Best Practices in Disinfection of Noncritical Surfaces in the Healthcare Setting

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Former Director, Hospital Epidemiology, Occupational Health and Safety, UNC Health Care, Chapel Hill, NC (1979-2017)
DISCLOSURES
2018

- Consultations
  - ASP (Advanced Sterilization Products), PDI
- Honoraria
  - PDI, ASP
- Scientific Advisory Board
  - Kinnos
- Grants
  - CDC, CMS
Disinfection of Noncritical Surfaces Bundle
NL Havill AJIC 2013;41:S26-30

- Develop policies and procedures
- Select cleaning and disinfecting products
- Educate staff-environmental services and nursing
- Monitor compliance (thoroughness of cleaning, product use) and feedback
- Implement “no touch” room decontamination technology and monitor compliance
Evidence environment contributes
Role-MRSA, VRE, C. difficile
Surfaces are contaminated ~25%
EIP survive days, weeks, months
Contact with surfaces results in hand contamination
Disinfection reduces contamination
Disinfection (daily) reduces HAIs
Rooms not adequately cleaned
Admission to Room Previously Occupied by Patient C/I with Epidemiologically Important Pathogen

- Results in the newly admitted patient having an increased risk of acquiring that pathogen by 39-353%.
- For example, increased risk for *C. difficile* is 235% (11.0% vs 4.6%).
- Exposure to contaminated rooms confers a 5-6 fold increase in odds of infection, hospitals must adopt proven methods for reducing environmental contamination (Cohen et al. ICHE. 2018;39:541-546)
Objective

Institute Practices that Prevent All Infectious Disease Transmission via Environment
Disinfection of Noncritical Surfaces Bundle

NL Havill AJIC 2013;41:S26-30

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Disinfection of Noncritical Surfaces Bundle

• Develop policies and procedures
  ■ Environmental cleaning and disinfection is an integral part of preventing transmission of pathogens
  ■ In addition to identifying products and procedures, ensure standardization of cleaning throughout the hospital

  ◆ Some units utilize ES to clean pieces of equipment (e.g., vital sign machines, IV pumps); some units use patient equipment, and some units utilize nursing staff.
  ◆ Multidisciplinary group to create a standardized plan for cleaning patient rooms and pieces of patient equipment throughout the hospital
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.
Blood Pressure Cuff
Non-Critical Patient Care Item
• Disinfecting Noncritical Patient-Care Items
  - Process noncritical patient-care equipment with an 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 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*
Use of a Daily Disinfectant Cleaner Instead of a Daily Cleaner Reduced HAI Rates
Alfa et al. AJIC 2015.43:141-146

- **Method:** Improved hydrogen peroxide disposable wipe was used once per day for all high-touch surfaces to replace cleaner
- **Result:** When cleaning compliance was ≥ 80%, there was a significant reduction in cases/10,000 patient days for MRSA, VRE and *C. difficile*
- **Conclusion:** Daily use of disinfectant applied to environmental surfaces with a 80% compliance was superior to a cleaner because it resulted in significantly reduced rates of HAIs caused by *C. difficile*, MRSA, VRE
It appears that not only is disinfectant use important but how often is important.

Daily disinfection vs clean when soiled
Daily disinfection of high-touch surfaces (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. **Daily disinfection less hand contamination.**

![Graphs showing the effect of daily disinfection on hand cultures of C. difficile and MRSA](image)

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

Huslage K, Rutala W, Gergen M, Sickbert-Bennett S, Weber D.
ICHE 2013;34:211-2

JHI 2018;98:90-95
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. Cleaning and disinfecting is one-step with disinfectant-detergent. No pre-cleaning necessary unless spill or gross contamination.
Effective disinfection of contaminated surfaces is essential to prevent transmission of epidemiologically-important pathogens.

Efforts to improve disinfection focuses on touched surfaces.

Although floors contaminated, limited attention because not frequently touched.

Floors are a potential source of transmission because often contacted by objects that are then touched by hands (e.g., shoes, socks).

