Role of the Environmental Surfaces in Disease Transmission: "No Touch" Technologies Reduce HAIs

William A. Rutala, Ph.D., M.P.H.

Director, Hospital Epidemiology, Occupational Health and Safety, UNC Health Care; Professor of Medicine and Director, Statewide Program for Infection Control and Epidemiology, University of North Carolina at Chapel Hill, NC, USA

Disclosure: Clorox

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"No Touch" Technologies Reduce HAIs

- Review the role of environmental surfaces
- Review the use of low-level disinfectants and the selection of the ideal disinfectant
- Review "best" practices for environmental cleaning and disinfection
- Discuss options for evaluating environmental cleaning and disinfection
- Discuss new "no touch" technologies for room decontamination and reduction of HAIs

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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 ENDEMIC AND EPIDEMIC MRSA

	Outbreak	Endemic				Site estimated mean§
	Rampling et al[27]*	Boyce et al[48]*	Sexton et al[51]†	Lemmen et al[50]*‡	French et al[64]*	
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

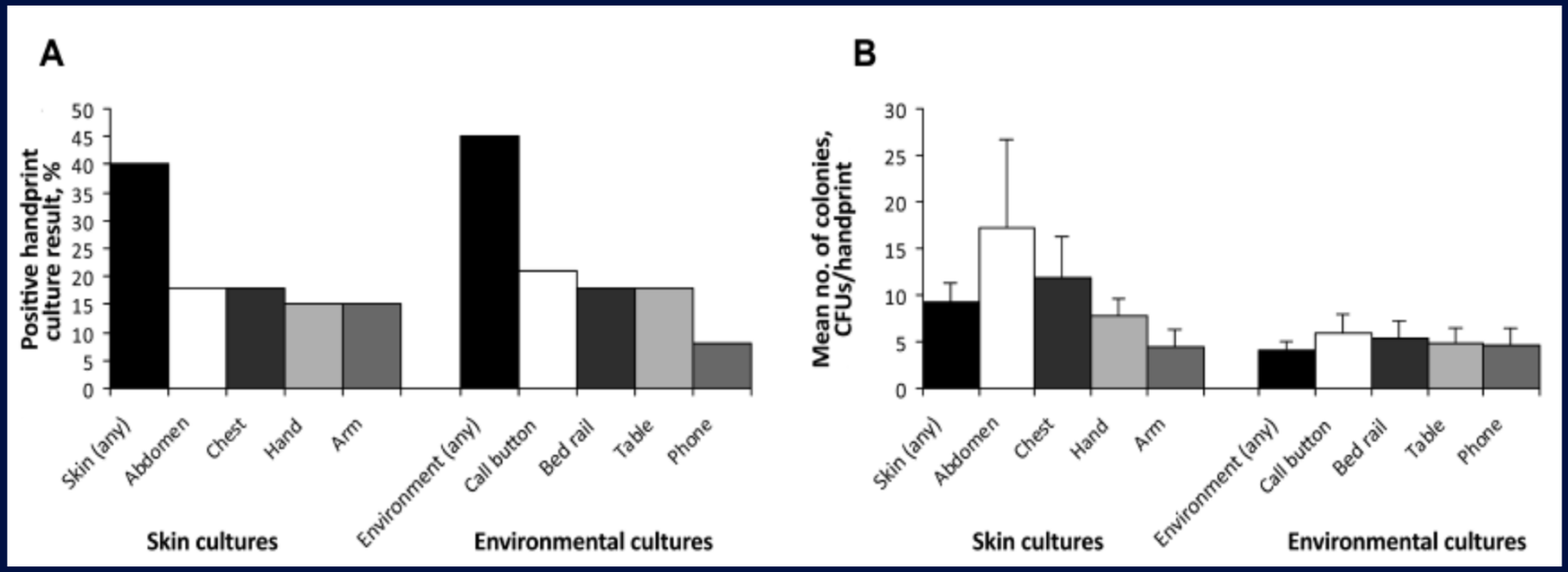
ENVIRONMENTAL SURVIVAL OF KEY PATHOGENS ON HOSPITAL SURFACES

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

RISK OF ACQUIRING PATHOGEN FROM PRIOR ROOM OCCUPANT~120%

JA Otter et al. Am J Infect Control 2013;41:S6-S11

* 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)

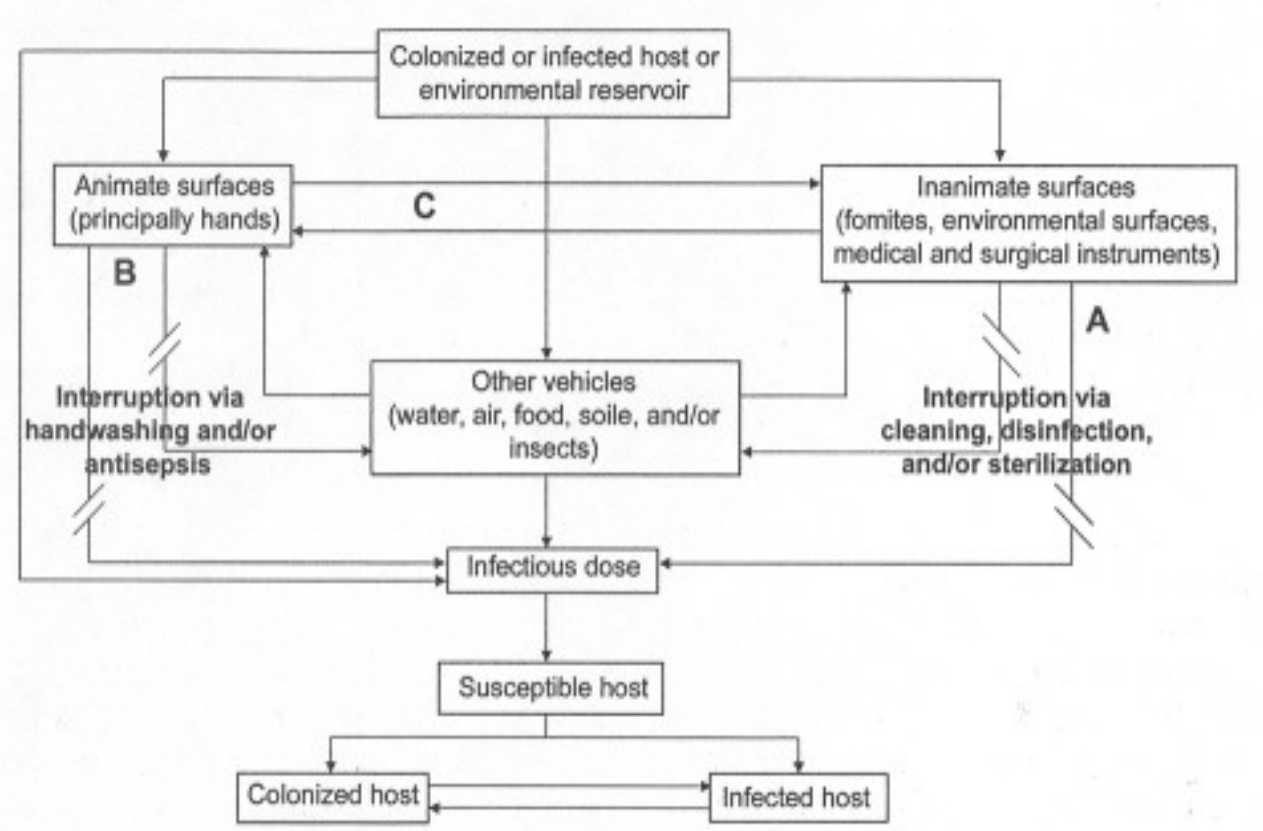
Shaughnessy MK, et al. ICHE 2011;32:201-206

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)	.71
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.

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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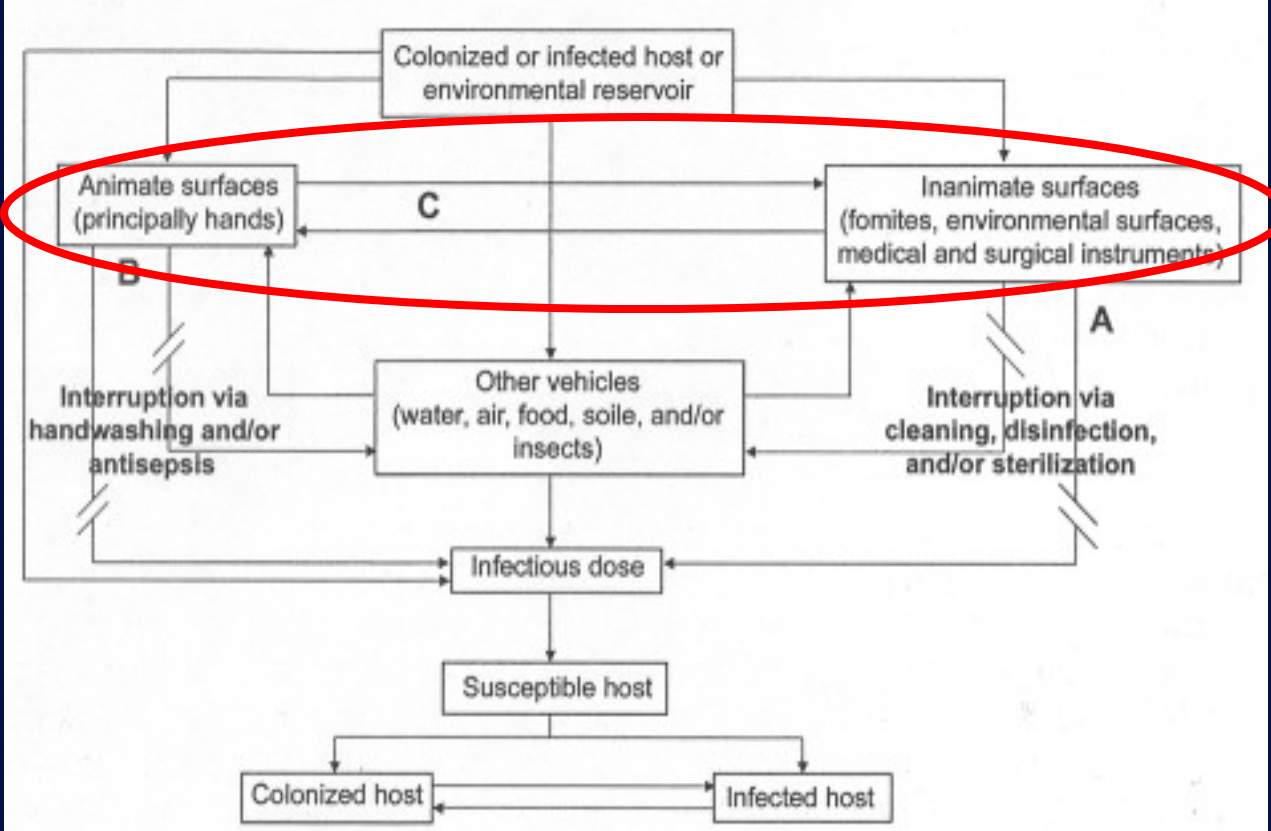

