Environmental Disinfection: What Works Best? Mechanical Systems vs Elbow Grease

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Objectives

- Environmental Disinfection: What Works Best
  - Environmental-relating to the environment (conditions surrounding a person or organism)
  - Disinfection-destruction of pathogenic microorganisms
  - What-which thing
  - Works-operates effectively or successfully
  - Best-exceeding all others in excellence
- Role of environment in transmission
- Evaluate the efficacy of surface disinfection (“elbow grease”)
- Evaluate the efficacy of room decontamination units-UV, HP

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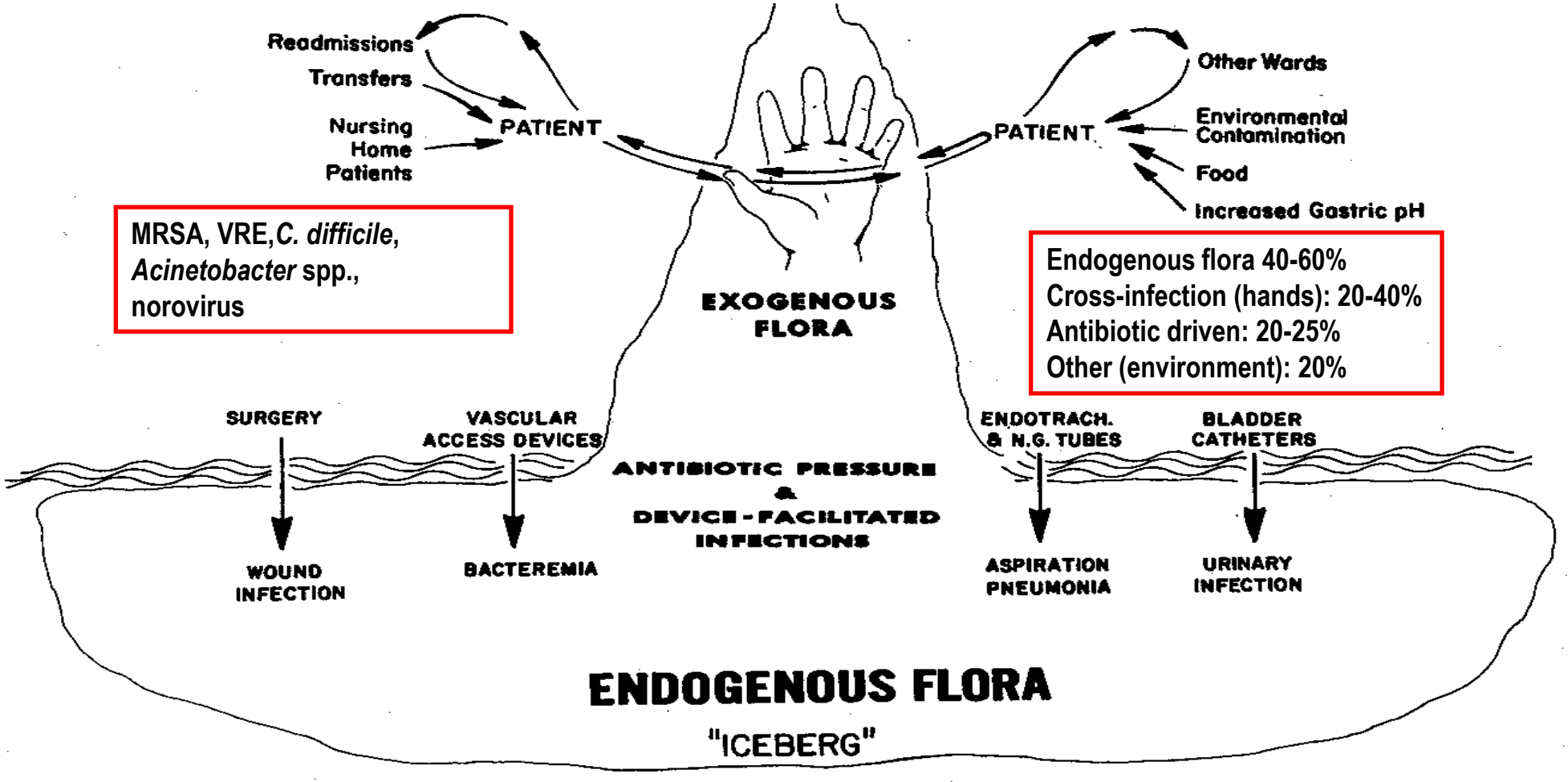
HAZARDS IN THE HOSPITAL

