Can We Prevent All Infections Associated with Medical Devices and the Environment in 5 Years?

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DISCLOSURES

• Consultation (2017)
  ■ PDI
  ■ ASP

• Honoraria (2017)
  ■ None

• Grants to UNC or UNC Hospitals (2017)
  ■ CDC, CMS
Can We Prevent All Infections Associated with Medical Devices and the Environment in 5 Years?
• Predictions are difficult, especially when they involve the future

Yogi Berra
Can We Prevent All Infections Associated with Medical Devices and the Environment in 5 Years?

Futurist asked why he was so good at predicking the future…

I see the world the way it should be and I make it that way!
Can We Prevent All Infections Associated with Medical Devices and the Environment in 5 Years?

www.disinfectionandsterilization.org

Our Responsibility to the Future

Prevent All Infectious Disease Transmission by Medical Devices and the Environment in 5 years

Via Research/Technology/Automation/Competency
First Challenge

Prevent All Infectious Disease Transmission Associated with Medical Devices in 5 years
Via Research/Technology/Automation/Competency
EH Spaulding believed that how an object will be disinfected depended on the object’s intended use (developed 1968).

**CRITICAL**-medical/surgical devices which enter normally sterile tissue or the vascular system or through which blood flows should be sterile.

**SEMICRITICAL**-medical devices 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**-medical devices that touch only intact skin require low-level disinfection.
Critical Medical/Surgical Devices

Rutala et al. ICHE 2014;35:883; Rutala et al. ICHE 2014;35:1068; Rutala et al. AJIC 2016;44:e47

- Critical
  - Contact: sterile tissue
  - Transmission: direct contact
  - Control measure: sterilization
  - Surgical instruments
    - Enormous margin of safety, rare outbreaks
    - ~85% of surgical instruments <100 microbes
    - Washer/disinfector removes or inactivates 10-100 million
    - Sterilization kills 1 trillion spores
- Contact: intact skin (noncritical medical devices, surfaces)
- Transmission: secondary transmission by contaminating hands/gloves via contact with the environment and transfer to patient
- Control measures: hand hygiene and low-level disinfection
- Noncritical devices (stethoscopes, blood pressure cuffs, wound vacuum), rare outbreaks
Semicritical Medical Devices
Rutala et al. AJIC 2016;44:e47

- **Semicritical**
  - Contact: Mucous membranes
  - Transmission: direct contact
  - Control measure: high-level disinfection
  - Endoscopes top ECRI list of 10 technology hazards, >120 outbreaks (GI, bronchoscopes)
    - 0 margin of safety
      - Microbial load, $10^7$-$10^{10}$
      - Complexity
      - Biofilm
  - Other semicritical devices, rare outbreaks
    - ENT scopes, endocavitary probes (prostate, vaginal, TEE), laryngoscopes, cystoscopes
    - Reduced microbial load, less complex
Endoscopes top ECRI’s list of 10 health technology hazards

Infections/infection risk
Complex [elevator channel]-10^{7-10} bacteria/GI endoscope

Surgical instruments-<10^2 bacteria

ENDOSCOPE REPROCESSING: CHALLENGES
NDM-producing *E. coli* recovered from elevator channel (elevator channel orients catheters, guide wires and accessories into the endoscope visual field; crevices difficult to access with cleaning brush and may impede effective reprocessing)
FEATURES OF ENDOSCOPES THAT PREDISPOSE TO DISINFECTION FAILURES

- Heat labile
- Long, narrow lumens (3.5ft, 1-3mm)
- Right angle bends
- Rough or pitted surfaces
- Springs and valves
- Damaged channels may impede microbial exposure to HLD
- Heavily contaminated with pathogens, $10^7-10^{10}$
- Cleaning ($2-6 \log_{10}$ reduction) and HLD ($4-6 \log_{10}$ reduction) essential for patient safe instrument
What does this off-road driver/vehicle have in common with endoscope? 10 billion particles, complex
Reason for Endoscope-Related Outbreaks


