The Healthcare Environment: Evaluating Cleaning Practices and Improving Compliance

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Boston University School of Medicine

Illinois Campaign to Eliminate *Clostridium difficile*

July 2012

Consultant – Ecolab, Steris, ASHES

Patent License - Ecolab
A 2012 Perspective

Developmental Emphasis

1990 – 2009  Next Decade

Healthcare
Environmental
Cleaning Goal

Near-Patient
Surface Bio-burden
Reduction
How is Environmental Cleaning being evaluated in this hospital?

Are Shiny Floors Enough??
A 2012 Perspective

**Developmental Emphasis**

1990 – 2009

Shinier Floors

Next Decade

Providing a safer patient environment

- Healthcare
- Environmental Cleaning Goal

Near-Patient Surface Bio-burden Reduction
A 2012 Perspective

Developmental Emphasis

1990 – 2009

Shinier Floors

Next Decade

Providing a safer patient environment

Healthcare Environmental Cleaning Goal

Near-Patient Surface Bio-burden Reduction

Disinfectant Efficacy
A 2012 Perspective

Developmental Emphasis

1990 – 2009

Shinier Floors

Disinfectant Efficacy

Next Decade

Providing a safer patient environment

Hygienic Practice (Technologic Enhancements)

Healthcare Environmental Cleaning Goal

Near-Patient Surface Bio-burden Reduction
SHEA abstracts related to surface environmental hygiene issues

Number of abstracts

- SHEA 2005: 2
- DECENNIAL 2010: 37
- 2011: 28
Today’s Presentation

• A new understanding healthcare surfaces microbial ecology

• Defining the risk of transmission from surfaces

• Addressing suboptimal cleaning practice

• Does improved practice matter?

• Approaches to monitoring hygienic practice in healthcare
The new (clarified) understanding of the healthcare surface environment
You Can’t Escape from Germs!
The microbial ecology of patient zone surfaces

All pathogens traditionally associated with health care transmission survive well on surfaces
## Survival of Pathogens on Dry Environmental Surfaces

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Survival time on dry environmental surface</th>
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<tbody>
<tr>
<td><em>C. difficile</em></td>
<td>&gt;5 months</td>
</tr>
<tr>
<td>Staphylococci</td>
<td>7 months</td>
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<tr>
<td>VRE</td>
<td>4 months</td>
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<tr>
<td>Acinetobacter</td>
<td>5 months</td>
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<tr>
<td>Norovirus</td>
<td>3 weeks</td>
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<tr>
<td>Adenovirus</td>
<td>3 months</td>
</tr>
<tr>
<td>Rotavirus</td>
<td>3 months</td>
</tr>
<tr>
<td>Hepatitis C</td>
<td>4 weeks</td>
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Figure 1. Survival of an outbreak strain (E745; open squares) and a non-outbreak strain (E802; filled triangles) of vancomycin-resistant Enterococcus faecium (VREfm).
The microbial ecology of patient zone surfaces

**All** Pathogens traditionally associated with health care transmission survive well on surfaces

Organism density is generally low but infective doses are low
The microbial ecology of patient zone surfaces

All Pathogens traditionally associated with health care transmission survive well on surfaces.

Organism density is generally low but infective doses are low.

Most near-patient surfaces are sterile or contain < 2.5 ACC / cm². Therefore, simple cleanliness (culture, ATP) can not be used as a surrogate for thoroughness of cleaning.
Defining the risk of transmission
Studies reporting a favorable impact of enhanced environmental hygiene during a CDAD outbreak
Increased acquisition risk from prior room occupant

8 studies as of October 2010

Two additional studies showed very significant risk without quantification – Martinez (VRE) and Wilks (Acinetobacter)
Is there a better programmatic model?
The Health Care Environmental Hygiene Study Group Hospitals Program

To develop a surrogate marking system to objectively evaluate and improve the thoroughness of environmental cleaning/disinfection of the near-patient environment.
The Targeting Solution

A mixture of several glues, soaps and a targeting dye which:

