# Do's and Don'ts for hospital cleaning

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*NHS Scotland & Edinburgh Napier University*

A. Denver Russell Memorial Teleclass Lecture

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

www.webbertraining.com April 25, 2017

## 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

***Dancer SJ, 'The effects of antibiotics on MRSA', J Antimicrobial Chemother (2008)***

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## *Properties of hospital pathogens*

| | *Survival time* | *Infectious dose* |
|---|---|---|
| **MRSA** | 7 days to >7 months | 4 cfu's |
| **Acinetobacter** | 3 days to >5 months | 250 cfu's |
| ***C.difficile*** | >5 months | 5 spores |
| **VRE** | 5 days to >4 months | $<10^3$ cfu's |
| ***E. coli*** | 2 hrs to 16 months | $10^2$-$10^6$ cfu's |
| **Klebsiella** | 2 hrs to >30 months | $10^2$ cfu's |
| **Norovirus** | 8 hrs to 7 days | <20 virions |

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

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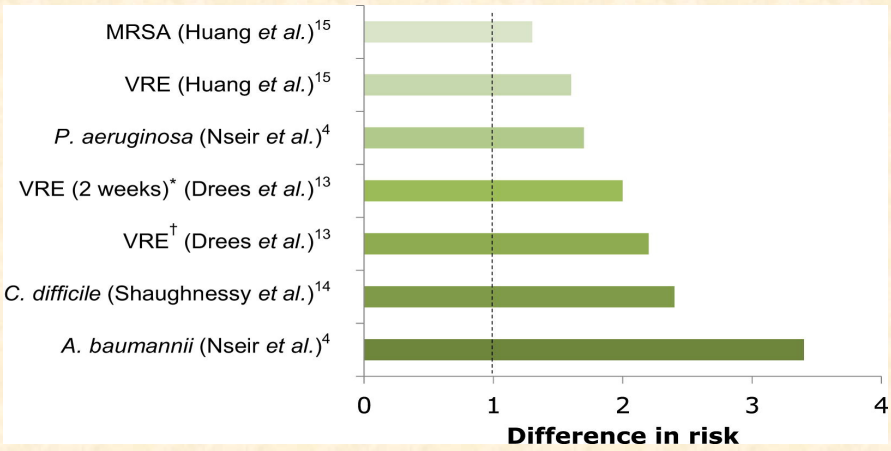
Increased risk associated with the prior room occupant.
The figures of difference in risk are unadjusted based on raw data.




***Is risk related to environmental longevity?*** *Otter et al, Am J Infect Control 2013*
*Mitchell et al, J Hosp Infect 2015*

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## *Where are the pathogens in a hospital?*

*Hayden et al, SHEA 2004*

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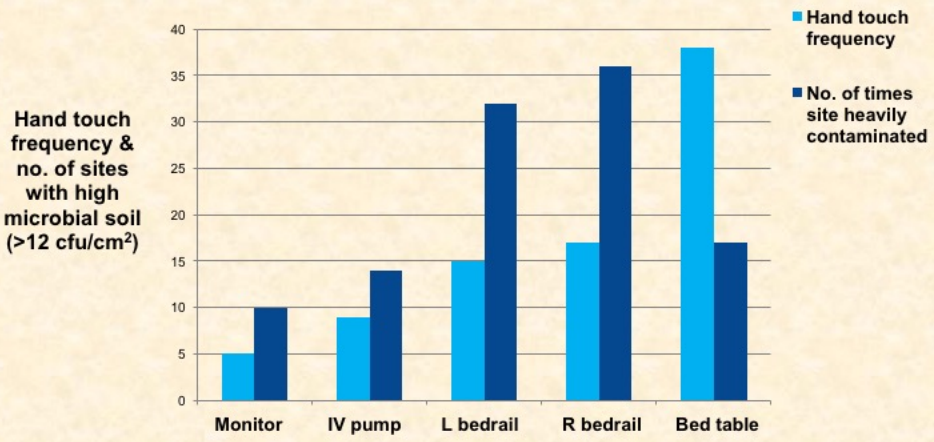
## Figure showing an association between hand touch frequency and gross microbial soil for five ICU sites




Five hand touch sites on ICU

*Adams et al, J Hosp Infect 2017*

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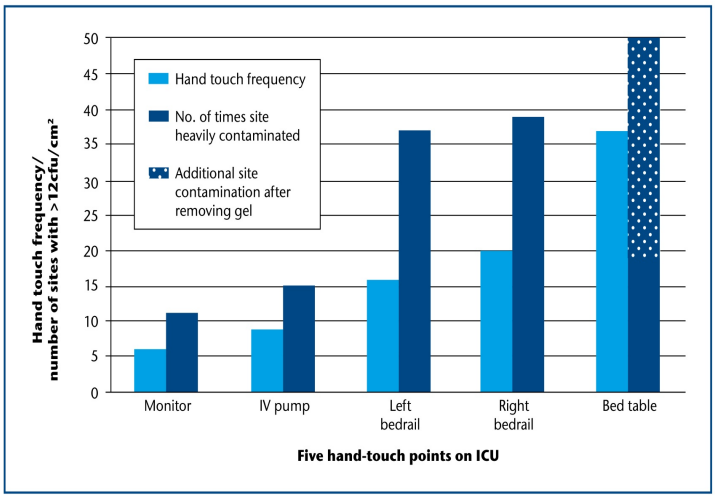
Figure 1: Hand touch frequency and gross microbial soil for five near patient sites on ICU




*Adams et al, J Hosp Infect 2017*

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## *How do we measure hospital cleaning?*

