and on hands caring for the patient

Daily Disinfection of High-Touch Surfaces
Kundrapu et al. ICHE 2012;33:1039

Daily disinfection of high-touch surfaces (vs cleaned when soiled) with sporicidal disinfectant in rooms of patients with CDI and MRSA reduced acquisition of pathogens on hands after contact with surfaces and of hands caring for the patient



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Major article

Does improving surface cleaning and disinfection reduce health care-associated infections?

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

Key Words: Environment Cleaning Transmission

Contaminated environmental surfaces provide an important potential source for transmission of health care-associated pathogens. In recent years, a variety of interventions have been shown to be effective in improving cleaning and disinfection of surfaces. This review examines the evidence that improving environmental disinfection can reduce health care-associated infections.

Contaminated environmental surfaces provide an important potential source for transmission of many health care associated pathogens.[1-5] These include *Clostridium difficile*, methicillin-resistant

infected with health care associated pathogens shed organisms onto their skin, clothing, bedding, and nearby environmental surfaces.[6] In addition to surfaces in rooms, portable equipment

Environmental Disinfection Interventions

Donskey CJ. AJIC. May 2013.

1. Cleaning product substitutions
2. Improvements in the effectiveness of cleaning and disinfection practices
   - Education
   - Audit and feedback
   - Addition of housekeeping personnel or specialized cleaning staff
3. Automated technologies

Disinfectant Product Subsitutions

Donskey CJ. AJIC. May 2013

Table 1
Studies involving disinfectant product substitutions

Ref	Setting and organism	Product	Practice	Monitoring of disinfection	Effect
31	2 Hospital wards Nosocomial infections	Active oxygen-based compound	Daily cleaning of oors and furniture	Cultures: decreased bacterial loadon surfaces	No reduction in bloodstream infections or MRSA colonization or infection
32	Medical ward *Clostridium dif cile*	Hypochlorite 500 ppm	Terminal CDI rooms	Cultures: surface contamination decreased to 21% of initial levels	Outbreak ended
33	Bone marrow transplant (BMT) unit, Medical Ward, ICU *Clostridium dif cile*	Hypochlorite 5,000 ppm	Terminal CDI rooms	No	Signi cant decrease on BMT unit but not on the other 2 wards
34	2 Medical wards (crossover study) *Clostridium dif cile*	Hypochlorite 1,000 ppm	Terminal CDI rooms	Cultures: no decrease in the percentage of positive environmental cultures	Decreased on 1 of 2 wards
35	Medical and surgical ICUs *Clostridium dif cile*	Hypochlorite 5,000 ppm	Ward 1: terminal CDI rooms; ward 2: all rooms	No	Decreased on both units
36	3 Hospitals *Clostridium dif cile*	Hypochlorite 5,000 ppm	Terminal CDI rooms	No	48% decrease in prevalence density of CDI
25	2 Medical wards *Clostridium dif cile*	Hypochlorite 5,500 ppm (wipes)	Terminal and daily CDI and non-CDI rooms	Yes (ATP bioluminescence)	85% decrease in hospital acquired CDI

ATP, Adenosine triphosphate; BMT, Bone marrow transplant; CDI, *C dif cile* infection; ICU, intensive-care unit; PPM, parts per million; Ref, reference number.
NOTE. 5,000 ppm 1:10 dilution of household bleach.

Disinfectant Product Substitutions

Donskey CJ. AJIC. May 2013

- Six of the 7 interventions were quasi-experimental studies in which rates were compared before and after interventions with no concurrent control group
- Confounding factors not reported (e.g., hand hygiene or Contact Precaution compliance)
- Decrease in the incidence in 6 of 7 studies

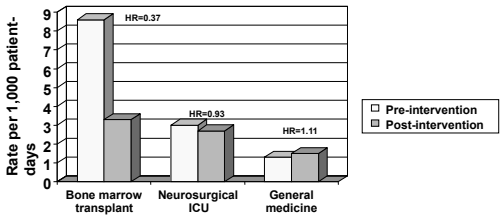
Substitution of Hypochlorite for Non-Sporicidal Cleaning Agents to Control *C. difficile*