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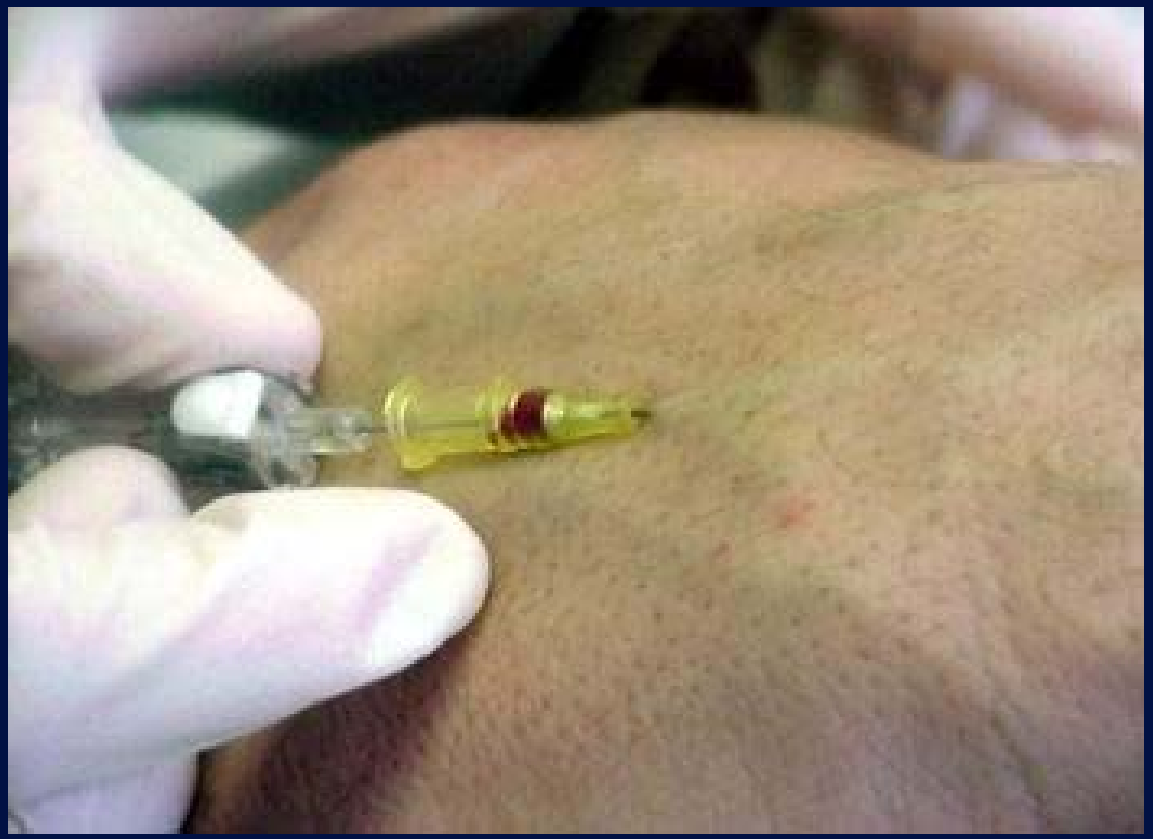
ACQUISITION OF MRSA ON HANDS AFTER CONTACT WITH ENVIRONMENTAL SITES

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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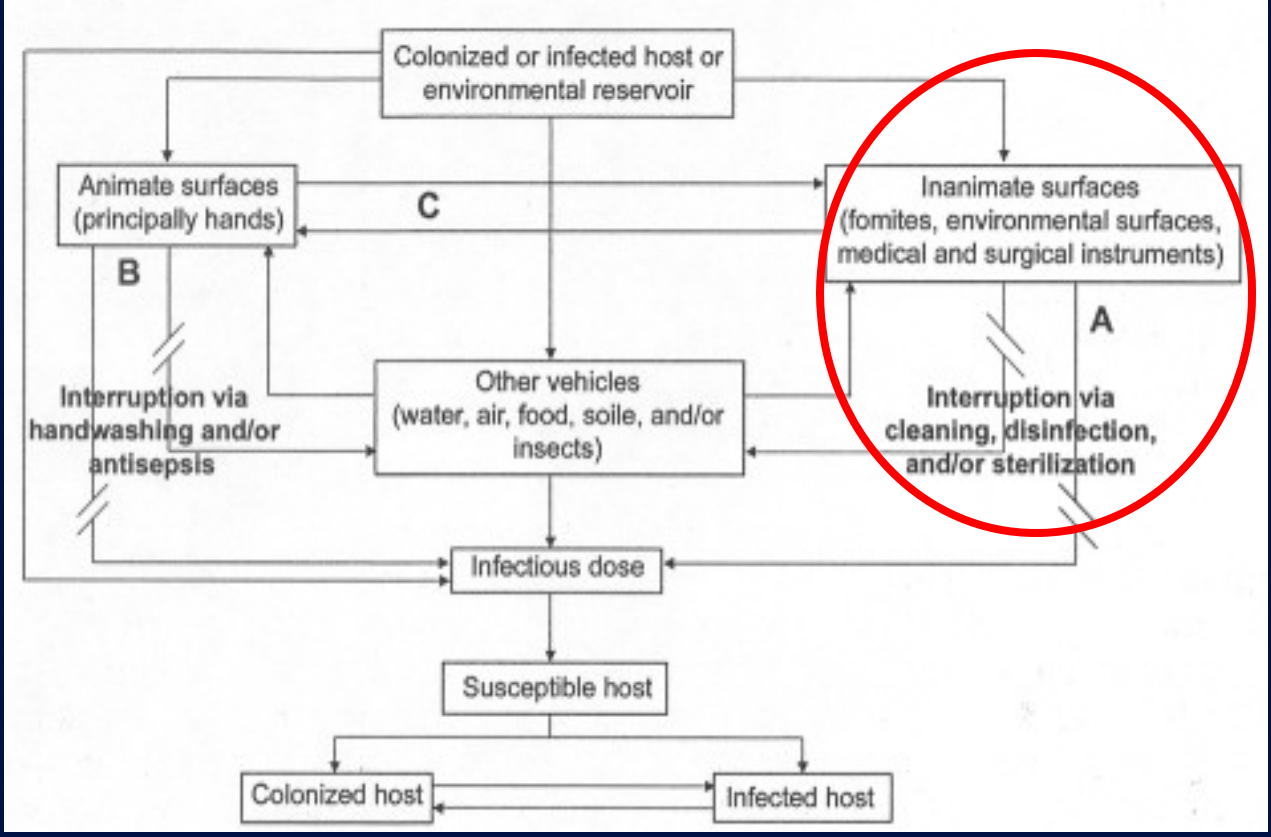

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ACQUISITION OF *C. difficile* ON PATIENT HANDS AFTER CONTACT WITH ENVIRONMENTAL SITES AND THEN INOCULATION OF MOUTH

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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.[1-6] These include *Clostridium difficile*, methicillin resistant infected with health care associated pathogens shed organisms onto their skin, clothing, bedding, and nearby environmental surfaces.[12] In addition to surfaces in rooms, portable equipment

Environmental Disinfection Interventions

Donskey CJ. Am J Infect Control 2013;41:S12

- Cleaning product substitutions
- Improvements in the effectiveness of cleaning and disinfection practices
  - Education
  - Audit and feedback
  - Addition of housekeeping personnel or specialized cleaning staff
- Automated technologies
- Conclusion: Improvements in environmental disinfection may prevent transmission of pathogens and reduce HAIs

Alfa et al. AJIC 2015;43:141-146

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major article

Use of a daily disinfectant cleaner instead of a daily cleaner reduced hospital-acquired infection rates

Michelle J. Alfa PhD [a,b,*], Evelyn Lo MD [b,c], Nancy Olson BSc [a], Michelle MacRae [c], Louise Buelow-Smith RN [c]

[a] St Boniface Research Centre, Winnipeg, MB, Canada
[b] Department of Medical Microbiology, University of Manitoba, Winnipeg, MB, Canada
[c] St Boniface Hospital, Winnipeg, MB, Canada

Key Words:
Methicillin-resistant *Staphylococcus aureus*
Vancomycin-resistant enterococci
Clostridium difficile
Housekeeping
Environmental cleaning

Background: Documenting effective approaches to eliminate environmental reservoirs and reduce the spread of hospital-acquired infections (HAIs) has been difficult. This was a prospective study to determine if hospital-wide implementation of a disinfectant cleaner in a disposable wipe system to replace a cleaner alone could reduce HAIs over 1 year when housekeeping compliance was ≥80%.

Methods: In this interrupted time series study, a ready-to-use accelerated hydrogen peroxide disinfectant cleaner in a disposable wipe container system (DCW) was used once per day for all high-touch surfaces in patient care rooms (including isolation rooms) to replace a cleaner only. The HAI rates for methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE), and *Clostridium difficile* were stratified by housekeeping cleaning compliance (assessed using ultraviolet-visible marker monitoring).

Results: When cleaning compliance was ≥80%, there was a significant reduction in cases/10,000 patient days for MRSA ($P = .0071$), VRE ($P < .0001$), and *C difficile* ($P = .0005$). For any cleaning compliance level there was still a significant reduction in the cases/10,000 patient days for VRE ($P = .0358$).

Conclusion: Our study data showed that daily use of the DCW applied to patient care high-touch environmental surfaces with a minimum of 80% cleaning compliance was superior to a cleaner alone because it resulted in significantly reduced rates of HAIs caused by *C difficile*, MRSA, and VRE.