**Fluorescent gel placed on chosen sites**

**After patient discharge, a site is considered cleaned if the fluorescent material is removed or disrupted**


***Carling et al, Am J Infect Control, 2006***

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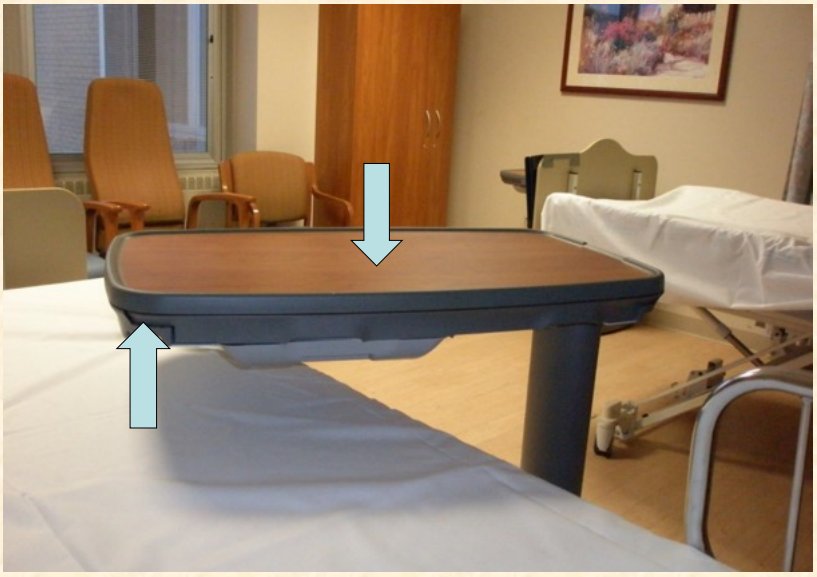

**Removal of marker may not correlate with cleaning of alternate sites on the same surface** ***Sitzlar et al, ICHE 2013***

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## 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***

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## *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***

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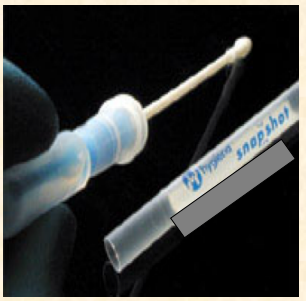
## Surface evaluation using ATP bioluminescence

*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*

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

| Site | | Before* | After* | Site Mean ATP Before | Site Mean ATP After |
|---|---|---|---|---|---|
| Locker (M) | Range<br>Mean | 15-316<br>106 | 17-148<br>47 | 120 | 69 |
| Locker (S) | Range<br>Mean | 7-325<br>134 | 5-208<br>91 | | |
| L Bed (M) | Range<br>Mean | 4-243<br>106 | 4-1512<br>206 | 105 | 131 |
| L Bed (S) | Range<br>Mean | 4-181<br>103 | 32-115<br>56 | | |
| O/B Table (M) | Range<br>Mean | 28-625<br>116 | 13-75<br>36 | 181 | 309 |
| O/B Table (S) | Range<br>Mean | 33-550<br>246 | 55-3846<br>581 | | |
| R Bed (M) | Range<br>Mean | 3-409<br>145 | 3-200<br>60 | 132 | 57 |
| R Bed (S) | Range<br>Mean | 0-266<br>118 | 16-128<br>54 | | |

**Benchmark = 100 RLU's*

*Mulvey et al, J Hosp Infect 2011* 16

## 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!**

*Chan MC, Lin TY, Chiu YH, et al. Applying ATP bioluminescence to design and evaluate a successful new intensive care unit cleaning programme. J Hosp Infect 2015; 90:344–346.*

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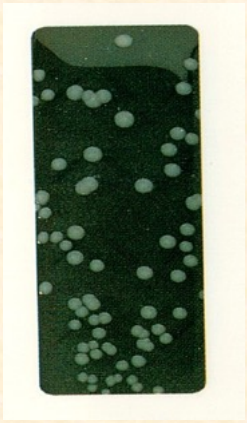
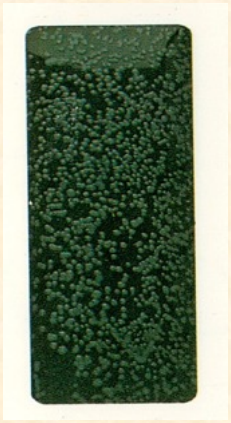
## *Would microbiological standards help?*





**5 cfu/cm$^2$** **45 cfu/cm$^2$**

*Slide from Chris Griffith*

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## Microbiological standards for surface hygiene in hospitals

***Standard 1***

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

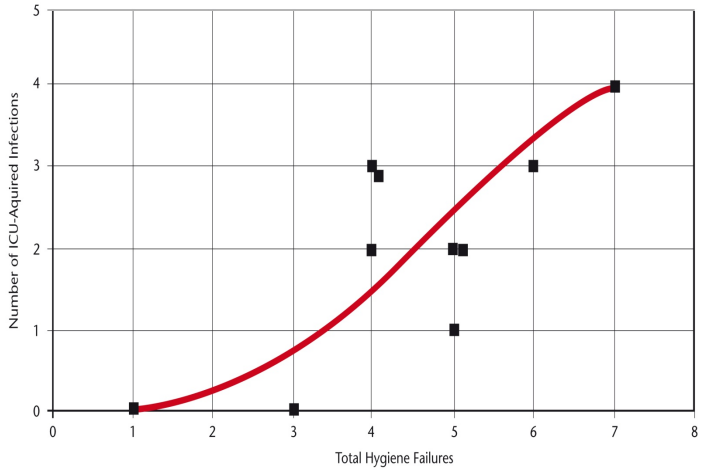
***Standard 2***

*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*** 19

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




***White et al, AmJIC 2008***

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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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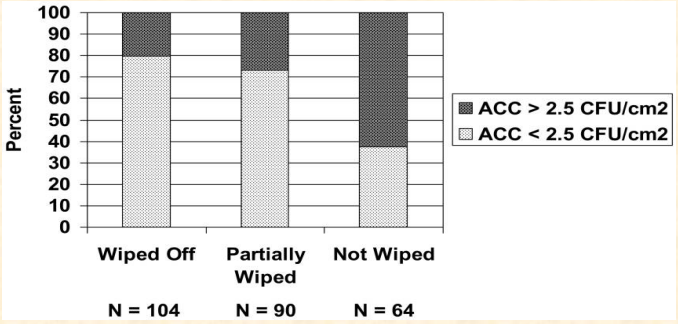
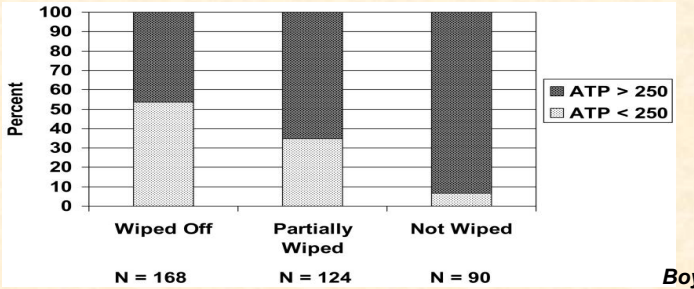
***Correlating cleaning effect against surface cleanliness indicators***