- Margin of safety with endoscope reprocessing minimal or non-existent
- Microbial load
  - GI endoscopes contain $10^{7-10}$
  - Cleaning results in 2-6 log$_{10}$ reduction
  - High-level disinfection results in 4-6 log$_{10}$ reduction
  - Results in a total 6-12 log$_{10}$ reduction of microbes
  - Level of contamination after processing: 4log$_{10}$ (maximum contamination, minimal cleaning/HLD)
- Complexity of endoscope
- Biofilms—unclear if contribute to failure of endoscope reprocessing
Based on outbreak data, if eliminated deficiencies associated with cleaning, disinfection, AER, contaminated water and drying would eliminate about 85% of the outbreaks.
# Recent Endoscopy-Related Outbreaks of MDRO Without Reprocessing Breaches

Rutala WA et al. In preparation

<table>
<thead>
<tr>
<th>MDRO</th>
<th>Scope</th>
<th>No.</th>
<th>Recovered From Scope</th>
<th>Molecular Link</th>
<th>Reference</th>
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</thead>
<tbody>
<tr>
<td><em>P. aeruginosa</em> (VIM-2)</td>
<td>Duodenoscope</td>
<td>22</td>
<td>Yes, under forceps elevator</td>
<td>Yes</td>
<td>Verfaillie CJ, 2015</td>
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<tr>
<td><em>E. coli</em> (AmpC)</td>
<td>Duodenoscope</td>
<td>35</td>
<td>Yes (2 scopes)</td>
<td>Yes</td>
<td>Wendorf, 2015</td>
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<tr>
<td><em>K. pneumoniae</em> (OXA)</td>
<td>Duodenoscope</td>
<td>12</td>
<td>No</td>
<td>Yes</td>
<td>Kola A, 2015</td>
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<tr>
<td><em>E. coli</em> (NDM-CRE)</td>
<td>Duodenoscope</td>
<td>39</td>
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<td>Epstein L, 2015</td>
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<td>Duodenoscope</td>
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<td>Kim S, 2016</td>
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<td><em>K. pneumoniae</em></td>
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<td>Yes</td>
<td>Marsh J, 2015</td>
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<td><em>E. coli</em></td>
<td>Duodenoscope</td>
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<td>No</td>
<td>Unknown</td>
<td>Smith Z, 2015</td>
</tr>
<tr>
<td><em>K. pneumoniae</em></td>
<td>Duodenoscope</td>
<td>13</td>
<td>Yes</td>
<td>Yes</td>
<td>Carbonne A, 2010</td>
</tr>
</tbody>
</table>
Endemic Transmission of Infections Associated with GI Endoscopes Likely Go Unrecognized


- Inadequate surveillance of outpatient procedures for healthcare-associated infections
- Long lag time between colonization and infection
- Low frequency of infection
- Pathogens “usual” enteric flora
- Risk of some procedures might be lower than others (colonoscopy versus ERCP where normally sterile areas are contaminated in the latter)

CRE and ESBLs
High-Level Disinfection
No Margin of Safety

0 margin of safety

Microbial contamination $10^7$-$10^{10}$: compliant with reprocessing guidelines
10,000 microbes after reprocessing:
maximum contamination, minimal cleaning ($10^2$/HLD $10^4$)
Gastrointestinal Endoscopes: A Need to Shift From Disinfection to Sterilization?

