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

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Disclosure: Clorox
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
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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 ENVIRONMENTAL SURFACES PLAY A ROLE IN TRANSMISSION

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

## Endemic and Epidemic MRSA


<table>
<thead>
<tr>
<th></th>
<th>Outbreak</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Site estimated mean§</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rampling et al²⁷</td>
<td>Boyce et al²⁸</td>
<td>Sexton et al³³</td>
<td>Lemmen et al³⁰</td>
<td>French et al³⁴</td>
<td></td>
</tr>
<tr>
<td>Floor</td>
<td>9%</td>
<td>50-55%</td>
<td>44-60%</td>
<td>24%</td>
<td>..</td>
<td>34-5%</td>
</tr>
<tr>
<td>Bed linen</td>
<td>..</td>
<td>38-54%</td>
<td>44%</td>
<td>34%</td>
<td>..</td>
<td>41%</td>
</tr>
<tr>
<td>Patient gown</td>
<td>..</td>
<td>40-53%</td>
<td>..</td>
<td>34%</td>
<td>..</td>
<td>40-5%</td>
</tr>
<tr>
<td>Overbed table</td>
<td>..</td>
<td>18-42%</td>
<td>64-67%</td>
<td>24%</td>
<td>..</td>
<td>40%</td>
</tr>
<tr>
<td>Blood pressure cuff</td>
<td>13%</td>
<td>25-33%</td>
<td>..</td>
<td>..</td>
<td>..</td>
<td>21%</td>
</tr>
<tr>
<td>Bed or siderails</td>
<td>5%</td>
<td>1-30%</td>
<td>44-60%</td>
<td>21%</td>
<td>43%</td>
<td>27%</td>
</tr>
<tr>
<td>Bathroom door handle</td>
<td>..</td>
<td>8-24%</td>
<td>..</td>
<td>12%¶</td>
<td>..</td>
<td>14%</td>
</tr>
<tr>
<td>Infusion pump button</td>
<td>13%</td>
<td>7-18%</td>
<td>..</td>
<td>30%</td>
<td>..</td>
<td>19%</td>
</tr>
<tr>
<td>Room door handle</td>
<td>11%</td>
<td>4-8%</td>
<td>..</td>
<td>23%</td>
<td>59%</td>
<td>21-5%</td>
</tr>
<tr>
<td>Furniture</td>
<td>11%</td>
<td>..</td>
<td>44-59%</td>
<td>19%</td>
<td>..</td>
<td>27%</td>
</tr>
<tr>
<td>Flat surfaces</td>
<td>7%</td>
<td>..</td>
<td>32-38%</td>
<td>..</td>
<td>..</td>
<td>21-5%</td>
</tr>
<tr>
<td>Sink taps or basin fitting</td>
<td>..</td>
<td>..</td>
<td>14%</td>
<td>33%</td>
<td>23-5%</td>
<td></td>
</tr>
<tr>
<td>Average quoted**</td>
<td>11%</td>
<td>27%</td>
<td>49%</td>
<td>25%</td>
<td>74%</td>
<td>37%</td>
</tr>
</tbody>
</table>
ENVIRONMENTAL SURVIVAL OF KEY PATHOGENS ON HOSPITAL SURFACES

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Survival Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. aureus</em> (including MRSA)</td>
<td>7 days to &gt;12 months</td>
</tr>
<tr>
<td><em>Enterococcus</em> spp. (including VRE)</td>
<td>5 days to &gt;46 months</td>
</tr>
<tr>
<td><em>Acinetobacter</em> spp.</td>
<td>3 days to 11 months</td>
</tr>
<tr>
<td><em>Clostridium difficile</em> (spores)</td>
<td>&gt;5 months</td>
</tr>
<tr>
<td>Norovirus (and feline calicivirus)</td>
<td>8 hours to &gt;2 weeks</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td>6 hours to 16 months</td>
</tr>
<tr>
<td><em>Klebsiella</em> spp.</td>
<td>2 hours to &gt;30 months</td>
</tr>
</tbody>
</table>

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)

RISK OF ACQUIRING PATHOGEN FROM PRIOR ROOM OCCUPANT ~120%

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

- MDR Acinetobacter (Nseir S, 2011)
- VRE^ (Drees M, 2008)
- VRE (Huang S, 2006)
- MDR Pseudomonas (Nseir S, 2011)
- MDR Acinetobacter (Nseir S, 2011)
- C. diff (Shaughnessy M, 2011)
- VRE (Huang S, 2006)
- VRE* (Drees M, 2008)
- MRSA (Huang S, 2006)

* 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
TRANSMISSION MECHANISMS INVOLVING THE SURFACE ENVIRONMENT

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 TRANSMISSION OF PATHOGEN
TRANSMISSION MECHANISMS INVOLVING THE SURFACE ENVIRONMENT

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

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

Curtis J. Donskey MD,a,b,*

*aGeriatric Research, Education and Clinical Center, Cleveland Veterans Affairs Medical Center, Cleveland, OH
*bCase Western Reserve University School of Medicine, Cleveland, OH

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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.