**Fluorescent marker vs ACCs; *how well have surfaces been cleaned***




**Fluorescent marker vs ATP; *which surfaces need cleaning***

***Boyce et al, ICHE 2011***

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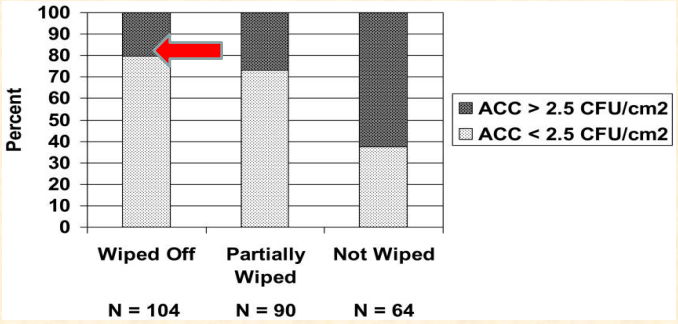
## *Correlating cleaning effect against surface cleanliness indicators*

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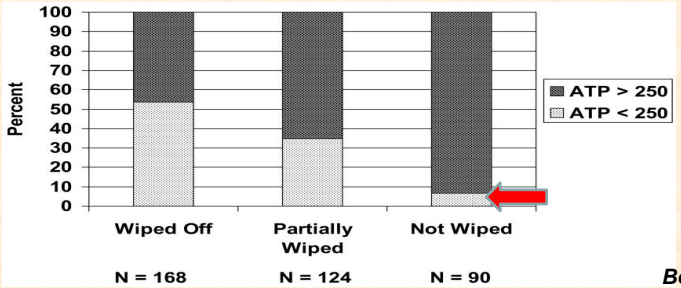


**Fluorescent marker vs ATP; *which surfaces need cleaning***

*Boyce et al, ICHE 2011*

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

*BBC website, 2008*

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%).

*Dancer et al, BMC Med, 2009*

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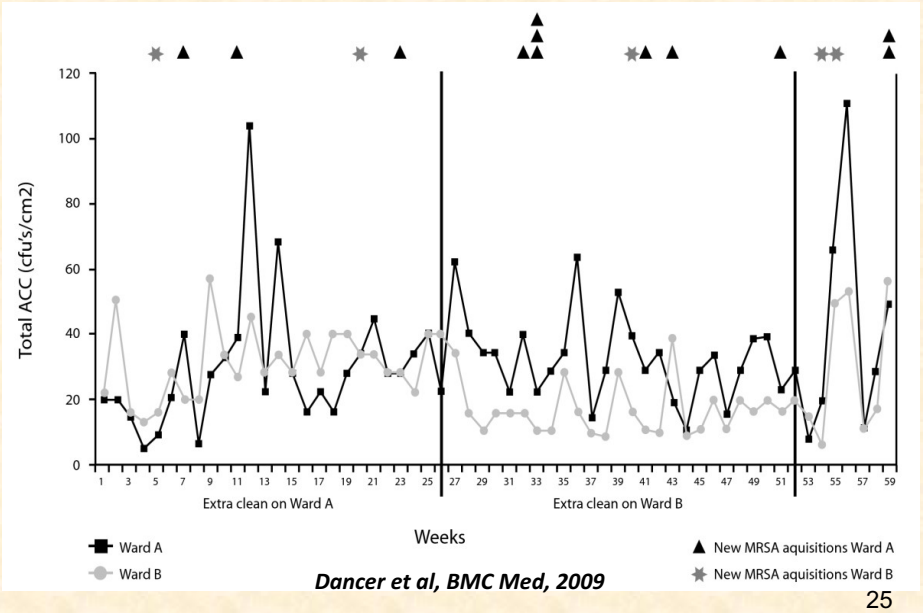
**Total aerobic colony counts (ACC) from hand-touch sites on two matched wards; the cleaner moved from Ward A to Ward B at week 26**




*Dancer et al, BMC Med, 2009*

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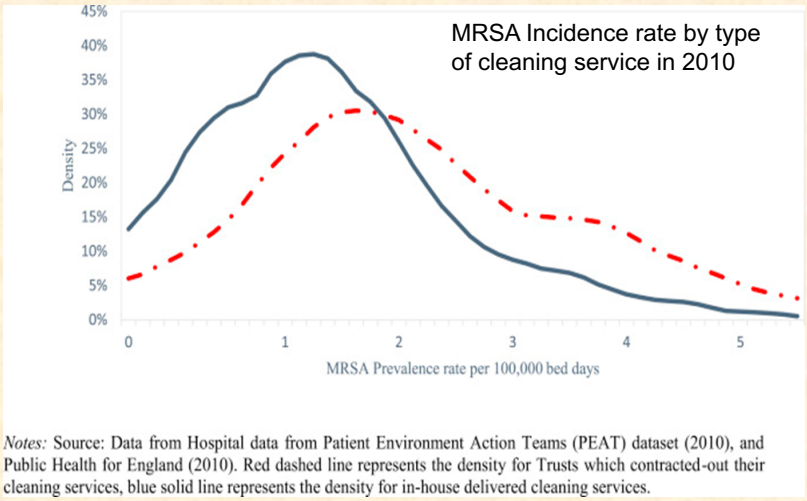
**Keep your cleaning staff in-house!**




*Notes:* Source: Data from Hospital data from Patient Environment Action Teams (PEAT) dataset (2010), and Public Health for England (2010). Red dashed line represents the density for Trusts which contracted-out their cleaning services, blue solid line represents the density for in-house delivered cleaning services.

