Safer Healthcare Environments for Infection Prevention

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Daniel

DISCLOSURES

- Consultation
  - Advanced Sterilization Products, Clorox
- Honoraria (speaking)
  - Advanced Sterilization Products, 3M
- Grants
  - CDC

disinfectionandsterilization.org

Safer Healthcare Environments for Infection Prevention

New Technologies and Future Challenges

- Reprocessing reusable medical/surgical instruments
- Hospital surfaces
- Water

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DISINFECTION AND STERILIZATION

- 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**


STERRAD NX


STERRAD NX

Newer Trends in Sterilization of Patient Equipment

- Alternatives to ETO-CFC

  ETO-CO_2, ETO-HCFC, 100% ETO

- New Low Temperature Sterilization Technology

  Hydrogen Peroxide Gas Plasma-most common

  Vaporized hydrogen peroxide-limited clinical use
  Ozone and hydrogen peroxide-not FDA cleared

  Nitrogen dioxide-not FDA cleared

Rapid Readout BIs for Steam Now Require a 1-3h Readout Compared to 24-48h

Vol. 17 No. 7 INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY 423

COMPARISON OF A RAPID READOUT BIOLOGICAL INDICATOR FOR STEAM STERILIZATION WITH FOUR CONVENTIONAL BIOLOGICAL INDICATORS AND FIVE CHEMICAL INDICATORS

William A. Rutala, PhD, MPH; Suzanne M. Jones, MPH; David J. Weber, MD, MPH



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Super Rapid Readout Biological Indicators

Commercially available in early 2013



1491 BI (blue cap)

- **Monitors 270°F and 275°F gravity –displacement steam sterilization cycles**
- **30 minute result (from 1 hour)**



1492V BI (brown cap)

- **Monitors 270°F and 275°F dynamic-air-removal (pre-vacuum) steam sterilization cycles**
- **1 hour result (from 3 hours)**

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High-Level Disinfection of "Semicritical Objects"

Exposure Time ≥ 8m-45m (US), 20°C

Germicide	Concentration
Glutaraldehyde	≥ 2.0%
Ortho-phthalaldehyde	0.55%
Hydrogen peroxide*	7.5%
Hydrogen peroxide and peracetic acid*	1.0%/0.08%
Hydrogen peroxide and peracetic acid*	7.5%/0.23%
Hypochlorite (free chlorine)*	650-675 ppm
Accelerated hydrogen peroxide	2.0%
Peracetic acid	0.2%
Glut and isopropanol	3.4%/26%
Glut and phenol/phenate**	1.21%/1.93%

*May cause cosmetic and functional damage; **efficacy not verified

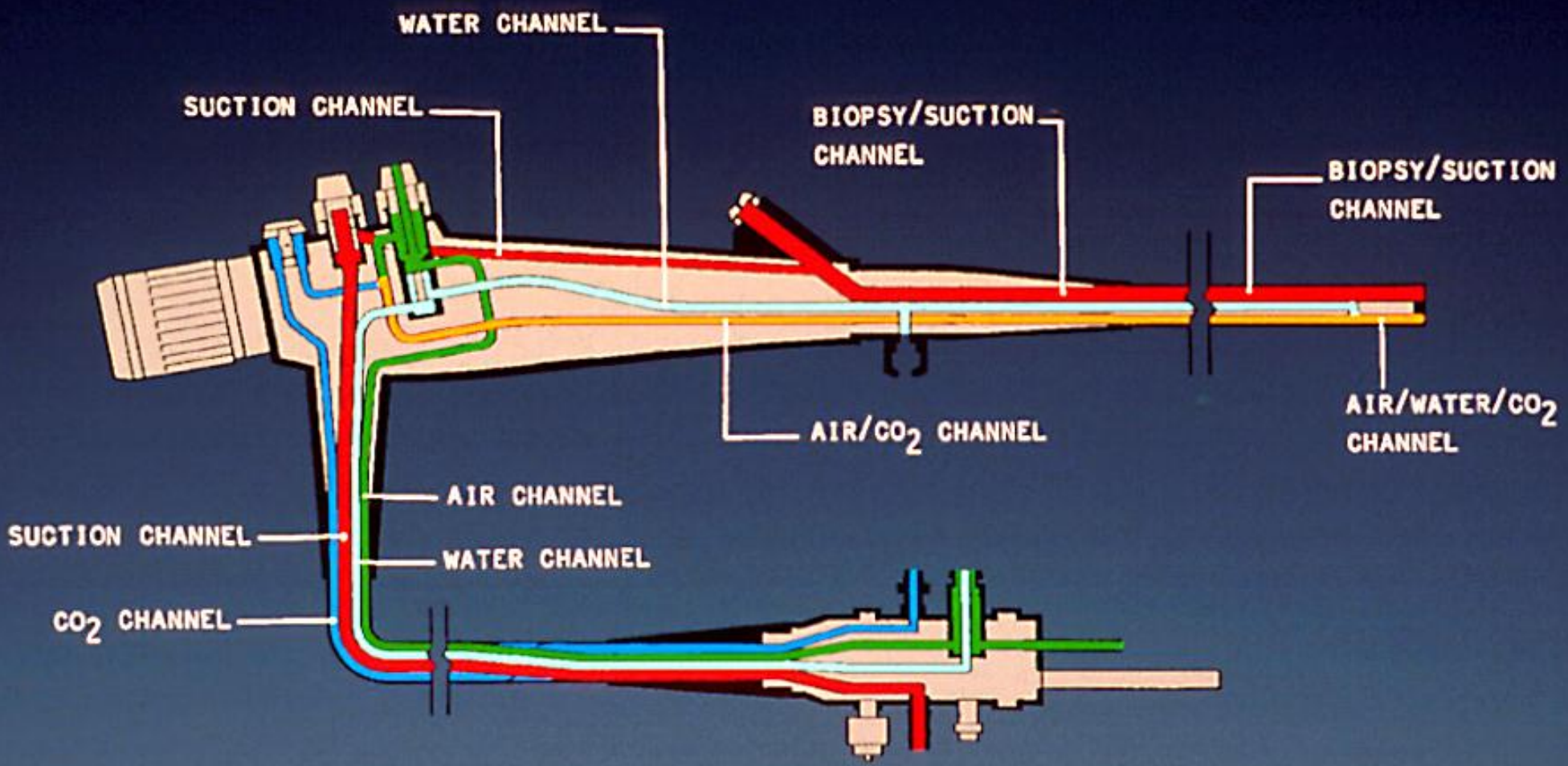
Semicritical Equipment

- **Reprocessing semicritical items has been shown to have a narrow margin of safety**
- **Generally, the narrow margin of safety attributed to high microbial load and complex instruments with lumens**
- **Any deviation from the recommended reprocessing protocol can lead to the survival of microorganisms and an increased risk of infection**
- **Problems encountered with reprocessing semicritical equipment often related to improper cleaning**

Reprocessing Semicritical Items

- **New Developments in Reprocessing**
  - **Endoscopes**
  - **Laryngoscopes**
  - **Infrared coagulation device**
  - **Nasopharyngoscopes**
  - **Endocavitary probe**
  - **Prostate biopsy probes**
  - **Tonometers**

ENDOSCOPE CHANNELS



MULTISOCIETY GUIDELINE ON REPROCESSING GI ENDOSCOPES, 2011

Petersen et al. ICHE. 2011;32:527

INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY JUNE 2011, VOL. 32, NO. 6