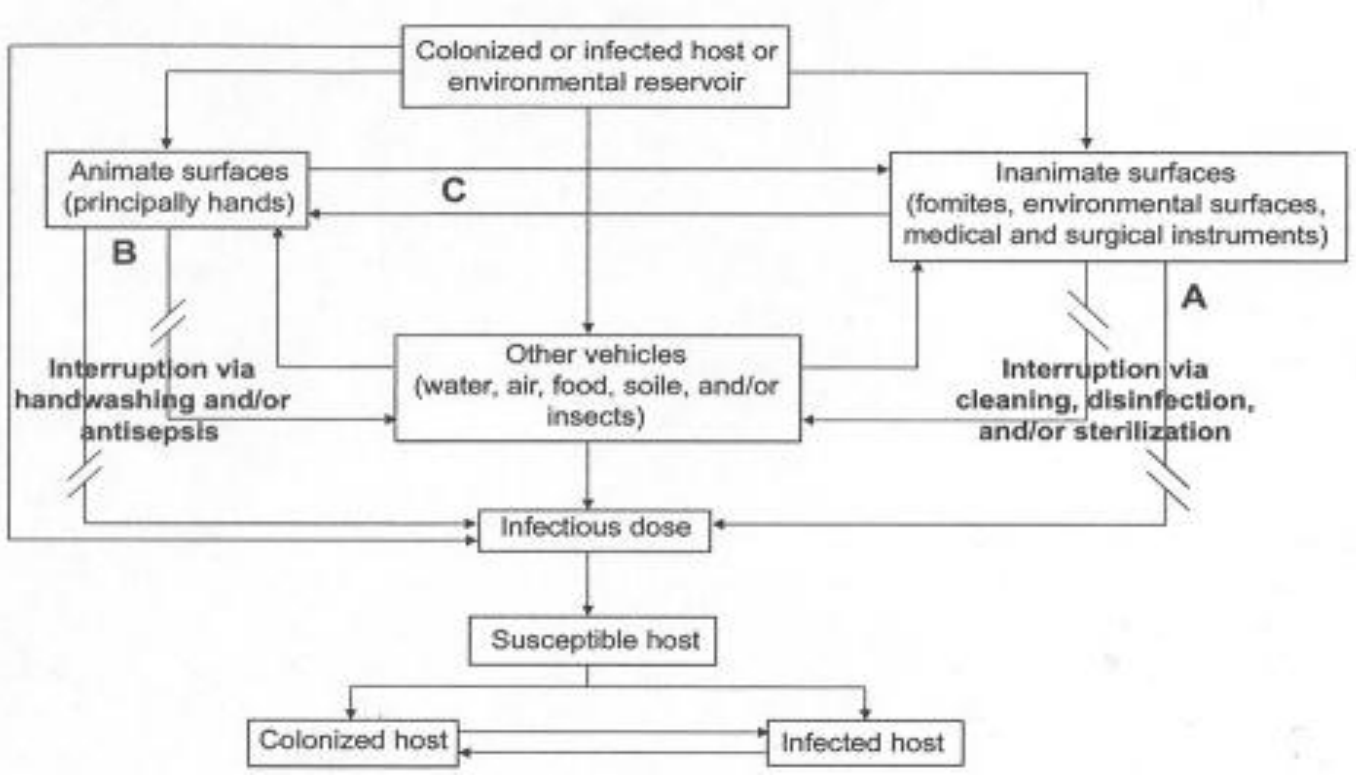


Weinstein RA. Am J Med 1991;91(suppl 3B):179S

THE ROLE OF THE ENVIRONMENT IN DISEASE TRANSMISSION

- Over the past decade there has been a growing appreciation that environmental contamination makes a contribution to HAI with MRSA, VRE, *Acinetobacter*, norovirus and *C. difficile*
- Surface disinfection practices are currently not effective in eliminating environmental contamination
- Inadequate terminal cleaning of rooms occupied by patients with MDR pathogens places the next patients in these rooms at increased risk of acquiring these organisms

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 LEADS TO HAIs

- Frequent environmental contamination
  - MRSA, VRE, AB, CDI
- Microbial persistence in the environment
  - *In vitro* studies and environmental samples
  - MRSA, VRE, AB, CDI
- HCW hand contamination
  - MRSA, VRE, AB, CDI
- Relationship between level of environmental contamination and hand contamination
  - CDI

ENVIRONMENTAL CONTAMINATION LEADS TO HAIs

- Transmission directly or hands of HCWs
  - Molecular link
  - MRSA, VRE, AB, CDI
- Housing in a room previously occupied by a patient with the pathogen of interest is a risk factor for disease
  - MRSA, VRE, CDI
- Improved surface cleaning/disinfection reduces disease incidence
  - MRSA, VRE, CDI

KEY PATHOGENS WHERE ENVIRONMENTIAL SURFACES PLAY A ROLE IN TRANSMISSION

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

ENVIRONMENTAL SURVIVAL OF KEY PATHOGENS

Pathogen	Survival	Environmental Data
MRSA	Days to weeks	2-3+
VRE	Days to weeks	3+
Acinetobacter	Days to months	2-3+
C. difficile	Months (spores)	3+
Norovirus	Days to weeks	3+

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

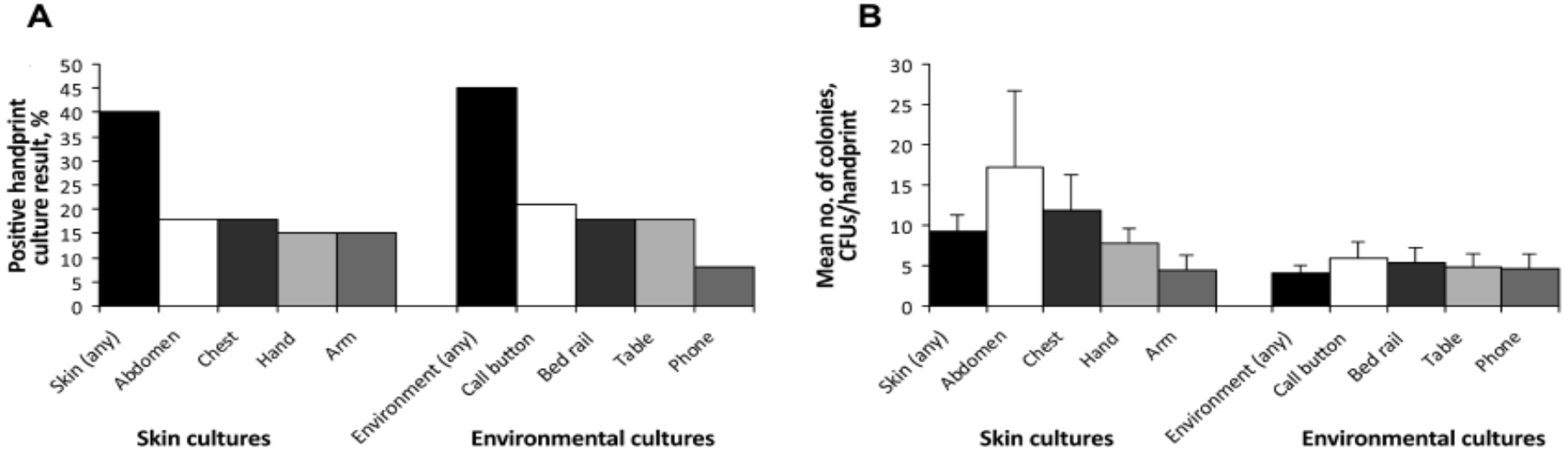
ENVIRONMENTAL CONTAMINATION ENDEMIC AND EPIDEMIC MRSA

