Do’s and Don’ts for Hospital Cleaning

Prof. Stephanie Dancer, NHS Scotland & Edinburgh Napier University

The A. Denver Russell Memorial Teleclass Lecture

Hosted by Prof. Jean-Yves Maillard
Cardiff University, Wales

www.webbertraining.com
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Do’s and Don’ts for hospital cleaning

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NHS Scotland & Edinburgh Napier University

How should we approach control of antimicrobial resistance?

Antimicrobial stewardship?

Antimicrobial drugs might be encouraging resistance.

...but patients acquire resistant pathogens from the contaminated near-patient environment

So controlling AMR requires attention on:

i) vertical (direct) effects by antimicrobial drugs
ii) horizontal (indirect) spread caused by infection prevention & control deficits


Why are we still debating the value of cleaning?

Invisible
Aesthetic bias
Pathogen detection
Evidence-based science?
No accepted measure
Womens’ work
Fabric deficits
Costly
Low paid; low status; and dirty

Properties of hospital pathogens

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Survival time</th>
<th>Infectious dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRSA</td>
<td>7 days to &gt;7 months</td>
<td>4 cfu’s</td>
</tr>
<tr>
<td>Acinetobacter</td>
<td>3 days to &gt;5 months</td>
<td>250 cfu’s</td>
</tr>
<tr>
<td>C. difficile</td>
<td>&gt;5 months</td>
<td>5 spores</td>
</tr>
<tr>
<td>VRE</td>
<td>5 days to &gt;4 months</td>
<td>&lt;10^3 cfu’s</td>
</tr>
<tr>
<td>E. coli</td>
<td>2 hrs to 16 months</td>
<td>10^2-10^6 cfu’s</td>
</tr>
<tr>
<td>Klebsiella</td>
<td>2 hrs to &gt;30 months</td>
<td>10^2 cfu’s</td>
</tr>
<tr>
<td>Norovirus</td>
<td>8 hrs to 7 days</td>
<td>&lt;20 virions</td>
</tr>
</tbody>
</table>

Kramer, BMC Infect Dis, 2006; Dancer SJ, Clin Microbiol Rev 2014

Increased risk associated with the prior room occupant.
The figures of difference in risk are unadjusted based on raw data.

Is risk related to environmental longevity?

Otter et al, Am J Infect Control 2013
Mitchell et al, J Hosp Infect 2013
Where are the pathogens in a hospital?

Fluorescent gel placed on chosen sites
After patient discharge, a site is considered cleaned if the fluorescent material is removed or disrupted

How do we measure hospital cleaning?

Removal of marker may not correlate with cleaning of alternate sites on the same surface
What’s the long term effect?

Maintenance of environmental services cleaning and disinfection in the ICU after a performance improvement project

Fitzgerald et al, AmJIC 2012

How do we measure hospital cleanliness?

82-91% Visually clean
10-24% ATP clean
30-45% Microbiologically clean

What is clean?

“what an individual thinks it is”

Griffith CJ et al, J Hosp Infect 2000

Surface evaluation using ATP bioluminescence

Swab surface → luciferase tagging of ATP → Luminometer

Used in the commercial food preparation industry to evaluate surface cleaning and as an educational tool for more than 30 years