*Toffolutti et al, Social Science & Medicine 2017; 174: 64–69*

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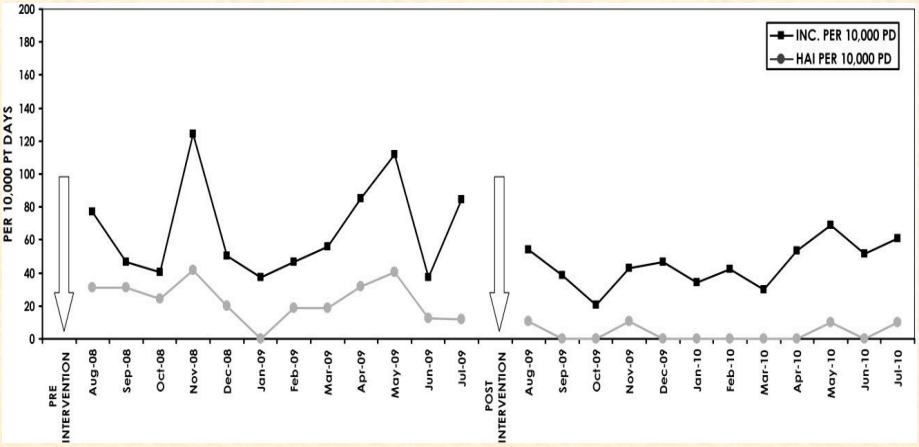
## Wiping Out *Clostridium difficile*




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

**HAI, hospital-acquired CDAD; INC, overall CDAD incidence; PD, patient days; PT, patient.**

***Orenstein et al, ICHE 2011***

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## *Basic hygiene measures reduced VRE incidence*

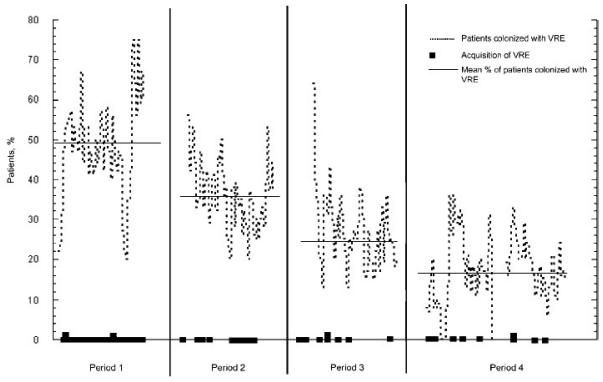


**Figure 1.** Daily percentage of patients colonized with vancomycin-resistant enterococcus (VRE), daily acquisition of rectal colonization with VRE, and mean percentage of patients colonized with VRE, by period. Period 1 was a baseline period (5 March–1 May 2001; duration, 58 days). Period 2 included environmental hygiene intervention (31 May–27 July 2001; duration, 58 days). Period 3 was a "washout" period in which there was no intervention (23 August–18 October 2001; duration, 57 days). Period 4 included hand hygiene intervention (8 November–7 February 2002; duration, 82 days).

Hayden et al,CID,2006

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## *The Hand-Touch equation:*

=

**Hand** **Hand-touch site**

***...is equal and opposite***

*Dancer SJ, ICHE 2010*

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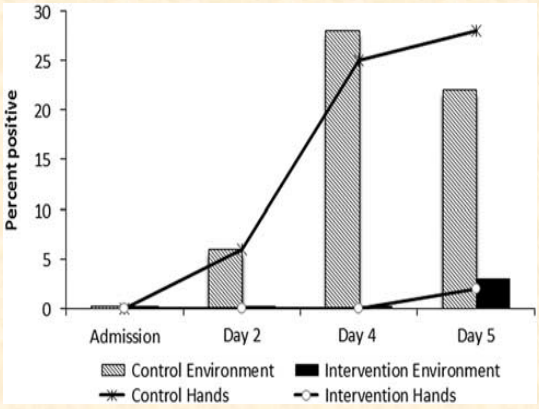
**Impact of a Hand-Hygiene Intervention on Contamination of Patient's Hands with Healthcare-Associated Pathogens**




***One surprising! finding was that patient hand hygiene was associated with reduced contamination of environmental surfaces……***

*Sunkesula et al, ICHE 2016*

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## Daily cleaning?


*The Telegraph, UK, 2008*

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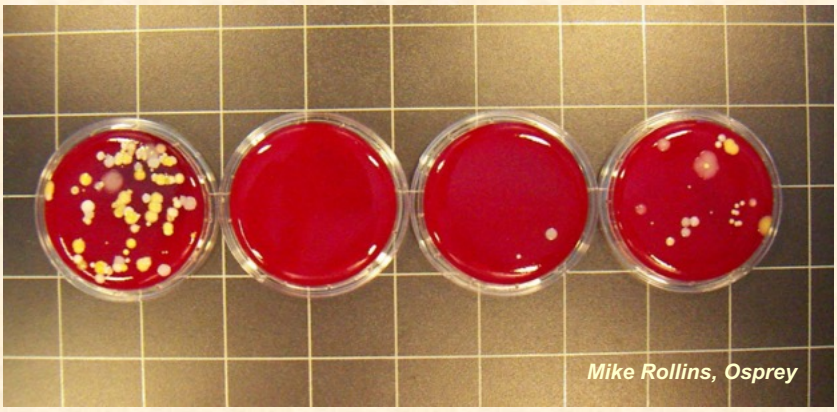
## How long do hospital surfaces stay 'clean'?