	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

FREQUENCY OF ENVIRONMENTAL CONTAMINATION AND RELATION TO HAND CONTAMINATION

- **Study design: Prospective study, 1992**
- **Setting: Tertiary care hospital**
- **Methods: All patients with CDI assessed with environmental cultures**
- **Results**
  - **Environmental contamination frequently found (25% of sites) but higher if patients incontinent (>90%)**
  - **Level of contamination low (<10 colonies per plate)**
  - **Presence on hands correlated with prevalence of environmental sites**

Frequency of Cultures Positive for *Clostridium difficile* From Different Environmental Sites Within the Hospital Room

Site	All Rooms	Double Rooms	
	No. Positive/ No. Tested (%)	Index Side (%)	Roommate Side (%)
Floor	15/31 (48)	NA	NA
Commode	7/17 (41)	NA	NA
Windowsill	6/16 (38)	NA	NA
Toilet	15/45 (33)	NA	NA
Buzzer	11/57 (19)	6/19 (32)	1/17 (6)
Bedsheets	12/56 (21)	4/20 (20)	2/14 (14)
Bedrails	15/81 (18)	7/26 (27)	2/25 (8)
Totals	81/303 (27)	17/65 (26)*	5/56 (9)

*$P = 0.02$ by Fisher's exact test, index side versus roommate side.
NA = not applicable.

Correlation Between Proportion of Positive Environmental Sites and Isolation of *Clostridium difficile* From Hands of Hospital Personnel

Environmental Sites Positive (%)	No. of Index Cases With Environmental Sites and Personnel Cultured	No. of Positive Personnel/ No. of Personnel Cultured (%)
0	12	0/25
1–25	5	0/11
26–50	5	1/12 (8)
>50	6	9/25 (36)*

*Chi-square test for linear trend in proportions: $P < 0.01$.

Samore MH, et al. Am J Med 1996;100:32-40

Risk of Acquiring MRSA and VRE from Prior Room Occupants

- Admission to a room previously occupied by an MRSA-positive patient or VRE-positive patient significantly increased the odds of acquisition for MRSA and VRE (although this route is a minor contributor to overall transmission). Arch Intern Med 2006;166:1945.
- Prior environmental contamination, whether measured via environmental cultures or prior room occupancy by VRE-colonized patients, increases the risk of acquisition of VRE. Clin Infect Dis 2008;46:678.
- Prior room occupant with CDAD is a significant risk for CDAD acquisition. Shaughnessy et al. ICHE 2011;32:201

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Touch (Elbow Grease) vs No-Touch (Mechanical)