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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
Major article

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

Michelle J. Alfa PhD\textsuperscript{a,b,*}, Evelyn Lo MD\textsuperscript{b,c}, Nancy Olson BSc\textsuperscript{a}, Michelle MacRae\textsuperscript{c}, Louise Buelow-Smith RN\textsuperscript{c}

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**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 \( \geq 80\% \).

**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 HAIs 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 \( \geq 80\% \), 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 $\geq 80\%$, there was a significant reduction in cases/10,000 patient days for MRSA, VRE and \textit{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 \textit{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 (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.
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.
Role of Environmental Surfaces in Disease Transmission

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- Review the role of environmental surfaces
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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
Exposure time $\geq$ 1 min

<table>
<thead>
<tr>
<th>Germicide</th>
<th>Use Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethyl or isopropyl alcohol</td>
<td>70-90%</td>
</tr>
<tr>
<td>Chlorine</td>
<td>100ppm (1:500 dilution)</td>
</tr>
<tr>
<td>Phenolic</td>
<td>UD</td>
</tr>
<tr>
<td>Iodophor</td>
<td>UD</td>
</tr>
<tr>
<td>Quaternary ammonium</td>
<td>UD</td>
</tr>
<tr>
<td>Improved hydrogen peroxide</td>
<td>0.5%, 1.4%</td>
</tr>
</tbody>
</table>

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

- 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


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

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


- 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


## TABLE 2
Disinfectant Activity Against Antibiotic-Susceptible and Antibiotic-Resistant Bacteria

<table>
<thead>
<tr>
<th>Product</th>
<th>VSE 0.5 min</th>
<th>VSE 5 min</th>
<th>VRE 0.5 min</th>
<th>VRE 5 min</th>
<th>MSSA 0.5 min</th>
<th>MSSA 5 min</th>
<th>MRSA 0.5 min</th>
<th>MRSA 5 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vesphene Ilse</td>
<td>&gt;4.3</td>
<td>&gt;4.3</td>
<td>&gt;4.8</td>
<td>&gt;4.8</td>
<td>&gt;5.1</td>
<td>&gt;5.1</td>
<td>&gt;4.6</td>
<td>&gt;4.6</td>
</tr>
<tr>
<td>Clorox</td>
<td>&gt;5.4</td>
<td>&gt;5.4</td>
<td>&gt;4.9</td>
<td>&gt;4.9</td>
<td>&gt;5.0</td>
<td>&gt;5.0</td>
<td>&gt;4.6</td>
<td>&gt;4.6</td>
</tr>
<tr>
<td>Lysol Disinfectant</td>
<td>&gt;4.3</td>
<td>&gt;4.3</td>
<td>&gt;4.8</td>
<td>&gt;4.8</td>
<td>&gt;5.1</td>
<td>&gt;5.1</td>
<td>&gt;4.6</td>
<td>&gt;4.6</td>
</tr>
<tr>
<td>Lysol Antibacterial</td>
<td>&gt;5.5</td>
<td>&gt;5.5</td>
<td>&gt;5.5</td>
<td>&gt;5.5</td>
<td>&gt;5.1</td>
<td>&gt;5.1</td>
<td>&gt;4.6</td>
<td>&gt;4.6</td>
</tr>
<tr>
<td>Vinegar</td>
<td>0.1</td>
<td>5.3</td>
<td>3.7</td>
<td>1.0</td>
<td>+1.1</td>
<td>+0.9</td>
<td>+0.6</td>
<td>+0.8</td>
</tr>
</tbody>
</table>

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 Nf/No, where Nf 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

**Most Resistant**

- Prions
- Spores (\textit{C. difficile})
- Mycobacteria
- Non-Enveloped Viruses (norovirus)
- Fungi
- Bacteria (MRSA, VRE, \textit{Acinetobacter})