**Contact plates from patient locker surface**
***Left to right: Pre clean, 1 hour, 2 hour, 3 hour assessment***




***MRSA rapidly recontaminates high-touch sites in ICU after H202 vapour***

*Hardy KJ et al, JHI 2007*

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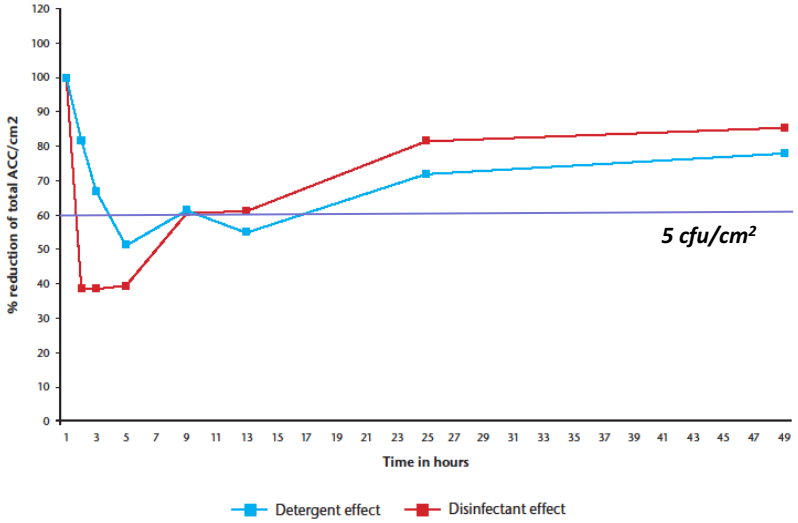
## Effect of detergent (blue line) and disinfectant (red line) cleaning on total ACC at hand-touch sites over 48 hours




*Stewart et al, ICHE 2014*

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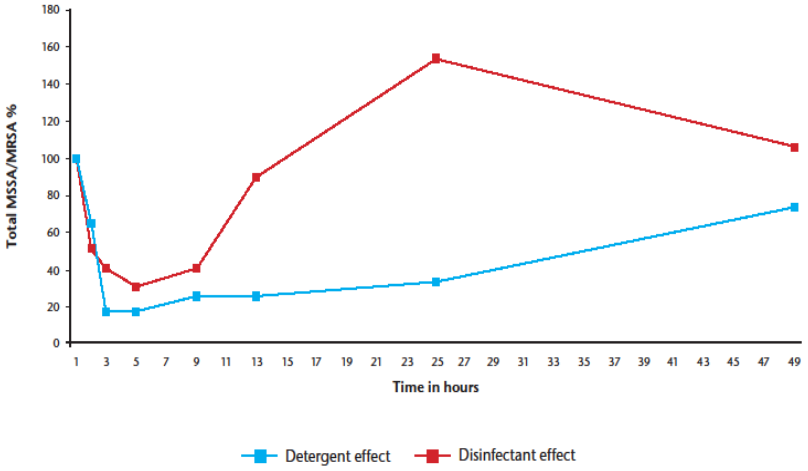
## Effect of detergent and disinfectant cleaning on total MSSA/MRSA at hand-touch sites on one 30 bed ward over 48 hours




*Stewart et al, ICHE 2014*

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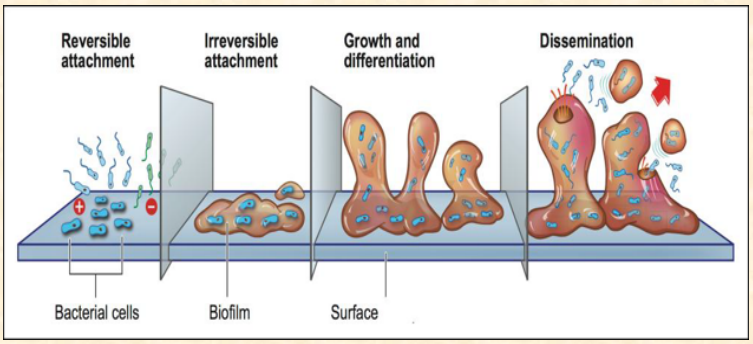


**Do biofilms on hospital surfaces protect viable pathogens from cleaning?**

***Vickery et al, J Hosp Infect 2015***

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## 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**

***Meakin N et al, J Hosp Infect 2012***

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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***

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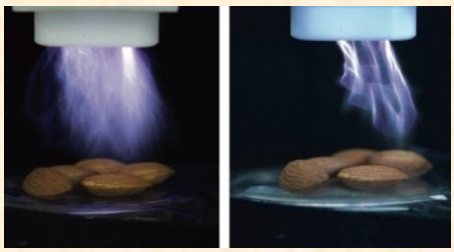
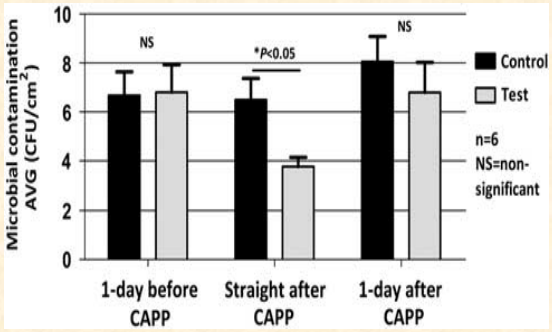
## Cold Plasma Technology reduces surface bacterial counts






Multiple-jet air decontamination of patient tray tables over 8 weeks (n= 6; NS, non significant; *P< .05).