Non-slip socks contaminated with MRSA, VRE (Mahida, J Hosp Infect. 2016;94:273).
Recovery of Nonpathogenic Viruses from Surfaces and Patients on Days 1, 2, and 3 After Inoculation of Floor Near Bed

Koganti et al. ICHE 2016. 37:1374

<table>
<thead>
<tr>
<th>Variable</th>
<th>Day 1 (% Positive)</th>
<th>Day 2 (% Positive)</th>
<th>Day 3 (% Positive)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Hands</td>
<td>40</td>
<td>63</td>
<td>43</td>
</tr>
<tr>
<td>Patient Footwear</td>
<td>100</td>
<td>100</td>
<td>86</td>
</tr>
<tr>
<td>High-touch surface &lt;3ft</td>
<td>58</td>
<td>62</td>
<td>77</td>
</tr>
<tr>
<td>High-touch surface &gt;3ft</td>
<td>40</td>
<td>68</td>
<td>34</td>
</tr>
<tr>
<td>Personal items</td>
<td>50</td>
<td>44</td>
<td>50</td>
</tr>
<tr>
<td>Adjacent room floor</td>
<td>NA</td>
<td>100</td>
<td>80</td>
</tr>
<tr>
<td>Adjacent room environment</td>
<td>NA</td>
<td>40</td>
<td>11</td>
</tr>
<tr>
<td>Nursing station</td>
<td>53</td>
<td>47</td>
<td>63</td>
</tr>
<tr>
<td>Portable equipment</td>
<td>33</td>
<td>23</td>
<td>100</td>
</tr>
</tbody>
</table>

Surfaces <3ft included bedrail, call button, telephone, tray table, etc; surfaces >3ft included side table, chair, IV pole, etc; personal-cell phones, books, clothing, wheelchairs; nurses station included computer keyboard, mouse, etc.
Found that a nonpathogenic virus inoculated onto floors in hospital rooms disseminated rapidly to the footwear and hands of patients and to high-touch surfaces in the room.

The virus was also frequently found on high-touch surfaces in adjacent rooms and nursing stations.

Contamination in adjacent rooms in the nursing station suggest HCP contributed to dissemination after acquiring the virus during contact with surfaces or patients.

Studies needed to determine if floors are source of transmission.
Disinfection of Noncritical Surfaces Bundle

- Develop policies and procedures
  - Standardize C/D patient rooms and pieces of equipment throughout the hospital
  - All touchable hand contact surfaces wiped with disinfection daily, when spills occur and when the surfaces are visibly soiled.
  - All noncritical medical devices should be disinfected daily and when soiled
  - Clean and disinfectant sink and toilet
  - Damp mop floor with disinfectant-detergent
  - If disinfectant prepared on-site, document correct concentration
  - Address treatment time/contact time for wipes and liquid disinfectants (e.g., treatment time for wipes is the kill time and includes a wet time via wiping as well as the undisturbed time).
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• Select cleaning and disinfecting products
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Effective Surface Decontamination

Product and Practice = Perfection
### Low-Level Disinfection for Noncritical Equipment and Surfaces


<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 (QUAT)</td>
<td>UD</td>
</tr>
<tr>
<td>QUAT with alcohol</td>
<td>RTU</td>
</tr>
<tr>
<td>Improved hydrogen peroxide (HP)</td>
<td>0.5%, 1.4%</td>
</tr>
<tr>
<td>Peracetic acid with HP (C. difficile)</td>
<td>UD</td>
</tr>
</tbody>
</table>

UD=Manufacturer's recommended use dilution; others in development/testing-electrolyzed water; polymeric guanidine; cold-air atmospheric pressure plasma (Boyce Antimicrob Res IC 2016. 5:10)
Microbiological Disinfectant Hierarchy
Rutala WA, Weber DJ, HICPAC. www.cdc.gov

Most Resistant

- Spores (C. difficile)
- Mycobacteria (M. tuberculosis)
- Non-Enveloped Viruses (norovirus, HAV, polio)
- Fungi (Candida, Trichophyton)
- Bacteria (MRSA, VRE, Acinetobacter)
- Enveloped Viruses (HIV, HSV, Flu)

Most Susceptible

LLD
MOST PREVALENT PATHOGENS CAUSING HAI

- Most prevent pathogens causing HAI (easy to kill)
  - *E. coli* (15.4%)
  - *S. aureus* (11.8%)
  - *Klebsiella* (7.7%)
  - Coag neg Staph (7.7%)
  - *E. faecalis* (7.4%)
  - *P. aeruginosa* (7.3%)
  - *C. albicans* (6.7%)
  - *Enterobacter* sp. (4.2%)
  - *E. faecium* (3.7%)