Use of a Daily Disinfectant Cleaner Instead of a Daily Cleaner Reduced HAI Rates

Alfa et al. AJIC 2015.43:141-146

- Method: Improved hydrogen peroxide disposable wipe was used once per day for all high-touch surfaces to replace cleaner
- Result: When cleaning compliance was ≥ 80%, there was a significant reduction in cases/10,000 patient days for MRSA, VRE and *C. difficile*
- Conclusion: Daily use of disinfectant applied to environmental surfaces with a 80% compliance was superior to a cleaner because it resulted in significantly reduced rates of HAIs caused by *C. difficile*, MRSA, VRE

It appears that not only is disinfectant use important but how often is important

Daily disinfection vs clean when soiled

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 (PA) 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**

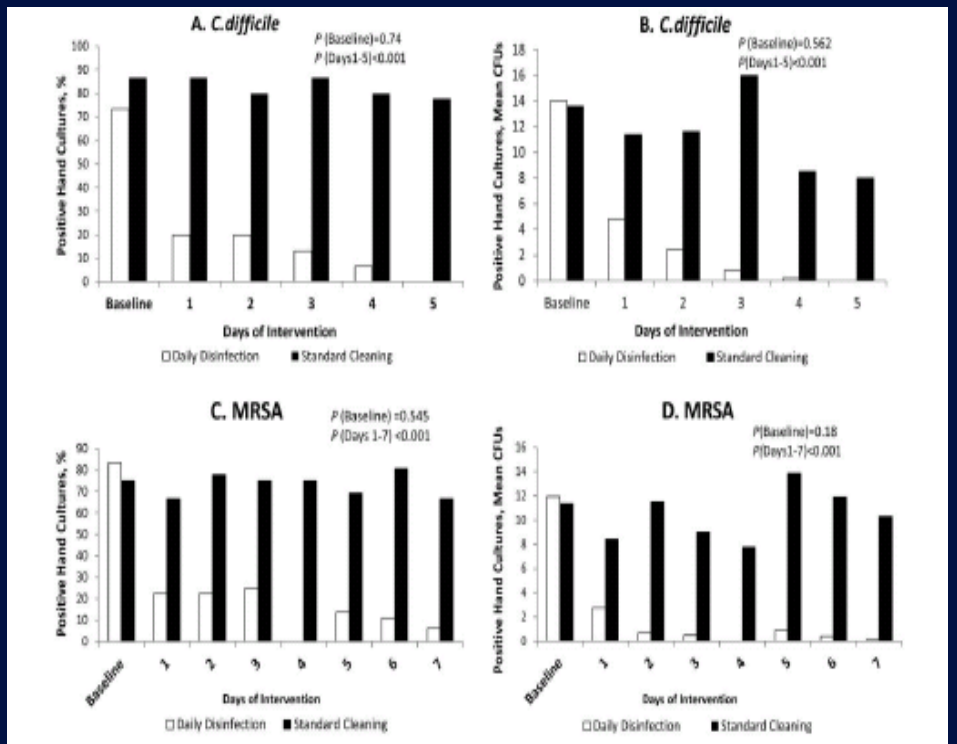

FIGURE 1. Effect of daily disinfection of high-touch environmental surfaces on acquisition of *Clostridium difficile* and methicillin-resistant *Staphylococcus aureus* (MRSA) on gloved hands of investigators after contact with the surfaces. *A*, Percentage of positive *C. difficile* cultures; *B*, mean number of *C. difficile* colony-forming units acquired; *C*, percentage of positive MRSA cultures; *D*, mean number of MRSA colony-forming units acquired.

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- There is increasing evidence to support the contribution of the environment to disease transmission
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- Review the role of environmental surfaces
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DISINFECTION AND STERLIZATION

- 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; however, small numbers of bacterial spores are permissible.**
  - **NONCRITICAL -objects that touch only intact skin require low-level disinfection**

Effective Surface Decontamination

Product and Practice = Perfection

Effective Surface Decontamination

Product and Practice = Perfection

LOW-LEVEL DISINFECTION FOR NONCRITICAL EQUIPMENT AND SURFACES

Rutala, Weber. Infect Control Hosp Epidemiol. 2014;35:855-865

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	0.5%, 1.4%

UD=Manufacturer's recommended use dilution

REVIEW THE "BEST" PRACTICES FOR CLEANING AND DISINFECTING

Cleaning and disinfecting is one-step with disinfectant-detergent. No pre-cleaning necessary unless spill or gross contamination. In many cases "best" practices not scientifically determined.

PROPERTIES OF AN IDEAL DISINFECTANT

Rutala, Weber. Infect Control Hosp Epidemiol. 2014;35:855-865

- **Broad spectrum**-wide antimicrobial spectrum
- **Fast acting**-should produce a rapid kill
- **Remains Wet**-meet listed kill/contact times with a single application
- **Not affected by environmental factors**-active in the presence of organic matter
- **Nontoxic**-not irritating to user
- **Surface compatibility**-should not corrode instruments and metallic surfaces
- **Persistence**-should have sustained antimicrobial activity
- **Easy to use**
- Acceptable odor
- Economical-cost should not be prohibitively high
- Soluble (in water) and stable (in concentrate and use dilution)
- Cleaner (good cleaning properties) and nonflammable

Key Considerations for Selecting the Ideal Disinfectant for Your Facility

Rutala, Weber. Infect Control Hosp Epidemiol. 2014;35:855-865

Consideration	Question to Ask	Score (1-10)
Kill Claims	Does the product kill the most prevalent healthcare pathogens	
Kill Times and Wet-Contact Times	How quickly does the product kill the prevalent healthcare pathogens. Ideally, contact time greater than or equal to the kill claim.	
Safety	Does the product have an acceptable toxicity rating, flammability rating	
Ease-of-Use	Odor acceptable, shelf-life, in convenient forms (wipes, spray), water soluble, works in organic matter, one-step (cleans/disinfects)	
Other factors	Supplier offer comprehensive training/education, 24-7 customer support, overall cost acceptable (product capabilities, cost per compliant use, help standardize disinfectants in facility	

Note: Consider the 5 components shown, give each product a score (1 is worst and 10 is best) in each of the 5 categories, and select the product with the highest score as the optimal choice (maximum score is 50).

MOST PREVALENT PATHOGENS CAUSING HAI

Rutala, Weber. Infect Control Hosp Epidemiol. 2014;35:855-865

- Most prevent pathogens causing HAI (~75% easy to kill)
  - *S. aureus* (15.6%)
  - *E. coli* (11.5%)
  - Coag neg Staph (11.4%)
  - *Klebsiella* (8.0%)
  - *P. aeruginosa* (8.0%)
  - *E. faecalis* (6.8%)
  - *C. albicans* (5.3%)
  - *Enterobacter* sp. (4.7%)
  - Other *Candida* sp (4.2%)
- Common causes of outbreaks and ward closures (relatively hard to kill)
  - *C. difficile* spores
  - Norovirus
  - Rotavirus
  - Adenovirus

EFFECTIVENESS OF DISINFECTANTS AGAINST MRSA AND VRE

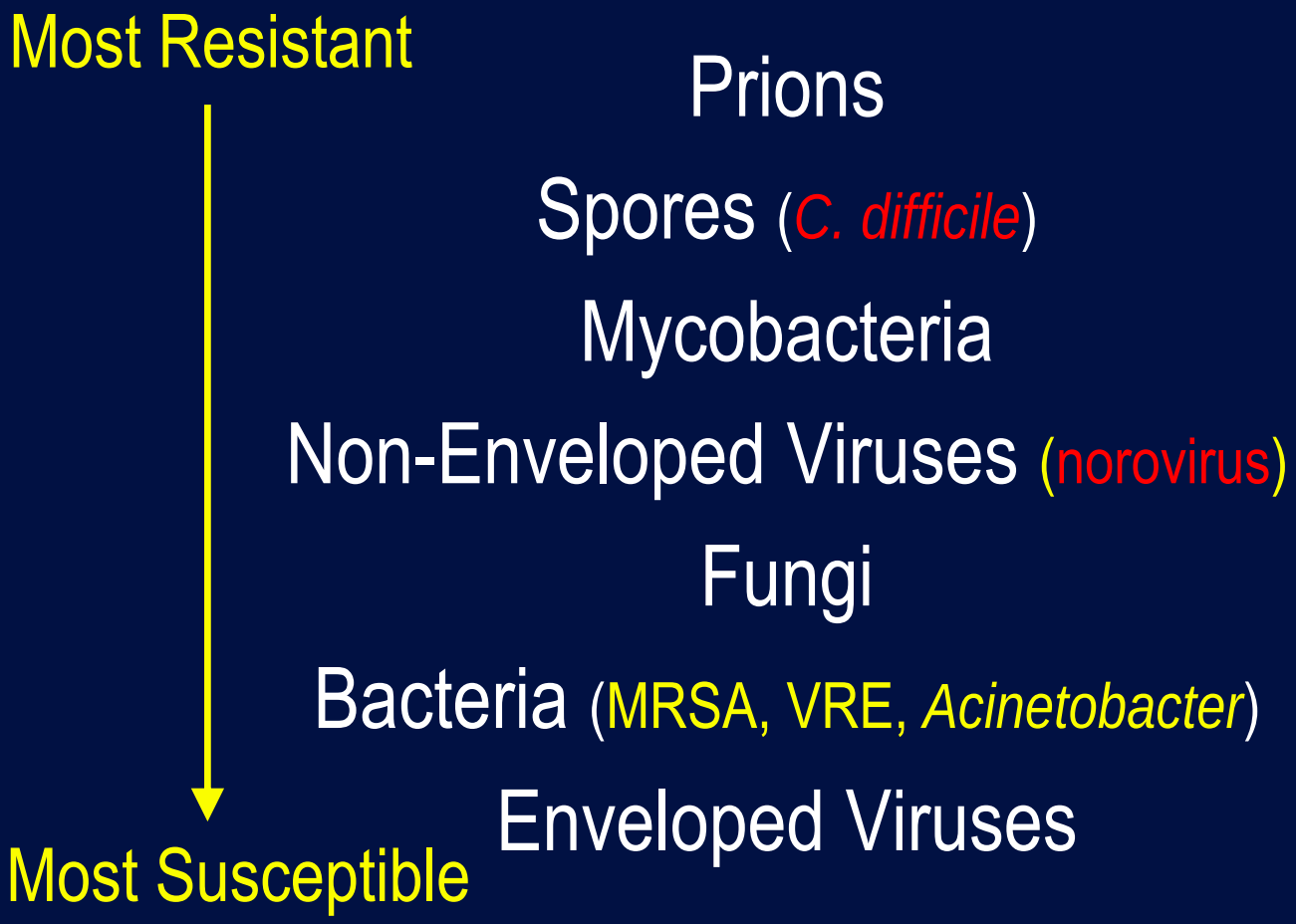
Rutala WA, et al. *Infect Control Hosp Epidemiol* **2000;21:33-38**

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 Nd/No, where Nd is the titer of bacteria surviving after exposure and No is the titer of the control.

