Do's and Don'ts for hospital cleaning

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A. Denver Russell Memorial Teleclass Lecture

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


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

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

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

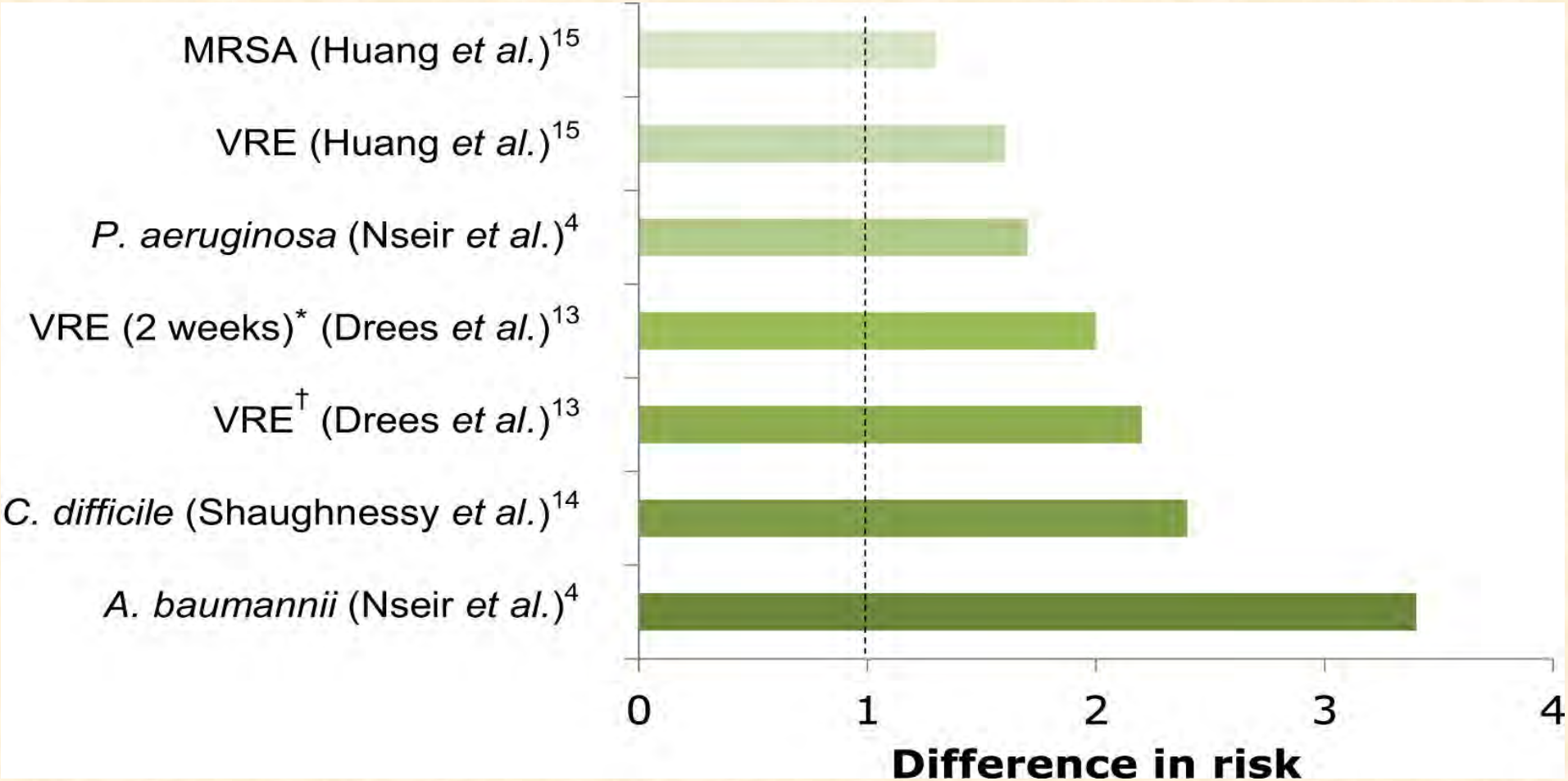
Properties of hospital pathogens

	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

Increased risk associated with the prior room occupant.

The figures of difference in risk are unadjusted based on raw data.