ASGE-SHEA GUIDELINE

Multisociety Guideline on Reprocessing Flexible GI Endoscopes: 2011

Bret T. Petersen, MD, FASGE; Jennifer Chennat, MD; Jonathan Cohen, MD, FASGE; Peter B. Cotton, MD, FASGE; David A. Greenwald, MD, FASGE; Thomas E. Kowalski, MD; Mary L. Krinsky, DO; Walter G. Park, MD; Irving M. Pike, MD, FASGE; Joseph Romagnuolo, MD, FASGE; for the ASGE Quality Assurance in Endoscopy Committee; and William A. Rutala, PhD, MPH; for the Society for Healthcare Epidemiology of America

The beneficial role of GI endoscopy for the prevention, diagnosis, and treatment of many digestive diseases and cancer is well established. Like many sophisticated medical devices, the endoscope is a complex, reusable instrument that requires reprocessing before being used on subsequent patients. The most commonly used methods for reprocessing endoscopes result in high-level disinfection. To date, all published occurrences of pathogen transmission related to GI endoscopy have been associated with failure to follow established cleaning and disinfection/sterilization guidelines or use of defective equipment. Despite the strong published data regarding the safety of endoscope reprocessing, concern over the potential spread gaps in infection prevention practices.[10] Given the ongoing occurrences of endoscopy-associated infections attributed to lapses in infection prevention, an update of the multisociety guideline is warranted.

This document provides an update of the previous guideline, with additional discussion of new or evolving reprocessing issues and updated literature citations, where appropriate. Specific additions or changes include review of expanded details related to critical reprocessing steps (including cleaning and drying), reprocessing issues for various endoscope attachments such as flushing catheters, discussion of risks related to selected periprocedural practices including

Multi-Society Guideline for Reprocessing Flexible Gastrointestinal Endoscopes, 2011

- **Since 2003, changes in**
  - **High-level disinfectants**
  - **Automated endoscope reprocessors- one AER with cleaning claim**
  - **Endoscopes**
  - **Endoscopic accessories**
- **However, efficacy of decontamination and high-level disinfection is unchanged and the principles guiding both remain valid**
- **Additional outbreaks of infection related to suboptimal infection prevention practices during endoscopy or lapses in endoscope reprocessing (unfamiliarity with endoscope channels, accessories, attachments; gaps in infection prevention at ASC; care of intravenous lines and administration of anesthesia or other medications (reuse of needles and syringes, multidose vials)**


RUSCH
RUSCH
Mac 2


RUSCH
Msc. 2/s
RUSCH

Reprocessing of Rigid Laryngoscopes

JHI 2008;68:101; ICHE 2007;28:504; AJIC 2007;35:536

- **Limited guidelines for reprocessing laryngoscope's blades and handles**
- **Many hospitals consider blade as semicritical (HLD) and handle as noncritical (LLD)**
- **Blades linked to HAIs; handles not directly linked to HAIs but contamination with blood/OPIM suggest its potential and blade and handle function together**
- **Ideally, clean then HLD/sterilize blades and handles (UNCHC-blades wrapped in a tray-Sterrad; handle wrapped in tray [without batteries]-steam); the blades and handles placed together in a Ziploc bag. Blades and handles checked for function prior to packaging.**

Contamination of Laryngoscope Handles

J Hosp Infect 2010;74:123

- **55/64 (86%) of the handles deemed "ready for patient use" positive for HA pathogens (*S. aureus*, enterococci, *Klebsiella*, *Acinetobacter*)**

Anesth Analg 2009;109:479

- **30/40 (75%) samples from handles positive (CONS, *Bacillus*, *Streptococcus*, *S. aureus*, *Enterococcus*) after cleaning**

AANA J 1997;65:241

- **26/65 (40%) of the handles and 13/65 (20%) of the blades were positive for occult blood. These blades and handles were identified as ready for patient use.**





ASP STERRAD® Chemical Indicator Strip
REF 14100
Use in STERRAD® Sterilizer only.
Bar changes from red to yellow (or lighter) as compared to the color bar when exposed to H_2O_2 during processing in the STERRAD® Sterilizer.
LC-14100-004 Rev. A

3M Comply™ SteriGage™.
Class 5 Steam
BIER Chemical
1243 Integrator
DARK BAR MUST PASS THIS POINT
REJECT ACCEPT STEAM


ADULT
LARYNGOSCOPE SET
DO NOT DISCARD REUSABLE
PLACE ALL CONTENTS OF BAG
IN GREEN TUBS IN DIRTY
UTILITY ROOM

Laryngoscopes Blades

The Joint Commission, FAQ, October 24, 2011

- How should we process and store laryngoscope blades?
  - Processed via sterilization or HLD
  - Packaged in some way
  - Stored in a way that prevents recontamination. Examples of compliant storage include, but are not limited to, a peel pack post steam sterilization (long-term) or wrapping in a sterile towel (short term)
  - Should not place unwrapped blades in an anesthesia drawer

DISINFECTION AND STERILIZATION

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

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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

IMPROVED HYDROGEN PEROXIDE (HP) SURFACE DISINFECTANT

- Advantages
  - 30 sec -1 min bactericidal and virucidal claim (fastest non-bleach contact time)
  - 5 min mycobactericidal claim
  - Safe for workers (lowest EPA toxicity category, IV)
  - Benign for the environment; noncorrosive; surface compatible
  - One step cleaner-disinfectant
  - No harsh chemical odor
  - EPA registered (0.5% RTU, 1.4% RTU, wet wipe)
- Disadvantages
  - More expensive than QUAT

BACTERICIDAL ACTIVITY OF DISINFECTANTS (log_{10} reduction) WITH A CONTACT TIME OF 1m WITH/WITHOUT FCS. Rutala et al. ICHE. 2012;33:1159

Improved hydrogen peroxide is significantly superior to standard HP at same concentration and superior or similar to the QUAT tested

Organism	IHP-0.5%	0.5% HP	IHP Cleaner-Dis 1.4%	1.4% HP	3.0% HP	QUAT
MRSA	>6.6	<4.0	>6.5	<4.0	<4.0	5.5
VRE	>6.3	<3.6	>6.1	<3.6	<3.6	4.6
MDR-*Ab*	>6.8	<4.3	>6.7	<4.3	<4.3	>6.8
MRSA, FCS	>6.7	NT	>6.7	NT	<4.2	<4.2
VRE, FCS	>6.3	NT	>6.3	NT	<3.8	<3.8
MDR-*Ab*, FCS	>6.6	NT	>6.6	NT	<4.1	>6.6


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"The patient in the next bed is highly infectious. Thank God for these curtains."