Ref	Setting	Effect on CDI rates
1	Medical Ward	Outbreak ended
2	Bone marrow transplant (BMT) unit, Medical Ward, ICU	Significant decrease on BMT unit, but not on the other 2 wards
3	2 medical wards (crossover study)	Decreased on 1 of 2 wards
4	Medical and surgical ICUs	Decreased on both units
5	3 hospitals	48% decrease in prevalence density of CDI
6	2 medical wards	85% decrease in hospital acquired CDI

1). Kaatz G. Am J Epidemiol 1988;127:1289-94; 2). Mayfield JL. Clin Infect Dis 2000;31:995-1000;
3). Wilcox MH. J Hosp Infect 2003;54:109-114; 4). McMullen KM. Infect Control Hosp Epidemiol 2007;28:205-7;
5). Hacek DM. Am J Infect Control 2010;38:350-3; 6). Orenstein R. Infect Control Hosp Epidemiol 2011;32:1137-9

Effect of Environmental Disinfection with 10% Bleach on CDI Rates

(results suggest greater impact when baseline incidence is high)



Mayfield JL, et al. Clin Infect Dis. 2000;31:995-1000

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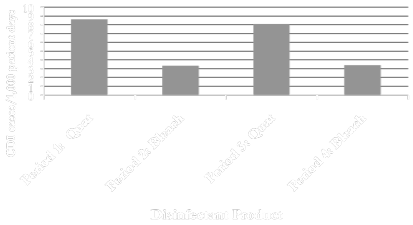
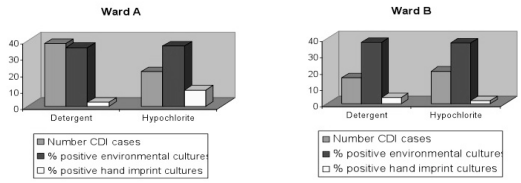
CDI Decreased When Bleach Substituted for QUAT
(higher study quality-repeated treatment design)



Mayfield JL, et al. Clin Infect Dis. 2000;31:995-1000

Incidence Decreased on the Ward with the Higher Baseline CDI Rate
(no decrease in environmental contamination during hypochlorite periods-application of chlorine suboptimal?)



Wilcox MH. J Hosp Infect 2003;54:109-114

Environmental Disinfection Interventions
Donskey CJ. AJIC. May 2013.

1. Cleaning product substitutions
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Improve Effectiveness of Cleaning/Disinfection
Donskey CJ. AJIC. May 2013

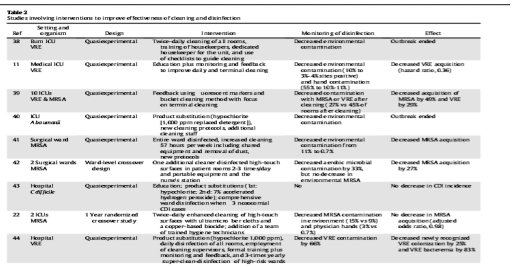

Table 2
Studies involving interventions to improve effectiveness of cleaning and disinfection

Ref	Setting and organism	Design	Intervention	Monitoring of disinfection	Effect
38	Burn ICU VRE	Quasiexperimental	Twice-daily cleaning of all rooms, training of housekeepers, dedicated housekeeper for the unit, and use of checklists to guide cleaning	Decreased environmental contamination	Outbreak ended
11	Medical ICU VRE	Quasiexperimental	Education plus monitoring and feedback to improve daily and terminal cleaning	Decreased environmental contamination (11% to 0.7%) and decreased gown and hand contamination (35% to 16%)	Decreased VRE acquisition (hazard ratio, 0.36)
39	10 ICUs VRE & MRSA	Quasiexperimental	Feedback using fluorescent markers and bucket cleaning method with focus on terminal cleaning	Decreased contamination with MRSA or VRE after cleaning (27% versus 45% of rooms after cleaning)	Decreased acquisition of MRSA by 48% and VRE by 25%
40	ICU Aceinetobacter	Quasiexperimental	Product substitution (hypochlorite [1,000 ppm-replaced detergent]), new cleaning protocol, additional cleaning staff	Decreased environmental contamination	Outbreak ended
41	Surgical ward MRSA	Quasiexperimental	Education and enforced, increased cleaning 57 hours per week including shared equipment and removal of dust; new protocols	Decreased environmental contamination from 11% to 0.7%	Decreased MRSA acquisition
42	2 Surgical wards MRSA	Ward-level crossover design	One additional cleaner disinfected high-touch surfaces in patient rooms 2-3 times/day and shared equipment and the nurses' station	Decreased aerobic microbial contamination by 33%, no decrease in environmental MRSA	Decreased MRSA acquisition by 27%
43	Hospital Cat[illegible]	Quasiexperimental	Education; product substitutions (1st: hypochlorite; 2nd: 7% accelerated hydrogen peroxide); comprehensive infection control when 3 nosocomial CDI cases	No	No decrease in CDI incidence
22	2 ICUs MRSA	1 Year randomized crossover study	Twice-daily enhanced cleaning of high-touch surfaces with chlorine bleach cloths and a copper-based biocide; addition of a team of trained hygiene technicians	Decreased MRSA contamination in environment (15% vs 0%) and physician hands (33% vs 0.7%)	No decrease in MRSA acquisition (adjusted odds ratio, 0.58)
44	Hospital VRE	Quasiexperimental	Physician champion, 2,000 ppm chlorine daily disinfection of all rooms, employment of cleaning supervisors, formal training plus monitoring and feedback, and 3-times yearly supervised disinfection of high-risk wards	Decreased VRE contamination by 46%	Decreased newly recognized VRE extension by 29% and VRE bacteremia by 85%