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

More than 10 million gastrointestinal endoscopic procedures are performed annually in the United States for diagnostic purposes, therapeutic interventions, or both. Because gastrointestinal endoscopes contact mucosal surfaces, use of a contaminated endoscope may lead to patient-to-patient transmission of potential pathogens with a subsequent risk of infection. In this issue of *JAMA*, Epstein and colleagues report findings from their investigation of a cluster of New Delhi metallo–β-lactamase (NDM)–producing *Escherichia coli* associated with gastrointestinal endoscopy that occurred from March 2013 to July 2013 in a single hospital in northeastern Illinois. During the 5-month period, 9 pa-

First, endoscopes are semicritical devices, which contact mucous membranes or nonintact skin, and require at least high-level disinfection. High-level disinfection achieves complete elimination of all microorganisms, except for small numbers of bacterial spores. Because flexible gastrointestinal endoscopic instruments are heat labile, only high-level disinfection with chemical agents or low-temperature sterilization technologies are possible. However, no low-temperature sterilization technology is US Food and Drug Administration (FDA)-cleared for gastrointestinal endoscopes such as duodenoscopes.

Second, more health care–associated outbreaks and clusters of infection have been linked to contaminated endoscopes than to any other medical device. However, until now,
What Is the Public Health Benefit?
No ERCP-Related Infections

Margin of Safety—currently nonexistent; sterilization will provide a safety margin (~6 log\(_{10}\)). To prevent infections, all duodenoscopes should be devoid of microbial contamination.

HLD (6 log\(_{10}\) reduction) vs Sterilization (12 log\(_{10}\) reduction=SAL 10\(^{-6}\))
FDA Panel, May 2015, Recommended Sterilization of Duodenoscopes
(requires FDA-cleared sterilization technology that achieves a SAL $10^{-6}$ with duodenoscopes—not yet available)
EH Spaulding believed that how an object will be disinfected depended on the object’s intended use (developed 1968).

**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 (or non-germicidal detergent).
EH Spaulding believed that how an object will be disinfected depended on the object’s intended use (modified).

CRITICAL - objects which directly or secondarily (i.e., via a mucous membrane such as duodenoscope, cystoscope, bronchoscope) 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 (or non-germicidal detergent).
Some Potential Sterilization Technologies for Duodenoscopes


- Optimize existing low-temperature sterilization technology
  - Hydrogen peroxide gas plasma
  - Vaporized hydrogen peroxide
  - Ethylene oxide
- Potential new low-temperature sterilization technology
  - Ozone plus hydrogen peroxide vapor
  - Nitrogen dioxide
  - Supercritical CO$_2$
  - Peracetic acid vapor
- Steam sterilization for heat-resistant GI endoscopes
- Redesign
- Sterile, single use GI scopes
LTS Technology Is Being Optimized to Sterilize Endoscopes and Use a Sterile, Disposable GI Scopes
How Will We Prevent Infections Associated with Medical Devices (HLD to Sterilization)?

- FDA Panel has accepted sterilization for duodenoscopes
- Sterilization manufacturer’s are optimizing their LTST to sterilize GI endoscopes/bronchoscopes
- Sterile, single use GI endoscopes are developed
- Professional organizations (SHEA, APIC, AORN, SGNA, ASGE, IAHCSMM, AAMI) are starting to embrace conversion. Scheduled presentations on transition from HLD to sterilization with AAMI Sterilization/HLD Committees, APIC, SGNA, Canadian APIC, World Sterilization Congress
- Researchers/Opinion Leaders need to continue the science-based evaluations on why conversion is necessary
Second Challenge

Prevent All Infectious Disease Transmission Associated with Environment in 5 years

Via Research/Technology/Automation/Competency
Evidence environment contributes
Role-MRSA, VRE, *C. difficile*
Surfaces are contaminated ~25%
EIP survive days, weeks, months
Contact with surfaces results in hand contamination; contaminated hands transmit EIP to patients
Disinfection reduces contamination
Disinfection (daily) reduces HAIs
Rooms not adequately cleaned
Admission to Room Previously Occupied by Patient C/I with Epidemiologically Important 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%)
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
Thoroughness of Environmental Cleaning