Hospital Privacy Curtains

(pre- and post-intervention study; sampled curtain, sprayed “grab area” 3x from 6-8” with 1.4% IHP and allowed 2 minute contact; sampled curtain)



Decontamination of Curtains with Activated HP (1.4%)

Rutala, Gergen, Weber. 2012

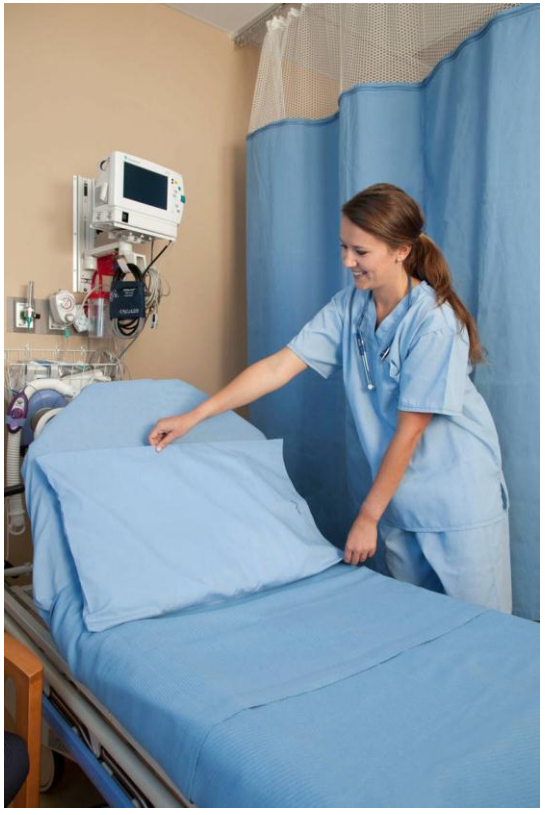
CP for:	Before Disinfection CFU/5 Rodacs (#Path)	After Disinfection CFU/5 Rodacs (#Path)	% Reduction
MRSA	330 (10 MRSA)	21*(0 MRSA)	93.6%
MRSA	186 (24 VRE)	4* (0 VRE)	97.9%
MRSA	108 (10 VRE)	2* (0 VRE)	98.2%
VRE	75 (4 VRE)	0 (0 VRE)	100%
VRE	68 (2 MRSA)	2* (0 MRSA)	97.1%
VRE	98 (40 VRE)	1* (0 VRE)	99.0%
MRSA	618 (341 MRSA)	1* (0 MRSA)	99.8%
MRSA	55 (1 VRE)	0 (0 MRSA)	100%
MRSA, VRE	320 (0 MRSA, 0 VRE)	1* (0 MRSA, 0 VRE)	99.7%
MRSA	288 (0 MRSA)	1* (0 MRSA)	99.7%
Mean	2146/10=215 (432/10=44)	33*/10=3 (0)	98.5%

* **All isolates after disinfection were *Bacillus sp;* now treat CP patient curtains at discharge with IHP**

HOSPITAL CURTAINS WITH ANTIMICROBIAL PROPERTIES

Schweizer et al. ICHE. 2012;33:1081-85

Use of privacy curtains with antimicrobials (Ag, Cu in nylon and polyester) may reduce time to first contamination and could increase time between washings.



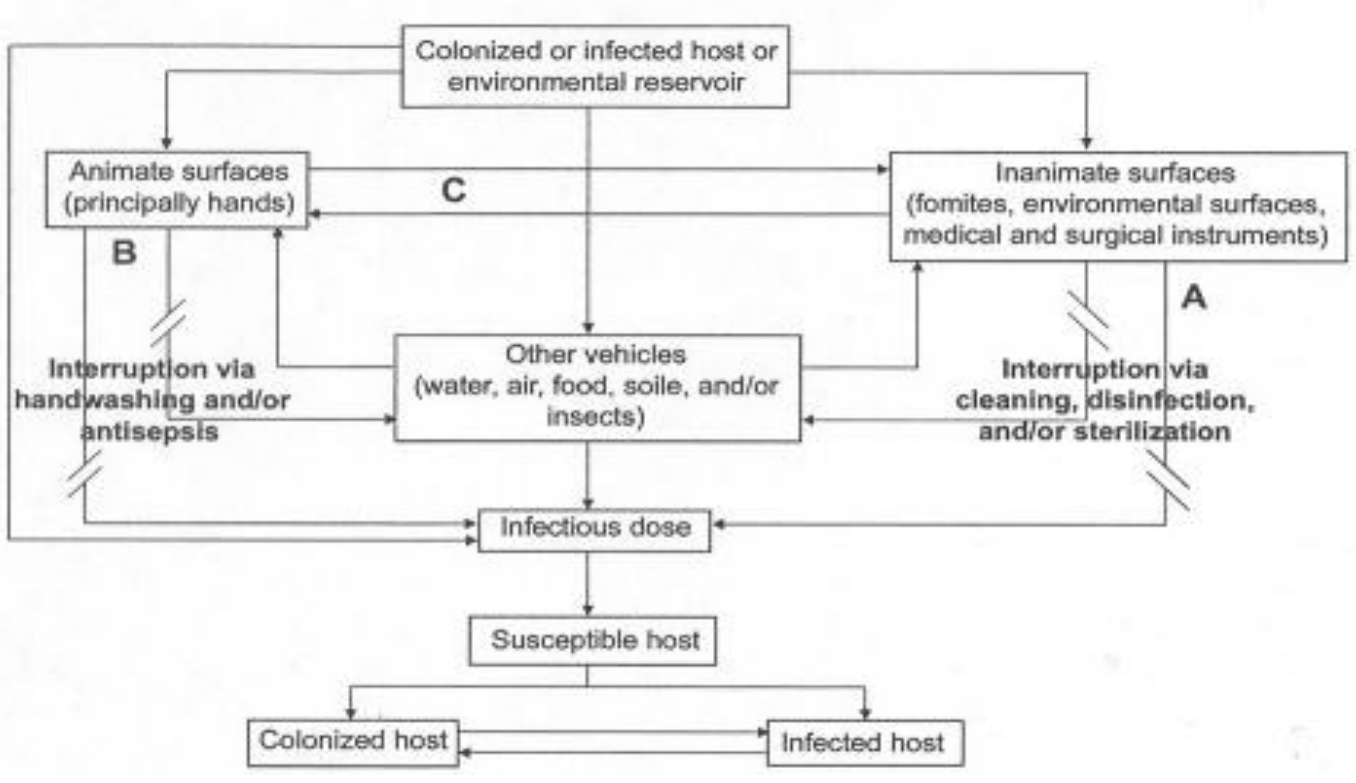
Safer Healthcare Environments for Infection Prevention

New Technologies and Future Challenges

- Reprocessing reusable medical/surgical instruments
- Hospital surfaces (increasing evidence to support the contribution of the environment to disease transmission)
- Water
- Air



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.

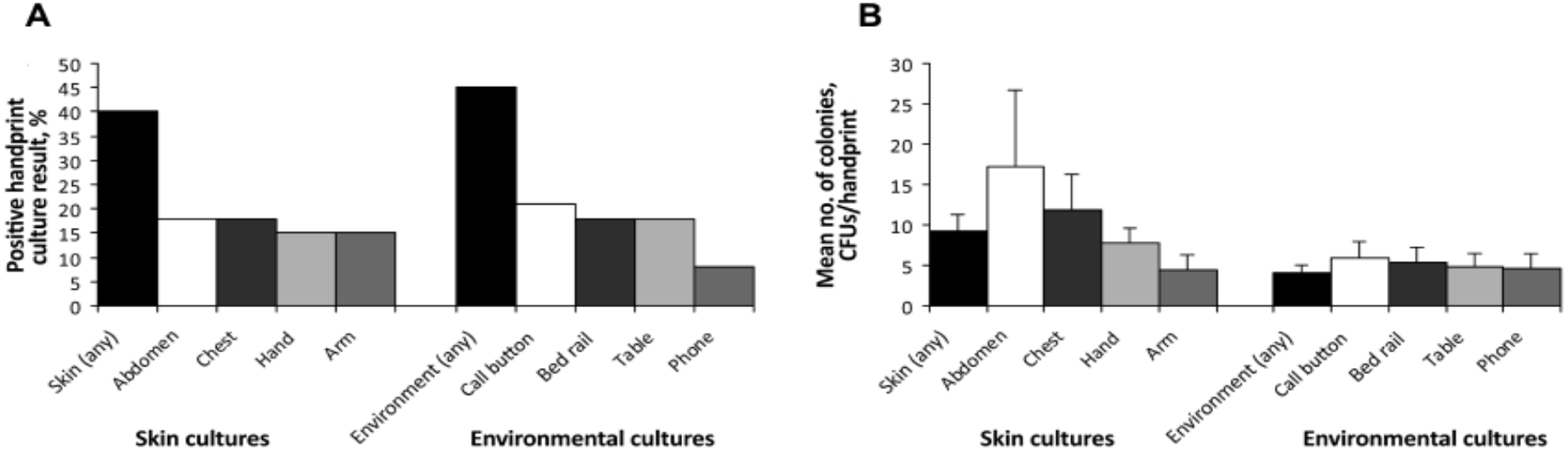
ENVIRONMENTAL CONTAMINATION ENDEMIC AND EPIDEMIC MRSA

