Disinfection and Sterilization: Special Emphasis on Pediatric Issues

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Disclosure

This educational activity is brought to you, in part, by Advanced Sterilization Products (ASP) and Ethicon. The speaker receives an honorarium from ASP and Ethicon and must present information in compliance with FDA requirements applicable to ASP.

Disinfection and Sterilization in Healthcare Facilities

WA Rutala, DJ Weber, and HICPAC, cdc.gov

- Overview
  - Last Centers for Disease Control and Prevention guideline in 1985
  - 274 pages (>130 pages preamble, 21 pages recommendations, glossary of terms, tables/figures, >1100 references)
  - Evidence-based guideline
  - Cleared by HICPAC February 2003; delayed by FDA
  - Published in November 2008

Disinfection and Sterilization: Special Emphasis in Pediatrics

- Going Green
- Bleach or not to bleach-*C. difficile*
- Pediatric approach to disinfection: is there a difference in products used?
- Quality improvement-surface disinfection
- Room decontamination-UV and HPV
- Toys (reusable) and books
- Emerging pathogens (rotavirus, norovirus, influenza H1N1)
- CF patients and *B. cepacia + S. maltophilia*
- Pet Therapy

disinfectionandsterilization.org

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**.

Processing "Critical" Patient Care Objects

Classification:	Critical objects enter normally sterile tissue or vascular system, or through which blood flows.
Object:	Sterility.
Level germicidal action:	Kill all microorganisms, including bacterial spores.
Examples:	Surgical instruments and devices; cardiac catheters; implants; etc.
Method:	Steam, gas, hydrogen peroxide plasma, ozone, HPV or chemical sterilization.

Critical Objects

- Surgical instruments
- Cardiac catheters
- Implants

Sterilization of "Critical Objects"

Steam sterilization
Hydrogen peroxide gas plasma
Ethylene oxide
Peracetic acid (0.2%)-chemical sterilization
Ozone
Vaporized hydrogen peroxide

Chemical Sterilization of "Critical Objects"

Glutaraldehyde (≥ 2.0%)
Hydrogen peroxide-HP (7.5%)
Peracetic acid-PA (0.2%)
HP (1.0%) and PA (0.08%)
HP (7.5%) and PA (0.23%)
Glut (1.12%) and Phenol/phenate (1.93%)

Exposure time per manufacturers' recommendations

Processing "Semicritical" Patient Care Objects

Classification:	Semicritical objects come in contact with mucous membranes or skin that is not intact.
Object:	Free of all microorganisms except high numbers of bacterial spores.
Level germicidal action:	Kills all microorganisms except high numbers of bacterial spores.
Examples:	Respiratory therapy and anesthesia equipment, GI endoscopes, thermometer, etc.
Method:	High-level disinfection

Semicritical Items

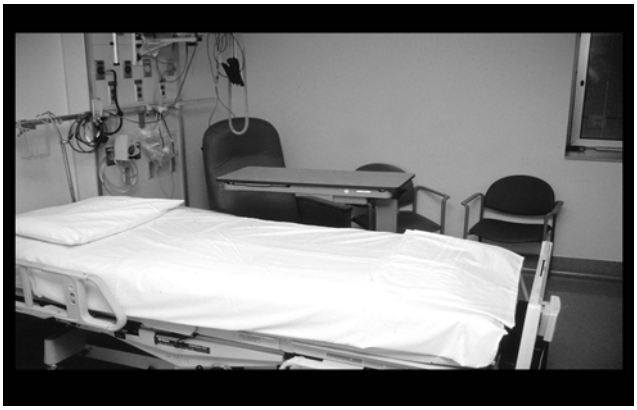
- Endoscopes
- Respiratory therapy equipment
- Anesthesia equipment
- Endocavitary probes
- Tonometers
- Diaphragm fitting rings

High Level Disinfection of "Semicritical Objects"

