No-touch room disinfection (NTD) systems: when to use them and how to choose between them...

(Can you ‘C’ the difference?)

APIC New England, April 24 2014

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Disclosures

I am employed part-time by Bioquell and have received payment from 3M for webinars.

I have received research funding from Pfizer, the Guy’s and St. Thomas Charity and the Royal Commission for the Exhibition of 1851.
Question

Should all acute hospitals be using a ‘no-touch’ automated room disinfection (NTD) system for terminal disinfection of some patient rooms?

• Yes
• No
• Not sure
Transmission routes

‘The room lotto’

Patient infected or colonised with a pathogen (e.g. *C. difficile*, MRSA, VRE, *A. baumannii* or *P. aeruginosa*)

Patient is discharged and the room is cleaned / disinfected; surfaces in the room remain contaminated with the pathogen

The next room occupant is at an increased risk of acquiring the pathogen
The *C. difficile* ‘room lotto’

**Setting & design:** 18-month retrospective cohort study on an ICU, Ann Arbor, Michigan, USA.

**Methods:** 134 cases of *C. difficile* infection occurred among 48 hours after ICU admission or with 30 days of discharge in 1,844 patients admitted to the ICU during the study.

![Bar chart showing percentage of patients with CDI](chart.png)

Percentage of patients with CDI

<table>
<thead>
<tr>
<th>C. difficile+</th>
<th>C. difficile-</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>2</td>
</tr>
</tbody>
</table>

Hazard ratio 2.35, p=0.01

Increased risk from the prior room occupant

- **Nseir A. baumannii**: +71%
- **Shaughnessy C. difficile**: +58%
- **Drees VRE**: +55%
- **Drees VRE (2 weeks)**: +49%
- **Nseir P. aeruginosa**: +42%
- **Huang VRE**: +37%
- **Huang MRSA**: +28%

Surface survival

Persist despite terminal cleaning / disinfection

Hand transfer without direct patient contact\textsuperscript{1-2}

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>52%</td>
<td>23 HCW acquired VRE on their hands\textsuperscript{3}</td>
<td>Boyce et al. Infect Control Hosp Epidemiol 1997;18:622-627.</td>
</tr>
<tr>
<td>45%</td>
<td>50 HCW acquired MRSA on their hands\textsuperscript{4}</td>
<td>Bhalla et al. Infect Cont Hosp Epidemiol 2004;25:164-167.</td>
</tr>
<tr>
<td>50%</td>
<td>30 HCW acquired \textit{C. difficile} on their hands\textsuperscript{5}</td>
<td>Hayden et al. Infect Control Hosp Epidemiol 2008;29:149-154.</td>
</tr>
</tbody>
</table>

\textsuperscript{1} Contact with patient or surface = \textasciitilde10\% risk of acquiring VRE\textsuperscript{3}

\textsuperscript{2} 40\% of 50 HCW acquired MRSA on their hands\textsuperscript{4}

\textsuperscript{3} 50\% of 30 HCW acquired \textit{C. difficile} on their hands\textsuperscript{5}

\textsuperscript{4} Compliance with hand hygiene: 80\%\textsuperscript{6}
What is the goal of hospital disinfection?

Disinfection = to reduce contamination to ‘safe’ levels.

<table>
<thead>
<tr>
<th>Pragmatist</th>
<th>Prior room occupantist</th>
</tr>
</thead>
<tbody>
<tr>
<td>A reduction in contamination is good enough. A low level of residual contamination with pathogens represents a negligible risk and is acceptable.</td>
<td>Each patient should be admitted into a room free from contamination with pathogens. Residual contamination at any level represents unacceptable risk.</td>
</tr>
</tbody>
</table>
Contamination level $\propto$ transmission risk
Decontamination level $\propto$ transmission reduction
Emerging issues
Biofilms on dry hospital surfaces

- Scanning electron microscopy identified biofilm on 5/6 dry hospital surfaces from an Australian ICU.
- MRSA was identified on three of the surfaces.