Decreasing Order of Resistance of Microorganisms to Disinfectants/Sterilants



C. difficile
EPA-Registered Products

- List K: EPA's Registered Antimicrobials Products Effective Against *C. difficile* spores, April 2014
- http://www.epa.gov/oppad001/list_k_clostridium.pdf
- 34 registered products; most chlorine-based, some HP/PA-based

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CDC Guideline for Disinfection and Sterilization

Rutala, Weber, HICPAC. November 2008. www.cdc.gov

Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008

William A. Rutala, Ph.D., M.P.H.[1,2], David J. Weber, M.D., M.P.H.[1,2], and the Healthcare Infection Control Practices Advisory Committee (HICPAC)[3]

Blood Pressure Cuff
Non-Critical Patient Care Item

Rutala, Weber, HICPAC. November 2008. www.cdc.gov

DISINFECTION OF NONCRITICAL PATIENT-CARE DEVICES

Rutala, Weber, HICPAC. November 2008. www.cdc.gov

- Process noncritical patient-care devices using a disinfectant and concentration of germicide as recommended in the Guideline (IB)
- Disinfect noncritical medical devices (e.g., blood pressure cuff) with an EPA-registered hospital disinfectant using the label's safety precautions and use directions. Most EPA-registered hospital disinfectants have a label contact time of 10 minutes but multiple scientific studies have demonstrated the efficacy of hospital disinfectants against pathogens with a contact time of at least 1 minute (IB)
- Ensure that, at a minimum noncritical patient-care devices are disinfected when visibly soiled and on a regular basis (e.g., once daily or weekly) (II)
- If dedicated, disposable devices are not available, disinfect noncritical patient-care equipment after using on a patient, who is on contact precautions before using this equipment on another patient (IB)

CLEANING AND DISINFECTION OF ENVIRONMENTAL SURFACES IN HEALTHCARE FACILITIES

Rutala, Weber, HICPAC. November 2008. www.cdc.gov

- Clean housekeeping surfaces (e.g., floors, tabletops) on a regular basis, when spills occur, and when these surfaces are visibly soiled (II)
- Disinfect (or clean) environmental surfaces on a regular basis (e.g., daily, 3x per week) and when surfaces are visibly soiled (II)
- Follow manufacturers' instructions for proper use of disinfecting (or detergent) products – such as recommended use-dilution, material compatibility, storage, shelf-life, and safe use and disposal (II)
- Clean walls, blinds, and window curtains in patient-care areas when these surfaces are visibly contaminated or soiled (II)
- Prepare disinfecting (or detergent) solutions as needed and replace with fresh solution frequently (e.g., replace floor mopping solution every 3 patient rooms, change no less often than at 60-minute intervals) (IB)

Effective Surface Decontamination

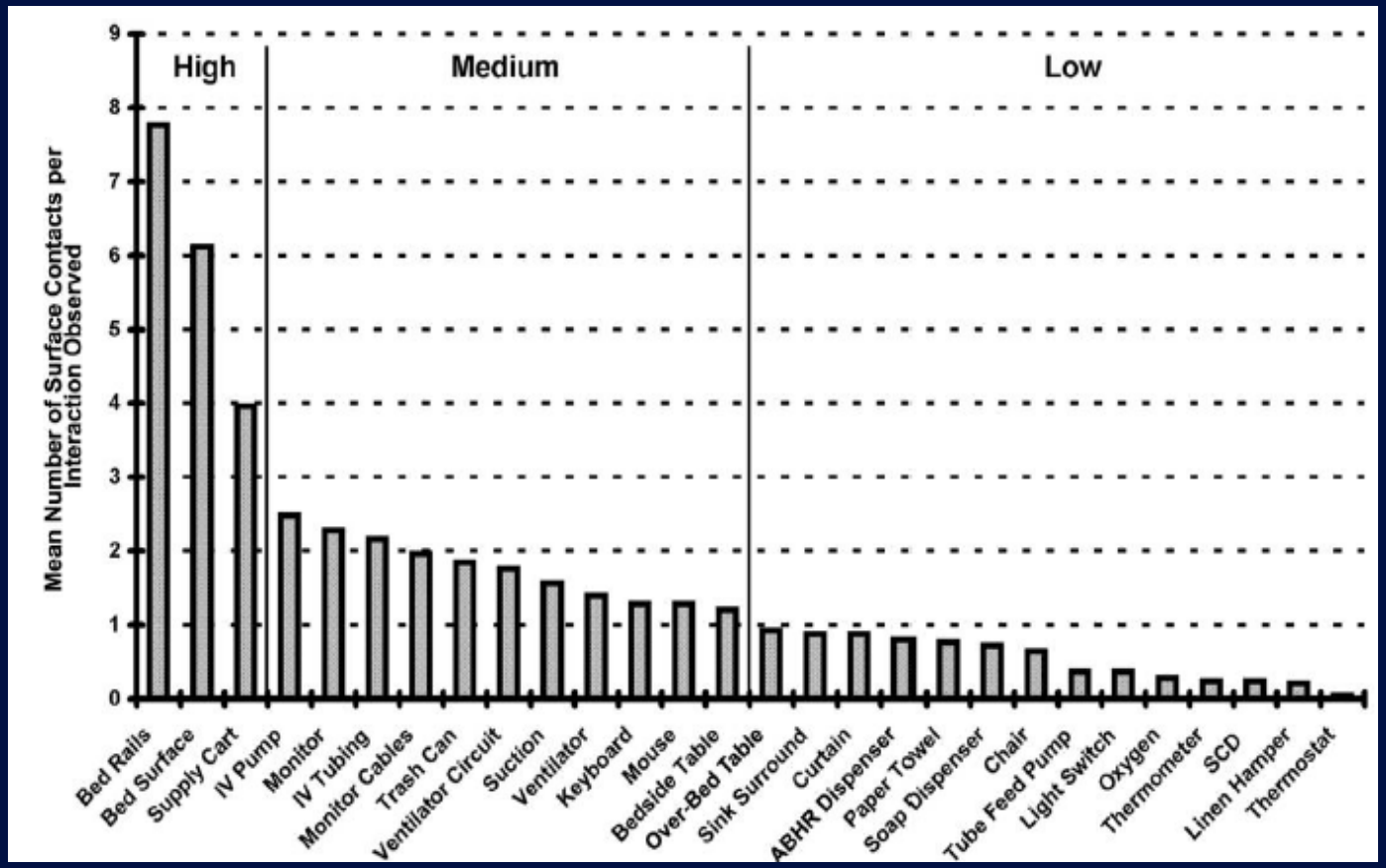
Product and Practice = Perfection

SHOULD WE CONCENTRATE ON "HIGH TOUCH" OR "HIGH RISK" OBJECTS

No, not only "high risk" (all surfaces).
"High touch" objects only recently defined
and "high risk" objects not scientifically
defined.