Touch

Wipes

Cotton, Disposable, Microfiber

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

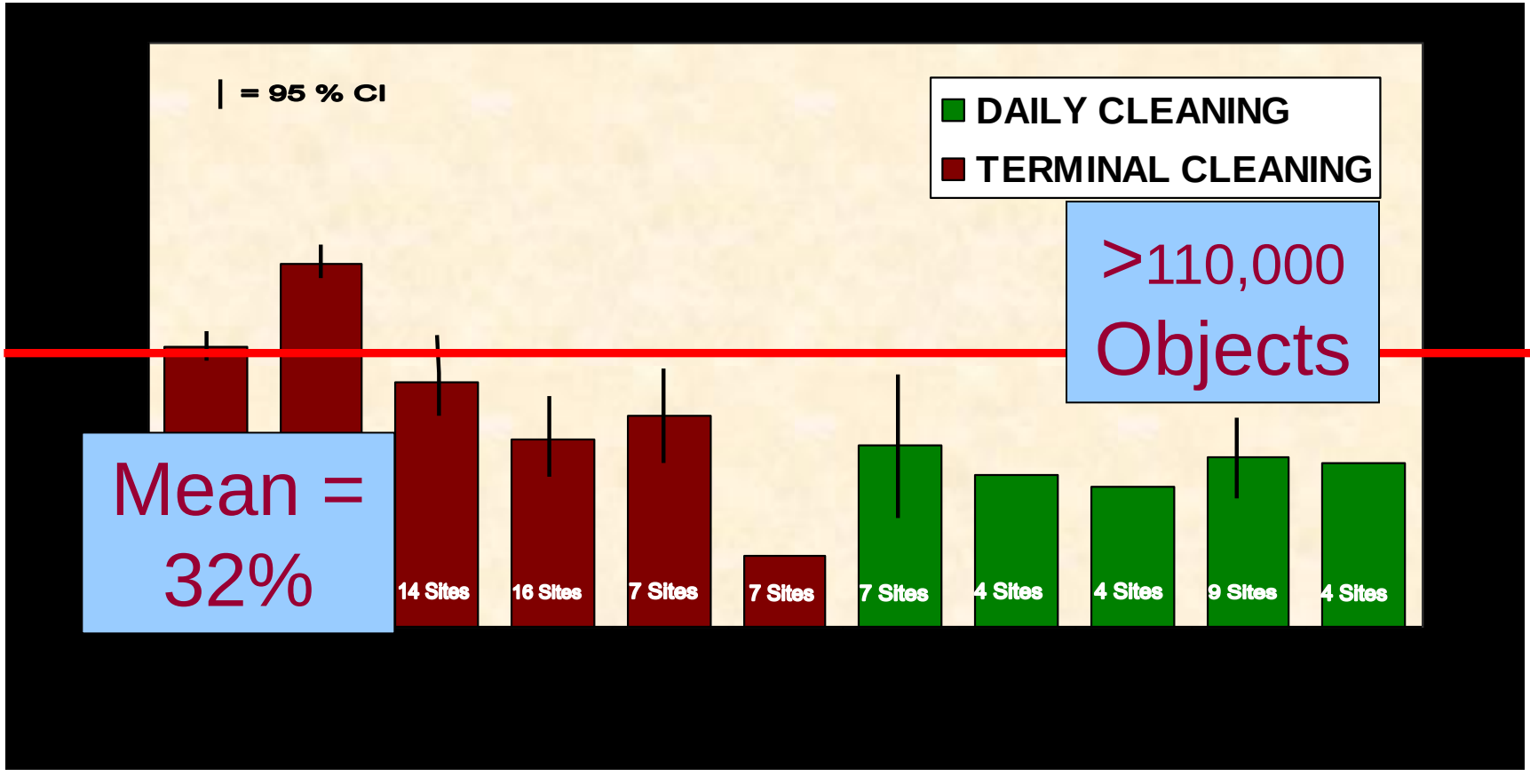
Effectiveness of Different Methods

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

Rutala, Gergen, Weber. Unpublished data.

THOROUGHNESS OF ENVIRONMENTAL CLEANING

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



Mean proportion of surfaces disinfected at cleaning is 32%

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

Effective Surface Decontamination

Practice and Product

Practice* NOT Product

*surfaces not wiped

Thoroughness of Environmental Cleaning

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

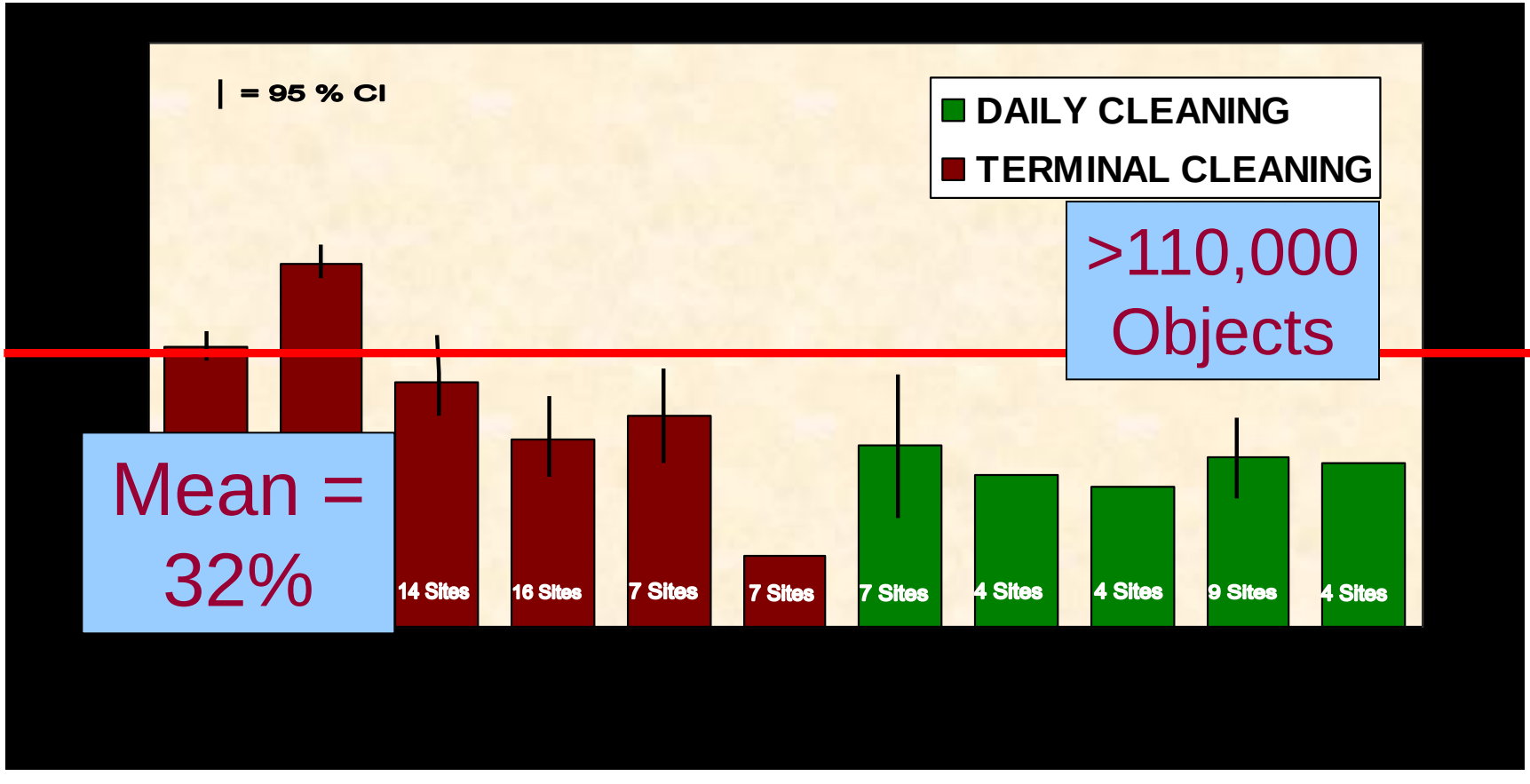


TABLE. Rates of Cleaning for 14 Types of High-Risk Objects

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.

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Touch (Elbow Grease) vs No-Touch (Mechanical)

No Touch

(supplements but do not replace surface cleaning/disinfection)

No Touch

Systems that are fully automated and generally do not require personnel intervention once the treatment is initiated

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.