Could explain why vegetative bacteria can survive on dry hospital surfaces for so long

Be part of the reason why they are so difficult to remove or inactivate using disinfectants

Explain (to some degree) the difficulty in recovering environmental pathogens by surface sampling

CRE – is surface contamination a risk?

Error bars represent plus one standard deviation of the mean.

Enterobacteriaceae are “less environmental”

Cleaning failure

External

Procedure

Cleaning failure

Product
Improve existing procedures

Try something new!
Persistent contamination

\[ % \text{sites contaminated with } A. \text{baumannii} \]
\[ % \text{sites contaminated with MRSA} \]

- 140 samples from 9 rooms after 2x bleach disinfection
- 5705 samples from 312 rooms after 4x bleach disinfection

26.6% of rooms remained contaminated with either MRSA or \textit{A. baumannii} following 4 rounds of bleach disinfection.

'Given the choice of improving technology or improving human behavior, technology is the better choice'.

Dr Bob Weinstein

### “No-touch” automated room disinfection (NTD)

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce reliance on the operator for distribution, contact time and</td>
<td>Requires a room to be cleaned then vacated for an additional period of time (typically 1-2 hrs)</td>
</tr>
<tr>
<td>repeatability</td>
<td></td>
</tr>
<tr>
<td>Can eliminate pathogens from surfaces (e.g. 6-log reduction)</td>
<td>Health and safety risks need to be managed appropriately</td>
</tr>
<tr>
<td>Monitoring and validation using BIs* / cycle data</td>
<td></td>
</tr>
<tr>
<td>Most systems are compatible with hospital materials including</td>
<td></td>
</tr>
<tr>
<td>electronics</td>
<td></td>
</tr>
</tbody>
</table>

* BI = biological indicator, typically consisting of a >6-log loading of *Geobacillus stearothermophilus* spores

Patient status

- Pathogen associated with transmission from the environment
  - Daily cleaning / disinfection
    - Enhanced cleaning / disinfection
  - Terminal cleaning / disinfection
    - NTD or enhanced cleaning / disinfection

- No known pathogen, or pathogen not associated with transmission from the environment
  - Low-risk setting (e.g. general ward)
    - Standard cleaning / disinfection
  - High-risk setting (e.g. ICU)
    - Enhanced cleaning / disinfection

No-touch automated room disinfection (NTD) systems

- Hydrogen peroxide vapour (HPV)
- Aerosolised hydrogen peroxide (AHP)
- Ultraviolet radiation (UVC)
- Pulsed-xenon UV (PX-UV)

Question

Has your hospital has used the following NTD systems?

- Ultraviolet C radiation (UVC)
- Pulsed-xenon UV (PX-UV)
- Hydrogen peroxide vapor (HPV)
- Aerosolised hydrogen peroxide (AHP)
- Yes, other
Hydrogen peroxide vapor (HPV)

- Portable HPV generator + aeration unit for the healthcare industry
- Produces HPV from a 30% (w/w) H$_2$O$_2$ liquid solution (EPA-registered sterilant).
- Distributed as a vapour (gas) then condenses on surfaces.
- The process also generate hydroxyl free radicals (OH-) which kill microorganisms.
- At the end of the process HPV is catalytically broken down to water vapor and O$_2$.
- Compatible with hospital materials including sensitive electronics.
HPV in vitro activity

Impact of HPV on persistent contamination

- 140 samples from 9 rooms after 2x bleach disinfection
- 5705 samples from 312 rooms after 4x bleach disinfection
- 2680 sites from 134 rooms after HPV