Exposure Time ≥ 8m-30m (US), 20°C

Germicide	Concentration
Glutaraldehyde	≥ 2.0%
Ortho-phthalaldehyde (12 m US)	0.55%
Hydrogen peroxide*	7.5%
Accelerated hydrogen peroxide	2.0%
Hydrogen peroxide and peracetic acid*	1.0%/0.08%
Hydrogen peroxide and peracetic acid*	≥7.35%/≥0.23%
Hypochlorite (free chlorine)*	650-675 ppm
Glut and phenol/phenate	1.21%/1.93%
Glut and alcohol	3.4%/26% IPA

*May cause cosmetic and functional damage



Processing "Noncritical" Patient Care Objects

Classification:	Noncritical objects will not come in contact with mucous membranes or skin that is not intact.
Object:	Can be expected to be contaminated with some microorganisms.
Level germicidal action:	Kill vegetative bacteria, fungi and lipid viruses.
Examples:	Bedpans; crutches; bed rails; EKG leads; bedside tables; walls, floors and furniture.
Method:	Low-level disinfection

Low-Level Disinfection for "Noncritical" Objects

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
Accelerated hydrogen peroxide	0.5%

UD=Manufacturer's recommended use dilution

ACCELERATED HYDROGEN PEROXIDE

AHP-Based Surface Disinfectant

- Advantages
  - 1 min bactericidal (VRE, MRSA) and virucidal claim
  - 5 min mycobactericidal claim
  - Safe for workers, environment
  - Good cleaner
  - EPA (0.5% RTU, wet wipe)
- Disadvantage
  - Cost (RTU $5.80/32oz/pt, $92.83/512oz/gal; RTU QUAT $3.21/32oz/pt)

Surface Disinfection

Environmental Surfaces-CDC, 2007

- Disinfecting Environmental Surfaces in HCF
  - Disinfect (or clean) housekeeping surfaces (e.g., floors, tabletops) on a regular basis (e.g., daily, three times per week), when spills occur, and when these surfaces are visibly soiled. *Category IB*
  - Use disinfectant for housekeeping purposes where: uncertainty exists as to the nature of the soil on the surfaces (blood vs dirt); or where uncertainty exists regarding the presence of multi-drug resistant organisms on such surfaces. *Category II*

Surface Disinfection
Noncritical Patient Care-CDC, 2007

- Disinfecting Noncritical Patient-Care Items
  - Process noncritical patient-care equipment with a EPA-registered disinfectant at the proper use dilution and a contact time of at least 1 min. *Category IB*
  - Ensure that the frequency for disinfecting noncritical patient-care surfaces be done minimally when visibly soiled and on a regular basis (such as after each patient use or once daily or once weekly). *Category IB*

Disinfecting Pediatric Items

Commonly Shared Patient Equipment
Inpatient Care

- Monitor leads, transducer cables, dopplers, skin probes, alligator clamps, nondisposable blood pressure cuffs are cleaned with 70% alcohol, a bleach solution, or a phenolic when obviously soiled and between use for different patients
- Rolling blood pressure monitors should be disinfected daily, after use on nonintact skin, after use with a patient on Contact Precautions and when visibly soiled
- Infusion pumps, monitors and IV poles are disinfected with a bleach or phenolic solution at least weekly and between use for different patients

Commonly Shared Patient Equipment
Inpatient Care

- Scales are disinfected on a routine basis (e.g., weekly), when obviously soiled and after use for a patient on Contact Precautions
- Electronic thermometer probe unit and cord are disinfected daily and when visibly soiled with a 70-90% alcohol single-use pledget.