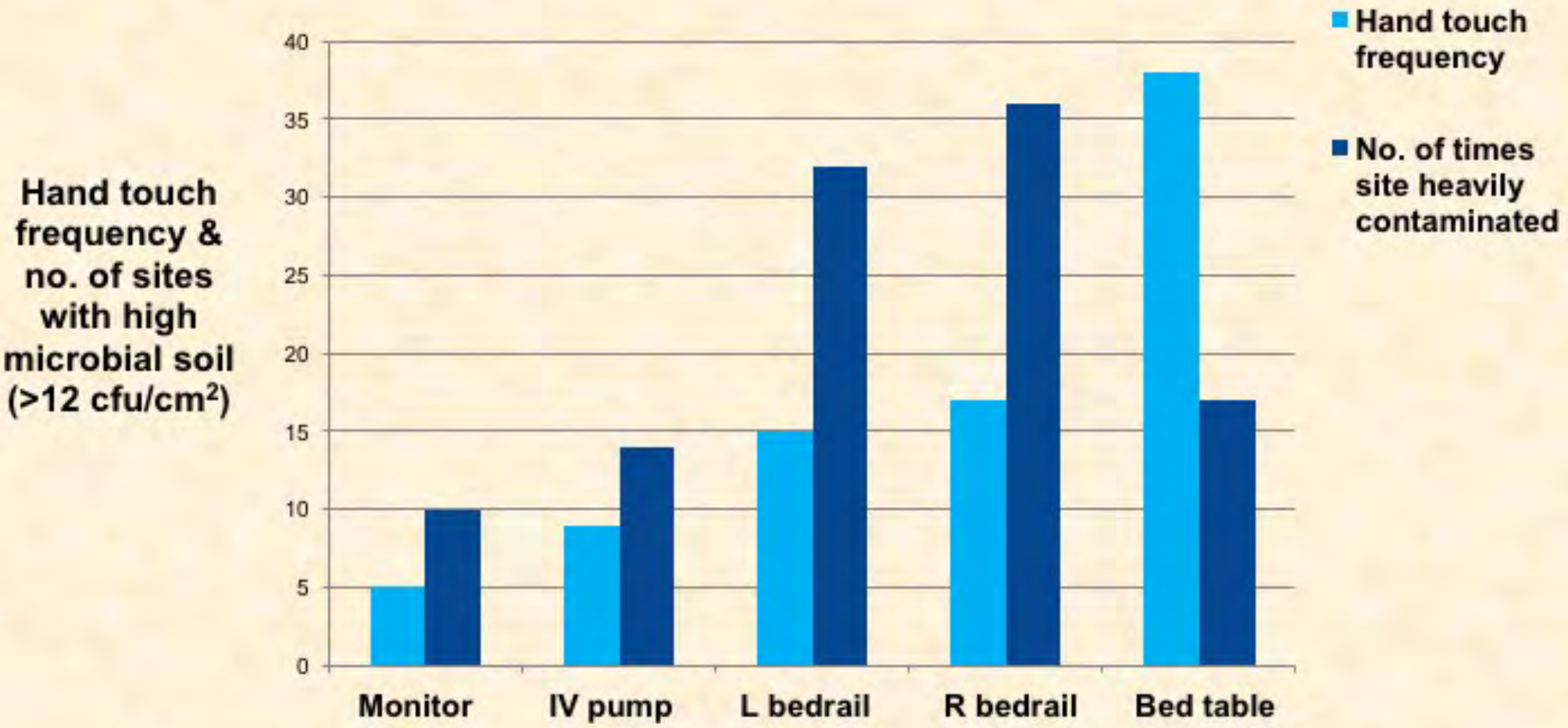


Is risk related to environmental longevity? ***Otter et al, Am J Infect Control 2013***
Mitchell et al, J Hosp Infect 2015

Where are the pathogens in a hospital?