## HPV: *in situ* efficacy

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>Pathogen*</th>
<th>Surfaces contaminated before HPV</th>
<th>Surfaces contaminated after HPV</th>
<th>% reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>French et al.¹</td>
<td>MRSA</td>
<td>61 (72%) of 85</td>
<td>1 (1%) of 85</td>
<td>98</td>
</tr>
<tr>
<td>2005</td>
<td>Jeanes et al.²</td>
<td>MRSA</td>
<td>8 (16%) of 50</td>
<td>None of 50</td>
<td>100</td>
</tr>
<tr>
<td>2005</td>
<td>Bates et al.³</td>
<td><em>Serratia</em></td>
<td>2 (4%) of 42</td>
<td>None of 25</td>
<td>100</td>
</tr>
<tr>
<td>2006</td>
<td>Boyce et al.⁴</td>
<td><em>C. difficile</em></td>
<td>11 (24%) of 45</td>
<td>None of 35</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MRSA</td>
<td>9 (5%) of 165</td>
<td>None of 155</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VRE</td>
<td>23 (14%) of 165</td>
<td>None of 155</td>
<td>100</td>
</tr>
<tr>
<td>2007</td>
<td>Hardy et al.⁵</td>
<td>MRSA</td>
<td>5 (17%) of 86</td>
<td>None of 86</td>
<td>100</td>
</tr>
<tr>
<td>2007</td>
<td>Otter et al.⁶</td>
<td>MRSA</td>
<td>12 (40%) of 30</td>
<td>1 (3%) of 30</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VRE</td>
<td>1 (3%) of 30</td>
<td>None of 30</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GNR</td>
<td>3 (10%) of 30</td>
<td>None of 30</td>
<td>100</td>
</tr>
<tr>
<td>2010</td>
<td>Otter et al.⁷</td>
<td>GNR</td>
<td>10 (48%) of 21</td>
<td>None of 63</td>
<td>100</td>
</tr>
<tr>
<td>2011</td>
<td>Manian et al.⁸</td>
<td>GNR</td>
<td>6 (2%) of 370</td>
<td>None of 370</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MRSA</td>
<td>6 (2%) of 370</td>
<td>None of 370</td>
<td>100</td>
</tr>
<tr>
<td>2012</td>
<td>Barbut et al.⁹</td>
<td>MRSA</td>
<td>2 (2%) of 102</td>
<td>None of 102</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GNR</td>
<td>6 (6%) of 102</td>
<td>None of 102</td>
<td>100</td>
</tr>
<tr>
<td>2013</td>
<td>Landelle et al.¹⁰</td>
<td>GNR</td>
<td>8 (62%) of 13</td>
<td>None of 29</td>
<td>100</td>
</tr>
</tbody>
</table>

Clinical impact: outbreaks

Environmental contamination is often implicated in the continuation of outbreaks.

HPV can be used to decontaminate entire wards (after vacation) or high-risk rooms / bays.

HPV has been used to tackle outbreaks of:

- MRSA
- Gram-negative rods (e.g. CRE, Serratia, Acinetobacter)
- C. difficile

An Evaluation of Environmental Decontamination With Hydrogen Peroxide Vapor for Reducing the Risk of Patient Acquisition of Multidrug-Resistant Organisms

Catherine L. Passaretti,1,2,3 Jonathan A. Otter,4 Nicholas G. Reich,5,6 Jessica Myers,5 John Shepard,1 Tracy Ross,7 Karen C. Carroll,7 Pam Lipsett,8 and Trish M. Perl1,2,5

1Division of Infectious Diseases, Department of Medicine, Johns Hopkins University School of Medicine, 2Department of Hospital Epidemiology and Infection Control, The Johns Hopkins Hospital, Baltimore, Maryland; 3Division of Infectious Diseases, Department of Medicine, Carolinas Medical Center, Charlotte, North Carolina; 4Bioquell Inc, Horsham, Pennsylvania; 5Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Johns Hopkins University, Baltimore, Maryland; 6Division of Biostatistics and Epidemiology, School of Public Health and Health Sciences, University of Massachusetts, Amherst; 7Department of Pathology, and 8Department of Surgery, Johns Hopkins University School of Medicine, Baltimore, Maryland