3325
Hill-Rom

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

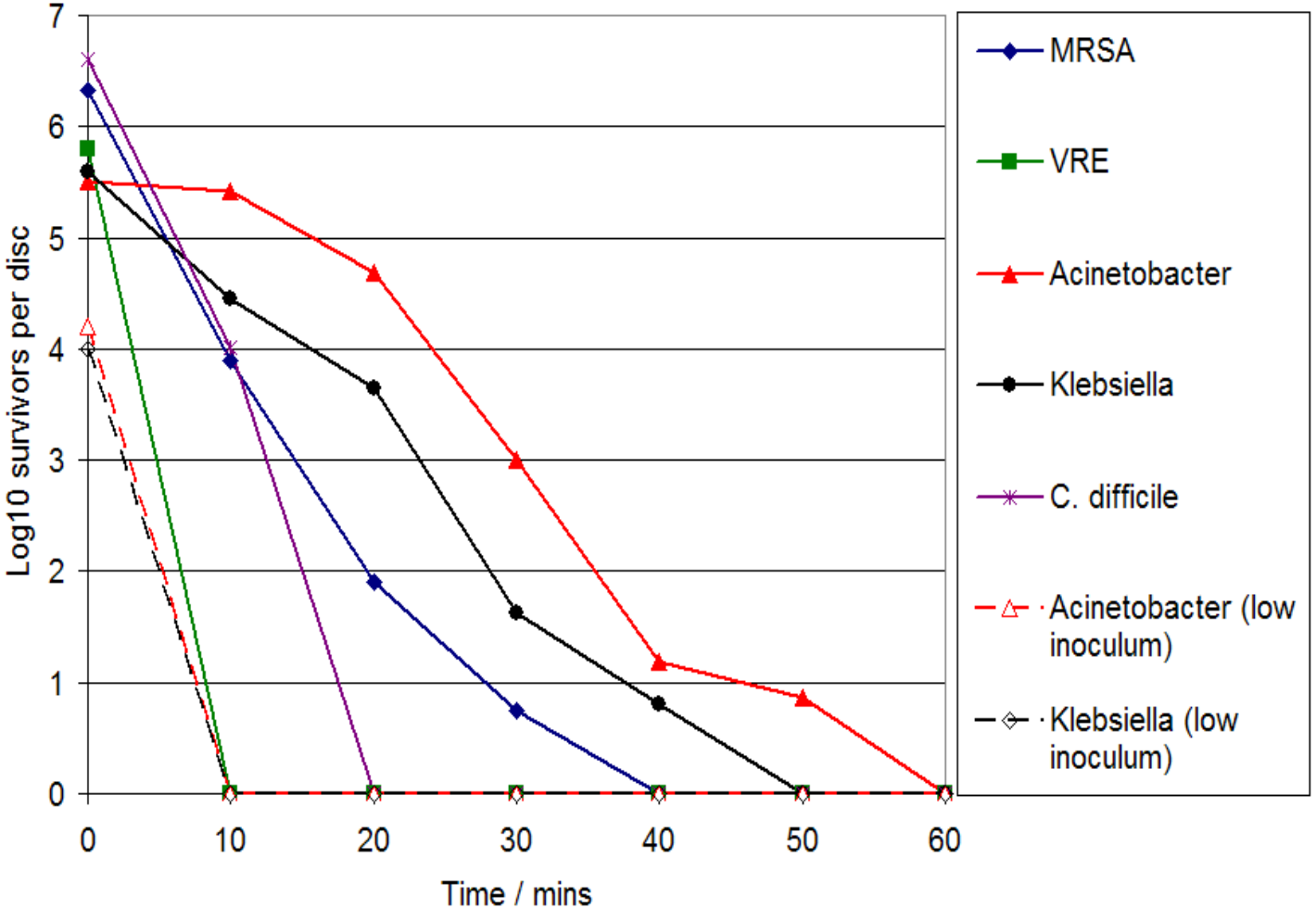
TABLE 1. UV-C Decontamination of Formica Surfaces in Patient Rooms Experimentally Contaminated with Methicillin-Resistant *Staphylococcus aureus* (MRSA), Vancomycin-Resistant *Enterococcus* (VRE), Multidrug-Resistant (MDR) *Acinetobacter baumannii*, and *Clostridium difficile* Spores

		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

Rutala WA, Gergen MF, Weber DJ. Infect Control Hosp Epidemiol 2010;31:1025-9

HP SYSTEMS FOR ROOM DECONTAMINATION

HPV *in vitro* Efficacy



Otter and French. *J Clin Microbiol* 2009;47:205-207.

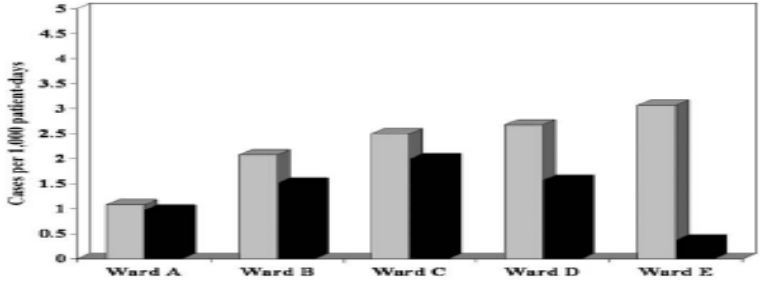
HP for Decontamination of the Hospital Environment

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

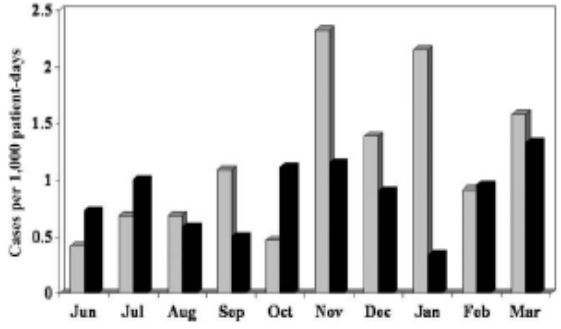
Author, Year	HP System	Pathogen	Before HPV	After HPV	% Reduction
French, 2004	VHP	MRSA	61/85-72%	1/85-1%	98
Bates, 2005	VHP	*Serratia*	2/42-5%	0/24-0%	100
Jeanes, 2005	VHP	MRSA	10/28-36%	0/50-0%	100
Hardy, 2007	VHP	MRSA	7/29-24%	0/29-0%	100
Dryden, 2007	VHP	MRSA	8/29-28%	1/29-3%	88
Otter, 2007	VHP	MRSA	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	7/203-3%; 0.4	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