Equipment

- Shared equipment that has contact with the patient's intact skin must be cleaned between uses on different patients. An EPA-approved disinfectant or 70% alcohol should be used.
- If shared equipment is taken into the Isolation Room, it is best to leave it with the patient until no longer needed.
- If removed from the Isolation Room, it should be thoroughly cleaned with soap and water (if visibly soiled) and wiped with EPA-registered disinfectant or 70% alcohol

ENT Equipment

- Reusable ear and nasal specula, reusable otoscope tips and nasal tongs are washed with detergent and water and then autoclaved after each patient. Alternatively, disposable speculae may be used. Curettes (used to clean the ear canal of ear wax) should be cleaned in the same manner.
- Non-disposable rubber tips on audioscopes/tympanometers should be washed in soap and water, immersed in glutaraldehyde for 20 minutes, rinsed and allowed to dry
- Rhinoscopes should be HLD

Bacterial Colonization of Toys in NICU Cots

Pediatrics 2000;106:E18

- Over 4-week period, there were 86 cultures from 34 toys of 19 infants
- Bacteria were grown from 84/86 (98%), many were potentially pathogenic (84 CONS, 13 MRSA, 4 GBS)
- Study demonstrated nearly all toys in NICU incubators/cots are contaminated with bacteria
- No direct evidence that bacteria on toys cause infection
- Concern that nearly all toys contaminated with bacteria

Toys

- Items used by younger children (who have a tendency to put things in their mouth) should be made of washable material
- Used washable toys are cleaned with soap and water and rinsed with tapwater, or wiped with 70% alcohol when soiled
- Non-washable toys (puzzles, puppets) may be used by older children
- Non-washable toys are gas sterilized or disposed of when soiled
- New toys brought into the play areas do not need to be sterilized or disinfected

Toys

- Toys that are not washable should not be taken into the room of a patient on Isolation Precautions unless they can be gas sterilized. Preferably, the child should have his own toys or be given toys he can keep.
- Washable toys used by a patient on Isolation Precautions should be washed with soap and water followed by 70% alcohol before being returned to the play areas for use by other children
- Washing plastic/vinyl toys in the dishwasher with chlorine bleach detergent is acceptable, on the hottest water setting

Toys

- Playing cards should be decontaminated using a disinfectant, stored for six months, or sterilized
- Games, puzzles, and books that cannot be disinfected, stored for six months, or sterilized should be given to the patient
- Pool table felt does not have to be disinfected, but cue sticks, balls, chalk, and racking triangle will be disinfected

Fisk Tanks and Water Gardens

- Fish tanks are allowed with the following strict precautions (Recreational Therapy):
  - They are inaccessible to patients (enclosed area with observation window; freestanding tank with a solid, affixed top)
  - They are not managed by health care workers, but by a contracted service provider
  - All patients may participate in feeding the fish but must wash their hands before and after the feeding and be supervised by a therapist during the activity
- No tabletop waterfalls/water gardens are allowed in patient care areas

Phenolics in Nurseries

- Use of phenolics questioned due to hyperbilirubinemia in infants placed in bassinets where phenolics were used
- If phenolics are used to clean nursery floors, they must be diluted according to the recommendation on the product label
- Phenolics (and other disinfectants) should not be used to clean infant bassinets and incubators while occupied
- If phenolics are used to terminally clean infant bassinets and incubators, the surfaces should be rinsed thoroughly with water and dried before the infant bassinets and incubators are reused

Role of Surfaces in Transmission

Pathogens implicated in transmission via contaminated noncritical surfaces. Patients C/I with these pathogens contaminate the environment and these pathogens survive in the environment.

- Bacteria
  - Methicillin-resistant *Staphylococcus aureus*
  - Vancomycin-resistant *Enterococcus spp*.
  - *Clostridium difficile*
  - *Acinetobacter* and *P. aeruginosa*
- Viruses
  - Rotavirus
  - Norovirus
  - SARS coronavirus