Methods – clinical impact

- A 30-month prospective cohort intervention study performed on 6 high-risk units (5 ICUs) at Johns Hopkins Hospital.
- HPV was implemented on 3 of the units following a 12-month pre-intervention phase.
- Clinical impact was assessed by a cohort study. Each patient admitted to any study unit during both phases was included in one of three cohorts:
  
  - **‘MDRO-standard’**
    Patients admitted to a room where the prior room occupant had an MDRO and the room was disinfected using standard methods
  
  - **‘MDRO-HPV’**
    Patients admitted to a room where the prior room occupant had an MDRO and the room was decontaminated using HPV
  
  - **‘No MDRO-standard’**
    Patients admitted to a room where the prior room occupant was not known to have an MDRO and the room was disinfected using standard methods

Most important comparison
Results – clinical, MDROs combined

Patients admitted to rooms decontaminated using HPV were 64% less likely to acquire any MDRO (incidence rate ratio [IRR]=0.36, CI=0.19-0.70, p<0.001)*

* The difference between cohorts was adjusted for patient level variables such as length of stay, morbidities and other variables that could explain the difference. This means that the difference between cohorts is attributable to HPV alone.

Results – clinical, MDROs combined

Even when the prior room occupant was not known to have an MDRO, HPV reduced the risk of acquisition by 51%.

Mitigating the prior room occupant risk

In this study, enhanced conventional methods mitigated the increased risk for MRSA but not for VRE.
In this study, enhanced conventional methods mitigated the increased risk for MRSA but not for VRE.

The reduced acquisition of VRE was statistically significant; MDR-GNR, *C. difficile* and MRSA followed the same trend but were not individually statistically significant.
Environmental impact

The impact of HPV disinfection on the recovery of MDROs from rooms on 3 high-risk units. All patient rooms were sampled once per month for 3 months without HPV and for 6 months when HPV was in operation.¹

<table>
<thead>
<tr>
<th></th>
<th>No HPV (n=170)</th>
<th>HPV (n=397)</th>
<th>% difference</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rooms contaminated with MDROs</td>
<td>21.2%</td>
<td>13.9%²</td>
<td>-34%</td>
<td>0.03</td>
</tr>
<tr>
<td>Multiple MDROs</td>
<td>4.7%</td>
<td>0.8%</td>
<td>-83%</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>MDRO from room differed from the room occupant’s known MDRO</td>
<td>8.8%</td>
<td>3.3%</td>
<td>-63%</td>
<td>0.01</td>
</tr>
<tr>
<td>MDROs from empty rooms</td>
<td>4.1%</td>
<td>1.3%</td>
<td>-68%</td>
<td>0.05</td>
</tr>
</tbody>
</table>

These changes are due to improved terminal disinfection using HPV

1. No significant differences were observed in MDRO contamination on units not using HPV.
2. Swabs were collected from all patient rooms, occupied or unoccupied, regardless of patient status. 76% of rooms contaminated with MDROs from units where HPV was in operation matched the MDRO of the patient in the room.

Clinical impact: *C. difficile*

Environmental\(^1,2\)

<table>
<thead>
<tr>
<th></th>
<th>Standard swabs:</th>
<th>CDC “sponges”:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Post:</td>
<td>Post:</td>
</tr>
<tr>
<td></td>
<td>Bleach</td>
<td>Bleach</td>
</tr>
<tr>
<td></td>
<td>HPV</td>
<td>HPV</td>
</tr>
<tr>
<td><em>C. difficile</em></td>
<td>5%</td>
<td>24%</td>
</tr>
<tr>
<td>MRSA:</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>VRE:</td>
<td>14%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0%</td>
<td></td>
</tr>
</tbody>
</table>

CDI rates\(^3\)

- Before trial: 1.89
- During trial: 0.88

53% reduction (p=0.047)

Clinical impact: SJMMC, St. Louis, USA

# Contamination of supply packaging

<table>
<thead>
<tr>
<th>Organism</th>
<th>MRSA</th>
<th>R-GNR</th>
<th>VRE</th>
<th>Any pathogen</th>
</tr>
</thead>
<tbody>
<tr>
<td># positive</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>9*</td>
</tr>
<tr>
<td>Total sampled</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

* One of the supplies was contaminated with more than 1 organism.