Dries rapidly
Environmentally stable
Readily wetted by spray disinfectants
Easily removed with light abrasion
Inconspicuous
Target After Marking
Target Enhanced
Evaluation of the thoroughness of disinfection cleaning has shown substantial opportunities for improvement in all health care venues studied in the U.S., Canada, Ireland and Australia.
Baseline Environmental Evaluation of 3 Acute Care Hospitals

Mean = 47.7 %
Baseline Environmental Evaluation of 35 Acute Care Hospitals

Mean = 48.5 %

(20,056 Objects)
Baseline Environmental Evaluation of 82 Acute Care Hospitals

Proportion of Objects Cleaned (%)

Mean = 54 %

(44,340 Objects)
PROPORTION OF OBJECTS CLEANED AS PART OF TERMINAL ROOM CLEANING IN 20 ACUTE CARE HOSPITALS
Thoroughness of Environmental Cleaning

Mean = 32%

>110,000 Objects
Phase I: Covert Baseline Environmental Cleaning Evaluation

- Terminal cleaning after 1 or 2 patient cycles
- Cleaned, empty room identified
- Room marked
- Room evaluated

Phase II:  
A. Programmatic Analysis  
B. Educational Interventions – ES staff

Phase III: Re-evaluation of Cleaning and feedback to ES
RESULTS

Improving Cleaning of the Environment Surrounding Patients in 36 Acute Care Hospitals

Philip C. Carling, MD; Michael M. Parry, MD; Mark E. Rupp, MD; John L. Po, MD, PhD; Brian Dick, MS, CIC; Sandra Von Beheren, RN, BSN, MS, CIC; for the Healthcare Environmental Hygiene Study Group
Terminal Room **Cleaning** Project – Three Programmatic Responses

- **RAPID IMPROVEMENT**
- **DELAYED IMPROVEMENT**
- **LIMITED IMPROVEMENT**

<table>
<thead>
<tr>
<th>Hospital Category</th>
<th>Number of Hospitals</th>
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<tr>
<td>PRE-INTERVENTION</td>
<td></td>
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<tr>
<td>POST ED</td>
<td></td>
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<tr>
<td>POST SINGLE F/U</td>
<td></td>
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<tr>
<td>POST 2-4 F/U</td>
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</table>

17 HOSPITALS
10 HOSPITALS
8 HOSPITALS
Hospitals Environmental Hygiene Study Group
36 Hospital Results

Resource Neutral

P = <.0001
Is it a surprise that this degree of improvement was resource neutral??
So much for acute hospitals. What about long term care?
THE SNF ENVIRONMENTAL HYGIENE STUDY
PICTORAL PRIMER

In this section:
1. Introduction
2. Pictoral examples of objects marked
3. Optimal marking and evaluation after cleaning

FIGURE 1: A patient room in a SNF

Unlike hospital ward rooms and similar rooms found in acute care facilities, patient rooms in SNFs are much more individualized, providing greater challenges in determining what areas can be marked in a consistent manner. Figure 1 represents a patient’s room in a SNF which contains many personal items as well as objects which have been associated with the transmission of bacterial and viral pathogens.

PICTORAL EXAMPLES OF COMMON AREA
OBJECT MARKING

Handrails

For handrails (Figure 2), the optimal place for marking is at the end of the rail. Mark the face of the rail rather than on top to minimize the chance of hand contact with the target. Marking near the terminus of a rail will decrease the chance of the target being accidently removed.

Figure 2: Hand rail marking

Mark here

DO NOT mark here

Patient Lifts and Scales

The lift control panel and handle should be marked and the scale control panel and the metal part of the hand hold should be marked” (Figure 6 A and B). Since these devices may be moved around the facility, it is recommended that an additional mark be placed in an area that will not be cleaned to allow the device can be “tracked down” to determine whether or not the object is actually the one marked for evaluation or an identical unmarked object.