- 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

<table>
<thead>
<tr>
<th>Product</th>
<th>Log&lt;sub&gt;10&lt;/sub&gt; Reductions</th>
<th>VSE</th>
<th>VRE</th>
<th>MSSA</th>
<th>MRSA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.5 min</td>
<td>5 min</td>
<td>0.5 min</td>
<td>5 min</td>
</tr>
<tr>
<td>Vesphene IIse</td>
<td>&gt;4.3</td>
<td>&gt;4.3</td>
<td>&gt;4.8</td>
<td>&gt;5.1</td>
<td>&gt;5.1</td>
</tr>
<tr>
<td>Clorox</td>
<td>&gt;5.4</td>
<td>&gt;5.4</td>
<td>&gt;4.9</td>
<td>&gt;5.0</td>
<td>&gt;5.0</td>
</tr>
<tr>
<td>Lysol Disinfectant</td>
<td>&gt;4.3</td>
<td>&gt;4.3</td>
<td>&gt;4.8</td>
<td>&gt;5.1</td>
<td>&gt;5.1</td>
</tr>
<tr>
<td>Lysol Antibacterial</td>
<td>&gt;5.5</td>
<td>&gt;5.5</td>
<td>&gt;5.5</td>
<td>&gt;5.1</td>
<td>&gt;5.1</td>
</tr>
<tr>
<td>Vinegar</td>
<td>0.1</td>
<td>5.3</td>
<td>1.0</td>
<td>+1.1</td>
<td>+0.9</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 Nd/No, where Nd is the titer of bacteria surviving after exposure and No is the titer of the control.
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Product and Practice = Perfection
Thoroughness of Environmental Cleaning
Carling et al. ECCMID, Milan, Italy, May 2011

Mean = 32%

DAILY CLEANING
TERMINAL CLEANING

>110,000 Objects
Practice* NOT Product

*surfaces not wiped
MONITORING THE EFFECTIVENESS OF CLEANING
Cooper et al. AJIC 2007;35:338

- Visual assessment-not a reliable indicator of surface cleanliness
- **ATP bioluminescence**-measures organic debris (each unit has own reading scale, <250-500 RLU)
- Microbiological methods-<2.5CFUs/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)
Hospitals can improve their thoroughness of terminal room disinfection through fluorescent monitoring.
Fluorescent marker is a useful tool in determining how thoroughly a surface is wiped and mimics the microbiological data better than ATP.
There was no statistical correlation between ATP levels and standard aerobic plate counts.
Future Methods to Ensure Thoroughness
Future May Have Methods to Ensure Thoroughness Such as Colorized Disinfectant

Kang et al. J Hosp Infect 2017

Colorized disinfection – contact time compliance

- Color-fading time matched to disinfectant contact time --> enforces compliance
- Provides real-time feedback when disinfection is complete
- Trains staff on importance of contact time as they use the product
Colorized disinfection – improved coverage

• Increased visibility when disinfecting surfaces, fewer missed spots
• Real-time quality control that allows staff to monitor thoroughness of cleaning
By improving thoroughness will it reduce microbial contamination and reduce transmission?
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These interventions (effective surface disinfection, thoroughness indicators) not enough to achieve consistent and high rates of cleaning/disinfection.

No Touch
(supplements but do not replace surface cleaning/disinfection)
"NO TOUCH" APPROACHES TO ROOM DECONTAMINATION
(UV/VHP~20 microbicidal studies, 12 HAI reduction studies; will not discuss technology with limited data)
Enhanced Disinfection Leading to Reduction of Microbial Contamination and a Decrease in Patient Col/Infection


<table>
<thead>
<tr>
<th></th>
<th>Standard Method</th>
<th>Enhanced method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quat</td>
<td>Quat/UV</td>
</tr>
<tr>
<td>EIP (mean CFU per room)</td>
<td>60.8</td>
<td>3.4</td>
</tr>
<tr>
<td>Reduction (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colonization/Infection (rate)</td>
<td>2.3</td>
<td>1.5</td>
</tr>
<tr>
<td>Reduction (%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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. First study which quantitatively described the entire pathway whereby improved disinfection decreases microbial contamination which in-turn reduced patient colonization/infection.
This technology ("no touch"-e.g., UV/HP) should be used (capital equipment budget) for terminal room disinfection (e.g., after discharge of patients on Contact Precautions).
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Our Responsibility to the Future