- No supplies were contaminated with MRSA, R-GNR or VRE after HPV (none of 100 vs. 9% of 100, p=0.003, Fisher’s Exact Test).
- Of the 12 individual MDROs isolates from supplies, only 6 matched the species of the patient in the room.
- HPV disinfection of unopened supply packaging is warranted and works.
- Annual savings of around $400,000 per annum identified on 6 ICUs.

Aerosolised hydrogen peroxide (AHP)

The technology & process

- Portable H$_2$O$_2$ aerosolisers (e.g. ASP Glosair, Steris BioGienie).
- 5-6% hydrogen peroxide and 50-60ppm silver plus stabilisers.
- Aerosolised (droplets – not gas) particles size (8-12 μm).
- Passive aeration. H$_2$O$_2$ left to degrade naturally.
- Cycle time >2 hr for a single room.
AHP – Tyvek pouched BIs*

*BIs = *Geobacillus stearothermophilus* biological indicators.

HPV – Tyvek pouched BIs*

* BIs = *Geobacillus stearothermophilus* biological indicators.

9% of 6-log BIs grew. 5% of 4-log BIs grew.

**A. baumannii** $\log_{10}$ reductions achieved by HPV vs. AHP at various locations in a test room

![Graph showing log reductions](image)

* BSA = bovine serum albumin.

Fu *et al.* *J Hosp Infect* 2012;80:199-205.
MRSA $\log_{10}$ reductions achieved by HPV vs. AHP at various locations in a test room

* BSA = bovine serum albumin.

C. difficile $\log_{10}$ reductions achieved by HPV vs AHP at various locations in a test room

* BSA = bovine serum albumin.

HPV vs. AHP for *C. difficile* decontamination

- **Bioquell HPV**
  - Boyce *et al.* ICHE 2008
  - 100% reduction

- **AHP* (ASP Glosair)**
  - Barbut *et al.* ICHE 2009
  - 89% reduction

- **AHP* (ASP Glosair)**
  - Shapey *et al.* JHI 2009
  - 85% reduction

- **AHP* (Deprox)**
  - Best *et al.* JHI 2014
  - 86% reduction

* AHP = aerosolised hydrogen peroxide.
## Pros and cons of hydrogen peroxide systems

<table>
<thead>
<tr>
<th></th>
<th>HPV</th>
<th>AHP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Efficacy</strong></td>
<td>High-level disinfection (&gt;6-log reduction); complete inactivation of pathogens on surfaces.</td>
<td>Lower efficacy; catalase-positive bacteria problematic; does not eliminate pathogens.</td>
</tr>
<tr>
<td><strong>Distribution</strong></td>
<td>Homogeneous (vapour phase).</td>
<td>Non-homogeneous (aerosol).</td>
</tr>
<tr>
<td><strong>Ease of use</strong></td>
<td>Need to seal doors and air vents; 2 units plus cables.</td>
<td>Need to seal doors and air vents; 1 unit no cables.</td>
</tr>
<tr>
<td><strong>Cycle time</strong></td>
<td>~2 hrs for a single room (active aeration).</td>
<td>&gt;2 hrs for a single room (passive aeration).</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>Purchase and ongoing consumable costs.</td>
<td>Purchase and ongoing consumable costs.</td>
</tr>
<tr>
<td><strong>Registration</strong></td>
<td>EPA-registered sterilant.</td>
<td>Uncertain.</td>
</tr>
<tr>
<td><strong>Published data</strong></td>
<td>Micro &amp; clinical reductions, material compatibility, feasibility</td>
<td>Microbiological reductions.</td>
</tr>
</tbody>
</table>
UVC systems