DEFINING HIGH TOUCH SURFACES

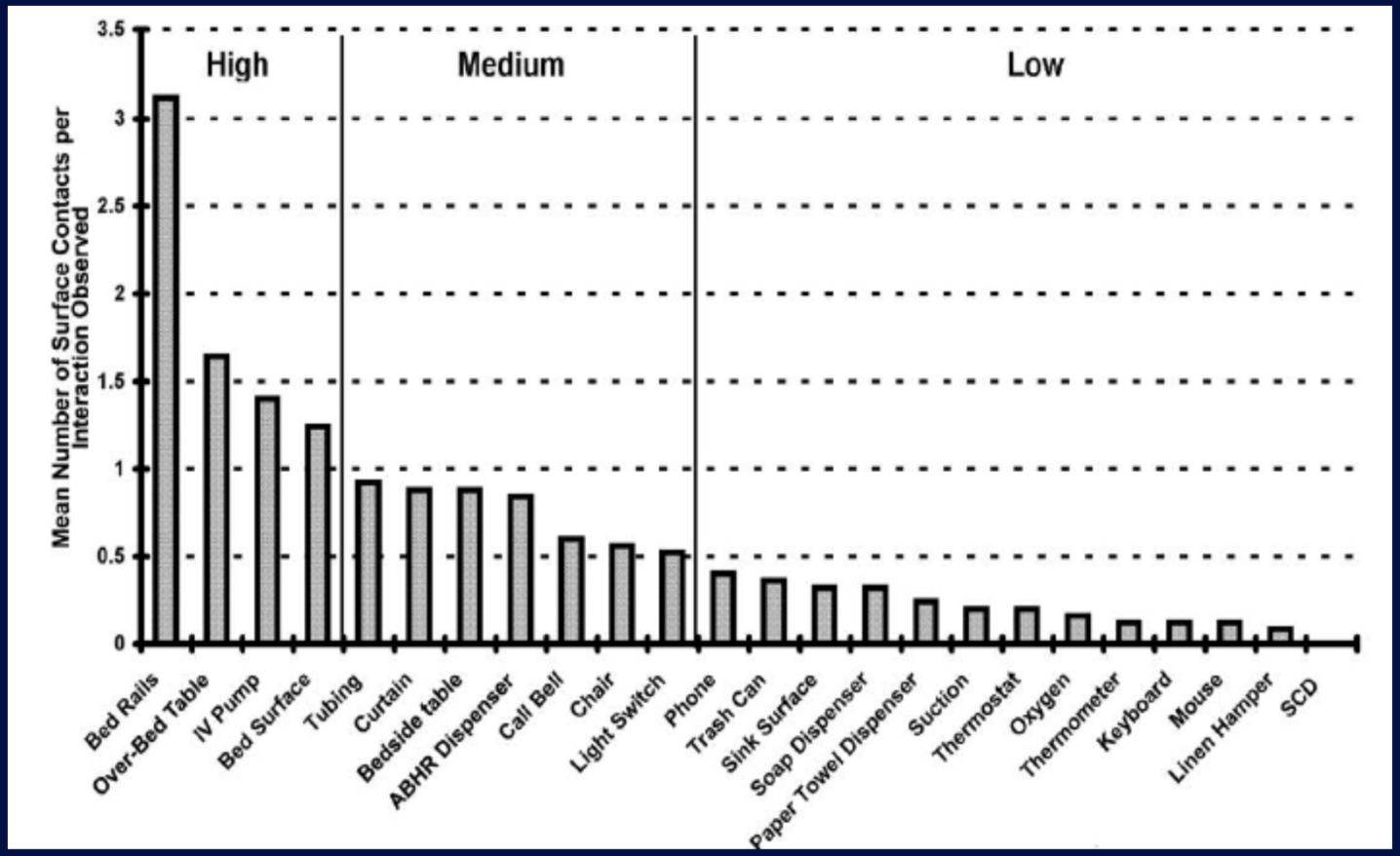
ICU



Huslage K, Rutala WA, Sickbert-Bennett E, Weber DJ. ICHE 2010;31:850-853

DEFINING HIGH TOUCH SURFACES

Non-ICU



Huslage K, Rutala WA, Sickbert-Bennett E, Weber DJ. ICHE 2010;31:850-853

MICROBIAL BURDEN ON ROOM SURFACES AS A FUNCTION OF FREQUENCY OF TOUCHING

Huslage K, Rutala WA, Weber DJ. ICHE. 2013;34:211-212

Surface	Prior to Cleaning Mean CFU/RODAC (95% CI)	Post Cleaning (mean) Mean CFU/RODAC (95% CI)
High	71.9 (46.5-97.3)	9.6
Medium	44.2 (28.1-60.2)	9.3
Low	56.7 (34.2-79.2)	5.7

- **The level of microbial contamination of room surfaces is similar regardless of how often they are touched both before and after cleaning**
- **Therefore, all surfaces that are touched must be cleaned and disinfected**

TABLE. Rates of Cleaning for 14 Types of High-Risk Objects

Object	Percentage cleaned		95% CI
	Mean ± SD	Range	
Sink	82 ± 12	57-97	77-88
Toilet seat	76 ± 18	40-98	68-84
Tray table	77 ± 15	53-100	71-84
Bedside table	64 ± 22	23-100	54-73
Toilet handle	60 ± 22	23-89	50-69
Side rail	60 ± 21	25-96	51-69
Call box	50 ± 19	9-90	42-58
Telephone	49 ± 16	18-86	42-56
Chair	48 ± 28	11-100	35-61
Toilet door knobs	28 ± 22	0-82	18-37
Toilet hand hold	28 ± 23	0-90	18-38
Bedpan cleaner	25 ± 18	0-79	17-33
Room door knobs	23 ± 19	2-73	15-31
Bathroom light switch	20 ± 21	0-81	11-30

NOTE. CI, confidence interval.

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.

Wipes

Cotton, Disposable, Microfiber, Cellulose-Based, Nonwoven Spunlace

WIPES

Rutala, Weber. Infect Control Hosp Epidemiol. 2014;35:855-865

- Wipes-cotton, disposable, microfiber, nonwoven spunlace
- Wipe should have sufficient wetness to achieve the disinfectant contact time. Discontinue use of the wipe if no longer leaves the surface visible wet for ≥ 1 minute.
- When the wipe is visibly soiled, flip to a clean/unused side and continue until all sides of the wipe have been used (or get another wipe)
- Dispose of the wipe/cloth wipe appropriately
- Do not re-dip a wipe into the clean container of pre-saturated wipes

DISPOSABLE WIPES

Rutala, Weber. Infect Control Hosp Epidemiol. 2014;35:855-865

- **Wetness**-ideally, stays wet long enough to meet EPA-registered contact times (e.g., bacteria-1 minute).
- **Surface Coverage**-premoistened wipe keeps surface area wet for 1-2 minutes (e.g., 12”x12” wipes keep 55.5 sq ft wet for 2m; 6”x5” equipment wipe keeps 6.7 sq ft wet for 2m). Wipe size based on use from small surfaces to large surfaces like mattress covers
- **Durable substrate**-will not easily tear or fall apart
- **Top**-keep closed or wipes dry out

Cleaning/Disinfection

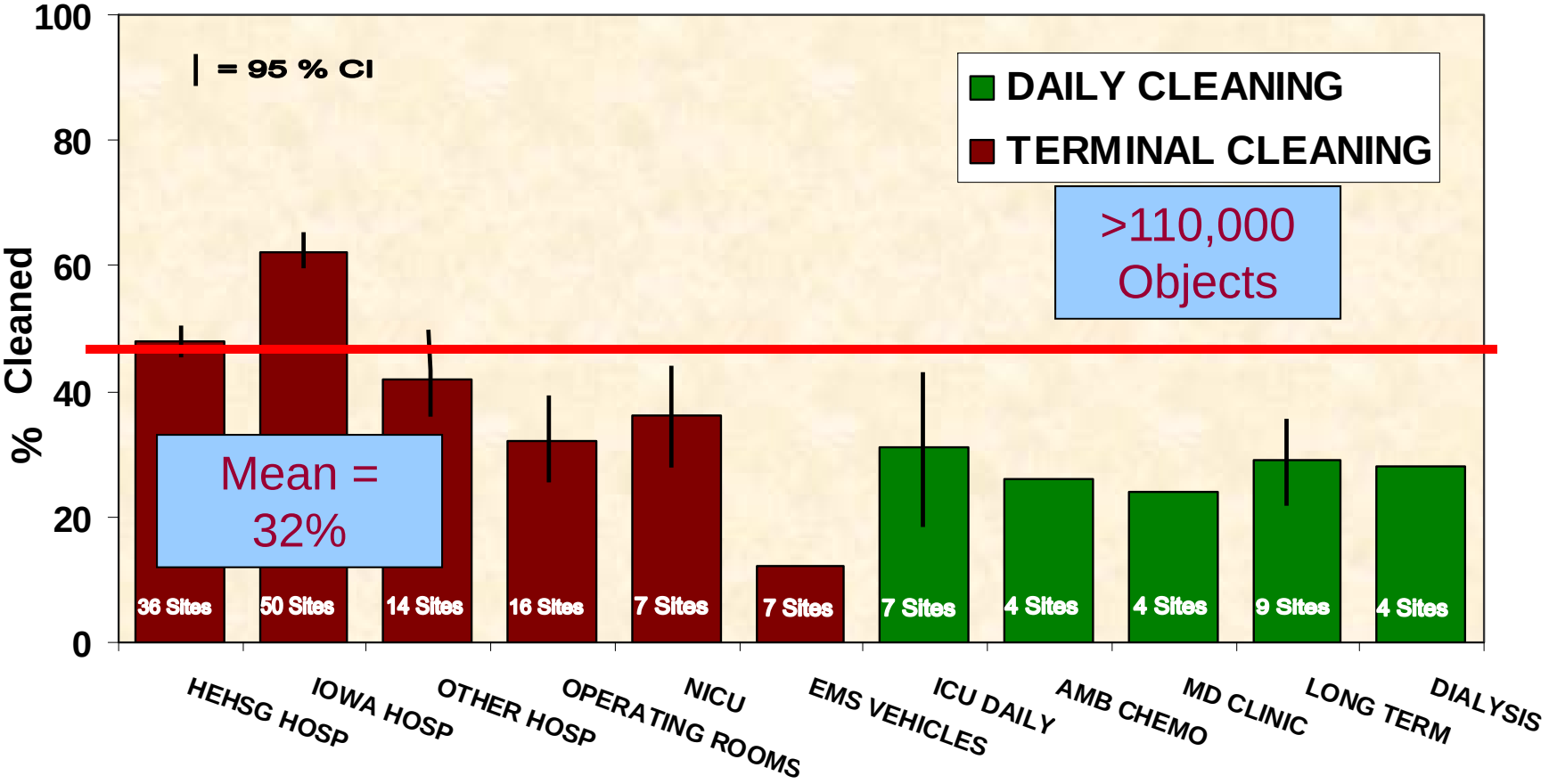
- ES and nursing need to agree on who is responsible for cleaning what (especially equipment)
- ES needs to know
  - Which disinfectant/detergent to use
  - What concentration would be used (and verified)
  - What contact times are recommended (bactericidal)
  - How often to change cleaning/disinfecting cloths/mop heads
  - How important their job is to infection prevention

Role of Environmental Surfaces in Disease Transmission
"No Touch" Technologies Reduce HAIs

- Review the role of environmental surfaces
- Review the use of low-level disinfectants and the selection of the ideal disinfectant
- Review "best" practices for environmental cleaning and disinfection
- Discuss options for evaluating environmental cleaning and disinfection
- Discuss new "no touch" technologies for room decontamination and reduction of HAIs

Thoroughness of Environmental Cleaning

Carling P. AJIC 2013;41:S20-S25



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 IP unbeknown to EVS, after EVS cleaning, markings are reassessed)

DAZO Solution (AKA – Goo)

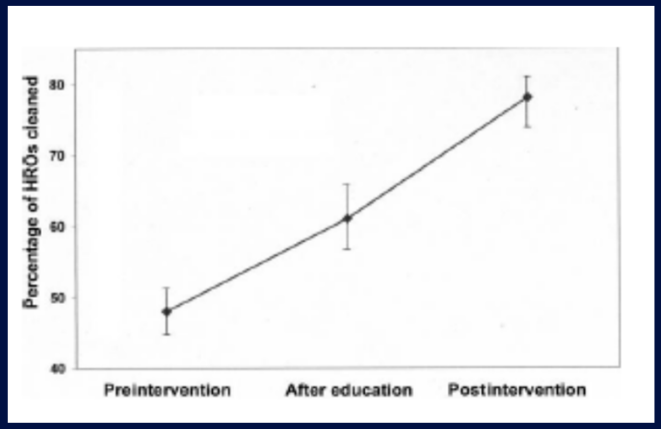
TARGET ENHANCED

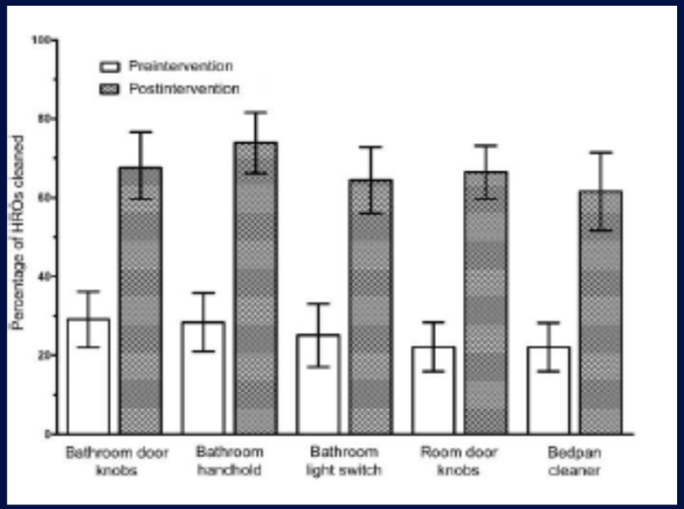
TERMINAL ROOM CLEANING: DEMONSTRATION OF IMPROVED CLEANING