	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

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



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



FACTORS LEADING TO ENVIRONMENTAL TRANSMISSION OF *CLOSTRIDIUM DIFFICILE*

- Stable in the environment
- Low inoculating dose
- Common source of infectious gastroenteritis
- Frequent contamination of the environment
- Susceptible population (limited immunity)
- Relatively resistant to disinfectants

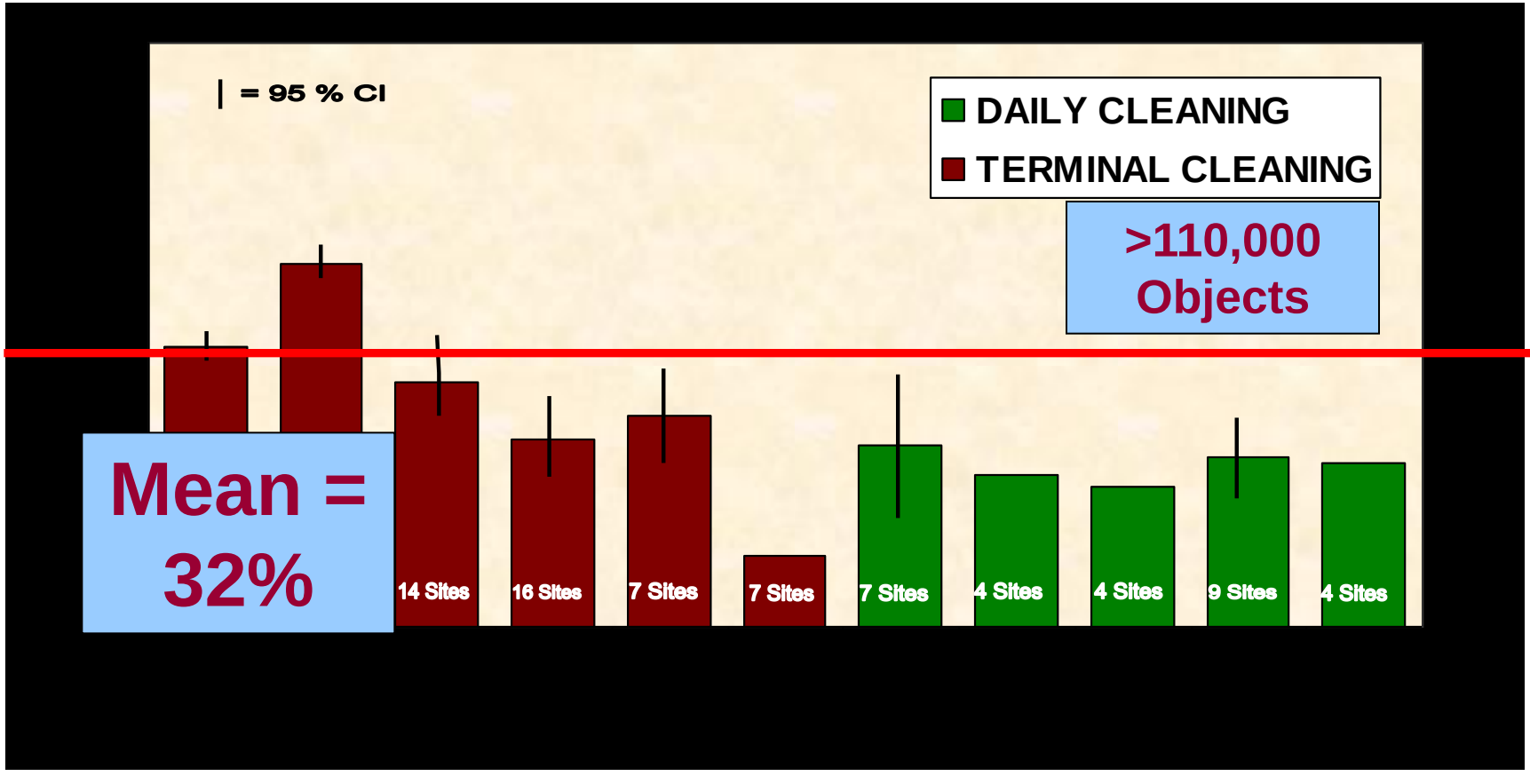
C. difficile Environmental Contamination

Rutala, Weber. SHEA. 3rd Edition. 2010

- Frequency of sites found contaminated~10->50% from 13 studies-stethoscopes, bed frames/rails, call buttons, sinks, hospital charts, toys, floors, windowsills, commodes, toilets, bedsheets, scales, blood pressure cuffs, phones, door handles, electronic thermometers, flow-control devices for IV catheter, feeding tube equipment, bedpan hoppers
- *C. difficile* spore load is low-7 studies assessed the spore load and most found <10 colonies on surfaces found to be contaminated. Two studies reported >100; one reported a range of "1->200" and one study sampled several sites with a sponge and found 1,300 colonies *C. difficile*.