ATP values (RLU’s) for sites on medical & surgical wards

<table>
<thead>
<tr>
<th>Site</th>
<th>Before*</th>
<th>After*</th>
<th>Site Mean ATP Before</th>
<th>Site Mean ATP After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locker (M)</td>
<td>Range</td>
<td>Mean</td>
<td>15-116</td>
<td>17-148</td>
</tr>
<tr>
<td>Locker (S)</td>
<td>Range</td>
<td>Mean</td>
<td>7-325</td>
<td>5-208</td>
</tr>
<tr>
<td>L. Bed (M)</td>
<td>Range</td>
<td>Mean</td>
<td>4-245</td>
<td>4-1512</td>
</tr>
<tr>
<td>L. Bed (S)</td>
<td>Range</td>
<td>Mean</td>
<td>4-181</td>
<td>32-115</td>
</tr>
<tr>
<td>O/B Table (M)</td>
<td>Range</td>
<td>Mean</td>
<td>28-625</td>
<td>13-75</td>
</tr>
<tr>
<td>O/B Table (S)</td>
<td>Range</td>
<td>Mean</td>
<td>33-376</td>
<td>55-3046</td>
</tr>
<tr>
<td>R Bed (M)</td>
<td>Range</td>
<td>Mean</td>
<td>3-489</td>
<td>3-200</td>
</tr>
<tr>
<td>R Bed (S)</td>
<td>Range</td>
<td>Mean</td>
<td>8-286</td>
<td>16-128</td>
</tr>
</tbody>
</table>

*Benchmark = 100 RLU's

Mulvey et al, J Hosp Infect 2011

What effect does ATP monitoring have?

Study in 2 ICUs in a public 1800-bed hospital in Taiwan

Cleaning efficacy was monitored by ATP bioluminescence after cleaning; <45% of 221 surfaces passed

After a new cleaning protocol, 88% of 270 surfaces were clean according to ATP criteria. Combined HAI rates in the ICUs apparently decreased by half!

ATP systems encourage cleaning effectiveness, but they do not necessarily measure surface cleanliness. High ATP values do not necessarily mean presence of microbial pathogens!


Would microbiological standards help?

5 cfu/cm²

45 cfu/cm²

Slide from Chris Griffith

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Microbiological standards for surface hygiene in hospitals

**Standard 1**
There should be <1 cfu/cm² pathogen (MRSA; C.difficile; VRE; etc) on healthcare surfaces

**Standard 2**
Aerobic Colony Count (ACC) or total microbial growth level from a hand touch surface should be <5 cfu/cm²

These standards are based upon food industry counts as applied to food preparation surfaces but could be utilised for frequent hand touch surfaces in hospitals

Dancer S, J Hosp Infect 2004

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**Is there a relationship between environmental bioburden and hospital-acquired infection?**

White et al, AmJC 2008

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**Correlating cleaning effect against surface cleanliness indicators**

Boyce et al, ICHE 2011

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**What is the evidence for cleaning as a viable control mechanism for hospital-acquired infections?**

Two matched wards received one extra cleaner (Monday to Friday), with each ward receiving enhanced cleaning for six months in a cross-over design; Enhanced cleaning led to a 33% reduction in levels of microbial soil at hand-touch sites; and 27% reduction in new MRSA infections, despite higher bed occupancies and MRSA colonisation pressures (p=0.032: 95% CI 7.7%, 92.3%).

BBC website, 2008

Dancer et al, BMC Med, 2009

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**So which is the best method for measuring how clean a hospital is?**

Aim for a system which shows measurable benefit for patients: aesthetics, cleaning focus, cleaner surfaces, and if you're lucky, HAI rates; but.... wouldn't it be nice to have a system that gives us early warning of an imminent outbreak?

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**Correlating cleaning effect against surface cleanliness indicators**

Boyce et al, ICHE 2011

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**Microbiological standards for surface hygiene in hospitals**

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Dancer S, J Hosp Infect 2004
Total aerobic colony counts (ACC) from hand-touch sites on two matched wards; the cleaner moved from Ward A to Ward B at week 26

Keep your cleaning staff in-house!

Clostridium difficile infection incidence for units A and B combined, before and after the intervention

Impact of a Hand-Hygiene Intervention on Contamination of Patient’s Hands with Healthcare-Associated Pathogens

The Hand-Touch equation:

Hand-touch site

...is equal and opposite

Hand

Wiping Out Clostridium difficile

Basic hygiene measures reduced VRE incidence

The Hand-Touch equation:
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Daily cleaning?