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

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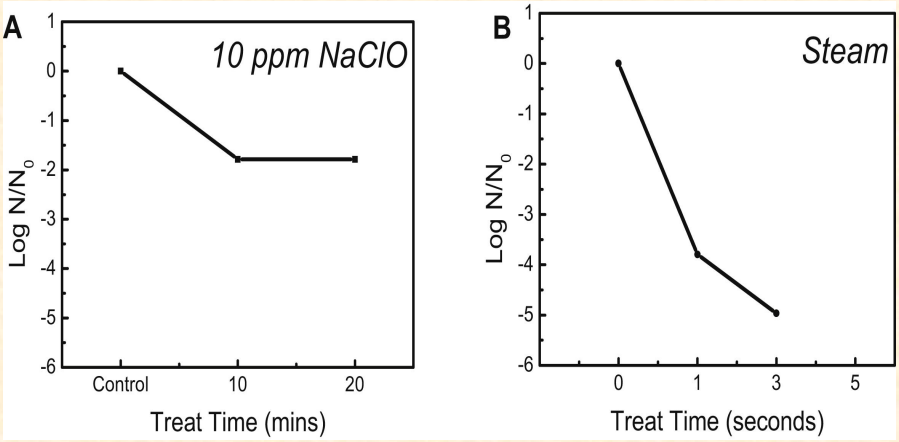
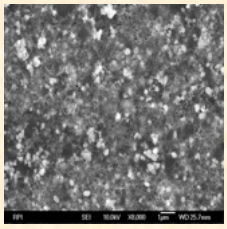
## Effect of bleach vs steam against *E.coli* biofilm




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

*Song et al, AmJIC 2012* 39

## *Antimicrobial surfaces*



- Copper (toilet seats, sinks, handles, etc)
- Silver (textiles, etc)
- Triclosan (tootpaste, 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* 40

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

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

Laminated wood bedside table coated with NanoCote following water spillage

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

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## '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…..**

*Dancer SJ, Clin Micro Rev 2014;*

*Po & Carling, ICHE 2010*

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## Does $H_20_2$ 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 H202 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..

*Blazejewski C et al, Crit Care 2015*

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## Terminal decontamination of rooms using H202 vapour

Patients were 64% less likely to acquire MDROs and 80% less likely to acquire VRE ($P < 0.001$) following $H_20_2$ 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.

***Passaretti et al. Clin Infect Dis, 56 (2013): 27–35***

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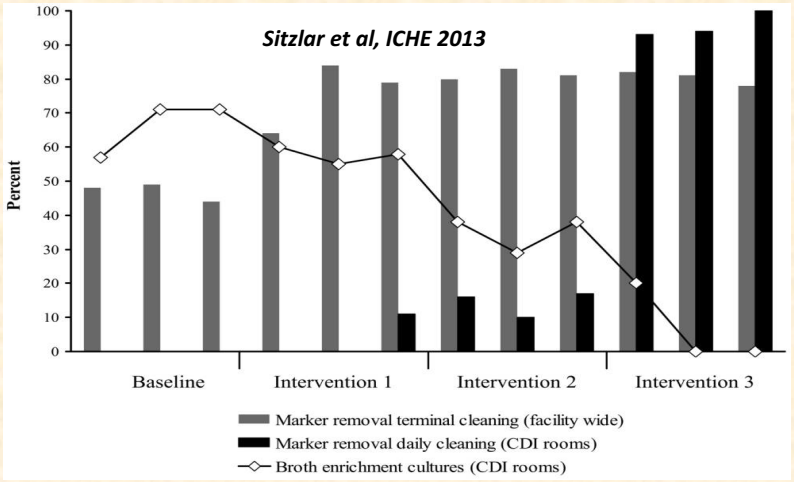
## An Environmental Disinfection Odyssey: evaluation of sequential interventions to improve disinfection of *C.difficile* isolation rooms




**35% of rooms remained culture positive for *C. difficile* after use of UV devices**

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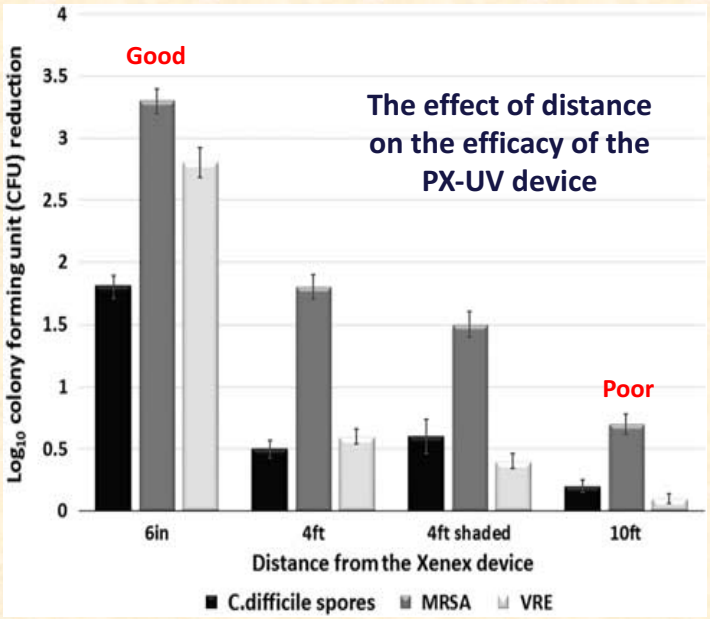


*Nerandzic et al, ICHE 2015*

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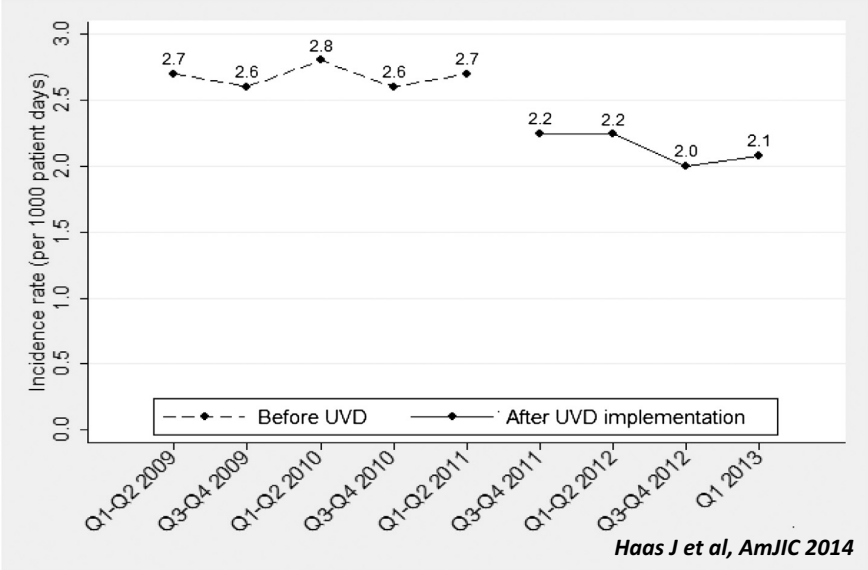
**Incidence of MDROs and *Clostridium difficile* from January 2009 until April 2013; pulsed UV light introduced May 2011**