Cleaning Interventions Associated with Reduced Acquisition of Pathogens

Ref	Setting/Organism	Intervention
1	Burn ICU/VRE	Twice daily cleaning
2	Medical ICU/VRE	Improved daily and terminal cleaning
3	10 ICUs VRE &MRSA	Feedback using fluorescent markers, bucket cleaning
4	Neuro ICU Acinetobacter	Hypochlorite and education of cleaning staff
5	Surgical ward/MRSA	Increased cleaning hours/wk including shared equipment and dust
6	2 surgical wards MRSA	1 additional cleaner; 6 month cross-over design

1). Falk PS. Infect Control Hosp Epidemiol 2000;21:575-82; 2). Hayden MK. Clin Infect Dis 2000;42:1552-60; 3). Datta R. Arch Intern Med 2011;171:491-4; 4). Denton M. J Hosp Infect 2004;56:106-1; 5). Rampling A. J Hosp Infect 2001;49:109-16; 6). Dancer SJ. BMC Medicine 2009;7:28

Cleaning Interventions Associated with Reduced Acquisition of Pathogens

Ref	Monitoring of disinfection	Effect
1	↓ environmental contamination	Outbreak ended
2	↓ environ/hand contamination	↓ VRE acquisition
3	↓ % of rooms contaminated with MRSA or VRE after cleaning (27% versus 45%)	↓ acquisition of MRSA and VRE
4	↓ environmental contamination	Outbreak ended
5	↓ environmental contamination (11% to 0.7%)	↓ MRSA acquisition
6	↓ microbial contamination 33% No decrease in environmental MRSA	↓ MRSA infections 27%

1). Falk PS. Infect Control Hosp Epidemiol 2000;21:575-82; 2). Hayden MK. Clin Infect Dis 2000;42:1552-60; 3). Datta R. Arch Intern Med 2011;171:491-4; 4). Denton M. J Hosp Infect 2004;56:106-1; 5). Rampling A. J Hosp Infect 2001;49:109-16; 6). Dancer SJ. BMC Medicine 2009;7:28

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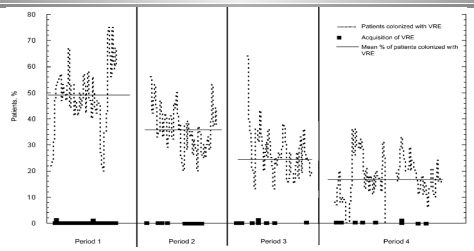
Improve Effectiveness of Cleaning/Disinfection
Donskey CJ. AJIC. May 2013

- Seven of the 9 interventions, pathogen acquisition was reduced or an outbreak resolved.
- Decrease in environmental contamination in 8 of 9 studies
- Interventions included: variety of different cleaning strategies (daily disinfection and/or disinfection of portable equipment, education of housekeepers, new protocols or checklists and designation of responsibility for cleaning specific items).