Carling P. AJIC 2013;41:S20-S25

Mean = 32%

>110,000 Objects

% Cleaned

DAILY CLEANING
TERMIAL CLEANING

HEHSG HOSP 14 Sites
IOWA HOSP 16 Sites
OTHER HOSP 7 Sites
OPERATING ROOMS 7 Sites
NICU 7 Sites
EMS VEHICLES 4 Sites
ICU DAILY 4 Sites
AMB CHEMO 9 Sites
MD CLINIC 4 Sites
LONG TERM 4 Sites
DIALYSIS

| = 95% CI
Future Methods to Ensure Thoroughness

Solution: Highlight®

- Color-fading time can be matched to contact kill time for a disinfectant --> enforces compliance
- Prevents staining on permanent structures + reusable materials
- Provides real-time feedback when a surface is safe to touch
Deadly, drug-resistant Candida yeast infection spreads in the US

*Candida auris* causes multidrug-resistant infections that can result in organ failure

Kateryna Kon/Science Photo Library
Efficacy of Disinfectants and Antiseptics against *Candida auris*
Rutala, Kanamori, Gergen, Sickbert-Bennett, Weber, 2017

- ≥3 log_{10} reduction (*C. auris*, 1m, 5% FCS, QCT)
  - Steris, 0.20% peracetic acid
  - Cidex, 2.4% glutaraldehyde
  - Oxycide, (0.65% hydrogen peroxide, 0.14% peroxyacetic acid)
  - Sani-Cloth Super, (0.5% Quat, 55% isopropyl alcohol)
  - Lysol disinfecting spray (58% ethanol, 0.1% QUAT)
  - Sani-Cloth Prime (28.7% isopropyl alcohol, 27.3% ethyl alcohol, 0.61% QAC)
  - Vesphene IIse, (0.07% o-phenylphenol, 0.06% p-tertiary amylphenol)
  - 70% isopropyl alcohol
  - Bleach, 1:10, ~5,250 ppm chlorine
  - Ethanol hand rub (70% ethanol)
  - Accelerated hydrogen peroxide, 1.4%
  - Accelerated hydrogen peroxide, 2%
Efficacy of Disinfectants and Antiseptics against *Candida auris*
Rutala, Kanamori, Gergen, Sickbert-Bennett, Weber, 2017

- \( \leq 3 \log_{10} \) (most <2 \( \log_{10} \)) reduction (*C. auris*, 1m, 5% FCS, QCT)
  - Cidex OPA, 0.55% OPA
  - 3% hydrogen peroxide
  - Quat, (0.085% QACs)
  - Betadine, 10% povidone-iodine
  - Bleach, 1:50, \( \sim 1,050 \) ppm chlorine
  - 2% Chlorhexidine gluconate-CHG
  - 4% CHG
  - 0.5% triclosan
  - 1% CHG, 61% ethyl alcohol
  - 1% chloroxylenol
Efficacy of Disinfectants and Antiseptics against Carbapenem-Resistant Enterobacteriaceae
Rutala, Kanamori, Gergen, Sickbert-Bennett, Weber, 2017

• \( \geq 3 \log_{10} \) reduction (CRE, 1m, 5% FCS, QCT)
  - Steris, 0.20% peracetic acid
  - Cidex, 2.4% glutaraldehyde
  - Sani-Wipe Super, (0.5% Quat, 55% isopropyl alcohol)
  - Lysol disinfecting spray (58% ethanol, 0.1% QUAT)
  - Sani-Cloth Prime (28.7% isopropyl alcohol, 27.3% ethyl alcohol, 0.61% QAC)
  - Vesphene Ilse, (0.07% o-phenylphenol, 0.06% p-tertiary amylphenol)
  - Bleach, 1:10, ~5,250 ppm chlorine
  - 70% isopropyl alcohol
  - Ethanol hand rub (70% ethanol)
  - Oxycide, (0.65% hydrogen peroxide, 0.15% peroxyacetic acid)
  - Accelerated hydrogen peroxide, 1.4% and 2.0%
  - Quat, (0.085% QACs; not \( K. \) pneumoniae)
These interventions (effective surface disinfectants, thoroughness indicators) not enough to achieve consistent and high rates of cleaning/disinfection.