Thoroughness of Environmental Cleaning

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



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)**

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

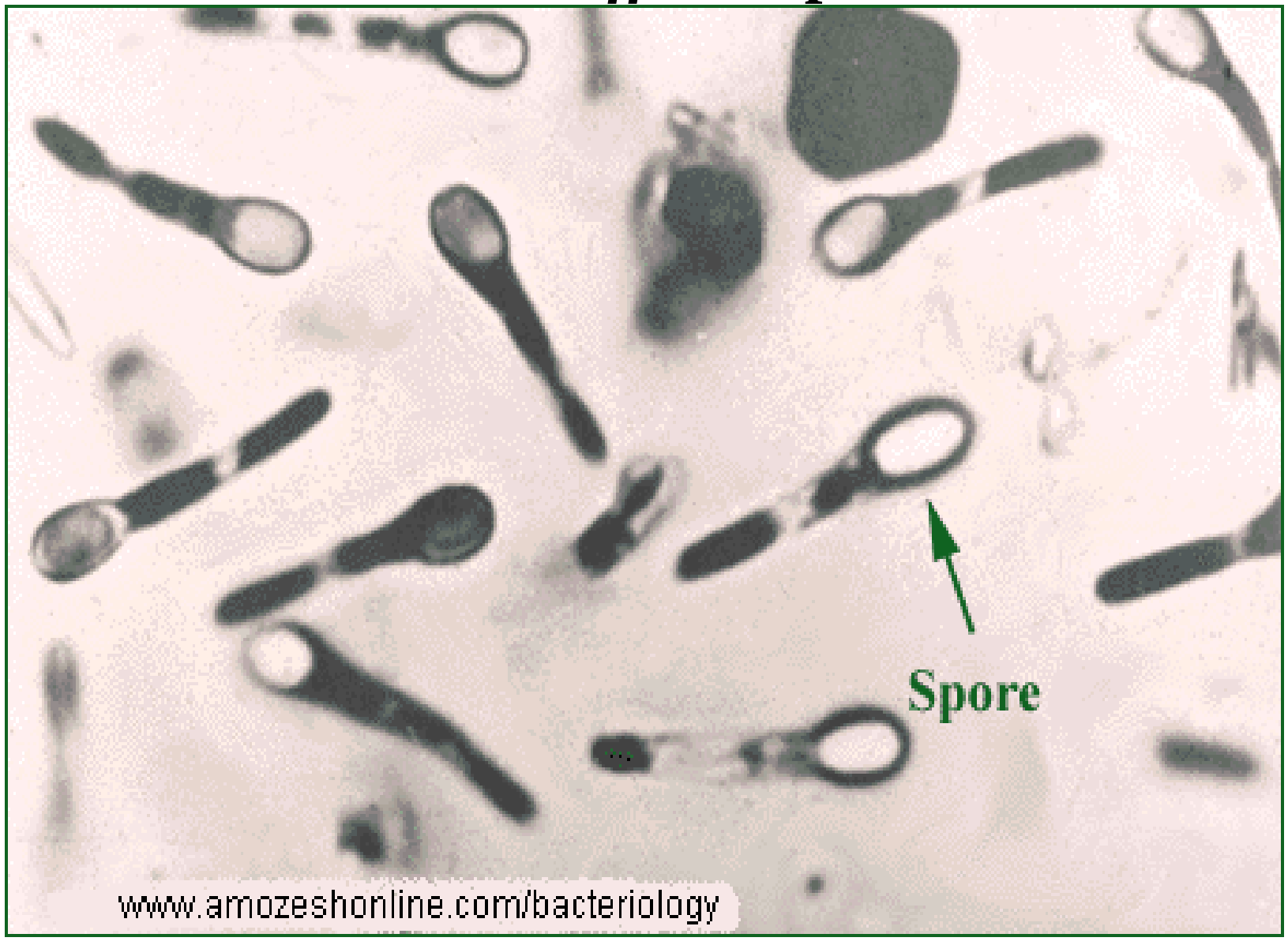
NOTE. APACHE, Acute Physiology and Chronic Health Evaluation; CI, confidence interval; HR, hazard ratio.

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

ALL “TOUCHABLE” (HAND CONTACT) SURFACES SHOULD BE WIPED WITH SPORICIDE

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

C. difficile spores



DISINFECTANTS AND ANTISEPSIS

C. difficile spores at 10 and 20 min, Rutala et al, 2006

- ~4 $\log_{10}$ reduction (3 *C. difficile* strains including BI-9)
  - Bleach, 1:10, ~6,000 ppm chlorine (but not 1:50)
  - Chlorine product, ~19,100 ppm chlorine
  - Chlorine product, ~25,000 ppm chlorine
  - 0.35% peracetic acid
  - 2.4% glutaraldehyde
  - OPA, 0.55% OPA
  - 2.65% glutaraldehyde
  - 3.4% glutaraldehyde and 26% alcohol

SURFACE DISINFECTION

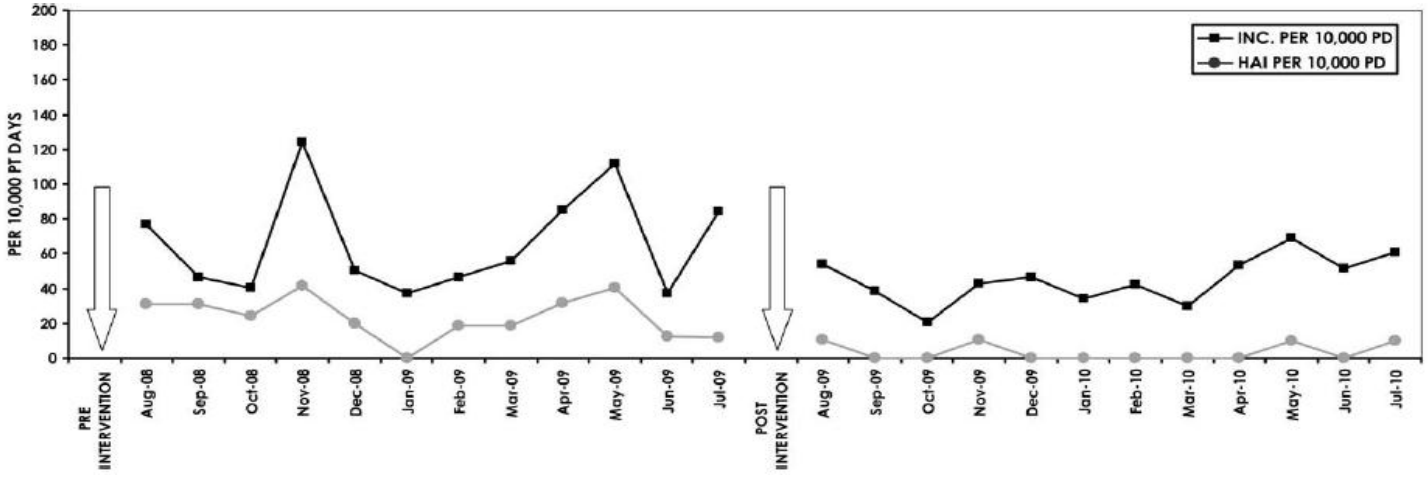
Effectiveness of Different Methods

Technique (with cotton)	*C. difficile* Log_{10} Reduction (1:10 Bleach)
Saturated cloth	3.90
Spray (10s) and wipe	4.48
Spray, wipe, spray (1m), wipe	4.48
Spray	3.44
Spray, wipe, spray (until dry)	4.48
5500 ppm chlorine pop-up wipe	3.98
Non-sporicidal wipe	$\geq$2.9

Rutala, Gergen, Weber. ICHE, In press

REDUCTION IN CDI INCIDENCE WITH ENHANCED (DAILY AND TERMINAL) ROOM DISINFECTION

- **Before-after study of CDI incidence rates in two hyperendemic wards at a 1,249 bed hospital**
- **Intervention: Change from cleaning rooms with QUAT to bleach wipes (0.55% Cl) for both daily and terminal disinfection**
- **Results: CDI incidence dropped 85% from 24.2 to 3.6 cases per 10,000 pt-days (p<0.001); prolonged median time between HA CDI from 8 to 80 days**