Figures 6, A and B: Note arrows

A: MECHANICAL PATIENT LIFT

Suggested area to mark for tracking device

B: PATIENT SCALE
Methicillin-Resistant *Staphylococcus aureus* Burden in Nursing Homes Associated with Environmental Contamination of Common Areas

Courtney R. Murphy, MS,* Samantha J. Eells, MPH,† Victor Quan, BA,‡ Diane Kim, BS,‡ Ellena Peterson, PhD,§ Loren G. Miller, MD, MPH,† and Susan S. Huang, MD, MPH‡
### Table 2. Multivariate Analysis of Methicillin-Resistant *Staphylococcus aureus* (MRSA)-Positive Objects and Nonremoval of Cleaning Marks

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio (95% Confidence Interval)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRSA-positive culture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High MRSA delta prevalence group&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.8 (1.4–5.9)</td>
<td>.005</td>
</tr>
<tr>
<td>Less time spent cleaning per room (per 10 minute reduction)</td>
<td>2.9 (1.5–5.4)</td>
<td>&lt;.001</td>
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<tr>
<td>Lower frequency of common room cleaning</td>
<td>1.5 (1.1–2.0)</td>
<td>.01</td>
</tr>
<tr>
<td>Nonremoval of cleaning mark</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Object type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tables</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>Hallway objects</td>
<td>4.2 (2.4–7.4)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Chairs</td>
<td>3.5 (1.6–7.3)</td>
<td>.001</td>
</tr>
<tr>
<td>Rehabilitation equipment</td>
<td>2.4 (1.4–4.3)</td>
<td>.002</td>
</tr>
<tr>
<td>Counters</td>
<td>0.9 (0.4–1.9)</td>
<td>.77</td>
</tr>
<tr>
<td>MRSA admission prevalence&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.2 (1.0–1.4)</td>
<td>.04</td>
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Patient Safety Environmental Cleaning

GOAL

CLEANED

HP  SW  EV  36 HOSPITALS

<table>
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<tr>
<th></th>
<th>BASELINE</th>
<th>POST EDUCATION</th>
<th>POST FEEDBACK</th>
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<tr>
<td>HP</td>
<td>29</td>
<td>62</td>
<td>65</td>
</tr>
<tr>
<td>SW</td>
<td>48</td>
<td>47</td>
<td>53</td>
</tr>
<tr>
<td>EV</td>
<td>28</td>
<td>66</td>
<td>80</td>
</tr>
<tr>
<td>36</td>
<td>48</td>
<td>62</td>
<td>81</td>
</tr>
</tbody>
</table>
Increased risk of prior room occupant transmission

Baseline Thoroughness of Cleaning

40%

Thoroughness of cleaning following structured interventions

82%

11 Studies
Does Improved thoroughness of disinfection decrease surface contamination?
Improving Disinfection Cleaning to Decrease Environmental Surface Contamination

- Improvement in Cleaning Practice:
  - A: 80%
  - B: 70%
  - C: 60%
  - D: 50%

- Decrease in Environmental Pathogens:
  - A: 64%
  - B: 50%
  - C: 40%
  - D: 30%
Improved thoroughness of hygienic cleaning is a worthy goal given the billions of dollars involved…but will it impact transmission of healthcare acquired pathogens (HAPs)?
Increased risk of prior room occupant transmission

Baseline thoroughness of Cleaning

Thoroughness of cleaning following structured interventions

Programmatic decrease in environmental contamination

Increased risk of prior room occupant transmission: 74%

Baseline thoroughness of Cleaning: 40%

Thoroughness of cleaning following structured interventions: 82%

Programmatic decrease in environmental contamination: 73%

11 Studies

MRSA, VRE, CD, AB 73%

8 Reports
Brigham & Woman’s ICU Study

Pre-Intervention: 44%
Post-Intervention: 71%

Thoroughness of cleaning MRSA/VRE contamination.
Brigham & Woman’s ICU Study

PRE-INTERVENTION

THOROUGHNESS OF CLEANING
MRSA/VRE CONTAMINATION

% 44 45

POST INTERVENTION

71

27

Goodman R, ICHE 2009
Brigham & Woman’s ICU Study

Result of the intervention

MRSA Acquisition Decreased 50% \( p<0.001 \)