No Touch

(supplements but do not replace surface cleaning/disinfection)
NEW “NO TOUCH” APPROACHES TO ROOM DECONTAMINATION
(will not discuss technology with limited data)
### Effectiveness of UV Devices on Reducing MDROs on Carriers

<table>
<thead>
<tr>
<th>Author, year</th>
<th>UV system</th>
<th>MDROs</th>
<th>Time (min)</th>
<th>Energy (µW/cm²)</th>
<th>Log₁₀ reduction direct (indirect)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rutala, 2010</td>
<td>UV-C, Tru-D</td>
<td>MRSA, VRE, A</td>
<td>~15</td>
<td>12,000</td>
<td>4.31 (3.85), 3.90 (3.25), 4.21 (3.79)</td>
</tr>
<tr>
<td>Rutala, 2010</td>
<td>UV-C, Tru-D</td>
<td>Cd</td>
<td>~50</td>
<td>36,000</td>
<td>4.04 (2.43)</td>
</tr>
<tr>
<td>Boyce, 2011</td>
<td>UV-C, Tru-D</td>
<td>Cd</td>
<td>67.8 (1 stage)</td>
<td>22,000</td>
<td>1.7-2.9</td>
</tr>
<tr>
<td>Havill, 2012</td>
<td>UV-C, Tru-D</td>
<td>Cd</td>
<td>73 (mean)</td>
<td>22,000</td>
<td>2.2</td>
</tr>
<tr>
<td>Rutala, 2013</td>
<td>UV-C, Tru-D</td>
<td>MRSA</td>
<td>25</td>
<td>12,000</td>
<td>4.71 (4.27)</td>
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<tr>
<td>Rutala, 2013</td>
<td>UV-C, Tru-D</td>
<td>Cd</td>
<td>43</td>
<td>22,000</td>
<td>3.41 (2.01)</td>
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<tr>
<td>Mahida, 2013</td>
<td>UV-C, Tru-D</td>
<td>OR: MRSA, VRE</td>
<td>49</td>
<td>12,000</td>
<td>≥4.0 (≥4.0), 3.5 (2.4)</td>
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<tr>
<td>Mahida, 2013</td>
<td>UV-C, Tru-D</td>
<td>Single patient room: VRE, A, As</td>
<td>23-93</td>
<td>12,000</td>
<td>≥4.0 (&gt;2.3), ≥4.0 (1.7), ≥4.0 (2.0)</td>
</tr>
<tr>
<td>Rutala, 2014</td>
<td>UV-C, Optimum</td>
<td>MRSA</td>
<td>5</td>
<td>NS</td>
<td>4.10 (2.74)</td>
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<tr>
<td>Rutala, 2014</td>
<td>UV-C, Optimum</td>
<td>Cd</td>
<td>10</td>
<td>NS</td>
<td>3.35 (1.80)</td>
</tr>
<tr>
<td>Nerandzic, 2015</td>
<td>UV, PX, Xenon</td>
<td>Cd, MRSA, VRE</td>
<td>10 at 4 ft (2 cycles)</td>
<td>NS</td>
<td>0.55, 1.85, 0.6</td>
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</table>
# Effectiveness of UV Devices on Reducing MDROs in Contaminated Patient Rooms