Orenstein R, et al ICHE 2011;32:1137

Daily Disinfection of High-Touch Surfaces

Kundrapu et al. ICHE 2012;33:1039

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

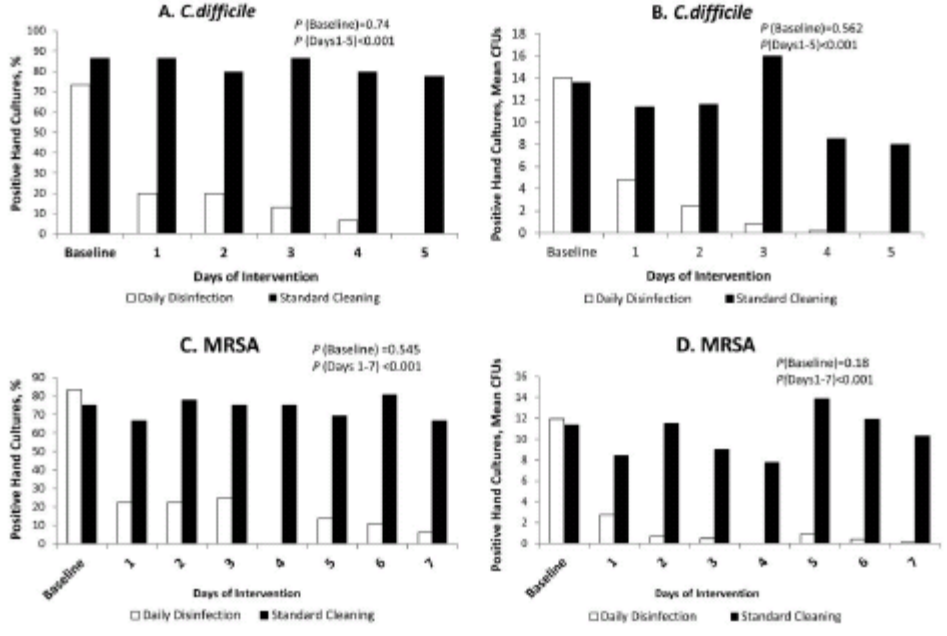


FIGURE 1. Effect of daily disinfection of high-touch environmental surfaces on acquisition of *Clostridium difficile* and methicillin-resistant *Staphylococcus aureus* (MRSA) on gloved hands of investigators after contact with the surfaces. *A*, Percentage of positive *C. difficile* cultures; *B*, mean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

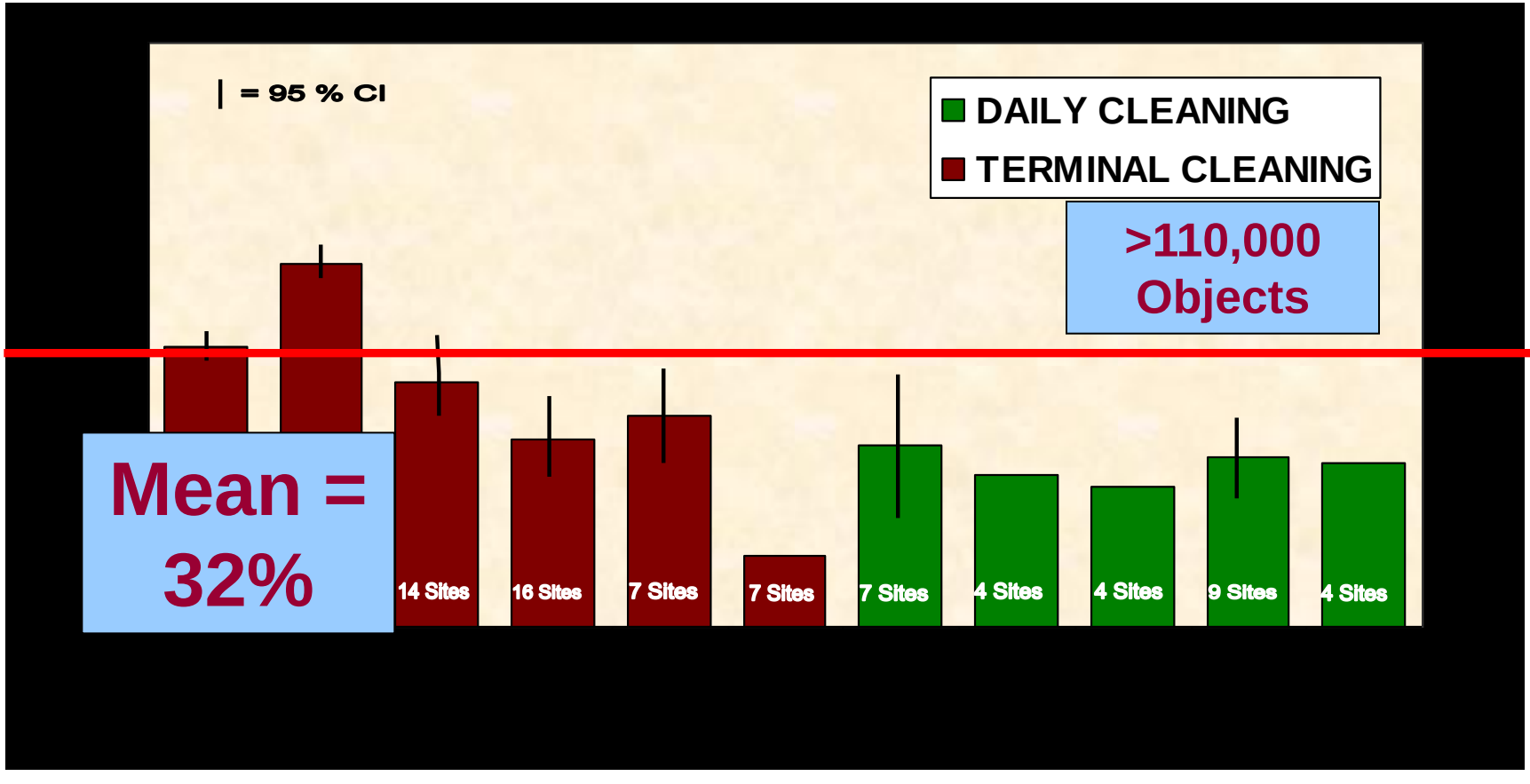
CONTROL MEASURES

C. difficile Disinfection

- In units with high endemic *C. difficile* infection rates or in an outbreak setting, use dilute solutions of 5.25-6.15% sodium hypochlorite (e.g., 1:10 dilution of bleach) for routine disinfection. (Category II).
- We now use sporicidal solution (chlorine) in all CDI rooms for routine daily and terminal cleaning (formerly used QUAT in patient rooms with sporadic CDI). One application of an effective product covering all “touchable” surfaces to allow a sufficient wetness for > 1 minute contact time. Chlorine solution normally takes 1-3 minutes to dry.
- For semicritical equipment, glutaraldehyde (20m), OPA (12m) and peracetic acid (12m) reliably kills *C. difficile* spores using normal exposure times