- Evaluated cleaning before and after an intervention to improve cleaning
- 36 US acute care hospitals
- Assessed cleaning using a fluorescent dye
- Interventions
  - Increased education of environmental service workers
  - Feedback to environmental service workers

†Regularly change "dotted" items to prevent targeting objects

Carling PC, et al. ICHE 2008;29:1035-41





SURFACE EVALUATION USING ATP BIOLUMINESCENCE

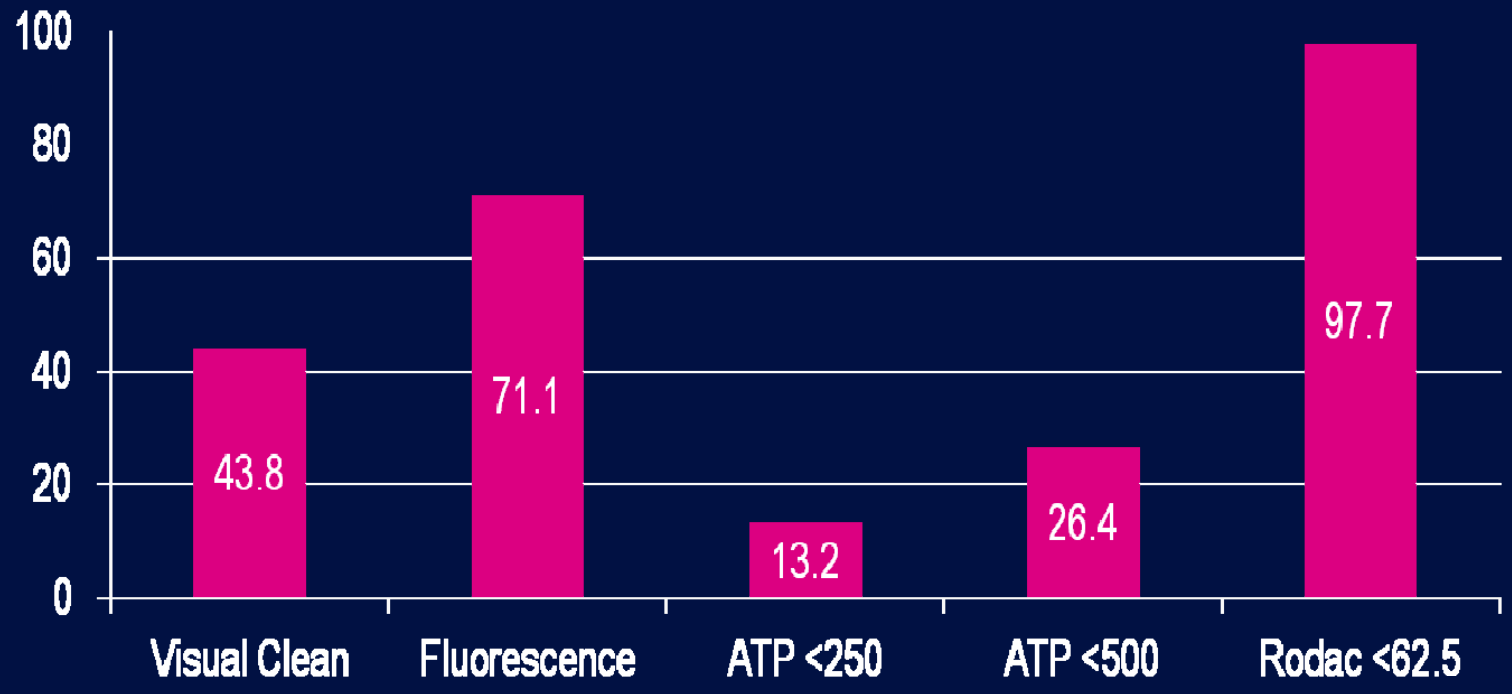
Swab surface → luciferace tagging of ATP → Hand held luminometer

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

Percentage of Surfaces Clean by Different Measurement Methods

Rutala, Gergen, Sickbert-Bennett, Huslage, Weber. 2013

Fluorescent marker is a useful tool in determining how thoroughly a surface is wiped and mimics the microbiological data better than ATP



Role of Environmental Surfaces in Disease Transmission

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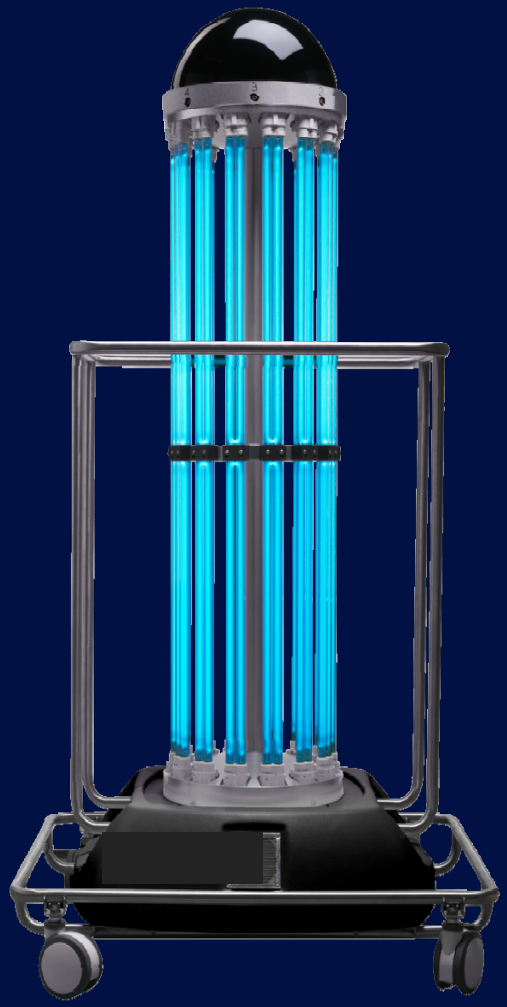
NEW "NO TOUCH" APPROACHES TO ROOM DECONTAMINATION

Supplement Surface Disinfection

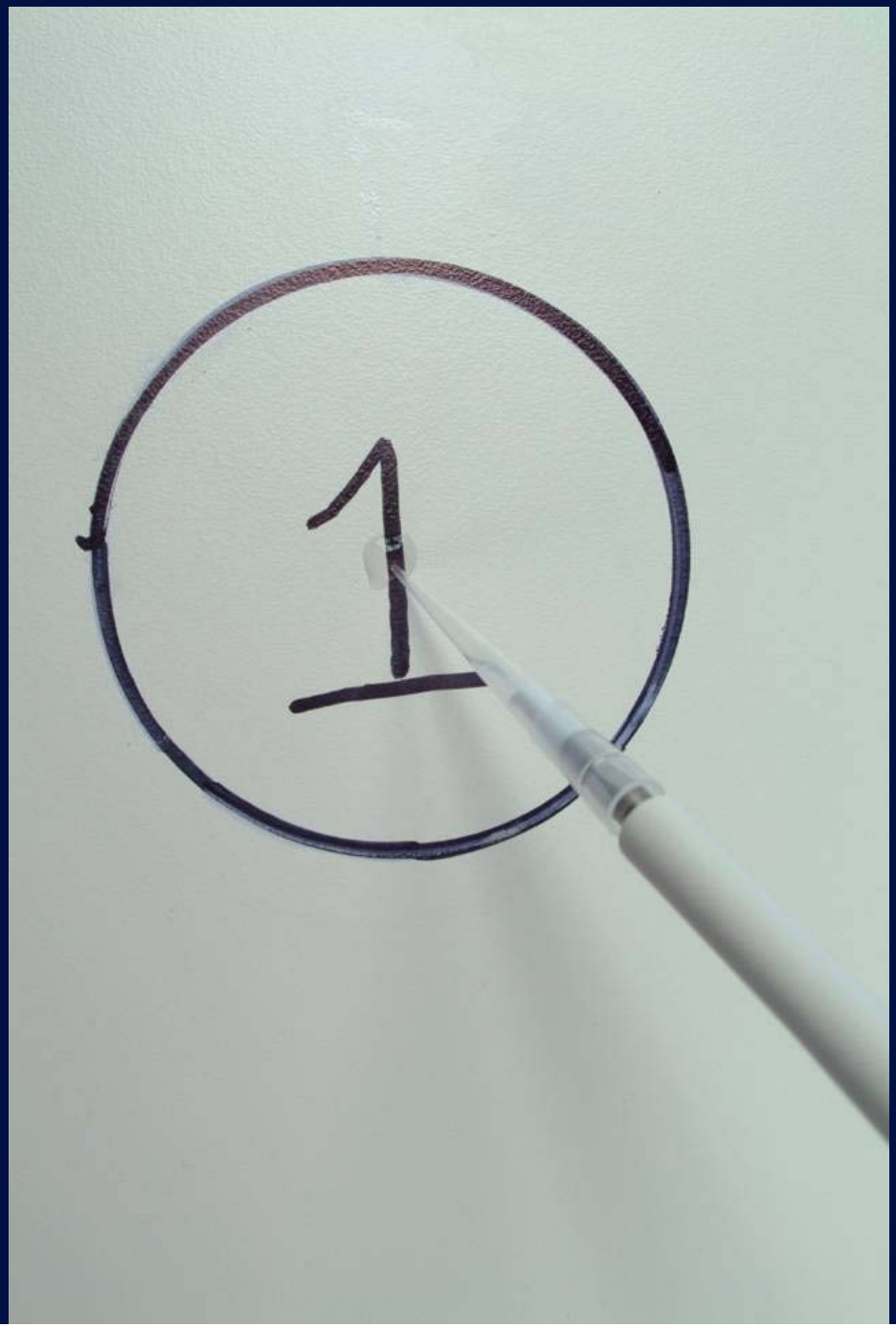
Rutala, Weber. Infect Control Hosp Epidemiol. 2013;41:S36-S41