*Haas J et al, AmJIC 2014*

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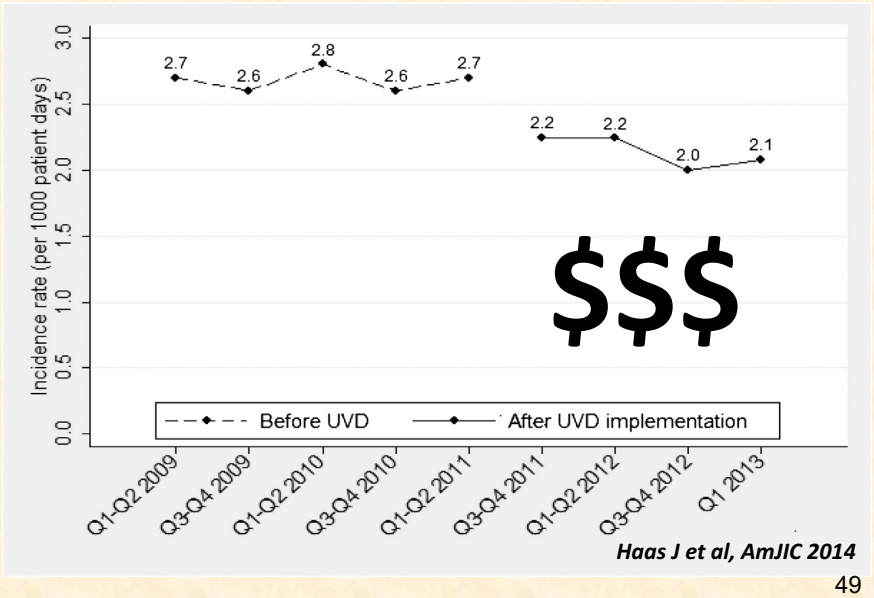
**Incidence of MDROs and *Clostridium difficile* from January 2009 until April 2013; pulsed UV light introduced May 2011**




*Haas J et al, AmJIC 2014*

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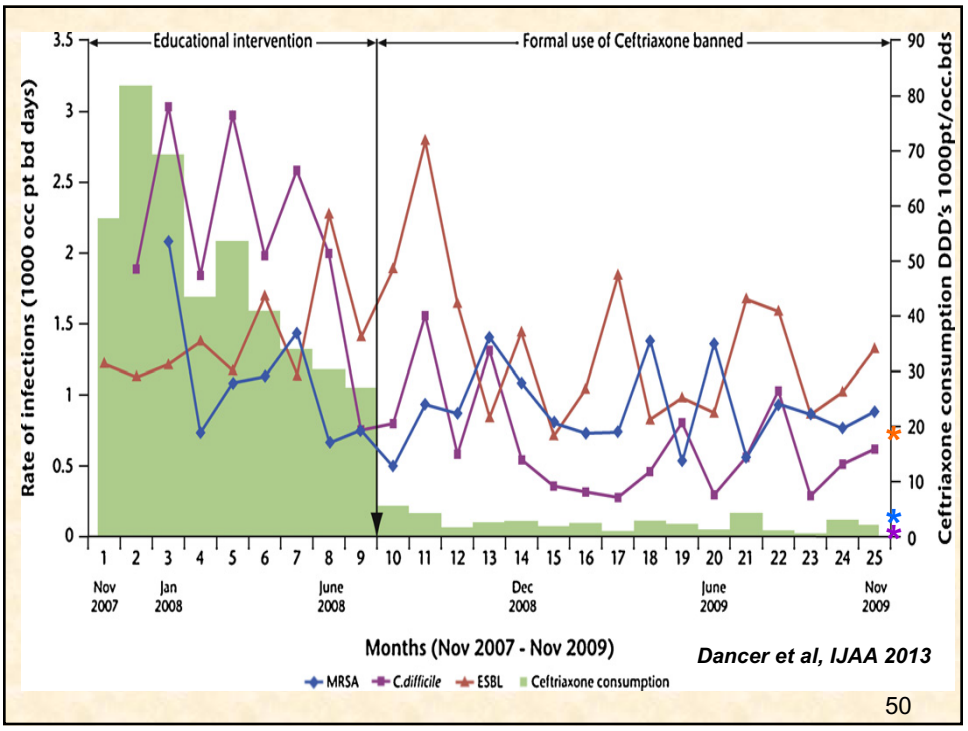


*Dancer et al, IJAA 2013*

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

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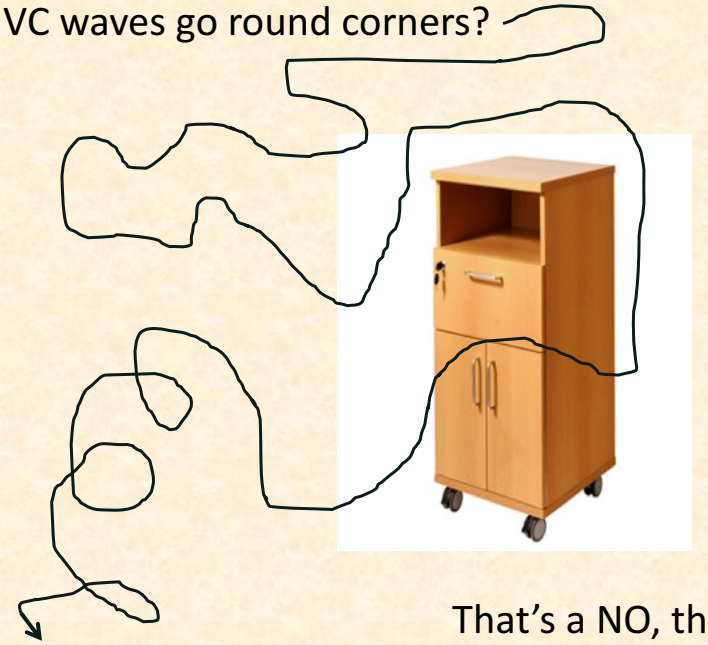
Can UVC waves go round corners?