The technology & process

- Mobile UV unit.
- Emits UVC (254nm), which damages DNA.
- Some systems control the dose of UV according to room topology.
- Multiple room locations recommended.
- Some have the option for multiple emitters.
- Single room cycle times range from ~30 mins to >90 mins depending on setting.¹

**UVC**

**Microbiological efficacy:**

- Most studies performed at a ‘sporicidal’ dose (22,000 \(\mu\)Ws/cm\(^2\))
- 1-3 log in *C. difficile* and 3-4 log reduction in MRSA and VRE at the spore killing dose *in vitro*\(^1\)\(^-\)\(^5\) and incomplete inactivation of pathogens on hospital surfaces.\(^1,4,6\)
- Significantly less effective out of direct line of sight, e.g. only 1 log reduction in *C. difficile* and *Aspergillus* sp.\(^1\)\(^-\)\(^5\)

### UVC cycle times

<table>
<thead>
<tr>
<th>Study</th>
<th>Room volume range (m³)</th>
<th>12,000 μWs/cm²</th>
<th>22,000 μWs/cm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mahida et al.¹</td>
<td>39-80</td>
<td>~30-40 mins</td>
<td>~60-90 mins</td>
</tr>
<tr>
<td>Anderson et al.²</td>
<td>-</td>
<td>Median 25 mins</td>
<td>Median 45 mins</td>
</tr>
<tr>
<td>Havill et al.³</td>
<td>46-86</td>
<td>-</td>
<td>Mean 73 mins (range 39–100)</td>
</tr>
<tr>
<td>Boyce et al. (one stage)³</td>
<td>46-86</td>
<td>-</td>
<td>Mean 68 mins (range 34-100)</td>
</tr>
<tr>
<td>Boyce et al. (two stage)⁴</td>
<td>57-80</td>
<td>-</td>
<td>Mean 84 mins (range 72-146)</td>
</tr>
<tr>
<td>Nerandzic et al.⁵</td>
<td>-</td>
<td>~20 mins</td>
<td>~45 mins</td>
</tr>
<tr>
<td>Rutala et al.⁶</td>
<td>-</td>
<td>~15 mins</td>
<td>~50 mins*</td>
</tr>
</tbody>
</table>

* The ‘sporicidal’ dose in this study was 36,000 mWs/cm²

2. Anderson et al. *Infect Control Hosp Epidemiol* 2013; 34:466-71
Time to redecorate your hospital rooms?

Targeted dose = 12,000 µWs/cm² for MRSA; 22,000 µWs/cm² for C. difficile.

Or maybe not...

Increasing the efficiency of feedback to the unit does not influence direct dose to a surface.
HPV vs. UVC

- Efficacy of UVC (Lumalier TruD) and HPV (Bioquell) tested in 15 patient rooms, which were disinfected with each device separated by at least 2 months.

- Efficacy was evaluated by:
  - Aerobic colony counts from five standardized high-touch sites.
  - Metal discs inoculated with *C. difficile* spores.
  - 6-log and 4-log *Geobacillus stearothermophilus* biological indicator spores.

Bacterial growth

HPV: Direct vs out of direct line of sight (p = 1)
UVC: Direct vs out of direct line of sight (p < 0.001)

C. difficile spores

Inactivation of C. difficile spores dried on metal discs.

Biological indicator spores

Inactivation of 4-log *G. stearothermophilus* BIs. Note, UVC did not inactivate any of the 6-log BIs.