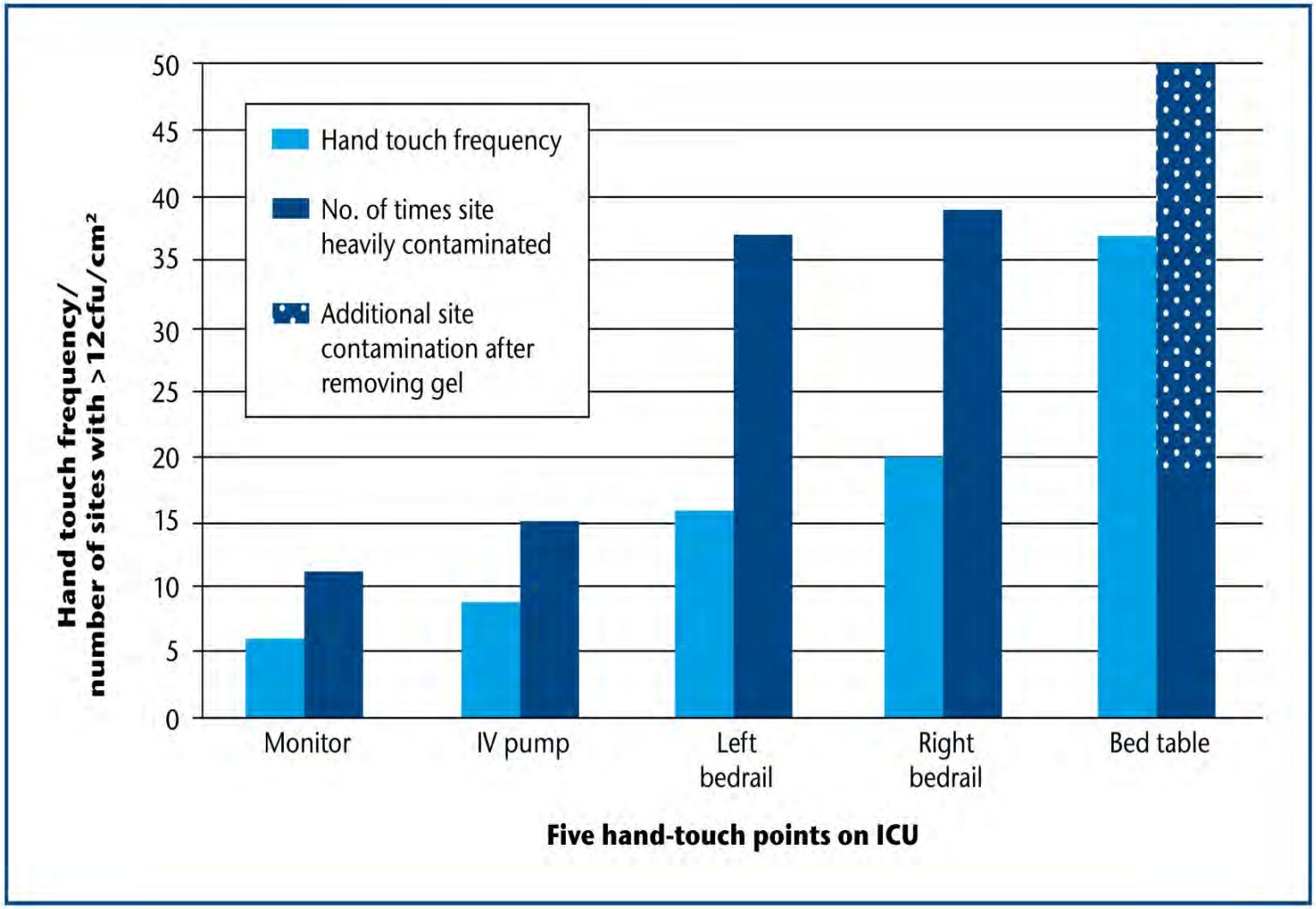
Hayden et al, SHEA 2004

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



Adams et al, J Hosp Infect 2017

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



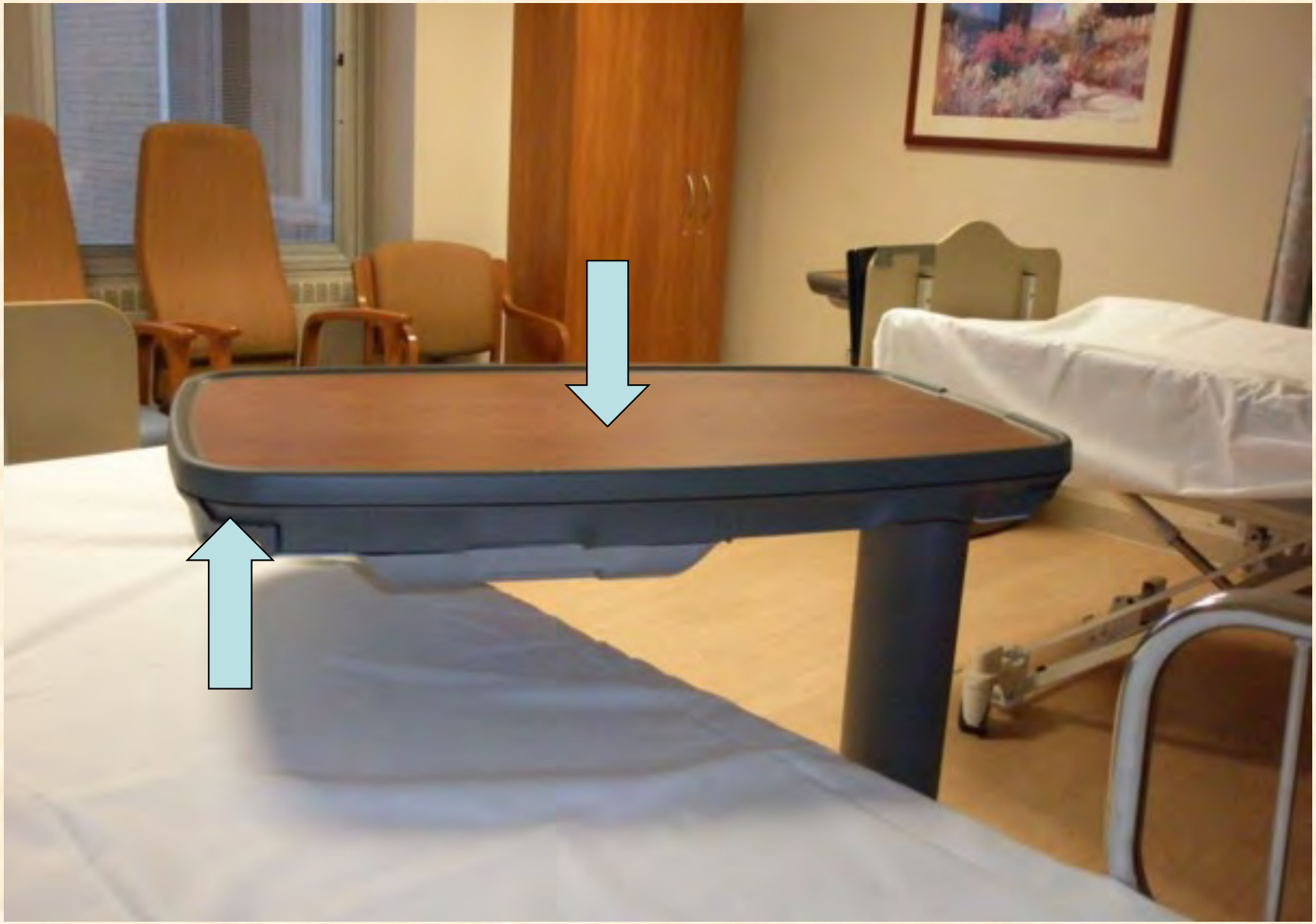
Adams et al, J Hosp Infect 2017

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



Removal of marker may not correlate with cleaning of alternate sites on the same surface