Institute Practices that Prevent All Infectious Disease Transmission via Environment
Core Projects

• Inactivation of the human papillomavirus (HPV)
• Continuous room decontamination technologies for disinfection of the healthcare environment
  ■ Visible light disinfection through LEDs
  ■ Low concentration hydrogen peroxide
  ■ Persistent disinfectant that provides continuous disinfection action
    ◆ Advantages and disadvantages of this technology
• Assess strategies to characterize/quantify environmental contamination to determine effectiveness of surface disinfection
Evaluation of A Persistent Surface Disinfectant Method

• Evaluation use the EPA “Protocol for Residual Self-Sanitizing Activity of Dried Chemical Residuals on Hard, Non-Porous Surfaces”
• Surfaces-glass, formica and SS
• Organisms- S. aureus, CRE and C. auris
Evaluation of A Persistent Surface Disinfectant Method

- Test method involves "wear" and re-inoculation of the test and control surfaces after
- Tester set to 5s for one pass
- Surface will undergo wear and re-inoculations over 24h
- Initial inoculation ($10^5$), apply disinfectant (dry overnight); 6 re-inoculations ($10^3$, 30m dry), last inoculation ($10^6$)
- 24 passes (6 dry, 6 wet cycles)
Methods: Surfaces were inoculated, treated with the novel disinfectant, allowed to dry, and then abraded using a standardized abrasion machine under multiple alternating wet and dry wipe conditions (N=12) interspersed with 6 re-inoculations. After 24 hours, the surface was re-inoculated a final time and ability of the disinfectant to kill >99.9% of 9 test microbes within 5min was measured on test surfaces (glass).

Persistent disinfectants may reduce or eliminate the problem of recontamination. Preliminary studies with a new persistent disinfectant are promising (4-5 log₁₀ reduction in 5m over 24h). When the novel disinfectant was compared to three other commonly used disinfectants using the same methodology with S. aureus, the mean log₁₀ reductions were: 4.4 (novel disinfectant); 0.9 (quat-alcohol); 0.2 (improved hydrogen peroxide); and 0.1 (chlorine).

<table>
<thead>
<tr>
<th>Test Pathogen</th>
<th>Mean Log₁₀ Reduction, 95% CI n=4</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.aureus*</td>
<td>4.4 (3.9, 5.0)</td>
</tr>
<tr>
<td>S.aureus (formica)</td>
<td>4.1 (3.8, 4.4)</td>
</tr>
<tr>
<td>S.aureus (stainless steel)</td>
<td>5.5 (5.2, 5.9)</td>
</tr>
<tr>
<td>VRE</td>
<td>≥4.5</td>
</tr>
<tr>
<td>E.coli</td>
<td>4.8 (4.6, 5.0)</td>
</tr>
<tr>
<td>Enterobacter sp.</td>
<td>4.1 (3.5, 4.6)</td>
</tr>
<tr>
<td>Candida auris</td>
<td>≥5.0</td>
</tr>
<tr>
<td>K pneumoniae</td>
<td>1.5 (1.4, 1.6)</td>
</tr>
<tr>
<td>CRE E.coli</td>
<td>3.0 (2.6, 3.4)</td>
</tr>
<tr>
<td>CRE Enterobacter</td>
<td>2.0 (1.6, 2.4)</td>
</tr>
<tr>
<td>CRE K pneumoniae</td>
<td>2.1 (1.8, 2.4)</td>
</tr>
</tbody>
</table>

Test surface glass unless otherwise specified
How Will We Prevent Infections Associated with the Environment?

• Implement evidence-based practices for surface disinfection
  ■ Evidence-based policies
  ■ Ensure use of safe and effective (against emerging pathogens such as C. auris and CRE) low-level disinfectants
  ■ Ensure thoroughness of cleaning (new thoroughness technology)

• Use “no touch” room decontamination technology proven to reduce microbial contamination on surfaces and reduction of HAIs at terminal/discharge cleaning

• Use new continuous room decontamination technology that continuously reduces microbial contamination
THANK YOU!
www.disinfectionandsterilization.org