Reduction in Acquisition of VRE after Enforcement of Routine Cleaning
(Period 1-baseline; 2-educ/thorough cleaning [↑ cleaning rates]; 3-"washout"; 4-HH)



Hayden MK, et a. Clin Infect Dis 2006;42:1552-60

Do we have to get to zero contamination after disinfection to reduce infections?

Ref	Measurement	Baseline	Intervention	Effect
1	% sites positive for VRE after cleaning	10%	3 - 4%	↓ VRE acquisition (hazard ratio 0.36)
2/3	% rooms with ≥1 sites positive for MRSA or VRE after cleaning	45%	27%	↓ acquisition of MRSA by 49% and VRE by 29%

1. Hayden MK, et a. Clin Infect Dis 2006;42:1552-60; 2. Goodman ER, et al. Infect Control Hosp Epidemiol 2008;29:593-9; 3. Datta R, et al. Arch Intern Med 2011;171:491-4

Environmental Disinfection Interventions
Donskey CJ. AJIC. May 2013.

1. Cleaning product substitutions (improved effectiveness)
2. Improvements in the effectiveness of cleaning and disinfection practices
   - Education
   - Audit and feedback
   - Addition of housekeeping personnel or specialized cleaning staff
3. Automated technologies

Touch (manual disinfection not thorough) vs No-Touch (mechanical)

No Touch

(supplements but do not replace surface cleaning/ disinfection; avoids the need for "touch" and the problems associated with manual disinfection)

NEW "NO TOUCH" APPROACHES TO ROOM DECONTAMINATION
Supplement Surface Disinfection
Rutala, Weber. Infect Control Hosp Epidemiol. 2011;32:743

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ROOM DECONTAMINATION UNITS
Rutala, Weber. ICHE. 2011;32:743

UV and HP systems have been demonstrated to be effective against various healthcare-associated pathogens

TABLE 1. Comparison of Room Decontamination Systems That Use UV Irradiation and Hydrogen Peroxide (HP)

	Steris		Bioquell	Tru-D
Abbreviation	DMHP (dry mist HP)	VHP (vaporized HP)	HPV (HP vapor)	UV-C
Active agent	Steranil (5% HP, <50 ppm silver cations)	Vaprox (35% HP)	35% HP	UV-C irradiation at 254 nm
Application	Aerosol of active solution	Vapor, noncondensing	Vapor, condensing	UV irradiation, direct and reflected
Location (removal of active agent from enclosure)	Passive decomposition	Active catalytic conversion	Active catalytic conversion	Not necessary
Sporicidal efficacy	Single cycle does not inactivate *Bacillus atrophaeus* BIs; ~4-$\log_{10}$ reduction in *Clostridium difficile*[a] and incomplete inactivation in situ	Inactivation of *Geobacillus stearothermophilus* BIs	Inactivation of *G. stearothermophilus* BIs >6-$\log_{10}$ reduction in *C. difficile*[a] in vitro and complete inactivation in situ	1.7–4-$\log_{10}$ reduction in *C. difficile*[a] in situ
Evidence of clinical impact	None published	None published	Significant reduction in the incidence of *C. difficile*	None published

NOTE. Adapted from Otter and Yezli.[36] BIs, biological indicators; VRE, vancomycin-resistant *Enterococcus*.
[a] All *C. difficile* experiments were done with *C. difficile* spores.

Automated Disinfection Devices
Donskey CJ. AJIC. May 2013

Table 3
Studies involving use of vaporized hydrogen peroxide for ward and/or terminal room disinfection

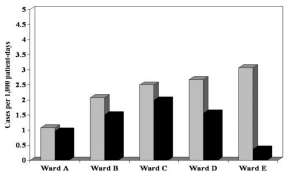
Reference	Setting/organism	Intervention	Monitoring of disinfection	Effect
45	Hospital-wide *Clostridium dif cile*	CDI rooms	No	Outbreak ended
46	Long-term acute care *Acinetobacter baumannii*	Affected patient rooms	Decrease sites positive (8.6% to 0%)	Outbreak ended
47	Neonatal ICU *Serratia marcescens*	Entire unit	No *Serratia* recovered after hydrogen peroxide vapor	Outbreak ended
48	12-Bed ICU MDR-GNR	All ICU rooms	Decrease sites positive (47.6% to 0%)	No MDR-GNR cases for 2 months but recurrent cases at 3–4 months
49	Hospital-wide *Clostridium dif cile*	Intensive decontamination of 5 high-incidence wards	Decrease sites positive (25.6% to 0%)	Significant decrease in CDI incidence on the high-incidence wards
50	6 High-risk wards (3 hydrogen peroxide vapor and 3 control wards) MDROs	Terminal MDRO rooms	Decreased contamination (relative risk, 0.65)	64% Decrease in MDRO acquisition; 80% decrease in VRE acquisition

ICU, Intensive care unit; MDR-GNR, multidrug-resistant gram-negative rods; MDRO, multidrug-resistant organisms.