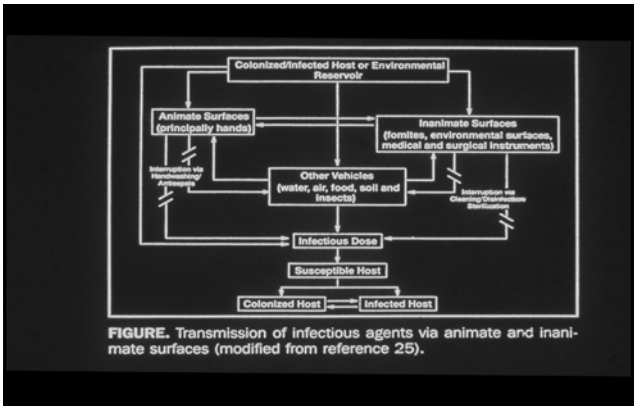


FIGURE. Transmission of infectious agents via animate and inanimate surfaces (modified from reference 25).

Environmental Contamination MRSA

- 27% of 350 surfaces sampled in the rooms of affected patients were contaminated with MRSA. When patients had MRSA in a wound or urine, 36% of surfaces were contaminated. Boyce et al. ICHE 1997;18:622.
- 74% of 359 swabs taken before cleaning yielded MRSA. French et al. J Hosp Infect 2004;57:31

C. difficile Environmental Contamination

- 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*.

Patient Area Cleaning/Disinfecting

PC Carling et al, ICHE 2008;29:1 and ICHE 2008;29:1035

- Monitor cleaning performance using an invisible fluorescent targeting method. Rooms (14 high-touch objects) were marked and evaluated after terminal cleaning.
- Results: 1,605 rooms and 20,646 objects were evaluated in 36 hospitals. Mean proportion of objects cleaned was 48%. Following education and process improvement feedback, cleaning improved to 77%
- Conclusion: Substantial opportunity for improving terminal cleaning/disinfecting activities.

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.

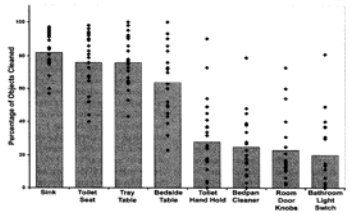


FIGURE 2. Rates of cleaning for the 4 types of object with the highest cleaning rates and the 4 types of object with the lowest rates. *Shaded bar*, mean value; *filled diamond*, value for a single hospital.

Mean proportion of surfaces disinfected at terminal cleaning is ~50%

Risk of Acquiring MRSA, VRE, and *C. difficile* 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. ICACC (K-4194) 2008. Shaughnessy et al.

Quality Improvement

Monitoring the Effectiveness of Cleaning

Cooper et al. AJIC 2007;35:338

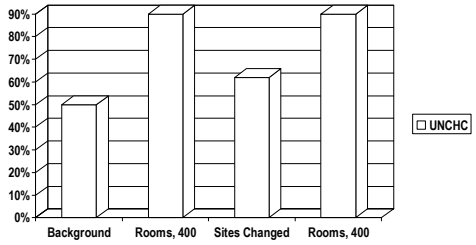
- Visual assessment-not a reliable indicator of surface cleanliness
- ATP bioluminescence-measures organic debris (each unit has own reading scale)
- Microbiological methods-<2.5CFUs/cm^2-pass; can be costly and pathogen specific
- Fluorescent marker

Fluorescent Marker

- A mixture of several glues, soaps, and a target dye (Carling, 2009)
  - Dries rapidly
  - Simple
  - Easily removed by wetted cloth
  - Environmentally stable
  - Rapid
  - Unfortunately, not readily available (Carling and Sodexho)

The Dazo Solution

Rates of Cleaning for High-Risk Objects



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Hydrogen Peroxide Vapor Decontamination