Room Decontamination With VHP

- Study design
  - **Before and after study of VHP**
- Outcome
  - ***C. difficile* incidence**
- Results
  - **VHP decreased environmental contamination with *C. difficile* (p<0.001), rates on high incidence floors from 2.28 to 1.28 cases per 1,000 pt-days (p=0.047), and throughout the hospital from 1.36 to 0.84 cases per 1,000 pt days (p=0.26)**



IGURE 2. Incidence of nosocomial *Clostridium difficile*–associated disease on 5 wards (A–E) that underwent intensive hydrogen peroxide vapor decontamination, during the preintervention period (*gray bars*; June 2004 through March 2005) and the intervention period (*black bars*; June 2005 through March 2006).



Boyce JM, et al. ICHE 2008;29:723-729

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- Data that compares “elbow grease” vs “mechanical”

Tackling contamination of the hospital environment by methicillin-resistant *Staphylococcus aureus* (MRSA): a comparison between conventional terminal cleaning and hydrogen peroxide vapour decontamination

G.L. French[a,*], J.A. Otter[b], K.P. Shannon[a], N.M.T. Adams[b], D. Watling[b], M.J. Parks[b]

[a]*Department of Infection, King's College London, 5th Floor, North Wing, St Thomas' Hospital, Lambeth Palace Road, London SE1 7EH, UK*
[b]*BIOQUELL PLC, Andover, Hampshire, UK*

Table I Results of surface swabbing

	Total before cleaning	Matched before cleaning	Matched after cleaning	Matched before H_2O_2[a]	Matched after H_2O_2[a]
No. of rooms sampled	24[b]	10[c]	10[c]	6[d]	6[d]
No. of swabs	359	124	124	85	85
Number yielding MRSA	264 (73.5)	111 (89.5)	82 (66.1)	61 (71.8)	1 (1.2)
From direct plating	185 (70.1)	87 (78.4)	61 (74.4)	44 (72.1)	0 (0.0)
++Growth	75 (40.5)	37 (42.5)	26 (42.6)	24 (54.5)	-
+Growth	110 (59.5)	50 (57.5)	35 (57.4)	20 (45.5)	-
From enrichment only	79 (29.9)	24 (21.6)	21 (25.6)	17 (27.9)	1 (100.0)

Matched denotes rooms in which adjacent sites were sampled before and after intervention. The number in parenthesis denotes the percentage.

[a] Hydrogen peroxide vapour decontamination.
[b] Eighteen single isolation rooms, two four-bed bays, four bathrooms.
[c] Eight single isolation rooms, two four-bed bays.
[d] Four single isolation rooms, two bathrooms.

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[b]*BIOQUELL PLC, Andover, Hampshire, UK*

Summary The hospital environment can sometimes harbour methicillin-resistant *Staphylococcus aureus* (MRSA) but is not generally regarded as a major source of MRSA infection. We conducted a prospective study in surgical wards of a London teaching hospital affected by MRSA, and compared the effectiveness of standard cleaning with a new method of hydrogen peroxide vapour decontamination. MRSA contamination, measured by surface swabbing was compared before and after terminal cleaning that complied with UK national standards, or hydrogen peroxide vapour decontamination. All isolation rooms, ward bays and bathrooms tested were contaminated with MRSA and several antibiogram types were identified. MRSA was common in sites that might transfer organisms to the hands of staff and was isolated from areas and bed frames used by non-MRSA patients. Seventy-four percent of 359 swabs taken before cleaning yielded MRSA, 70% by direct plating. After cleaning, all areas remained contaminated, with 66% of 124 swabs yielding MRSA, 74% by direct plating. In contrast, after exposing six rooms to hydrogen peroxide vapour, only one of 85 (1.2%) swabs yielded MRSA, by enrichment culture only. The hospital environment can become extensively contaminated with MRSA that is not eliminated by standard cleaning methods. In contrast, hydrogen peroxide vapour decontamination is a highly effective method of eradicating MRSA from rooms, furniture and equipment. Further work is needed to determine the importance of environmental contamination with MRSA and the effect on hospital infection rates of effective decontamination.

Elbow Grease vs Mechanical

French et al. J Hosp Infect. 2004;57:31

- Results
  - Before cleaning -89.5% (111/124)
  - After cleaning (elbow grease)-66.1% (82/124)
  - Before HPV -71.8% (61/85)
  - After HPV (mechanical)-1.2% (1/85)
  - Environmental Disinfection: What Works Best?
  - Microbial Reduction: Elbow grease-23.4% vs Mechanical-70.6%

Comparison of the Efficacy of a Hydrogen Peroxide Dry-Mist Disinfection System and Sodium Hypochlorite Solution for Eradication of *Clostridium difficile* Spores

F. Barbut, PharmD, PhD; D. Menuet, BSc; M. Verachten, BSc; E. Girou, PharmD

OBJECTIVE. To compare a hydrogen peroxide dry-mist system and a 0.5% hypochlorite solution with respect to their ability to disinfect *Clostridium difficile*–contaminated surfaces in vitro and in situ.

DESIGN. Prospective, randomized, before-after trial.

SETTING. Two French hospitals affected by *C. difficile*.