**Most Susceptible**

Enveloped Viruses
**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](http://www.epa.gov/oppad001/list_k_clostridium.pdf)
- 34 registered products; most chlorine-based, some HP/PA-based
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William A. Rutala, Ph.D., M.P.H.\textsuperscript{1,2}, David J. Weber, M.D., M.P.H.\textsuperscript{1,2}, and the Healthcare Infection Control Practices Advisory Committee (HICPAC)\textsuperscript{3}
Blood Pressure Cuff
Non-Critical Patient Care Item
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).
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

DEFINING HIGH TOUCH SURFACES

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

<table>
<thead>
<tr>
<th>Object</th>
<th>Percentage cleaned</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± SD</td>
<td>Range</td>
</tr>
<tr>
<td>Sink</td>
<td>82 ± 12</td>
<td>57-97</td>
</tr>
<tr>
<td>Toilet seat</td>
<td>76 ± 18</td>
<td>40-98</td>
</tr>
<tr>
<td>Tray table</td>
<td>77 ± 15</td>
<td>53-100</td>
</tr>
<tr>
<td>Bedside table</td>
<td>64 ± 22</td>
<td>23-100</td>
</tr>
<tr>
<td>Toilet handle</td>
<td>60 ± 22</td>
<td>23-89</td>
</tr>
<tr>
<td>Side rail</td>
<td>60 ± 21</td>
<td>25-96</td>
</tr>
<tr>
<td>Call box</td>
<td>50 ± 19</td>
<td>9-90</td>
</tr>
<tr>
<td>Telephone</td>
<td>49 ± 16</td>
<td>18-86</td>
</tr>
<tr>
<td>Chair</td>
<td>48 ± 28</td>
<td>11-100</td>
</tr>
<tr>
<td>Toilet door knobs</td>
<td>28 ± 22</td>
<td>0-82</td>
</tr>
<tr>
<td>Toilet hand hold</td>
<td>28 ± 23</td>
<td>0-90</td>
</tr>
<tr>
<td>Bedpan cleaner</td>
<td>25 ± 18</td>
<td>0-79</td>
</tr>
<tr>
<td>Room door knobs</td>
<td>23 ± 19</td>
<td>2-73</td>
</tr>
<tr>
<td>Bathroom light switch</td>
<td>20 ± 21</td>
<td>0-81</td>
</tr>
</tbody>
</table>

**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

- 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


- **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

- DAILY CLEANING
- TERMINAL CLEANING

Mean = 32%

>110,000 Objects

- 95% CI
• 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/cm²-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)
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 → luciferase 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.
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

- 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
NEW “NO TOUCH” APPROACHES TO ROOM DECONTAMINATION
Supplement Surface Disinfection
Touch (Wiping) vs No-Touch (Mechanical)

No Touch
(supplements but do not replace surface cleaning/disinfection)
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


- 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/cm² for spore, 12,000µWs/cm² for bacteria), will power-down and audibly notify the operator
- Reduces colony counts of pathogens by >99.9% within 20 minutes
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

<table>
<thead>
<tr>
<th>Organism</th>
<th>Inoculum log\textsubscript{10}</th>
<th>No. of samples</th>
<th>Total Decontamination, log\textsubscript{10} reduction, mean (95% CI)</th>
<th>Direct Decontamination, log\textsubscript{10} reduction, mean (95% CI)</th>
<th>Indirect Decontamination, log\textsubscript{10} reduction, mean (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRSA</td>
<td>4.88</td>
<td>50</td>
<td>3.94 (2.54–5.34)</td>
<td>4.31 (3.13–5.50)</td>
<td>3.85 (2.44–5.25)</td>
<td>.06</td>
</tr>
<tr>
<td>VRE</td>
<td>4.40</td>
<td>47</td>
<td>3.46 (2.16–4.81)</td>
<td>3.90 (2.99–4.81)</td>
<td>3.25 (1.97–4.62)</td>
<td>.003</td>
</tr>
<tr>
<td>MDR <em>A. baumannii</em></td>
<td>4.64</td>
<td>47</td>
<td>3.88 (2.59–5.16)</td>
<td>4.21 (3.27–5.15)</td>
<td>3.79 (2.47–5.10)</td>
<td>.07</td>
</tr>
<tr>
<td>C. difficile spores</td>
<td>4.12</td>
<td>45</td>
<td>2.79 (1.20–4.37)</td>
<td>4.04 (3.71–4.37)</td>
<td>2.43 (1.46–3.40)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>
Objective: Determine the effectiveness of a UVC device

Method: Study carried out in standard hospital room using Formica sheets contaminated with MRSA, *C. difficile*

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 min.