Touch (Wiping) vs No-Touch (Mechanical)

No Touch

(supplements but do not replace surface cleaning/disinfection)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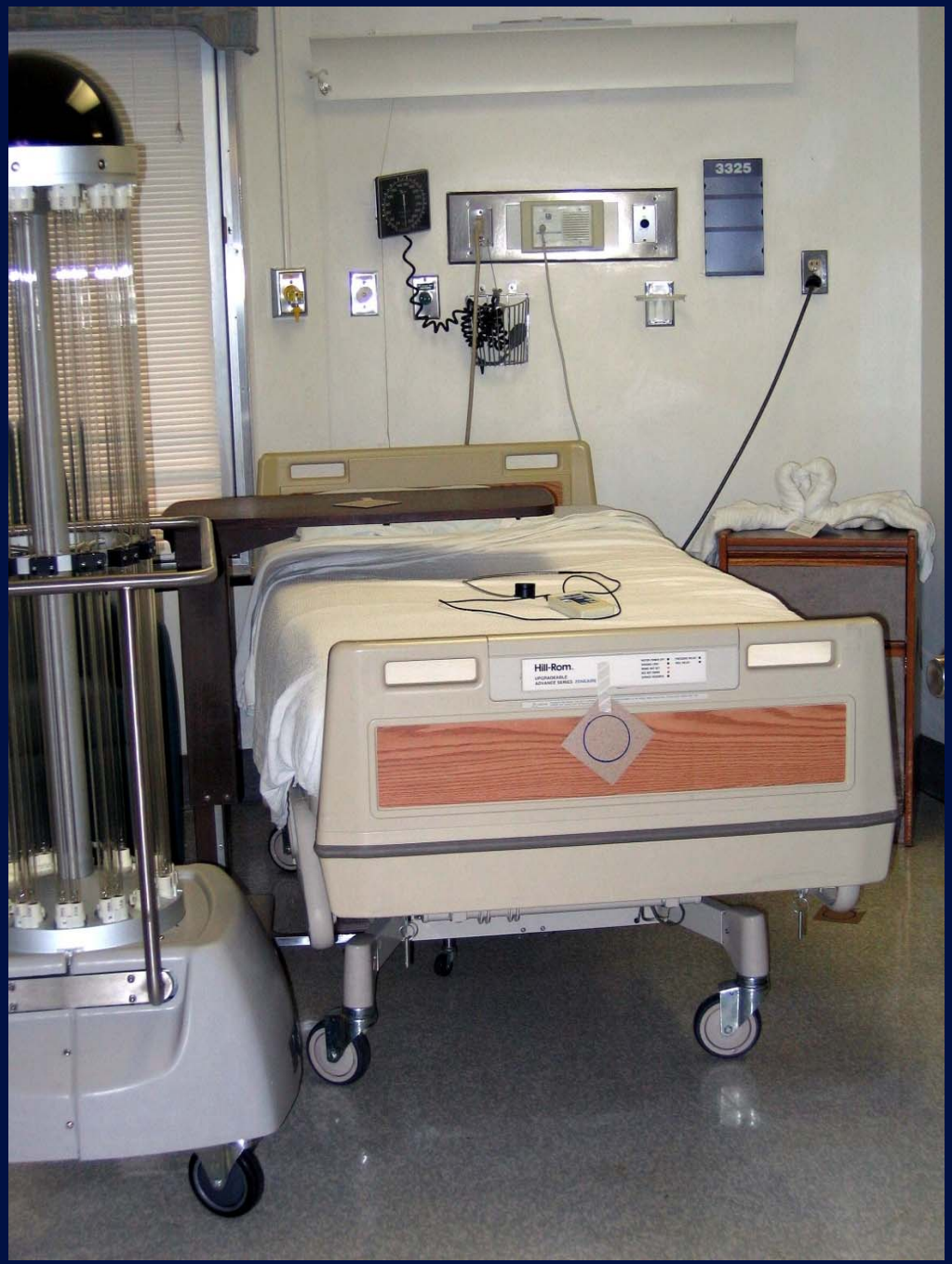

3325
Hill-Rom.

Formica Placement in the Patient Room

- Toilet seat
- Back of head-of-the-bed
- Back-of-computer
- Bedside table (far side)
- Side of sink
- Foot of bed, facing the door
- Bathroom door

UV Room Decontamination

Rutala, Gergen, Weber, ICHE. 2010:31:1025-1029

- Fully automated, self calibrates, activated by hand-held remote
- Room ventilation does not need to be modified
- Uses UV-C (254 nm range) to decontaminate surfaces
- Measures UV reflected from walls, ceilings, floors or other treated areas and calculates the operation total dosing/time to deliver the programmed lethal dose for pathogens.
- UV sensors determines and targets highly-shadowed areas to deliver measured dose of UV energy
- After UV dose delivered (36,000µWs/cm^2 for spore, 12,000µWs/cm^2 for bacteria), will power-down and audibly notify the operator
- Reduces colony counts of pathogens by >99.9% within 20 minutes

EFFECTIVENESS OF UV ROOM DECONTAMINATION

Rutala, Gergen, Weber, ICHE. 2010:31:1025-1029

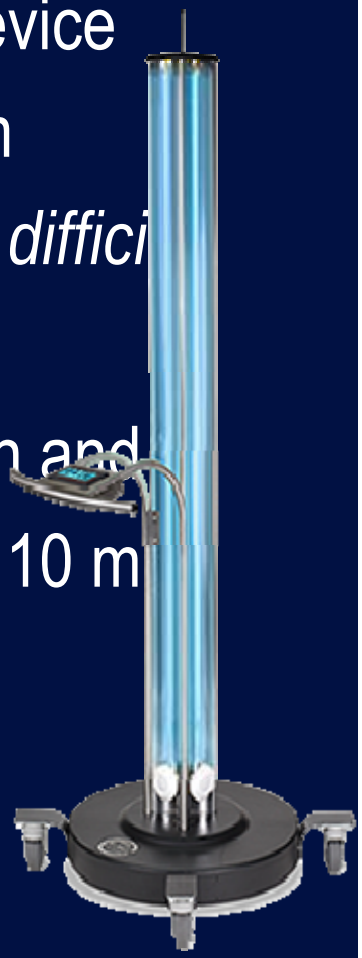
TABLE 1. UV-C Decontamination of Formica Surfaces in Patient Rooms Experimentally Contaminated with Methicillin-Resistant *Staphylococcus aureus* (MRSA), Vancomycin-Resistant *Enterococcus* (VRE), Multidrug-Resistant (MDR) *Acinetobacter baumannii*, and *Clostridium difficile* Spores

		UV-C line of sight						
		Total		Direct		Indirect		
Organism	Inoculum	No. of samples	Decontamination, $\log_{10}$ reduction, mean (95% CI)	No. of samples	Decontamination, $\log_{10}$ reduction, mean (95% CI)	No. of samples	Decontamination, $\log_{10}$ reduction, mean (95% CI)	*P*
MRSA	4.88 $\log_{10}$	50	3.94 (2.54–5.34)	10	4.31 (3.13–5.50)	40	3.85 (2.44–5.25)	.06
VRE	4.40 $\log_{10}$	47	3.46 (2.16–4.81)	15	3.90 (2.99–4.81)	32	3.25 (1.97–4.62)	.003
MDR *A. baumannii*	4.64 $\log_{10}$	47	3.88 (2.59–5.16)	10	4.21 (3.27–5.15)	37	3.79 (2.47–5.10)	.07
C. difficile spores	4.12 $\log_{10}$	45	2.79 (1.20–4.37)	10	4.04 (3.71–4.37)	35	2.43 (1.46–3.40)	<.001

Room Decontamination with UV

Rutala, Gergen, Tande, Weber. ICHE. 2014. 35:1070-1072.

- Objective: Determine the effectiveness of a UVC device
- Method: Study carried out in standard hospital room using Formica sheets contaminated with MRSA, *C. diffici*
- Results: The effectiveness of UVC radiation in reducing MRSA was more than >99.9% within 5 min and the reduction of *C. difficile* spores was >99% within 10 m
- Conclusion: This UVC device (UVDI) allowed room decontamination in 5-10 minutes



Room Decontamination with UV

Rutala, Gergen, Weber. ICHE. 2014. 35:1070-1072

UVDI delivers lethal dose of UV in 5-10 min (may be attributable to design (e.g., reflector)

Organism (Decontamination Time)	Inoculum	Total Decontamination Log_{10} Reduction	Direct Decontamination Log_{10} Reduction	Indirect Decontamination Log_{10} Reduction
MRSA (5 min)	4.80	3.56 (n=50)	4.10 (n=30)	2.74 (n=20)
C. difficile spores (10 min)	3.69	2.78 (n=50)	3.35 (n=30)	1.80 (n=20)

HYDROGEN PEROXIDE FOR DECONTAMINATION OF THE HOSPITAL ENVIRONMENT

Falagas, et al. J Hosp Infect. 2011;78:171.