Automated Disinfection Devices
Donskey CJ. AJIC. May 2013

- Hydrogen peroxide vapor has been used in outbreak settings and has been associated with reductions in colonization or infection with pathogens.
- Boyce et al demonstrated that HP vapor for terminal disinfection of CDI rooms was associated with a significant reduction in the incidence of CDI

Reduction in CDI on 5 High-Incidence Wards with Hydrogen Peroxide Vapor Disinfection [1]



	Before HP vapor	After HP vapor
% sites contaminated	26%	0%

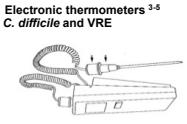
1. Boyce JM et al. Infect Control Hosp Epidemiol 2008;29:723-9

Equipment Associated with Outbreaks
(disinfection or replacement of contaminated equipment effective in eliminating outbreaks. Donskey CJ. AJIC May 2013)

Ultrasonic nebulizers [1]
MRSA

Hydrotherapy equipment [2]
MRSA

Electronic thermometers [3-5]
***C. difficile* and VRE**



1. Schultsz C, et al. J Hosp Infect 2003;55:269-75; 2. Embil JM, et al. Burns 2001;27:681-8; 3. Brooks SE et al. Infect Control Hosp Epidemiol 1992;13:98-103; 4. Jernigan JA, et al. Infect Control Hosp Epidemiol 1998;494-9; 5. Livornese LL, et al. Ann Intern Med 1992;117:112-116; 6. Cotterill S, et al. J Hosp Infect 1996;32:207-16; 7. Kumari DN, et al. J Hosp Infect 1998;39;127-33; 8. Engelhart S, et al. J Hosp Infect 2002;52:93-98

Does Improving Surface Cleaning and Disinfection Reduce Healthcare-Associated Infections?
Summary

- Multiple publications suggest that environmental disinfection interventions can reduce acquisition of healthcare-associated pathogens
- Additional high-quality studies are needed
- Reductions in pathogen acquisition have been achieved despite less than perfect room disinfection

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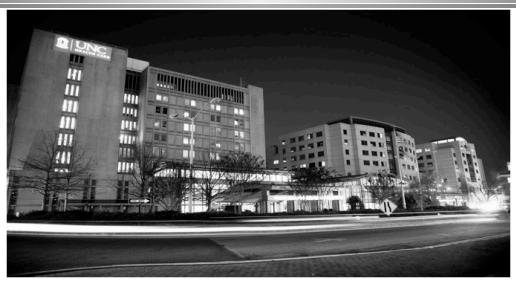
- Donskey CJ. Does improving surface cleaning and disinfection reduce healthcare-associated infections? Am J Infect Control May 2013.

www.disinfectionandsterilization.org

THANK YOU!



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06 May *(Free WHO Teleclass … Europe … Special Lecture for May 5)*
HAND HYGIENE PROMOTION UNIVERSAL SPREAD: IMPACT AND PATIENT PARTICIPATION
Speaker: Prof. Didier Pittet, University of Geneva Hospitals
Margaret Murphy, Patients for Patient Safety, WHO

09 May SURVEILLANCE OF HEALTHCARE ASSOCIATED INFECTION IN ACUTE CARE SETTINGS
Speaker: Teresa Horan, Rollins School of Public Health, Emory University

May 16 WHAT'S NEW IN TECHNOLOGIC INNOVATIONS FOR THE PREVENTION OF INTRAVASCULAR CATHETER ASSOCIATED BLOODSTREAM INFECTION
Speaker: Prof Mark Rupp, University of Nebraska Medical Center

30 May PREVENTING CATHETER-ASSOCIATED URINARY TRACT INFECTIONS IN ACUTE CARE SETTINGS

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