Sitzlar et al, ICHE 2013

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

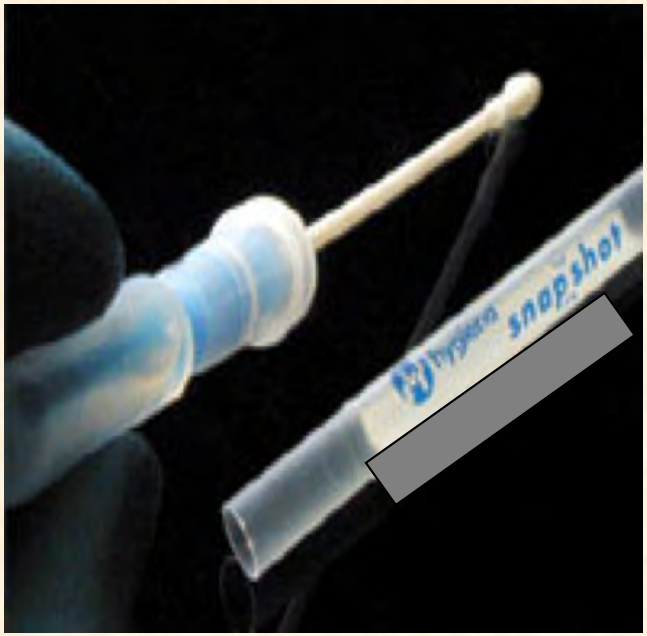
What is clean?

“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

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

**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!

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.

Would microbiological standards help?

5 cfu/cm^2

45 cfu/cm^2

Slide from Chris Griffith

Microbiological standards for surface hygiene in hospitals

Standard 1

There should be <1cfu/cm^2 pathogen (MRSA; C.difficile; VRE; etc) on healthcare surfaces