INTERVENTION. In situ efficacy of disinfectants was assessed in rooms that had housed patients with *C. difficile* infection. A prospective study was performed at 2 hospitals that involved randomization of disinfection processes. When a patient with *C. difficile* infection was discharged, environmental contamination in the patient's room was evaluated before and after disinfection. Environmental surfaces were sampled for *C. difficile* by use of moistened swabs; swab samples were cultured on selective plates and in broth. Both disinfectants were tested in vitro with a spore-carrier test; in this test, 2 types of material, vinyl polychloride (representative of the room's floor) and laminate (representative of the room's furniture), were experimentally contaminated with spores from 3 *C. difficile* strains, including the epidemic clone ribotype 027–North American pulsed-field gel electrophoresis type 1.

RESULTS. There were 748 surface samples collected (360 from rooms treated with hydrogen peroxide and 388 from rooms treated with hypochlorite). Before disinfection, 46 (24%) of 194 samples obtained in the rooms randomized to hypochlorite treatment and 34 (19%) of 180 samples obtained in the rooms randomized to hydrogen peroxide treatment showed environmental contamination. After disinfection, 23 (12%) of 194 samples from hypochlorite-treated rooms and 4 (2%) of 180 samples from hydrogen peroxide treated rooms showed environmental contamination, a decrease in contamination of 50% after hypochlorite decontamination and 91% after hydrogen peroxide decontamination ($P < .005$). The in vitro activity of 0.5% hypochlorite was time dependent. The mean ($\pm$SD) reduction in initial $\log_{10}$ bacterial count was 4.32 ± 0.35 $\log_{10}$ colony-forming units after 10 minutes of exposure to hypochlorite and 4.18 ± 0.8 $\log_{10}$ colony-forming units after 1 cycle of hydrogen peroxide decontamination.

CONCLUSION. In situ experiments indicate that the hydrogen peroxide dry-mist disinfection system is significantly more effective than 0.5% sodium hypochlorite solution at eradicating *C. difficile* spores and might represent a new alternative for disinfecting the rooms of patients with *C. difficile* infection.

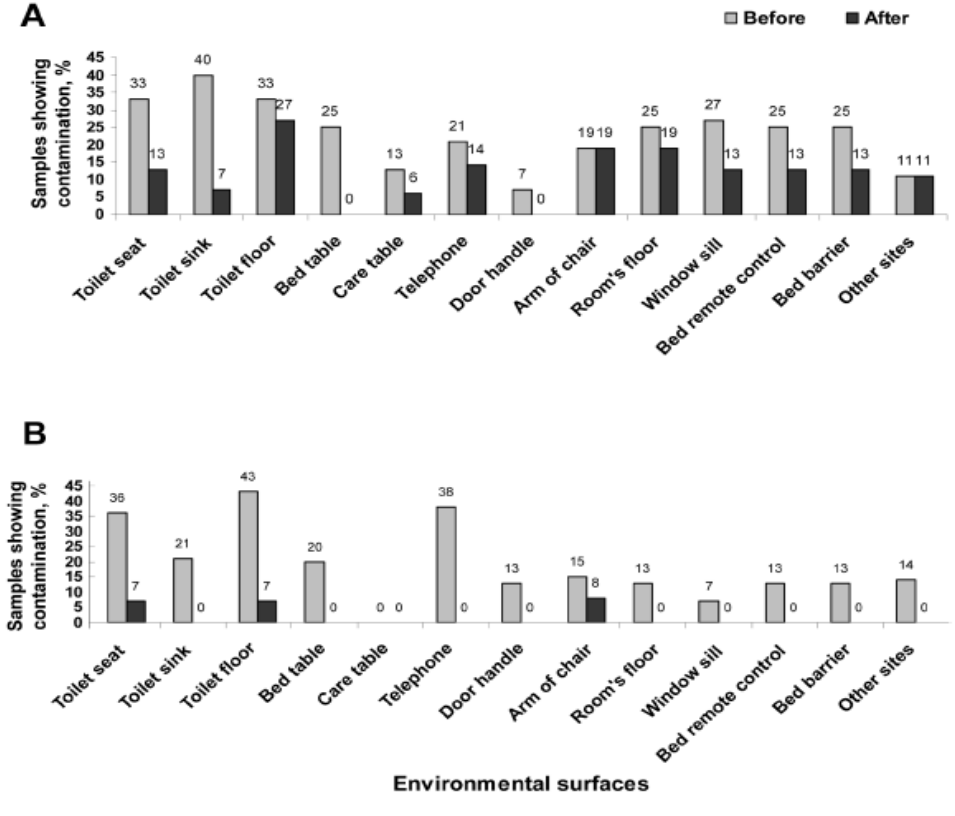
Comparison of HP and Chlorine with *C. difficile*

(Barbut et al. *Infect Control Hosp Epidemiol* 2009;30:507)

Treatment	Before Treatment	After Treatment	% Reduction
Hydrogen peroxide mist	19% (34/180)	2% (2/180)	91% (p<.005)
Chlorine	24% (46/194)	12% (23/194)	50%

EFFICACY OF HYPOCHLORITE VS HYDROGEN PEROXIDE DRY MIST

- **Study design: Prospective randomized before-after study, 2007**
- **Setting: 2 French hospitals**
- **Methods: Disinfection: A=0.5% hypochlorite; B=HP-Ag cation dry-mist (Sterusil)**
- **Results**
  - **After disinfection 12% of samples from hypochlorite rooms and 2% from HP showed contamination ($p<0.005$)**
- **No measurement of cleaning thoroughness**



Barbut F, et al. ICHE 2009;30:07-514

Comparison of the Efficacy of a Hydrogen Peroxide Dry-Mist Disinfection System and Sodium Hypochlorite Solution for Eradication of *Clostridium difficile* Spores

F. Barbut, PharmD, PhD; D. Menuet, BSc; M. Verachten, BSc; E. Girou, PharmD

RESULTS. There were 748 surface samples collected (360 from rooms treated with hydrogen peroxide and 388 from rooms treated with hypochlorite). Before disinfection, 46 (24%) of 194 samples obtained in the rooms randomized to hypochlorite treatment and 34 (19%) of 180 samples obtained in the rooms randomized to hydrogen peroxide treatment showed environmental contamination. After disinfection, 23 (12%) of 194 samples from hypochlorite-treated rooms and 4 (2%) of 180 samples from hydrogen peroxide treated rooms showed environmental contamination, a decrease in contamination of 50% after hypochlorite decontamination and 91% after hydrogen peroxide decontamination ($P < .005$). The in vitro activity of 0.5% hypochlorite was time dependent. The mean ($\pm$SD) reduction in initial $\log_{10}$ bacterial count was 4.32 ± 0.35 $\log_{10}$ colony-forming units after 10 minutes of exposure to hypochlorite and 4.18 ± 0.8 $\log_{10}$ colony-forming units after 1 cycle of hydrogen peroxide decontamination.