Author, Year	HP System	Pathogen	Before HPV	After HPV	% Reduction
French, 2004	VHP	MRSA	61/85-72%	1/85-1%	98
Bates, 2005	VHP	*Serratia*	2/42-5%	0/24-0%	100
Jeanes, 2005	VHP	MRSA	10/28-36%	0/50-0%	100
Hardy, 2007	VHP	MRSA	7/29-24%	0/29-0%	100
Dryden, 2007	VHP	MRSA	8/29-28%	1/29-3%	88
Otter, 2007	VHP	MRSA	18/30-60%	1/30-3%	95
Boyce, 2008	VHP	*C. difficile*	11/43-26%	0/37-0%	100
Bartels, 2008	HP dry mist	MRSA	4/14-29%	0/14-0%	100
Shapey, 2008	HP dry mist	*C. difficile*	48/203-24%	7/203-3%	88
Barbut, 2009	HP dry mist	*C. difficile*	34/180-19%	4/180-2%	88
Otter, 2010	VHP	GNR	10/21-48%	0/63-0%	100

Clinical Trials Using HP for Terminal Room Disinfection to Reduce HAIs

Weber, Rutala et al. Am J Infect Control, 2016;44:e77-e84

Author, Year	Design	Pathogen	Reduction in HAIs
Boyce, 2008	Before-After	CDI	Yes
Cooper, 2011	Before-After	CDI	Decrease cases (incidence not stated)
Passaretti, 2013	Prospective cohort	MRSA, VRE, CDI	Yes, in all MDROs
Manian, 2013	Before-After	CDI	Yes
Mitchell, 2014	Before-After	MRSA	Yes

EFFECTIVENESS OF UV-C FOR ROOM DECONTAMINATION (Inoculated Surfaces)

[1]ICHE 2010;31:1025; [2]BMC 2010;10:197; [3]ICHE 2011;32:737; [4]JHI 2013;84:323I [5]ICHE 2012;33:507-12 [6]ICHE 2013;34:466 * $\mu Ws/cm^2$; min = minutes; NA = not available

Pathogens	Dose*	Mean log_{10} Reduction Line of Sight	Mean log_{10} Reduction Shadow	Time	Reference
MRSA, VRE, MDR-A	12,000	3.90-4.31	3.25-3.85	~15 min	Rutala W, et al.[1]
C. difficile	36,000	4.04	2.43	~50 min	Rutala W, et al.[1]
MRSA, VRE	12,000	>2-3	NA	~20 min	Nerandzic M, et al.[2]
C. difficile	22,000	>2-3	NA	~45 min	Nerandzic M, et al.[2]
C. difficle	22,000	2.3	overall	67.8 min	Boyce J, et al.[3]
MRSA, VRE, MDR-A, *Asp*	12,000	3.-5->4.0	1.7->4.0	30-40 min	Mahida N, et al.[4]
MRSA, VRE, MDR-A, *Asp*	22,000	≥4.0*	1.0-3.5	60-90 min	Mahida N, et al.[4]
C. difficile, G. stear spore	22,000	2.2	overall	73 min	Havill N et al[5]
VRE, MRSA, MDR-A	12,000	1.61	1.18	25 min	Anderson et al[6]

Clinical Trials Using UV for Terminal Room Decontamination to Reduce HAIs

Weber, Rutala et al. Am J Infect Control, 2016;44:e77-e84

Author, Year	Design	Pathogens	Reduction in HAIs
Levin, 2013	Before-After, Pulsed Xenon	CDI	Yes
Hass, 2014	Before-After, Pulsed Xenon	CDI, MRSA, VRE, MDRO-GNR	Yes
Miller, 2015	Before-After, Pulsed Xenon	CDI	Yes
Nagaraja, 2015	Before-After, Pulsed Xenon	CDI	Yes (p=0.06)
Pegues, 2015	Before-After, Optimum	CDI	Yes
Anderson, 2015	Randomized-controlled trial, Tru-D	MRSA, VRE, CDI	Yes

The Benefits of Enhanced Terminal Room (BETR) Disinfection Study: Duke/UNC Epicenter

Anderson et al, 2015, ID Week

A Pragmatic, Prospective, Cluster Randomized, Multicenter Crossover Study with 2x2 Factorial Design to Evaluate the Impact of Enhanced Terminal Room Disinfection on Acquisition and Infection Caused by Multidrug-Resistant Organisms

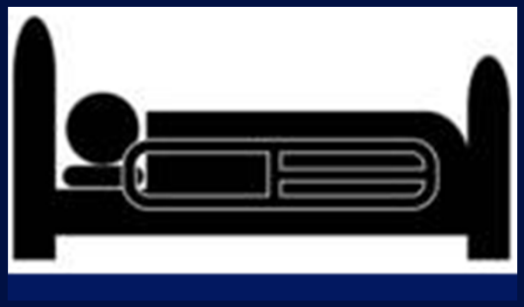
2x2 Factorial Design

	No UV Light	UV Light
Quat*	A	B
Bleach	C	D

*NOTE: Bleach always used in rooms of patients with suspected or confirmed *C. difficile*

Rooms of Patients on Contact Precautions Decontaminated with Standard or Enhanced Methods and "Exposed" Patient Monitored for Target MDRO

Patient in "Seed Room"



Documented infection or colonization with

MRSA

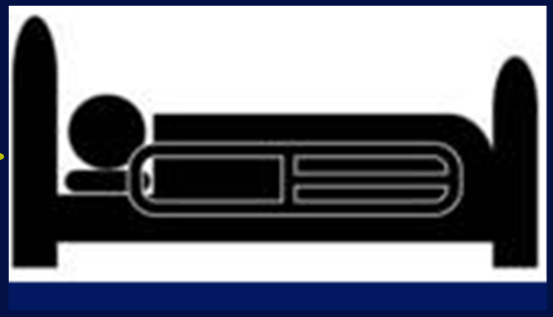
VRE

C. difficile

MDR-Acinetobacter

Terminal Clean

"Exposed Patient"



In room ≥ 24 hours

Exposure days = Time spent in "seed room"

Clinical Incidence of All Target MDROs Following the Use of Four Strategies for Terminal Room Disinfection

Study Phase Strategy	A Quat	B Quat/UV	C Bleach	D Bleach/UV
All target MDROs				
n/exposure days	115/22,426	76/22,389	101/24,261	131/28,757
Cumulative rate	51.3	33.9	41.6	45.6
Average rate ± STD	46.1±27.9	28.7±20.5	41.1±16.6	39.2±20.9
RR (95% CI) p-value	*ref*	0.70 (0.50-0.98) 0.036	0.85 (0.69-1.04) 0.12	0.91 (0.76-1.09) 0.30

Conclusion: Enhanced terminal room disinfection strategies decreased the clinical incidence of target MDROs by 10-30%

Relationship Between Reduced Environmental Contamination and Reduction of HAIs

Rutala, Kanamori, Gergen et al. 2016

Intervention	MDR-*Acinetobacter*	*C. difficile*	MRSA	VRE	EIP*
Quat	8.95	3.76	8.52	39.6	60.8
Quat/UV	0.17	2.86	0.11	0.21	3.4
Bleach	0.39	4.48	4.39	2.43	11.7
Bleach/UV	0.25	3.25	0.85	1.90	6.3

*EIP-epidemiologically-important pathogens (mean CFU/room/125cm^2) by intervention and contamination in patient rooms

All enhanced disinfection technologies were significantly superior to Quat alone in reducing EIPs. Comparing the best strategy with the worst strategy (i.e., Quat vs Quat/UV) revealed that a reduction of 94% in EIP (60.8 vs 3.4) led to a 35% decrease in colonization/infection (2.3% vs 1.5%). Our data demonstrated that a decrease in room contamination was associated with a decrease in patient colonization/infection.

Based on 12 studies, this technology should be used (capital equipment budget) for terminal room disinfection (e.g., after discharge of patients under CP).

UV ROOM DECONTAMINATION: ADVANTAGES AND DISADVANTAGES

Rutala WA, Weber DJ. AJIC 2013;41:s36

- Advantages
  - Reliable biocidal activity against a wide range of pathogens
  - Studies demonstrating a reduction in HAIs
  - Surfaces and equipment decontaminated
  - Room decontamination is rapid (5-25 min) for vegetative bacteria
  - HVAC system does not need to be disabled and room does not need to be sealed
  - UV is residual free and does not give rise to health and safety concerns
  - No consumable products so operating costs are low (key cost = acquisition)
- Disadvantages
  - Can only be done for terminal disinfection (i.e., not daily cleaning)
  - All patients and staff must be removed from room
  - Substantial capital equipment costs
  - Does not remove dust and stains which are important to patients/visitors
  - Sensitive use parameters (e.g., UV dose delivered)

HP ROOM DECONTAMINATION: ADVANTAGES AND DISADVANTAGES

Rutala WA, Weber DJ. AJIC 2013;41:s36

- Advantages
  - Reliable biocidal activity against a wide range of pathogens
  - Studies demonstrate a reduction in HAIs
  - Surfaces and equipment decontaminated
  - Residual free and does not give rise to health and safety concerns (aeration units convert HPV into oxygen and water)
  - Useful for disinfecting complex equipment and furniture
  - Does not require direct or indirect line of sight
- Disadvantages
  - Can only be done for terminal disinfection (i.e., not daily cleaning)
  - All patients and staff must be removed from room
  - Decontamination takes approximately 2.0 hours
  - HVAC system must be disabled and the room sealed with tape
  - Substantial capital equipment costs
  - Does not remove dust and stains which are important to patients/visitors
  - Sensitive use parameters (e.g., HP concentration)

Selection of a UV or HP Device

Weber, Rutala et al. Am J Infect Control. 2016;44:e77-e84.

- Since different UV and hydrogen peroxide systems vary substantially, infection preventionists should review the peer-reviewed literature and choose only devices with demonstrated bactericidal capability as assessed by carrier tests and/or the ability to disinfect actual patient rooms
- Ideally, one would select a device that has demonstrated bactericidal capability and the ability to reduce HAIs

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Role of the Environmental in Disease Transmission
"No Touch" Technologies Reduce HAIs

- Disinfection of noncritical environmental surfaces/equipment is an essential component of infection prevention
- Disinfection should render surfaces and equipment free of pathogens in sufficient numbers to cause human disease
- When determining the optimal disinfecting product, consider the 5 components (kill claims/time, safety, ease of use, others) and select the product with the highest score as the best choice for your healthcare facility
- Implement a method to improve the thoroughness of cleaning
- Goal: Product + Practice = Perfection
- An enhanced method of room decontamination is superior to a standard method
- "No touch" technology should be used at discharge for CP patients

THANK YOU!

www.disinfectionandsterilization.org

BEST PRACTICES FOR ROOM DISINFECTION

- Follow the CDC Guideline for Disinfection and Sterilization with regard to choosing an appropriate germicide and best practices for environmental disinfection
- Appropriately train environmental service workers on proper use of PPE and clean/disinfection of the environment
- Have environmental service workers use checklists to ensure all room surfaces are cleaned/disinfected
- Assure that nursing and environmental service have agreed what items (e.g., sensitive equipment) are to be clean/disinfected by nursing and what items (e.g., environmental surfaces) are to be cleaned/disinfected by environmental service workers. Staff must have sufficient time. Increasing workload compromising infection control activities.
- Use a method (e.g., fluorescent dye, ATP) to ensure proper cleaning