VRE Acquisition Decreased 28% \( p<0.02 \)
 Increased risk of prior room occupant transmission
Baseline thoroughness of Cleaning
Thoroughness of cleaning following structured interventions
Programmatic decrease in environmental contamination
Programmatic decrease in acquisition

- Increased risk of prior room occupant transmission: 74% (11 Studies)
- Baseline thoroughness of Cleaning: 40% (11 Studies)
- Thoroughness of cleaning following structured interventions: 82% (8 Reports)
- Programmatic decrease in environmental contamination: 68% (8 Reports)
- Programmatic decrease in acquisition: 40% (4 Studies)
Acute Care Hospitals should implement a:

Level I Program:
- Basic interventions to optimize disinfection cleaning policies, procedures and ES staff education and practice. When completed move to Level II Program

Level II Program:
- All elements of Level I + Objective monitoring

Options for Evaluating Environmental Cleaning
October 2010
CDC Recommendations

Web Link:

http://www.cdc.gov/HAI/toolkits/Evaluating-Environmental-Cleaning.html

Options for Evaluating Environmental Cleaning

October 2010
So much for the why

Let’s get to the how
First establish a structure for the program

- Early joint planning to define expectations, clarify policies and foster mutual respect

- One sided programs fail on many levels

Infection Prevention AND Environmental Services
Systems of Objectively Monitoring Hygienic Practice

What are the merits and limitations of the tools that can be used to objectively monitor the thoroughness of patient zone cleaning?
## Defining the Difference Between Cleaning and Cleanliness

<table>
<thead>
<tr>
<th></th>
<th>Cleanliness</th>
<th>Cleaning</th>
</tr>
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<tbody>
<tr>
<td>Definition</td>
<td>A measure of bacteria on a surface</td>
<td>Measured by evaluating process</td>
</tr>
<tr>
<td>Defined Criteria</td>
<td>No “Cleanliness Standard”</td>
<td>Compliance with existing cleaning policy</td>
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<tr>
<td>Improvement shown to decrease bacterial transmission (Published)</td>
<td>None</td>
<td>Two</td>
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<tr>
<td>Impacted by</td>
<td>Bioburden, thoroughness of recent cleaning, effectiveness of disinfectant, recent contamination or lack of</td>
<td>Thoroughness of evaluated cleaning practice</td>
</tr>
<tr>
<td>CDC endorsed to improve patient safety</td>
<td>No</td>
<td>Yes</td>
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### Evaluating Patient Zone Environmental Cleaning

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Surface evaluation using ATP bioluminescence

Swab surface → luciferace 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.
The ATP tool in context

Industrial Use
- Developed in the 1970s for commercial food preparation
- Used when very clean surfaces are important
- High-grade disinfectants + Rinsing
- Testing immediately after cleaning and just before use is the standard

Healthcare Use
- Griffiths – JHI studies – Effectively used cultures and ATP to debunk the “visibly clean ” standard
- He and later Dancer showed that most surfaces had both high bacterial and ATP counts (89% of surfaces “Failed”) (many appeared dirty!)
- The Hygienic standard is proposed
Limitations of ATP evaluation of cleanliness in healthcare settings

Two independent studies of ATP sensitivity and specificity have clarified the limits of the ATP “Cleanliness Standard” as it was proposed several years ago.
Evaluation of ATP bioluminescence swabbing as a monitoring and training tool for effective hospital cleaning

2007
Correlation between ATP bioluminescence (RLU/Swab) and aerobic colony count (cfu/swab)
Correlation between ATP bioluminescence (RLU/Swab) and aerobic colony count (cfu/swab)

Satisfactory by RLUs but Unsatisfactory by # CFU

Bioluminescence
PPV = 63%  NPV= 71%

Figure 2. Receiver operating characteristic ROC curve of benchmarks based upon ATP levels calibrated against growth. Some ATP values are superimposed in grey tint, just about their associated sensitivity values.
Lack of Correlation between RLU & Microbial Contamination.