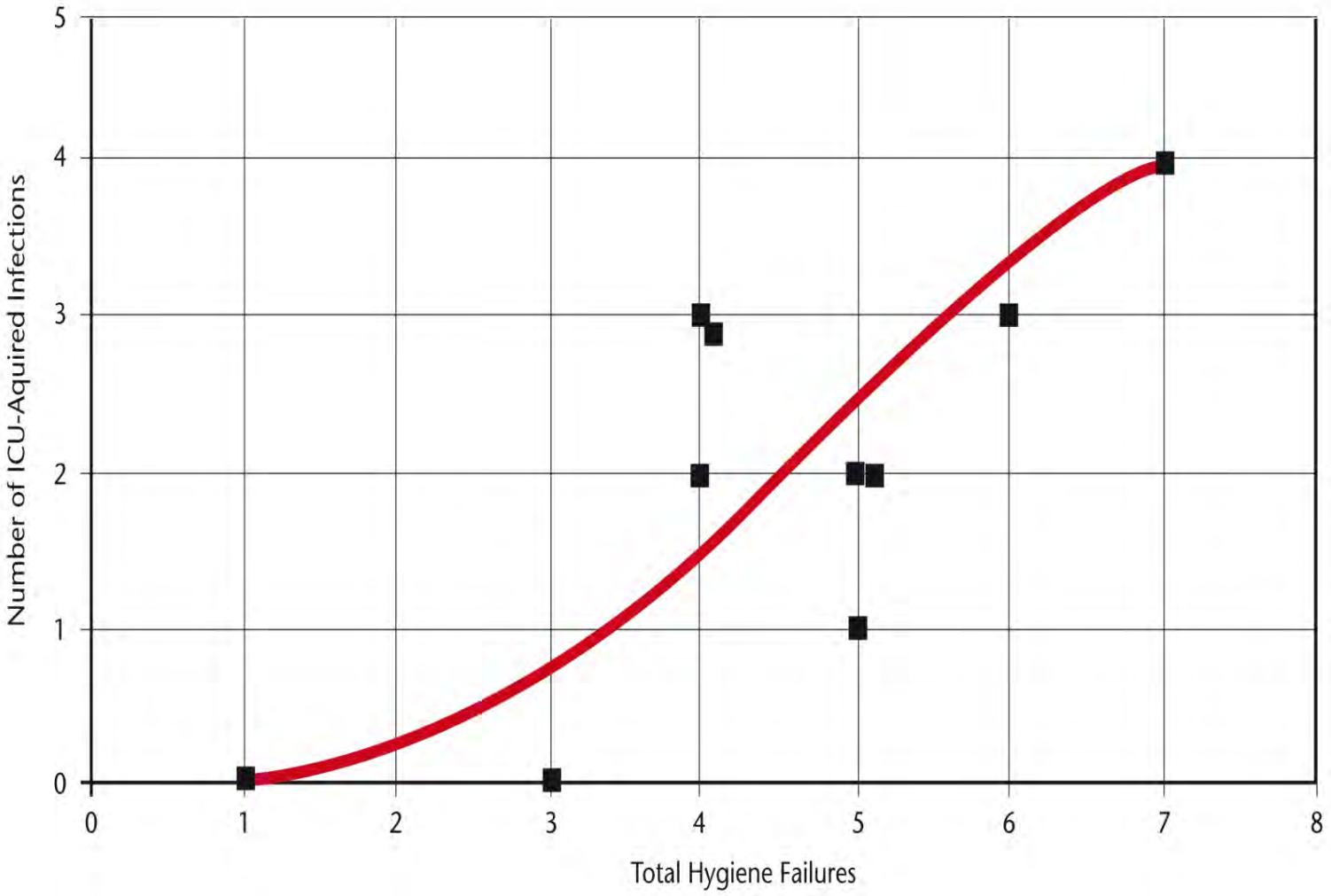
Standard 2

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

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

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



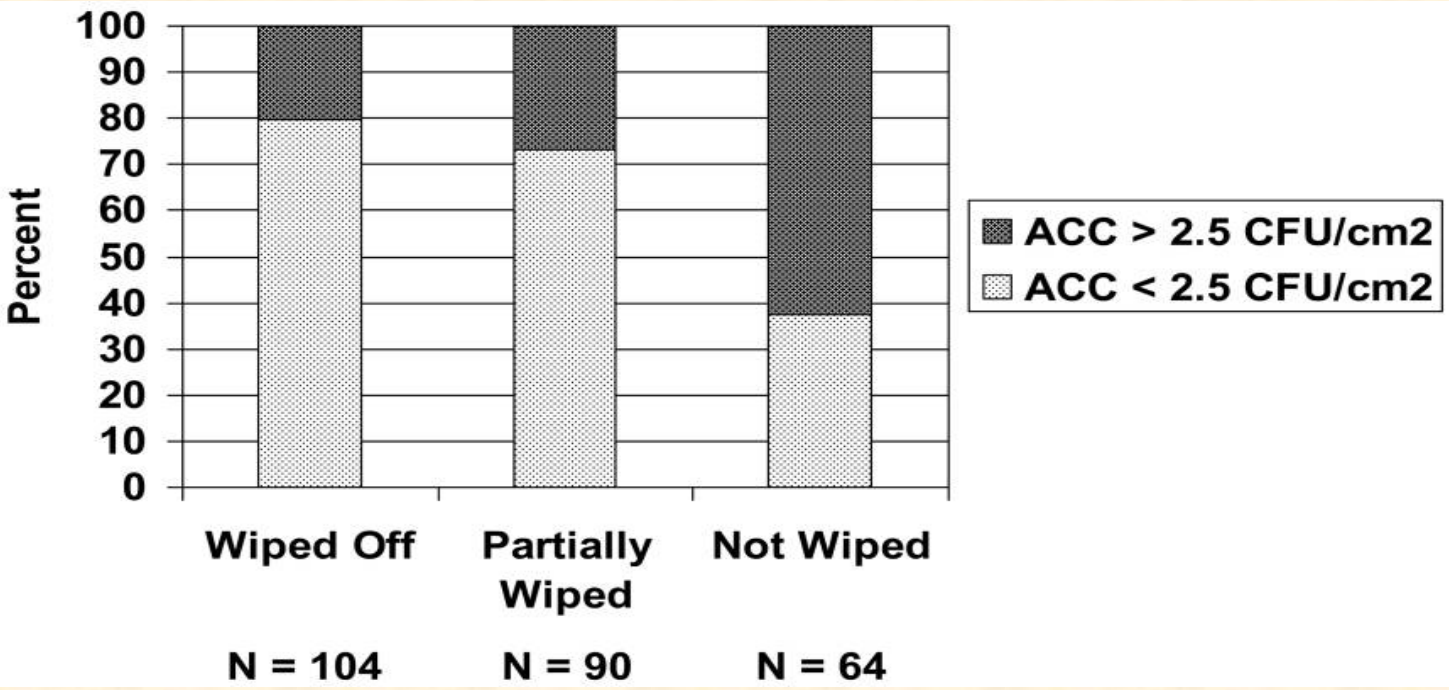
White et al, AmJIC 2008

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

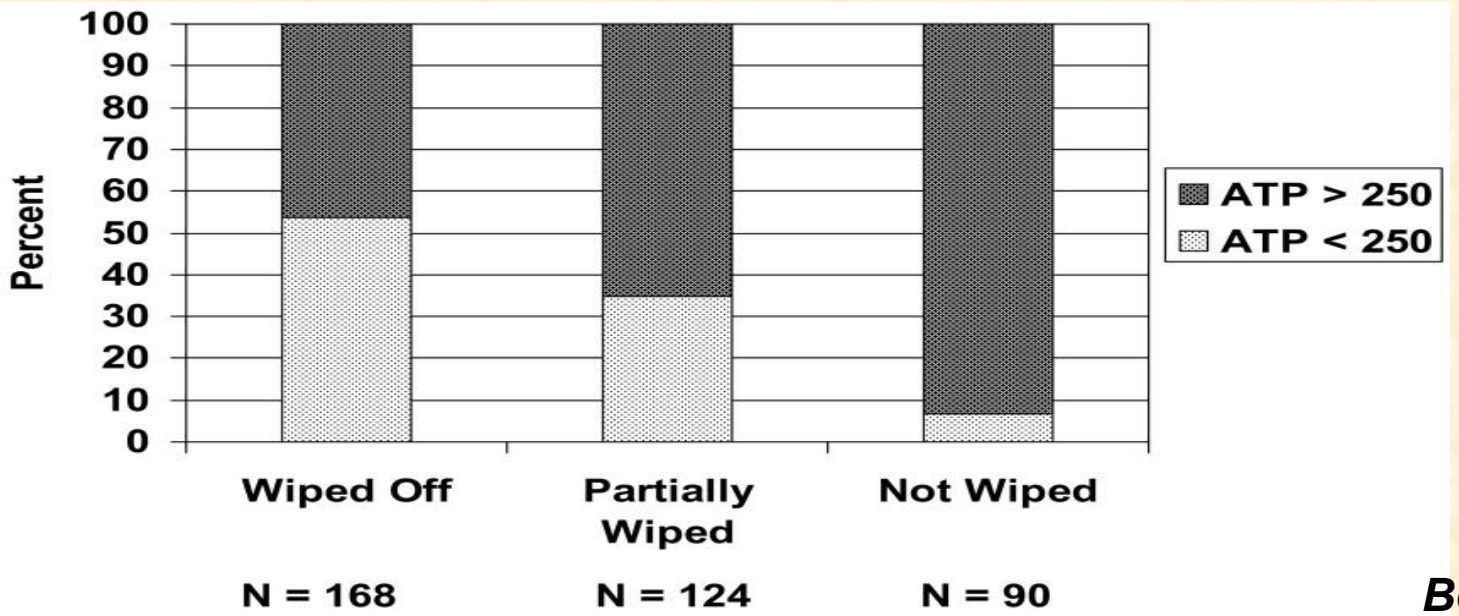
Aim for a system which shows measurable benefit for patients: aesthetics, cleaning focus, cleaner surfaces, and if you're lucky, HAI rates; but….