How long do hospital surfaces stay ‘clean’?
Contact plates from patient locker surface
Left to right: Pre clean, 1 hour, 2 hour, 3 hour assessment

Effect of detergent (blue line) and disinfectant (red line) cleaning on total ACC at hand-touch sites over 48 hours

Effect of detergent and disinfectant cleaning on total MSSA/MRSA at hand-touch sites on one 30 bed ward over 48 hours

Do biofilms on hospital surfaces protect viable pathogens from cleaning?

New disinfectants on the Block
‘Chemzyme Plus’
A soup of Bacillus subtilis!
A disinfectant containing good bacteria reduced ‘bad’ bacteria by 1,000-fold compared with standard cleaning
http://chemexuk.com
Phage disinfectants
Bacteriophages that target hospital pathogens can be incorporated into disinfectants
http://www.phageworks.com
Neutral Electrolysed water
Normal tap water with added salt that has had an electric current passed through it

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Electrolysed water

**What is it?**
Electrolysed water is normal tap water with added salt exposed to an electric current. Non-toxic!

It is microbiocidal due to the presence of hypochlorous acid. This acid is only present in very low concentrations so that the product has a neutral pH, the same as ordinary water.

How good a disinfectant is it? Is it better than bleach?
Also effective for decontaminating sensitive clinical equipment

**Meakin N et al, JHI 2012; Dancer et al, Healthcare Infection 2015**

Cold Plasma Technology reduces surface bacterial counts

**Claro et al, Infect Control Hosp Epidemiol 2017**

Effect of bleach vs steam against *E. coli* biofilm

<1 second steam achieves better disinfection than 10 ppm sodium hypochlorite for 10-20 minutes

**Song et al, AmJIC 2012**

Antimicrobial surfaces

- Copper (toilet seats, sinks, handles, etc)
- Silver (textiles, etc)
- Triclosan (toothpaste, chopping boards, etc)
- Paints containing polyurethanes, epoxy materials, styrene acrylics
- Polymer ‘conjugated poly-electrolyte’ plus fluorescent light
- Nanocoating (nanotubes plus lysostaphin)

**Page et al, J Mater Chem 2009**

‘...antimicrobial coatings must not undermine traditional hygiene methods and neither should conventional cleaning be relaxed if antimicrobial coatings are employed’

**Child T, www.allbusiness.com 2005**

Failure of copper-based NanoCote/Aqua-Based antimicrobial paint in a hospital setting

Laminated wood bedside table coated with NanoCote following water spillage

Laminated wood bedside table coated with NanoCote HD-WR (before curing).
Close-up view showing uneven distribution after application

**Ramsden et al, J Biol Phys Chem, 2016**

‘Oak in hospitals, the Worst Enemy of *Staphylococcus aureus*?’

Potential antimicrobial activity of oak (*Querceus spp.*) was tested against a panel of *S. aureus* isolates

Four MSSA and four MRSA; Two different orientations of oak used

Oak showed antimicrobial activity towards all the isolates tested; BUT... diameter of the wooden discs was 9mm, as opposed to 2mm for a standard antibiotic disc

**Pailhoriès et al, ICHE 2016**

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Disinfect everything......

Does H₂O₂ improve disinfection of ICU rooms?
Prospective crossover study in a French hospital; rooms were cleaned with quat & sodium hypochlorite, followed by either H₂O₂ vapour or aerosolized H₂O₂ combined with peracetic acid;
BEFORE any H₂O₂ disinfection, only 23 (1.5%) of 1,456 sampled surfaces and 15 (8%) of 182 rooms were MDRO-positive after patient discharge;
H₂O₂ disinfection reduced ESBLs only, since no other MDROs were found after routine cleaning;
These ESBLs were found mostly from sinks...

Terminal decontamination of rooms using H₂O₂ vapour
Patients were 64% less likely to acquire MDROs and 80% less likely to acquire VRE (P < 0.001) following H₂O₂ terminal cleaning.......... But the risk of acquiring *Clostridium difficile*, MRSA and multidrug-resistant Gram-negative bacilli was ‘not significantly reduced’;
The significance quoted for the overall result came from the VRE data only.