<table>
<thead>
<tr>
<th>Author, year</th>
<th>UV system</th>
<th>MDROs</th>
<th>Time (min); energy (μW/cm²)</th>
<th>Positive sites (before and after) (%)</th>
<th>Log₁₀ reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rutala, 2010</td>
<td>UV-C, Tru-D</td>
<td>MRSA</td>
<td>~15; 12,000</td>
<td>20.2, 0.5</td>
<td>1.30</td>
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<tr>
<td>Nerandzic, 2010</td>
<td>UV-C, Tru-D</td>
<td>MRSA, VRE</td>
<td>20; 12,000</td>
<td>10.7, 0.8; 2.7, 0.38</td>
<td>0.68; 2.52</td>
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<td>Nerandzic, 2010</td>
<td>UV-C, Tru-D</td>
<td>Cd</td>
<td>45; 22,000</td>
<td>3.4, 0.38</td>
<td>1.39</td>
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<td>Stibich, 2011</td>
<td>UV, PX, Xenex</td>
<td>VRE</td>
<td>12; NS</td>
<td>8.2, 0</td>
<td>1.36</td>
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<tr>
<td>Anderson, 2013</td>
<td>UV-C, Tru-D</td>
<td>All, VRE, A</td>
<td>25; 12,000</td>
<td>NS; 11, 1; 13, 3</td>
<td>1.35; 1.68; 1.71</td>
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<td>Anderson, 2013</td>
<td>UV-C, Tru-D</td>
<td>Cd</td>
<td>45; 22,000</td>
<td>10, 5</td>
<td>1.16</td>
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<td>Jinadatha, 2015</td>
<td>UV, PX, Xenex</td>
<td>MRSA</td>
<td>15 (3 cycles of 5 min); NS</td>
<td>70, 8</td>
<td>2.0</td>
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<tr>
<td>Nerandzic, 2015</td>
<td>UV, PX, Xenex</td>
<td>MRSA, VRE, Cd</td>
<td>10 (2 cycles of 5 min); NS</td>
<td>10, 2; 4, 0.9; 19, 8</td>
<td>0.90, 1.08, NS</td>
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<tr>
<td>Jinadatha, 2015</td>
<td>UV-PX, Xenex</td>
<td>MRSA</td>
<td>15 (3 cycles of 5 min); NS</td>
<td>NS, NS</td>
<td>0.63</td>
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</tbody>
</table>

* A, *Acinetobacter* spp; All, all target organisms; Cd, *Clostridium difficile*; MDRO, multidrug-resistant organism; MRSA, methicillin-resistant *Staphylococcus aureus*; NS, not stated; PX, pulsed xenon; UV, ultraviolet light; VRE, vancomycin-resistant enterococci.