wouldn't it be nice to have a system that gives us early warning of an imminent outbreak?

Correlating cleaning effect against surface cleanliness indicators



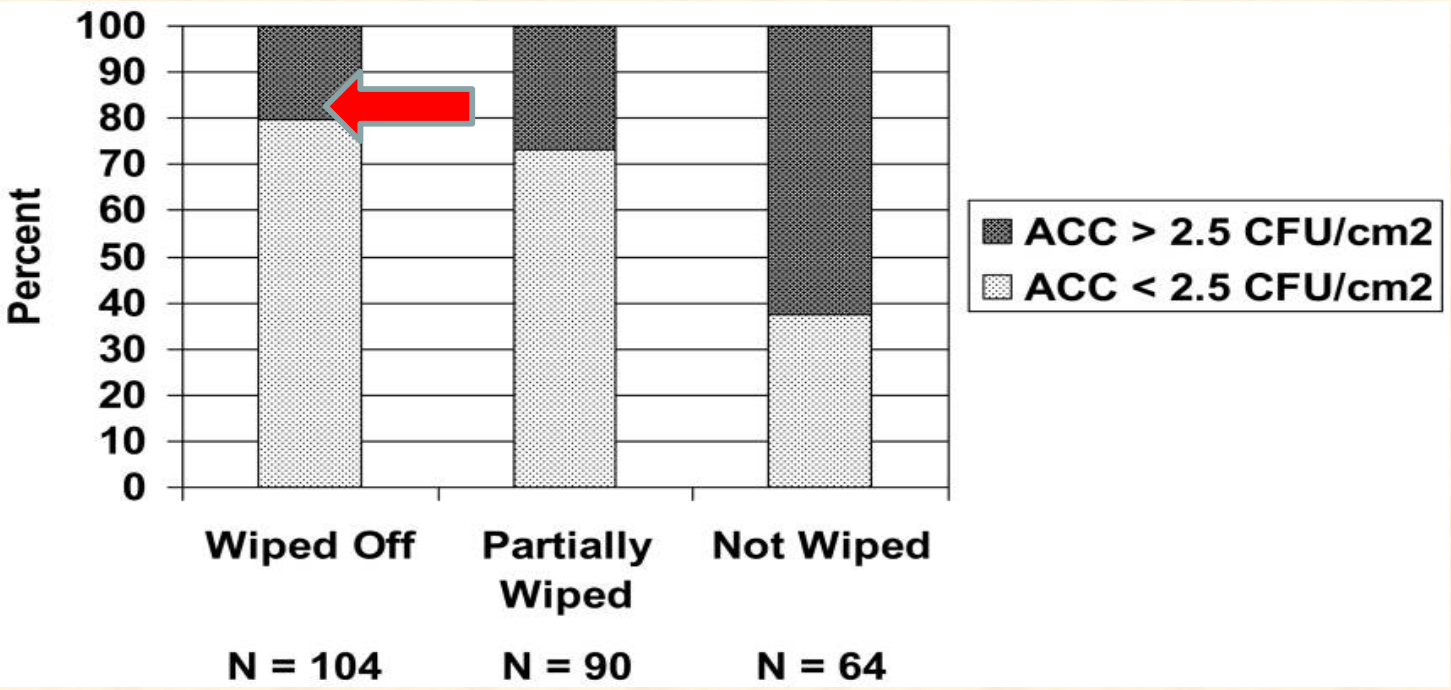
Fluorescent marker vs ACCs; *how well have surfaces been cleaned*