An Environmental Disinfection Odyssey: evaluation of sequential interventions to improve disinfection of *C. difficile* isolation rooms

The effect of distance on the efficacy of the PX-UV device

Incidence of MDROs and *Clostridium difficile* from January 2009 until April 2013; pulsed UV light introduced May 2011

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Incidence of MDROs and *Clostridium difficile* from January 2009 until April 2013; pulsed UV light introduced May 2011

Hydrogen peroxide can’t penetrate linen, pillows or soft furnishings

Can UVC waves go round corners? That’s a NO, then?

Time taken for decontamination

- Need to remove the patient;
- Need to totally seal off a room before H202 exposure;
- Need to reposition UVC apparatus for uniform coverage;
- Need to train staff;
- Need to prepare room;
- Need to remove soft furnishings;
- Can’t do open plan....

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‘The H2O2 robot system costs about US $40,000; the UV light system costs more than US $100,000.……..

..is current evidence on clinical benefit sufficiently plentiful, and indeed, robust, to allocate scarce healthcare resources for these systems?’ Dancer SJ, Floor Wars letter, JHI 2013

Aggressive marketing by robot companies encourages healthcare managers to choose these methods...

...but no one knows whether plain old soap and water might actually do the job just as well, for much less cost and minimal effect on people and environment

Man-agers are more likely to choose push-button gadgets rather than reduce bed occupancy or engage more cleaners

Boys with toys?

Man-agers are more likely to choose push-button gadgets rather than reduce bed occupancy or engage more cleaners

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![Image 1](https://via.placeholder.com/150)

The efficacy of any cleaning/disinfectant agent tested is dependent on physical action.

-Alfa MJ et al, BMC Infect Dis 2010;10:268

![Image 2](https://via.placeholder.com/150)

Even if all the rooms are decontaminated by robots, we still need staff to manually pick up litter...

-A Webber Training Teleclass

![Image 3](https://via.placeholder.com/150)

Time to get PHYSICAL!

C. difficile and cleaning – alternative options to using chlorine-releasing disinfectants... could C. difficile be removed by routine physical cleaning?

-Awadel-Kariem et al, J Hosp Infect 2011

A single clean can reduce contamination by around 90%....

-Spight et al, J Hosp Infect 2011

Detergent gives the same result as disinfectant for cleaning clinical equipment

-Petti et al, Am JIC 2012

When surfaces are wiped 3 or more times, detergent wipes are just as effective as disinfectant wipes

-Physical removal of C. difficile spores is more important than sporidal inactivation

-Rutala et al, ICOME 2012

![Image 4](https://via.placeholder.com/150)

CONCLUSION

DO value traditional cleaning

DO monitor cleaners; cleaning; or what is left behind (however you like)

DO keep your cleaners in-house!

Don’t prioritise hand hygiene over cleaning

Don’t waste money on robots or antimicrobial paint

Don’t believe everything that salesmen tell you!

-NB. No disclosures

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April 27, 2017
COST ANALYSIS OF UNIVERSAL SCREENING VS. RISK FACTOR-BASED SCREENING FOR MRSA
Speaker: Dr. Virginia Ruth, University of Ottawa

May 5, 2017
SPECIAL LECTURE FOR 5 MAY
Speaker: Prof. Didier Pittet, World Health Organization, Geneva
Sponsored by the World Health Organization Infection Control Global Unit (www.who.int/gpcinfection)

May 18, 2017
THE AIRBORNE SPREAD OF INFECTIOUS AGENTS: SURVIVAL AND DECONTAMINATION OF HUMAN PATHOGENS IN INDOOR AIR
Speaker: Prof. Syed A. Sattar, University of Ottawa Faculty of Medicine

May 30, 2017
THE GOOD THE BAD AND THE UGLY METHODS FOR RECDP MANAGEMENT
Speaker: Gerit van Kroppenberg-Gordlbske, International Consultant Infection Prevention, The Netherlands
Sponsored by Clorox (www.clorox.com)

Using Unofficial Sources to Monitor Outbreaks of Emerging Infectious Diseases: Lessons from Ebola
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