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)

<table>
<thead>
<tr>
<th>Organism (Decontamination Time)</th>
<th>Inoculum</th>
<th>Total Decontamination Log_{10} Reduction</th>
<th>Direct Decontamination Log_{10} Reduction</th>
<th>Indirect Decontamination Log_{10} Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRSA (5 min)</td>
<td>4.80</td>
<td>3.56 (n=50)</td>
<td>4.10 (n=30)</td>
<td>2.74 (n=20)</td>
</tr>
<tr>
<td>C. difficile spores (10 min)</td>
<td>3.69</td>
<td>2.78 (n=50)</td>
<td>3.35 (n=30)</td>
<td>1.80 (n=20)</td>
</tr>
</tbody>
</table>
## HYDROGEN PEROXIDE FOR DECONTAMINATION OF THE HOSPITAL ENVIRONMENT


<table>
<thead>
<tr>
<th>Author, Year</th>
<th>HP System</th>
<th>Pathogen</th>
<th>Before HPV</th>
<th>After HPV</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>French, 2004</td>
<td>VHP</td>
<td>MRSA</td>
<td>61/85-72%</td>
<td>1/85-1%</td>
<td>98</td>
</tr>
<tr>
<td>Bates, 2005</td>
<td>VHP</td>
<td><em>Serratia</em></td>
<td>2/42-5%</td>
<td>0/24-0%</td>
<td>100</td>
</tr>
<tr>
<td>Jeanes, 2005</td>
<td>VHP</td>
<td>MRSA</td>
<td>10/28-36%</td>
<td>0/50-0%</td>
<td>100</td>
</tr>
<tr>
<td>Hardy, 2007</td>
<td>VHP</td>
<td>MRSA</td>
<td>7/29-24%</td>
<td>0/29-0%</td>
<td>100</td>
</tr>
<tr>
<td>Dryden, 2007</td>
<td>VHP</td>
<td>MRSA</td>
<td>8/29-28%</td>
<td>1/29-3%</td>
<td>88</td>
</tr>
<tr>
<td>Otter, 2007</td>
<td>VHP</td>
<td>MRSA</td>
<td>18/30-60%</td>
<td>1/30-3%</td>
<td>95</td>
</tr>
<tr>
<td>Boyce, 2008</td>
<td>VHP</td>
<td><em>C. difficile</em></td>
<td>11/43-26%</td>
<td>0/37-0%</td>
<td>100</td>
</tr>
<tr>
<td>Bartels, 2008</td>
<td>HP dry mist</td>
<td>MRSA</td>
<td>4/14-29%</td>
<td>0/14-0%</td>
<td>100</td>
</tr>
<tr>
<td>Shapey, 2008</td>
<td>HP dry mist</td>
<td><em>C. difficile</em></td>
<td>48/203-24%</td>
<td>7/203-3%</td>
<td>88</td>
</tr>
<tr>
<td>Barbut, 2009</td>
<td>HP dry mist</td>
<td><em>C. difficile</em></td>
<td>34/180-19%</td>
<td>4/180-2%</td>
<td>88</td>
</tr>
<tr>
<td>Otter, 2010</td>
<td>VHP</td>
<td>GNR</td>
<td>10/21-48%</td>
<td>0/63-0%</td>
<td>100</td>
</tr>
</tbody>
</table>
Clinical Trials Using HP for Terminal Room Disinfection to Reduce HAIs

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Design</th>
<th>Pathogen</th>
<th>Reduction in HAIs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boyce, 2008</td>
<td>Before-After</td>
<td>CDI</td>
<td>Yes</td>
</tr>
<tr>
<td>Cooper, 2011</td>
<td>Before-After</td>
<td>CDI</td>
<td>Decrease cases (incidence not stated)</td>
</tr>
<tr>
<td>Passaretti, 2013</td>
<td>Prospective cohort</td>
<td>MRSA, VRE, CDI</td>
<td>Yes, in all MDROs</td>
</tr>
<tr>
<td>Manian, 2013</td>
<td>Before-After</td>
<td>CDI</td>
<td>Yes</td>
</tr>
<tr>
<td>Mitchell, 2014</td>
<td>Before-After</td>
<td>MRSA</td>
<td>Yes</td>
</tr>
</tbody>
</table>
# EFFECTIVENESS OF UV-C FOR ROOM DECONTAMINATION (Inoculated Surfaces)