Fluorescent marker vs ATP; *which surfaces need cleaning*

Boyce et al, ICHE 2011

Correlating cleaning effect against surface cleanliness indicators



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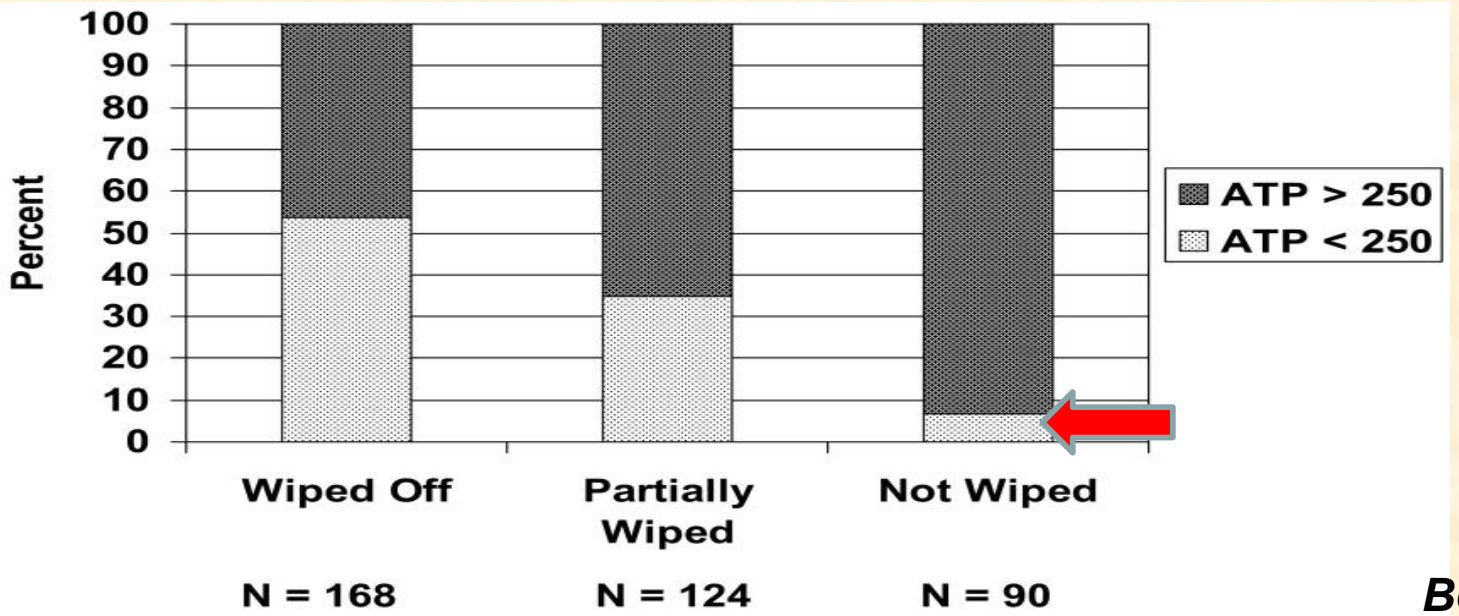