Havill et al. Summary

- UVC is considerably less efficacious than HPV for the inactivation of vegetative bacteria and spores.
- UVC is less effective out of direct line of sight.
- UVC is faster than HPV:
  - Mean HPV cycle time 153 mins (range 140–177)
  - Mean UVC cycle time 73 mins (range 39–100)

PX-UV systems

The technology & process

- Mobile UV unit.
- Produces flashes of UV light in the 200-320nm range.¹
- The devices is placed in 3 room locations.
- Cycles are fast: 15 minutes (process times 60 mins for standard methods vs. 50 mins for PX-UV including pre-cleaning).¹,²
- Limited published data.¹-⁴

53% significant reduction in rate, but...
• Low rate, small n (33 vs. 15)
• Changes in abx usage
• Introduction of PCR test

PX-UV and MRSA

<table>
<thead>
<tr>
<th></th>
<th>HPC</th>
<th>MRSA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>Manual</td>
<td>255</td>
<td>60</td>
</tr>
<tr>
<td>PX-UV</td>
<td>449</td>
<td>8</td>
</tr>
</tbody>
</table>


57% significant reduction, but...
- Bundled intervention of active surveillance, hand hygiene education and PX-UV
<table>
<thead>
<tr>
<th></th>
<th><strong>UVC</strong></th>
<th><strong>PX-UV</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Efficacy</strong></td>
<td>1-4 log reduction in vitro; reduces but does not eliminate pathogens.</td>
<td>Limited published data; reduces but does not eliminate pathogens.</td>
</tr>
<tr>
<td><strong>Distribution</strong></td>
<td>Less effective out of direct line of sight.</td>
<td>Limited published data; likely less effective out of direct line of sight.</td>
</tr>
<tr>
<td><strong>Ease of use</strong></td>
<td>No need to seal doors and air vents; single or multiple room locations; unknown capacity for larger areas.</td>
<td>No need to seal doors and air vents; multiple room locations; unknown capacity for larger areas.</td>
</tr>
<tr>
<td><strong>Cycle time</strong></td>
<td>15-50 mins (although may be longer in some rooms)</td>
<td>15 mins cycle time (5 mins in 3 locations).</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>High purchase cost; low maintenance costs.</td>
<td>High purchase cost; low maintenance costs.</td>
</tr>
<tr>
<td><strong>Registration</strong></td>
<td>None required (currently).</td>
<td>None required (currently).</td>
</tr>
<tr>
<td><strong>Published data</strong></td>
<td>In vitro and in situ microbiological reductions; clinical data coming.</td>
<td>In situ microbiological studies and clinical reductions study.</td>
</tr>
</tbody>
</table>
### Which to choose?

<table>
<thead>
<tr>
<th></th>
<th>HPV</th>
<th>AHP</th>
<th>UVC</th>
<th>PX-UV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficacy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Distribution</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Ease of use</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Cycle time</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Purchase cost</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Running costs</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Scenario 1

A patient with carbapenem-resistant *A. baumannii* is discharged from the ICU. Do you perform:

- Ultraviolet C radiation (UVC)
- Pulsed-xenon UV (PX-UV)
- Hydrogen peroxide vapor (HPV)
- Aerosolised hydrogen peroxide (AHP)
- Enhanced discharge disinfection
- Regular discharge disinfection
Scenario 2

A patient with MRSA colonization is discharged to a general medical unit. Do you perform:

- Ultraviolet C radiation (UVC)
- Pulsed-xenon UV (PX-UV)
- Hydrogen peroxide vapor (HPV)
- Aerosolised hydrogen peroxide (AHP)
- Enhanced discharge disinfection
- Regular discharge disinfection
Scenario 3

A patient with recently resolved CDI is discharged from a general medical unit. Do you perform:

- Ultraviolet C radiation (UVC)
- Pulsed-xenon UV (PX-UV)
- Hydrogen peroxide vapor (HPV)
- Aerosolised hydrogen peroxide (AHP)
- Enhanced discharge disinfection
- Regular discharge disinfection
No-touch room disinfection (NTD) systems: when to use them and how to choose between them...

(Can you ‘C’ the difference?)

APIC New England, April 24 2014

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