[ICHE 2010;31:1025; 2BMC 2010;10:197; 3ICHE 2011;32:737; 4JHI 2013;84:3231 5ICHE 2012;33:507-12 6ICHE 2013;34:466 * µWs/cm²; min = minutes; NA = not available]

<table>
<thead>
<tr>
<th>Pathogens</th>
<th>Dose*</th>
<th>Mean log₁₀ Reduction Line of Sight</th>
<th>Mean log₁₀ Reduction Shadow</th>
<th>Time</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRSA, VRE, MDR-A</td>
<td>12,000</td>
<td>3.90-4.31</td>
<td>3.25-3.85</td>
<td>~15 min</td>
<td>Rutala W, et al.¹</td>
</tr>
<tr>
<td>C. difficile</td>
<td>36,000</td>
<td>4.04</td>
<td>2.43</td>
<td>~50 min</td>
<td>Rutala W, et al.¹</td>
</tr>
<tr>
<td>MRSA, VRE</td>
<td>12,000</td>
<td>&gt;2-3</td>
<td>NA</td>
<td>~20 min</td>
<td>Nerandzic M, et al.²</td>
</tr>
<tr>
<td>C. difficile</td>
<td>22,000</td>
<td>&gt;2-3</td>
<td>NA</td>
<td>~45 min</td>
<td>Nerandzic M, et al.²</td>
</tr>
<tr>
<td>C. difficile</td>
<td>22,000</td>
<td></td>
<td>2.3</td>
<td>overall</td>
<td>Boyce J, et al.³</td>
</tr>
<tr>
<td>MRSA, VRE, MDR-A, Asp</td>
<td>12,000</td>
<td>3.5-&gt;4.0</td>
<td>1.7-&gt;4.0</td>
<td>30-40 min</td>
<td>Mahida N, et al.⁴</td>
</tr>
<tr>
<td>MRSA, VRE, MDR-A, Asp</td>
<td>22,000</td>
<td>&gt;4.0*</td>
<td>1.0-3.5</td>
<td>60-90 min</td>
<td>Mahida N, et al.⁴</td>
</tr>
<tr>
<td>C. difficile, G. stear spore</td>
<td>22,000</td>
<td>2.2</td>
<td>overall</td>
<td>73 min</td>
<td>Havill N et al⁵</td>
</tr>
<tr>
<td>VRE, MRSA, MDR-A</td>
<td>12,000</td>
<td>1.61</td>
<td>1.18</td>
<td>25 min</td>
<td>Anderson et al⁶</td>
</tr>
</tbody>
</table>
Clinical Trials Using UV for Terminal Room Decontamination to Reduce HAI s

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Design</th>
<th>Pathogens</th>
<th>Reduction in HAI s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levin, 2013</td>
<td>Before-After, Pulsed Xenon</td>
<td>CDI</td>
<td>Yes</td>
</tr>
<tr>
<td>Hass, 2014</td>
<td>Before-After, Pulsed Xenon</td>
<td>CDI, MRSA, VRE, MDRO-GNR</td>
<td>Yes</td>
</tr>
<tr>
<td>Miller, 2015</td>
<td>Before-After, Pulsed Xenon</td>
<td>CDI</td>
<td>Yes</td>
</tr>
<tr>
<td>Nagaraja, 2015</td>
<td>Before-After, Pulsed Xenon</td>
<td>CDI</td>
<td>Yes (p=0.06)</td>
</tr>
<tr>
<td>Pegues, 2015</td>
<td>Before-After, Optimum</td>
<td>CDI</td>
<td>Yes</td>
</tr>
<tr>
<td>Anderson, 2015</td>
<td>Randomized-controlled trial, Tru-D</td>
<td>MRSA, VRE, CDI</td>
<td>Yes</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Quat*</th>
<th>No UV Light</th>
<th>UV Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>D</td>
<td></td>
</tr>
</tbody>
</table>

*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”

Terminal Clean

“Exposed Patient”

Documented infection or colonization with
MRSA
VRE
C. difficile
MDR-Acinetobacter

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

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

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

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

*EIP- epidemiologically-important pathogens (mean CFU/room/125cm²) 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

- 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.
Role of Environmental Surfaces in Disease Transmission

- 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
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