- **Bartels MD et al. J Hosp Infect 2008;70:35. MRSA/Sterinis**
- **Boyce JM et al. ICHE 2008;29:723.** ***C. difficile*****/Bioquell**
- **Shapey S et al. J Hosp Infect 2008 (in press).** ***C. difficile*****/Sterinis**
- **Hardy KJ et al. J Hosp Infect 2007;66:360. MRSA/Bioquell**
- **Hall L et al. J Clin Microbiol 2007;45: 810.** ***M. tuberculosis*****/Bioquell**
- **Bates CJ, Pearse R. J Hosp Infect 2005;61:364.** ***S. marcescens*****/Bioquell**
- **Johnston MD et al. J Microbiol Methods 2005;60:403.** ***C. botulinum*****/Bioquell**
- **French GL et al. J Hosp Infect 2004;57:31. MRSA/Bioquell**
- **Heckert RA et al. Appl Environ Microbiol 1997;63:3916. Viruses/Steris VHP**
- **Klapes NA et al. Appl Environ Microbiol 1990;56;503.** ***Bacillus*** **spores/Prototype HPV generator**

Decontamination by Hydrogen Peroxide Vapor

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

- 74% of swabs taken before cleaning yielded MRSA
- After detergent cleaning 66% yielded MRSA
- After HPV, only 1.2% yielded MRSA
- Conclusion: HPV is a highly effective method of eradicating MRSA from rooms, furniture and equipment

Decontamination with Hydrogen Peroxide Vapor

Hardy et al. J Hosp Infect 2007;66:360.

- MRSA was isolated from 11.2% of environmental sites in ICU
- MRSA from environment similar to those colonizing patients
- After terminal cleaning, MRSA was isolated from 5 sites (17.2%)
- After HPV decontamination, MRSA was not isolated from the environment
- 24 hours after readmitting patients (including MRSA), MRSA was isolated from 5 sites
- In 8 weeks after VHP, the environment was sampled and MRSA isolated from 16.3%
- Conclusion: VHP is effective in eliminating bacteria, but rapid rate of recontamination suggest it is not a effective means of maintaining low levels of environmental contamination

Decontamination with Hydrogen Peroxide Vapor

Boyce et al: ICHE 2008;29:723

- 5 wards with a high incidence of *C. difficile*
- HPV was injected into sealed wards and individual patient rooms using generators until approx 1 micron film of HP was achieved on the surface
- 11/43 (25.6%) surface samples yielded *C. difficile* compared to 0/27 (0%) after HPV decontamination
- The incidence of nosocomial CDAD was significantly lower during the intervention period
- Conclusion: HPV was efficacious in eradicating *C. difficile* from contaminated surfaces

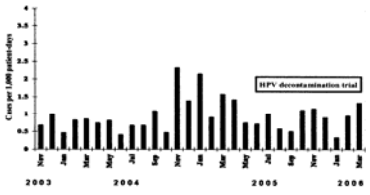

FIGURE 1. Hospital-wide incidence of nosocomial *Clostridium difficile*–associated disease, November 2003 through March 2006. HPV, hydrogen peroxide vapor.

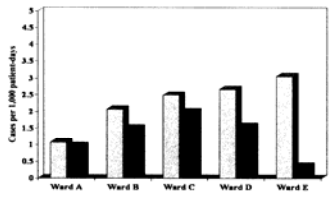

FIGURE 2. Incidence of nosocomial *Clostridium difficile*–associated disease on 5 wards (A–E) that underwent intensive hydrogen peroxide vapor decontamination, during the preintervention period (*gray bars*; June 2004 through March 2005) and the intervention period (*black bars*; June 2005 through March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

UV Room Decontamination

- 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 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, will power-down and audibly notify the operator
- Reduces colony counts of pathogens by >99.9% within 20 minutes

Room Decontamination with UV

(Rutala, Gergen, Weber, 2009, Unpublished Results)

Organism	Dose Reading (time)	Log_{10} Reduction (10 sites, 5 replicates)
MRSA	~470 mj/cm^2 (~15m)	3.91
VRE	~660 mj/cm^2 (~15m)	3.36
Acinetobacter	~630 mj/cm^2 (~14m)	3.77
C. difficile	~2120 mj/cm^2 (~50m)	2.67