Thoroughness of Environmental Cleaning

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



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

MONITORING THE EFFECTIVENESS OF CLEANING

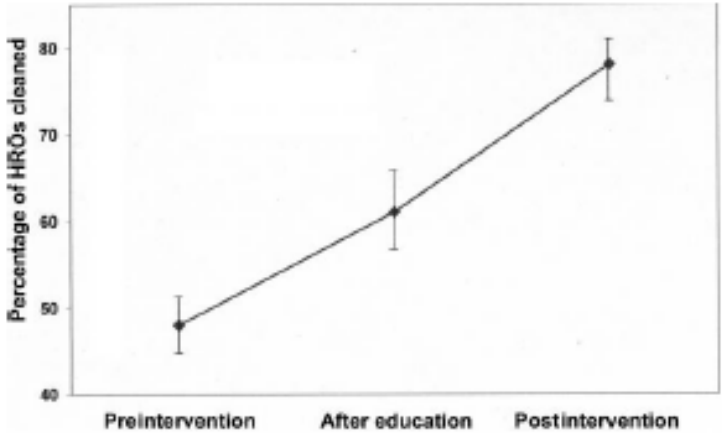
Cooper et al. AJIC 2007;35:338

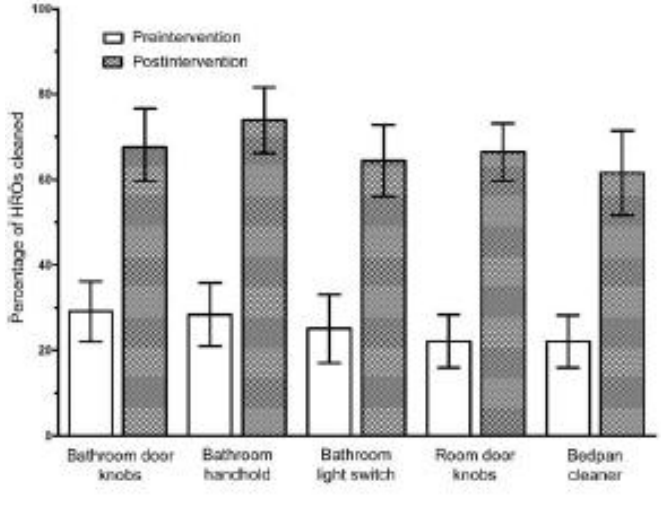
- Visual assessment-not a reliable indicator of surface cleanliness
- ATP bioluminescence-measures organic debris (each unit has own reading scale, <250-500 RLU)
- Microbiological methods-<2.5CFUs/cm^2-pass; can be costly and pathogen specific
- Fluorescent marker

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

NEW “NO TOUCH” APPROACHES TO ROOM DECONTAMINATION

Supplement Surface Disinfection







ROOM DECONTAMINATION UNITS

Rutala, Weber. ICHE. 2011;32:743

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

	Sterinis	Steris	Bioquell	Tru-D
Abbreviation	DMHP (dry mist HP)	VHP (vaporized HP)	HPV (HP vapor)	UV-C
Active agent	Stenusil (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
Aeration (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.[18] BIs, biological indicators; VRE, vancomycin-resistant *Enterococcus*.

[a] All *C. difficile* experiments were done with *C. difficile* spores.

ROOM DECONTAMINATION WITH UV, HP

- **Issues-Room decontamination time; where the occupancy is high and fast patient turnaround time is critical**
  - **Room decontamination with UV is 15-25 minutes for vegetative bacteria and 50 minutes for *C. difficile* spores**
  - **HP room decontamination takes approximately 2.5 hours**



Rapid Hospital Room Decontamination Using UV Light With a Nanostructured Reflective Coating

- Assessed the time required to kill HAI pathogens in a room with standard white paint (3-7% UV reflective) versus walls coated with an agent formulated to be reflective to UV-C wavelengths (65% UV reflective)
- Coating/painted uses nanoscale metal oxides whose crystal structures are reflective to UV-C
- Coating is white in appearance and can be applied with a brush or roller in the same way as any common interior latex paint
- Cost to coat walls used in this study was estimated to be <$300.

UV Reflective Coating

Rutala, Gergen, Tande, Weber. 2012

With the nanoscale reflective coating, cycle times were 5-10m (~80% reduction) which would substantially reduce the turnover time of the room

Line-of-Sight MRSA w/coating MRSA no coating *C. difficile* w/coating *C. difficile* no coating

Cycle Time	5m03s	25m13s	9m24s	43m42s
Direct	4.70 (n=42)	4.72 (n=33)	3.28 (n=39)	3.42 (n=33)
Indirect	4.45 (n=28)	4.30 (n=27)	2.42 (n=31)	2.01 (n=27)
Total	4.60 (n=70)	4.53 (n=60)	2.91 (n=70)	2.78 (n=60)

SELF DISINFECTING SURFACES

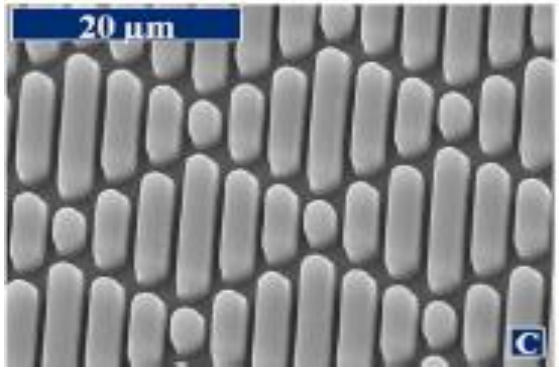
- Surface impregnated with a “heavy” metal
  - **Silver**
  - **Copper**
- Surface impregnated with a germicide
  - **Triclosan**
  - **Antimicrobial surfactant/quaternary ammonium salt?**
  - **Organosilane products?**
- Altered topography
  - **Sharklet pattern**
- Light-activated antimicrobial coating

Weber DJ, Rutala WA. ICHE 2012;33:10-13

SELF DISINFECTING SURFACES

Copper coated overbed table

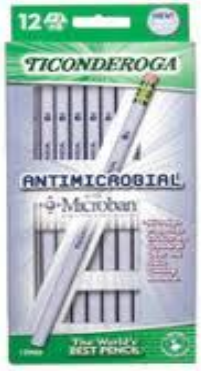




Sharklet Pattern

Antimicrobial effects of silver





Triclosan pen

Enhancing Patient Safety Through Copper Surfaces

M Schmidt et al. IFIC, October 2012

- Three hospital (NY, SC) study to evaluate the potential value (reduced bacterial burden, HAIs) of antimicrobial copper applied to 6 touch surfaces in ICUs
- 83% reduction in bacterial burden
- Significant decrease in the incidence of HAI/colonization by MRSA and VRE
- Warrants further consideration when published to fully appreciate the potential benefit and optimization of the risk reduction