“Routine cleaning with detergent can reduce concentration of microbes & organic matter by RLU. The effect is not large, with many sites exhibiting similar values after cleaning as they did before. …Further work is required to refine practical sampling strategy and choice of benchmarks.”
The range and diversity of the ATP results must be carefully considered. Despite monitoring in triplicate, occasional inflated values, for no apparent (visible) reason, skewed the overall results. It is already known that organic soil contains both microbial and human DNA, as well as food debris and liquids. ATP can also be confounded by disinfectants (bleach), microfibre products and manufactured plastics used in cleaning and laundering industries. If ATP assessment is introduced into hospitals, it should be on the understanding that there will be inevitable failures that do not necessarily indicate true infection risk for patients. Sensitivity and specificity of 57% mean that the margin for error is too high to justify stringent monitoring of the hospital environment at present. Further work is required to fully assess routine ATP monitoring in hospitals.
The other problem with using an evaluation of cleanliness by agar dip slide or ATP
How clean is clean? Proposed methods for hospital cleaning assessment
A. Al-Hamid a**, S. Maxwell b
a School of Medicine, University of Manchester, Manchester, UK
b Department of Clinical Microbiology, St John's Hospital, Stockport, UK

![Graph showing cfu/cm² ± SE from frequent-touch surfaces from clinical areas with cleaning policy.]

**Figure 1** Overall cfu/cm² ± SE from frequent-touch surfaces from clinical areas with cleaning policy.
How clean is clean? Proposed methods for hospital cleaning assessment

A. Al-Hamad a, * S. Maxwell b

a School of Medicine, University of Manchester, Manchester, UK
b Department of Clinical Microbiology, Stockport NHS Foundation Trust, Stockport, UK

Proposed “Hygienic Standard”

Figure 1  Overall cfu/cm² ± SE from frequent-touch surfaces from clinical areas with cleaning policy.
Basic cleanliness* of healthcare surfaces

* No aerobic growth or < 2.5 CFU/cm²

Nine Published studies 2006 - 2011
Despite their limitations, can dip slide cultures or ATP be theoretically used to evaluate cleaning practice?

The CDC Guidance says yes……But
Using tools that measure cleanliness to systematically evaluate cleaning process
But then you will need to deal with the other implication of the.....
Most surfaces have too low a bioburden to evaluate… you need to mark two to three times the number of surfaces you planned to get an appropriately sized sample to detect a 20% change in process.

* No aerobic growth or < 2.5 CFU/cm²

Nine Published studies 2006 - 2011
So what about the disinfectant?
Don’t forget the Rutala Equation

Product + Practice
Issues with disinfectants, detergents, cloths, etc.

- What is the true role of bleach in disinfection cleaning?
- How effective will new green disinfectants be?
- When is it okay to use detergents?
- Where are we going with dwell time?
- Where does microfibre fit in?
- If effective killing with bleach takes many minutes, what is the clinical efficacy of bleach wipes?
- What is the correct amount of quat?
- Are disinfectants being mixed accurately?
So what about Hand Hygiene??
Hand Hygiene Issues

What did Mark Anthony have to say about HH?
Hand Hygiene Issues

Friends, Romans and Minnesota IPs,
I come not to bury Hand Hygiene but to praise it (in context)
Hand Hygiene Issues

Success stories were based on mixed interventions….Not enhanced HH alone

Logistical limitations are becoming clarified

There may be a “compliance ceiling”

Microbial efficacy – Product Differences

Microbial resurgence is rapid following HH
HH in Complex Intense Environments is Very Difficult

30 to 40 HH “Moments” per Hour during direct patient care
HH in Complex Intense Environments is Very Difficult

WHO = 20 to 30 sec.

30 to 40 HH “Moments” per Hour during direct patient care
How rapidly does HH compliance deteriorate during a single patient encounter?

THE ENVIRONMENTAL HYGIENE IMPERATIVE
Conclusions

• It is very likely that surfaces in the Patient Zone are of relevance in the transmission of Healthcare Associated Pathogens.

• While optimizing hand hygiene and isolation practice is clearly important there is no reason why the effectiveness and thoroughness of environmental hygienic cleaning should not also be optimized, particularly since such an intervention can be essentially resource neutral.
Thanks for inviting me!!

Questions – Comments?  pcarling@cchcs.org