C. difficile

Clostridium difficile

- Have been found in abundance in the environment of individuals with disease
- Have been found on the hands of healthcare workers providing care to affected patients or touching the contaminated environment
- Survive in the environment (months [spores])
- Are relatively resistant to chemical disinfection (including alcohol)
- Have caused outbreaks in hospitals
- Are transmitted by either ingestion or direct inoculation of the GI tract
- Have epidemiological evidence that environmental surface contamination may be a source for infections

Decreasing Order of Resistance of Microorganisms to Disinfectants/Sterilants

Prions

Spores

Mycobacteria

Non-Enveloped Viruses

Fungi

Bacteria

Enveloped Viruses

C. difficile Inactivation

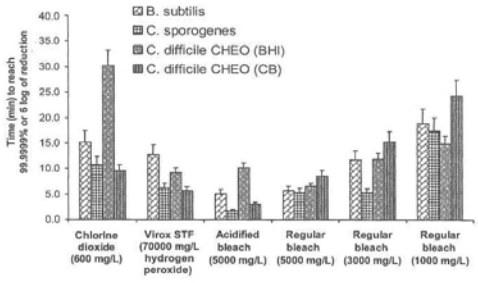

Fig 1. Times required for the microbicides to inactivate ≥6 log_{10} (99.9999%) of the spores tested.

Disinfectants and Antiseptics

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

- ~4 $\log_{10}$ reduction (3 *C. difficile* strains including BI-9)
  - Clorox, 1:10, ~6,000 ppm chlorine (but not 1:50, ~1,200 ppm)
  - Clorox Clean-up, ~1,910 ppm chlorine
  - Tilex, ~25,000 ppm chlorine
  - Steris 20 sterilant, 0.35% peracetic acid
  - Cidex, 2.4% glutaraldehyde
  - Cidex-OPA, 0.55% OPA
  - Wavicide, 2.65% glutaraldehyde
  - Aldahol, 3.4% glutaraldehyde and 26% alcohol

Environmental Disinfection

- Disinfection with a 1:10 dilution of concentrated sodium hypochlorite (i.e., bleach) has been shown to be effective in reducing environmental contamination in patient rooms and in reducing CDI rates in hospital units where the rate of CDI is high.

Epidemiological Studies

Effect of Hypochlorite on Environmental Contamination and Incidence of *C. difficile*

- Use of chlorine (500 [79%reduction]-1600 ppm [98%]) decreased surface contamination and the outbreak ended. Mean CFU/positive culture in outbreak 5.1, reduced to 2.0 with chlorine. Kaatz et al. Am J Epid 1988;127:1289.
- In an intervention study, the incidence of CDAD for bone marrow transplant patients decreased significantly, from 8.6 to 3.3 cases per 1000 patient days after the environmental disinfection was switched from QUAT to 1:10 hypochlorite solution in the rooms of patients with CDAD. No reduction in CDAD rates was seen among NS-ICU and medicine patients for whom baseline rates were 3.0 and 1.3 cases per 1000-patient days. Mayfield et al. Clin Inf Dis 2000;31:995.

Effect of Hypochlorite on Environmental Contamination and Incidence of *C. difficile*

- 35% of 1128 environmental cultures were positive for *C. difficile*. To determine how best to decontaminate, a cross-over study conducted. There was a significant decrease of *C. difficile* on one of two medicine wards (8.9 to 5.3 per 100 admissions) using hypochlorite (1,000 ppm) vs. detergent. Wilcox et al. J Hosp Infect 2003;54:109.
- The CDI rate decreased with the use of hypochlorite solutions (16.6 cases/1000 patient days to 3.7). Infect Control Hosp Epidemiol 2007;28:205-7.

Environmental Disinfection

- Disinfection with a 1:10 dilution of concentrated sodium hypochlorite (i.e., bleach) has been shown to be effective in reducing environmental contamination in patient rooms and in reducing CDI rates in hospital units where the rate of CDI is high.