Safer Healthcare Environments for Infection Prevention

New Technologies and Future Challenges

- Reprocessing reusable medical/surgical instruments
- Hospital surfaces
- Water

Water and Healthcare

Multiple Uses





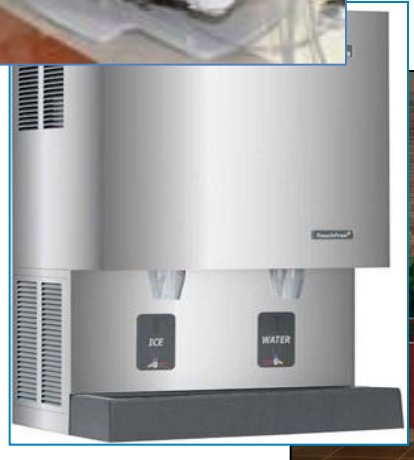








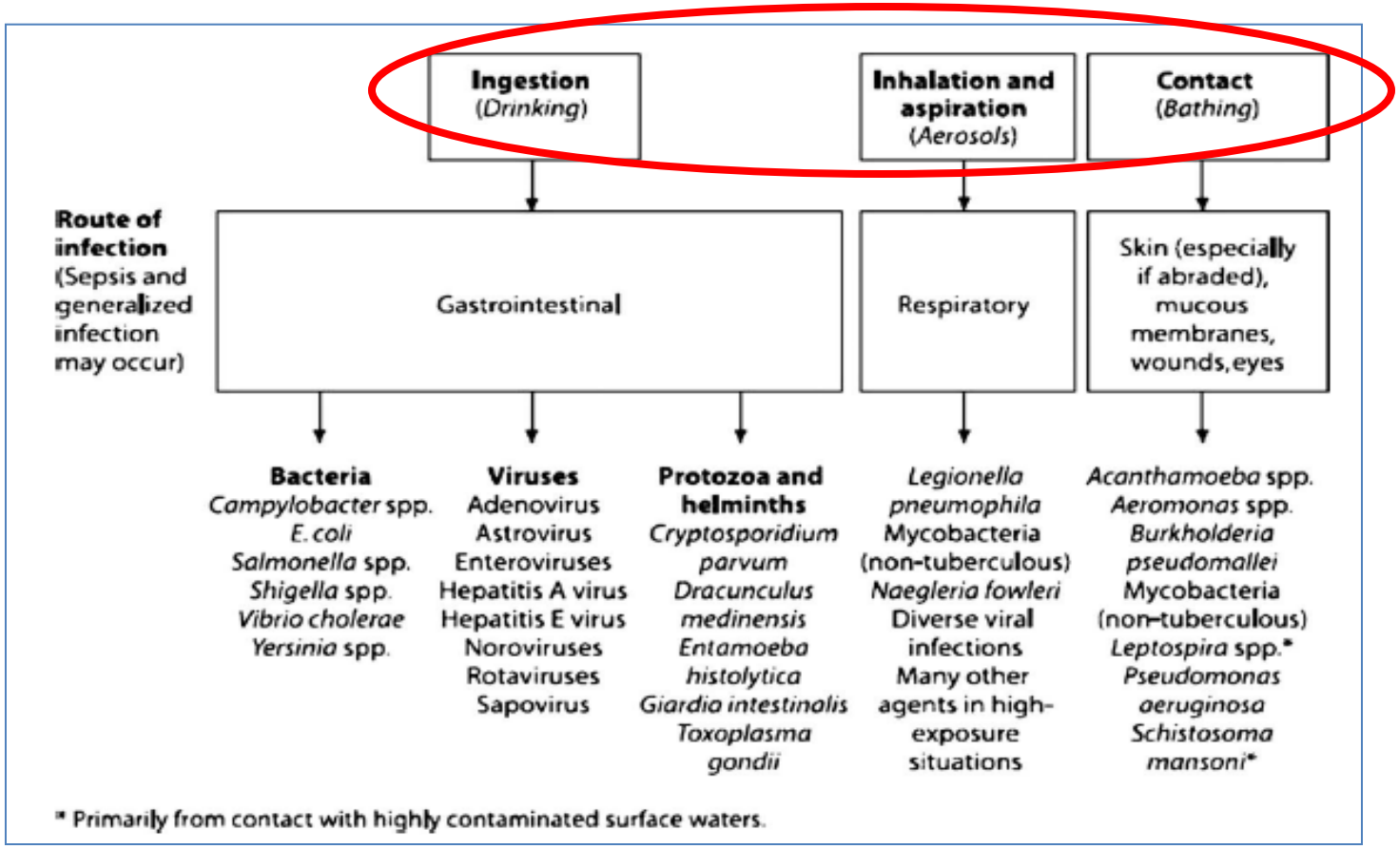






Water-Related Pathogens and Their Disease Transmission Pathways

Exner et al. AJIC 33:S26-40; 2005



WATER RESERVOIRS

Rutala, Weber. ICHE 1997;18:609

TABLE
WATER AS A RESERVOIR OF NOSOCOMIAL PATHOGENS

Reservoir	Associated Pathogen(s)	Transmission	Importance*	Prevention and Control
Potable water	*Pseudomonas, Mycobacteria, Legionella*	Contact	Moderate	Follow public health guidelines
Sinks	*Pseudomonas*	Contact, droplet	Low	Use separate sinks for handwashing and disposal of contaminated fluids
Faucet aerators	*Pseudomonas*	Contact, droplet	Low	No precautions necessary at present
Showers	*Legionella*	Inhalation	Low	Prohibit use in immunocompromised patients
Ice and ice machines	*Legionella, Enterobacter, Pseudomonas, Salmonella, Cryptosporidia*	Ingestion, contact	Moderate	Periodic cleaning; use automatic dispenser (ie, avoid open chest storage compartments in patient areas)
Eyewash stations	*Pseudomonas, Legionella, Ameba*	Contact	Low	Have available sterile water for eye flush or weekly (or monthly) flush eyewash stations
Dental-unit water systems	*Pseudomonas, Legionella, Sphingomonas, Acinetobacter*	Contact	Low	Clean water systems
Dialysis water	Gram-negative bacilli	Contact	Moderate	Follow guidelines: dialysate ≤2,000 organisms/mL; water ≤200 organisms/mL

Water Wall Fountains and Electronic Faucets





Water Walls Linked to Legionnaires'

- Palmore et al. ICHE 2009;30:764
  - 2 immunocompromised patients exposed to decorative fountain in radiation oncology; isolates from patients and fountain identical; disinfection with ozone, filter and weekly cleaning
- Houpt et al. ICHE 2012;33:185
  - Lab-confirmed Legionnaires disease was dx in 8 patients; 6 had exposure to decorative fountain (near main entrance to hospital); high counts of *Legionella pneumophila* 1 despite disinfection and maintenance

Water Walls and Decorative Water Fountains

Present unacceptable risk in hospitals serving immunocompromised patients (even with standard maintenance and sanitizing methods)

Electronic Faucets

A Possible Source of Nosocomial Infection?



Electronic Faucets

- Conserve water
- Conserve energy
- Hygienic
- Hands free
- Barrier free

Electronic (E) vs Handle-Operated (HO) Faucets

- 100% E vs 30% HO *Legionella* (no cases). Halabi et al. JHI 2001:49:117
- Significant difference HPC levels between brand A (32%) and B (8%) E compared to HO (11%). Hargreaves et al. 2001; 22:202
- No difference in *P. aeruginosa*. Assadian et al. ICHE. 2002;23:44.
- 73% E samples did not meet German water standard vs 0% HO. Chaberny et al. ICHE 2004;25:997
- 39% of water samples from E and 1% from HO yielded *P. aeruginosa*. Merrer et al. Intensive Care Med 2005;31:1715
- 95% E grew *Legionella* compared to 45% HO (water-disruption events). Syndor et al. ICHE; 33:235

Issues Associated with Electronic Faucets

- A longer distance between the valve and the tap, resulting in a longer column of stagnant, warm water, which favors production of biofilms
- Reduced water flow; reduced flushing effect (growth favored)
- Valves and pipes made of plastic (enhances adhesion *P. aeruginosa*)

Prevention Measures

- Electronic faucets constructed so they do not promote the growth of microorganisms
- A potential source of nosocomial pathogens but more data are needed to establish role in HAI
- No guideline (but some have recommended) to remove electronic faucets from at-risk patient care areas (BMTU)
- Some have recommended periodic monitoring of water samples for growth of *Legionella*

Safer Healthcare Environments for Infection Prevention

New Technologies and Future Challenges

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- Water

CONCLUSIONS

- **New sterilization, high-level disinfection and low-level disinfection technologies/practices/products are effective**
- **The contaminated surface environment in hospital rooms is important in the transmission of healthcare-associated pathogens (MRSA, VRE, *C. difficile*)**
- **Effective surface disinfection essential to eliminate the environment as a source for transmission of HA pathogens.**
- **New methods of reducing transmission of these pathogens may include: improved room cleaning/disinfection, "no-touch" methods (UV, HP), and self-disinfecting surfaces**
- **Water reservoirs of HA pathogens (e.g., water walls) may present unacceptable risk to high-risk patients**

THANK YOU!



disinfectionandsterilization.org