That's a NO, then?

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***Toxicity?***

**Humans**
**Surfaces**
**Plastics**
**Plants**
**Animals**

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## 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 H202 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***

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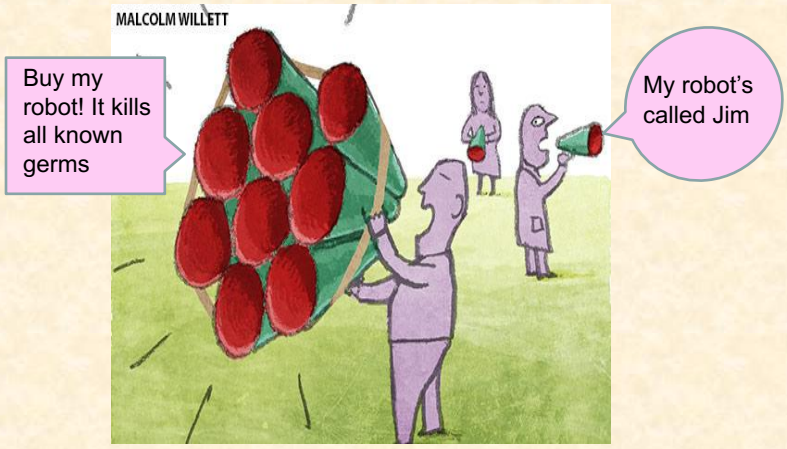
Aggressive marketing by robot companies encourages healthcare managers to choose these methods…




**…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**

56

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

57

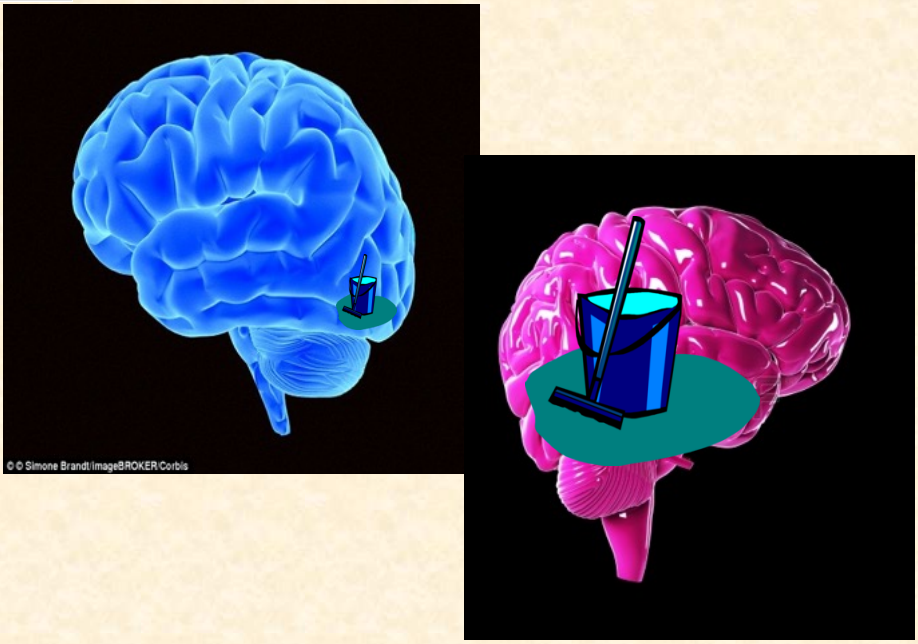
**Boys with toys?**


58

true


59

true




60

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

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

61

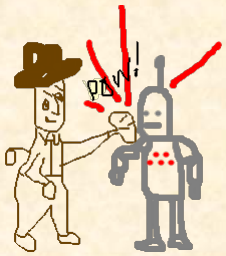
Even if all the rooms are decontaminated by robots, we still need staff to manually pick up litter…

62

## *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%.....**

***Speight et al, J Hosp Infect 2011***

**Detergent gives the same result as disinfectant for cleaning clinical equipment**

***Petti et al, AmJIC 2012***

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

***Berendt et al, AmJIC 2011***

***Physical removal of C.difficile spores is more important than sporicidal inactivation***

***Rutala et al, ICHE 2012***

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## 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!

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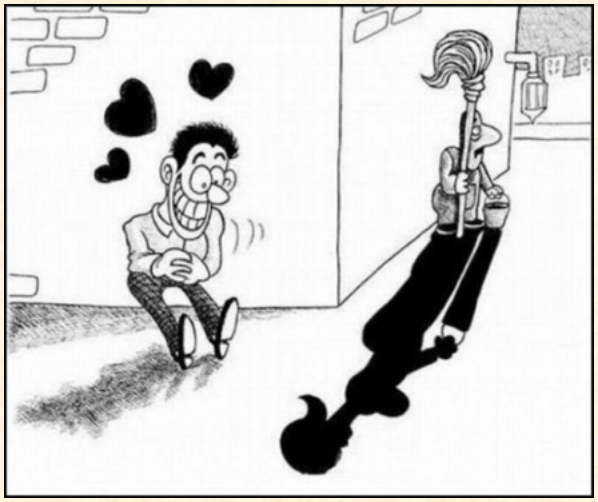
***NB. No disclosures***



65

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|---|---|
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| May 5, 2017 | *(FREE … WHO Teleclass - Europe)*<br>SPECIAL LECTURE FOR 5 MAY<br>Speaker: **Prof. Didier Pittet**, World Health Organization, Geneva<br>*Sponsored by the World Health Organization Infection Control Global Unit (www.who.int/gpsc/en)* |
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