The Green Hospital

Keslar. Proto (Mass Gen Hosp). Fall 2007

- Hospitals are feeling the pressure to go green, both from eco-conscious donors and governmental agencies
- Some features of The Green Hospital
  - Roof garden-wildlife habitat, adds insulation, absorbs rain
  - Fewer contaminants-upholstery and mattresses without flame retardants, formaldehyde-free insulation, green cleaning products (no hazardous fumes), triple-filtered air
  - Exposure to natural light
  - Reduced water usage-water efficient toilets and faucets
  - Greater energy efficiency-low energy fluorescent bulbs
  - More quiet-number 1 complaint is noise, better insulation between rooms

TABLE 1
EFFECTIVENESS OF DISINFECTANT AGAINST POTENTIAL PATHOGENS

	Log_{10} Reductions							
	Staphylococcus aureus		*Salmonella choleraesuis*		*Escherichia coli* O157:H7		*Pseudomonas aeruginosa*	
Product	0.5 min	5 min	0.5 min	5 min	0.5 min	5 min	0.5 min	5 min
Vesphene IIse	>8.2	>8.2	>6.7	>6.7	>6.6	>6.6	>6.7	>6.7
TBQ	>6.4	>6.4	>6.6	>6.6	>6.4	>6.4	>6.9	>6.2
Clorox	>5.8	>5.8	>5.9	>5.9	>5.6	>5.6	>5.3	>5.3
Ethanol	6.2	>6.7	>6.0	>6.0	>6.8	>6.8	>6.4	>6.4
Lysol Disinfectant	4.2	4.3	4.0	3.9	4.0	4.1	4.2	4.0
Lysol Antibacterial	>5.6	>5.6	>5.8	>5.8	>5.7	>5.7	>5.5	>5.5
Mr. Clean	4.1	>6.0	>5.7	>5.7	>6.1	4.7	>5.7	>5.7
Vinegar	0.03	0.3	>6.0	>6.0	0.4	2.4	>5.8	>5.8
Baking soda	0.2	0.5	2.3	2.3	0.4	0.7	1.1	1.1

Data represent mean of two replicates. 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.

Rutala WA, Barbee SL, Aguiar NC, Sobsey MD, Weber DJ. Antimicrobial Activity of Home Disinfectants and Natural Products Against Potential Human Pathogens. *Infection Control and Hospital Epidemiology* 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.

Rutala WA, Barbee SL, Aguiar NC, Sobsey MD, Weber DJ. Antimicrobial Activity of Home Disinfectants and Natural Products Against Potential Human Pathogens. *Infection Control and Hospital Epidemiology* 2000;21:33-38.

Currently, "green" cleaners will remove microbial contaminants but will not dependably kill pathogens causing HAIs

Summary

- **D/S guidelines must be followed to prevent exposure to pathogens that may lead to infection. Semicritical items represent the greatest risk. Class 6 indicators not a substitute for biological indicators.**
- **During clusters, surfaces potentially contaminated with norovirus or *C. difficile* spores should be disinfected with with an agent shown to have efficacy (e.g., hypochlorite, 5000 ppm)**
- **There is substantial opportunity for improving terminal cleaning/disinfecting activities; ensure complete cleaning of all potentially contaminated surfaces.**
- **Disinfectants (but not "green" products) demonstrate excellent activity against MRSA but practices are deficient.**

Disinfection and Sterilization: Special Emphasis in Pediatrics

- Going Green
- Bleach or not to bleach-C. difficile
- Pediatric approach to disinfection: is there a difference in products used?
- Quality improvement-surface disinfection
- Room decontamination-UV and HPV
- Toys (reusable) and books
- Emerging pathogens (rotavirus, norovirus, influenza H1N1)
- CF patients and *B. cepacia + S. maltophilia*
- Pet Therapy