CONCLUSION. In situ experiments indicate that the hydrogen peroxide dry-mist disinfection system is significantly more effective than 0.5% sodium hypochlorite solution at eradicating *C. difficile* spores and might represent a new alternative for disinfecting the rooms of patients with *C. difficile* infection.

Environmental Disinfection: What Works Best?

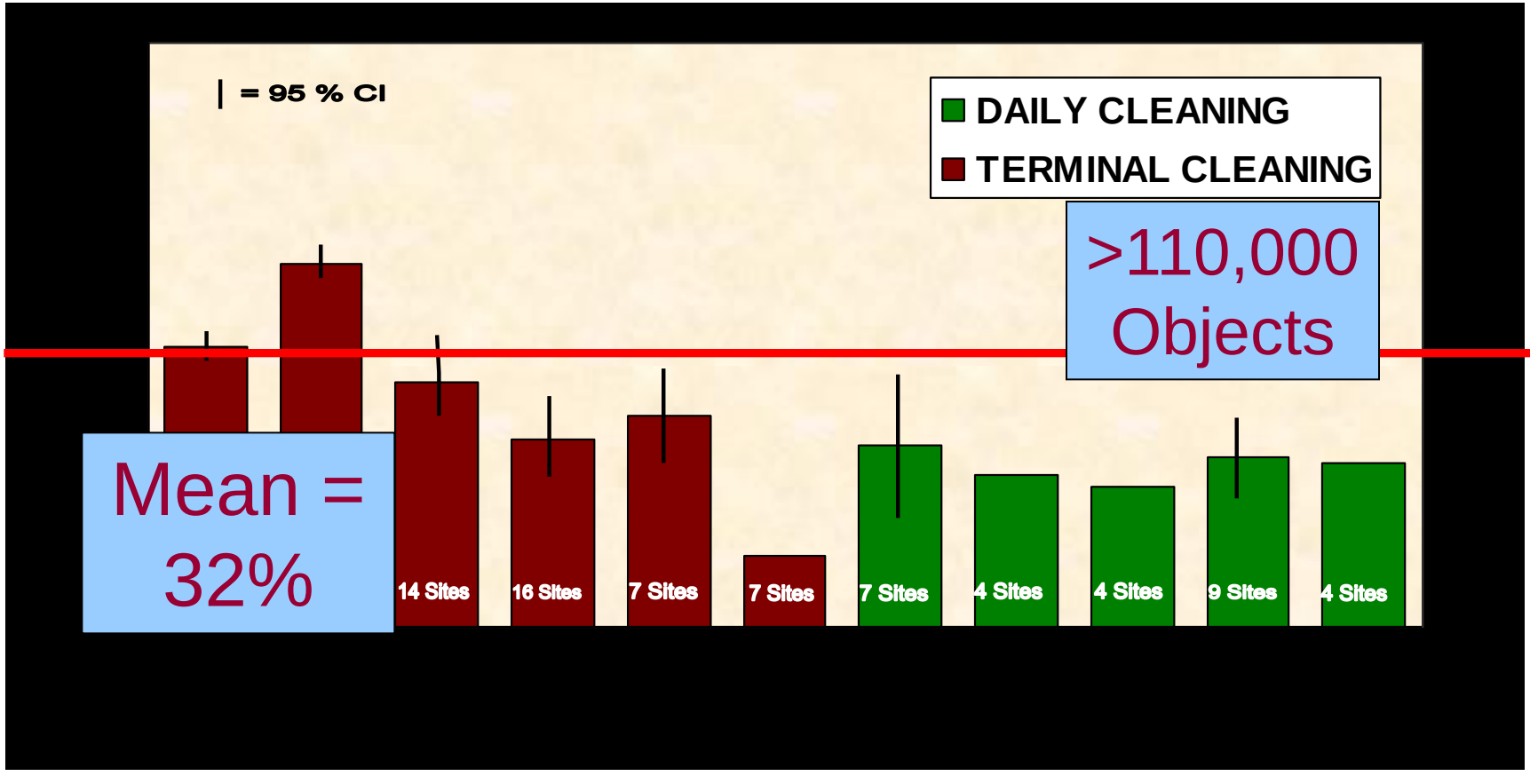
Environmental-relating to the environment (conditions surrounding a person or organism)
Disinfection- destruction of pathogenic microorganisms
What -which thing
Works-operates effectively or successfully
Best -exceeding all others in excellence

MECHANICAL

71% V 23% microbial reduction

Thoroughness of Environmental Cleaning

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



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Summary

- "Touch" techniques are ineffective when the surface is not "touched". Studies have shown that most near patient surfaces are not being cleaned in accordance with existing policies.
- "No touch" techniques are highly effective and disinfects all surfaces (even equipment or room sites that are difficult to clean) not just surfaces that are "touched" or wiped.
- "No touch" technology supplement but do not replace surface disinfection as it does not remove soil.
- **Which process operates successfully and exceeds all others in excellence- "no touch" methods such as hydrogen peroxide systems and UV**

Thank you

disinfectionandsterilization.org