# Clinical Trials Using UV for Terminal Room Decontamination to Reduce HAIs


<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Design</th>
<th>Pathogens</th>
<th>Reduction in HAIs</th>
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<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>
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<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, 2017</td>
<td>Randomized-controlled trial, Tru-D</td>
<td>MRSA, VRE, CDI</td>
<td>Yes</td>
</tr>
<tr>
<td>Author, Year</td>
<td>HP System</td>
<td>Pathogen</td>
<td>Before HPV</td>
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<td>French, 2004</td>
<td>VHP</td>
<td>MRSA</td>
<td>61/85-72%</td>
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<tr>
<td>Bates, 2005</td>
<td>VHP</td>
<td>Serratia</td>
<td>2/42-5%</td>
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<tr>
<td>Jeans, 2005</td>
<td>VHP</td>
<td>MRSA</td>
<td>10/28-36%</td>
</tr>
<tr>
<td>Hardy, 2007</td>
<td>VHP</td>
<td>MRSA</td>
<td>7/29-24%</td>
</tr>
<tr>
<td>Dryden, 2007</td>
<td>VHP</td>
<td>MRSA</td>
<td>8/29-28%</td>
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<tr>
<td>Otter, 2007</td>
<td>VHP</td>
<td>MRSA</td>
<td>18/30-60%</td>
</tr>
<tr>
<td>Boyce, 2008</td>
<td>VHP</td>
<td>C. difficile</td>
<td>11/43-26%</td>
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<tr>
<td>Bartels, 2008</td>
<td>HP dry mist</td>
<td>MRSA</td>
<td>4/14-29%</td>
</tr>
<tr>
<td>Shapey, 2008</td>
<td>HP dry mist</td>
<td>C. difficile</td>
<td>48/203-24%; 7</td>
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<tr>
<td>Barbut, 2009</td>
<td>HP dry mist</td>
<td>C. difficile</td>
<td>34/180-19%</td>
</tr>
<tr>
<td>Otter, 2010</td>
<td>VHP</td>
<td>GNR</td>
<td>10/21-48%</td>
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</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>
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<tbody>
<tr>
<td>Boyce, 2008</td>
<td>Before-After</td>
<td>CDI</td>
<td>Yes</td>
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<tr>
<td>Cooper, 2011</td>
<td>Before-After</td>
<td>CDI</td>
<td>Decrease cases (incidence not stated)</td>
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<td>Passaretti, 2013</td>
<td>Prospective cohort</td>
<td>MRSA, VRE, CDI</td>
<td>Yes, in all MDROs</td>
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<tr>
<td>Manian, 2013</td>
<td>Before-After</td>
<td>CDI</td>
<td>Yes</td>
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<tr>
<td>Mitchell, 2014</td>
<td>Before-After</td>
<td>MRSA</td>
<td>Yes</td>
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<tr>
<td>Horn, 2015</td>
<td>Before-After</td>
<td>CDI, VRE, ESBL GNR</td>
<td>Yes</td>
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This technology ("no touch"-UV/HP) should be used (capital equipment budget) for terminal room disinfection (e.g., after discharge of patients on Contact Precautions).
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.
To eliminate environmental contribution to HAIs, must also improve thoroughness of cleaning/disinfection daily basis also, evaluate new technologies. Hygienically clean (not sterile)-free of pathogens in sufficient numbers to prevent human disease.
Visible Light Disinfection in a Patient Room
(automatic switching between modes performed by wall-mounted controls)

White light

Blue light-increase irradiance, increase kill
Dilute Hydrogen Peroxide Technology

UV activates the catalyst which creates H ion and hydroxyl radical and free electron, hydroxyl radicals removed from catalyst and combine to form HP; also H₂ and O₂ and electron make HP.
Long-term efficacy of a self-disinfecting coating in an intensive care unit

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Key Words:
Disinfection
Bacteria
Self-disinfecting surface
Efficacy

Background: Cleaning and disinfecting fomites can effectively remove/kill pathogens on surfaces, but studies have shown that more than one-half the time, surfaces are not adequately cleaned or are recontaminated within minutes. This study evaluated a product designed to create a long-lasting surface coating that provides continuous disinfecting action.

Methods: This study was performed in an intensive care unit (ICU) in a major hospital. Various sites within the ICU were cultured before treatment and then at 1, 2, 4, 8, and 15 weeks after application of an antimicrobial coating. Samples were cultured for total bacteria, as well as Clostridium difficile, methicillin-resistant Staphylococcus aureus, vancomycin-resistant enterococcus, and carbapenemase-resistant Enterobacteriaceae.

Results: The average bacterial count on all treated surfaces was reduced by >99% (2 logs) for at least 8 weeks after treatment. Overall, average levels of bacteria never returned to those observed before treatment even after 15 weeks. Antibiotic-resistant bacteria were found on 25% of the sites tested before treatment, but were isolated at only 1 site during the 15 weeks after treatment.

Conclusions: The product assessed in this study was found to have persisted over 15 weeks in reducing the total number of bacteria and antibiotic-resistant bacteria on surfaces within an ICU.
Continuous Room Decontamination
Rutala, Gergen, Kanamori, Sickbert-Bennett, Weber, 2015-2018

- Visible light disinfection system-effective
- Dilute hydrogen peroxide system-not effective
- Self-disinfecting surface coating-testing pending
- Others-cold air plasma, copper
How Will We Prevent Infections Associated with the Environment?

- Implement evidence-based practices for surface disinfection
  - 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
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Set our goal, made a plan, we have a purpose, it is our passion that will make it happen!
“Some people want it to happen, some wish it would happen, others make it happen.”

-Michael Jordan