Fluorescent marker vs ATP; *which surfaces need cleaning*

Boyce et al, ICHE 2011

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

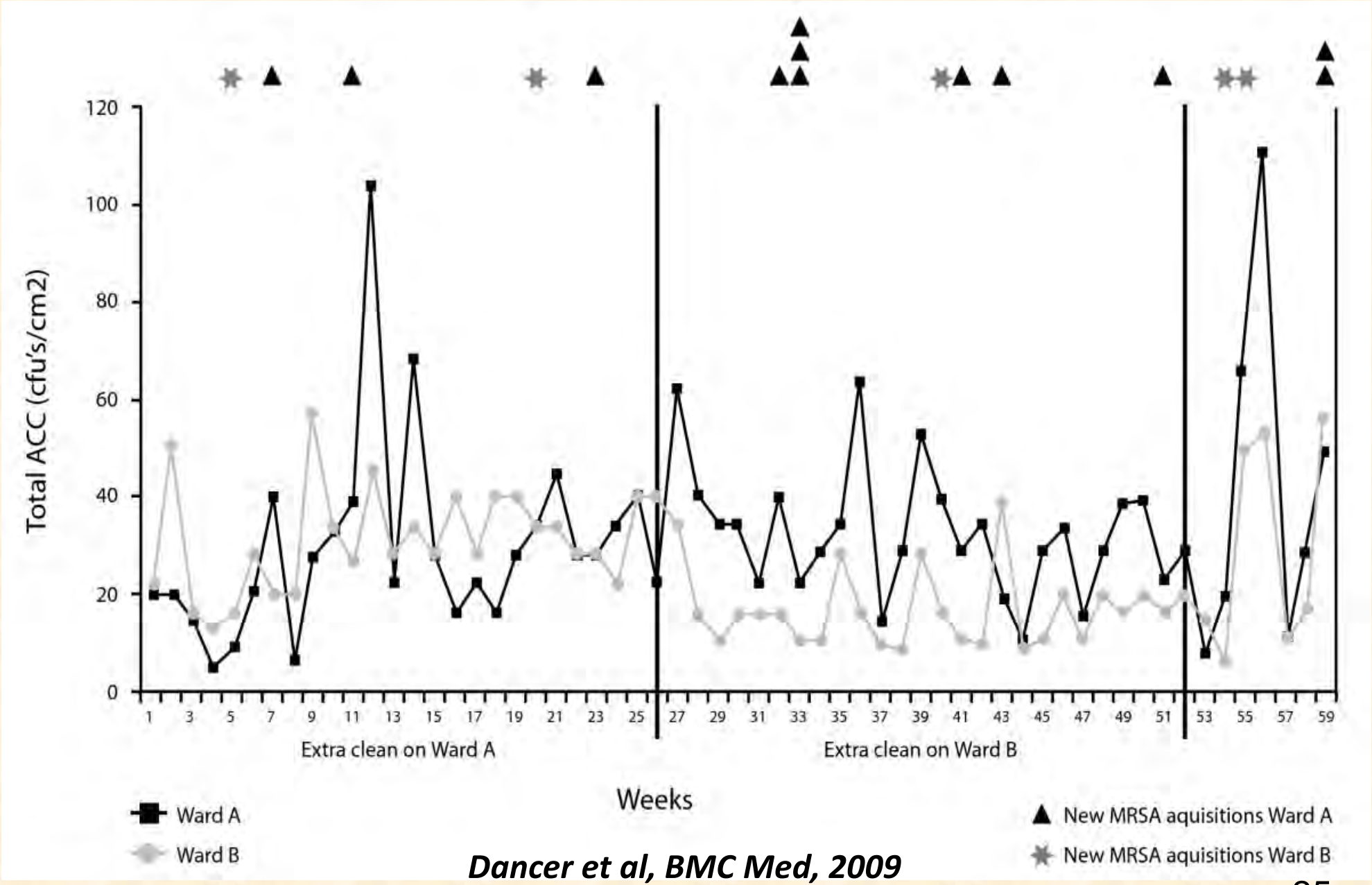
BBC website, 2008

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%).

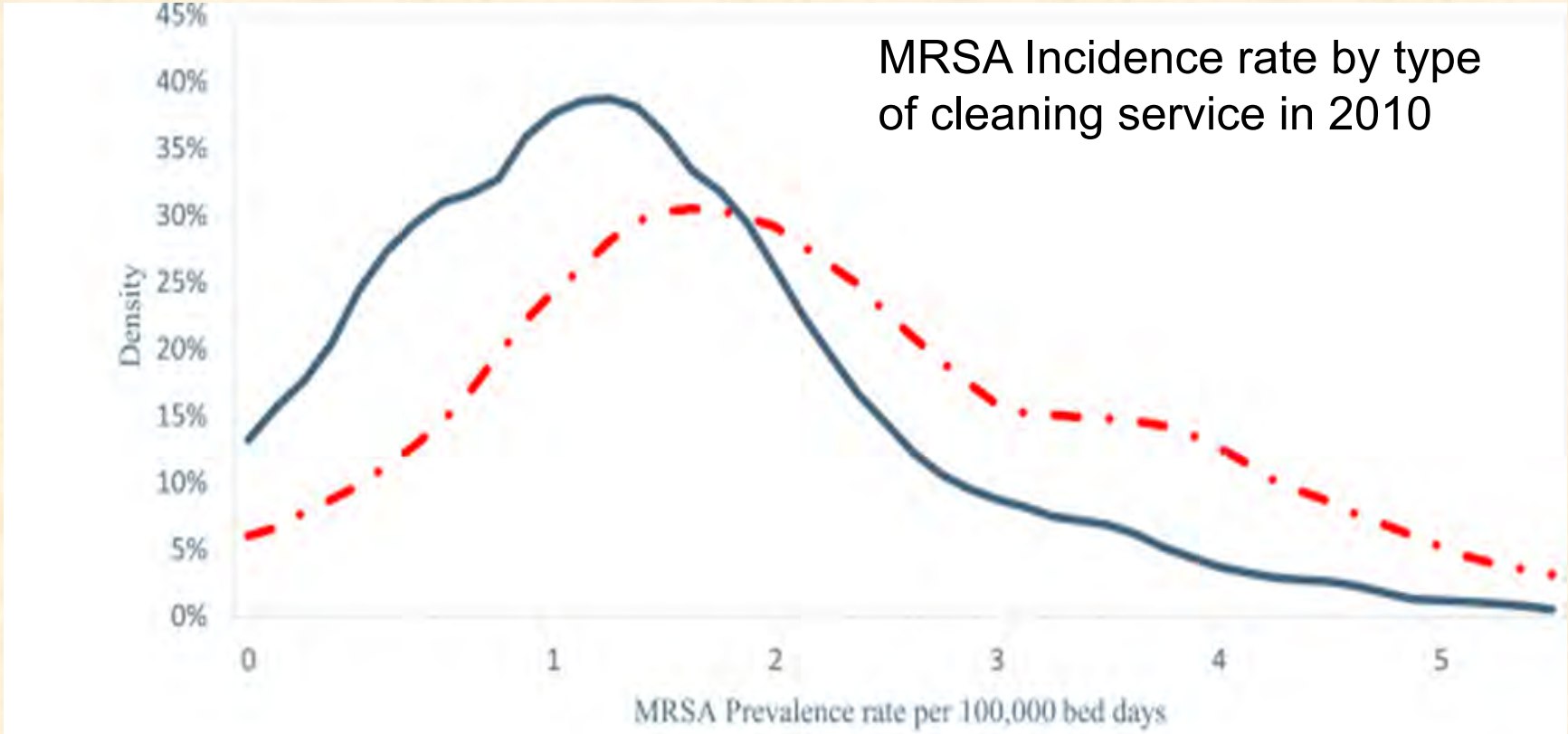
Dancer et al, BMC Med, 2009

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

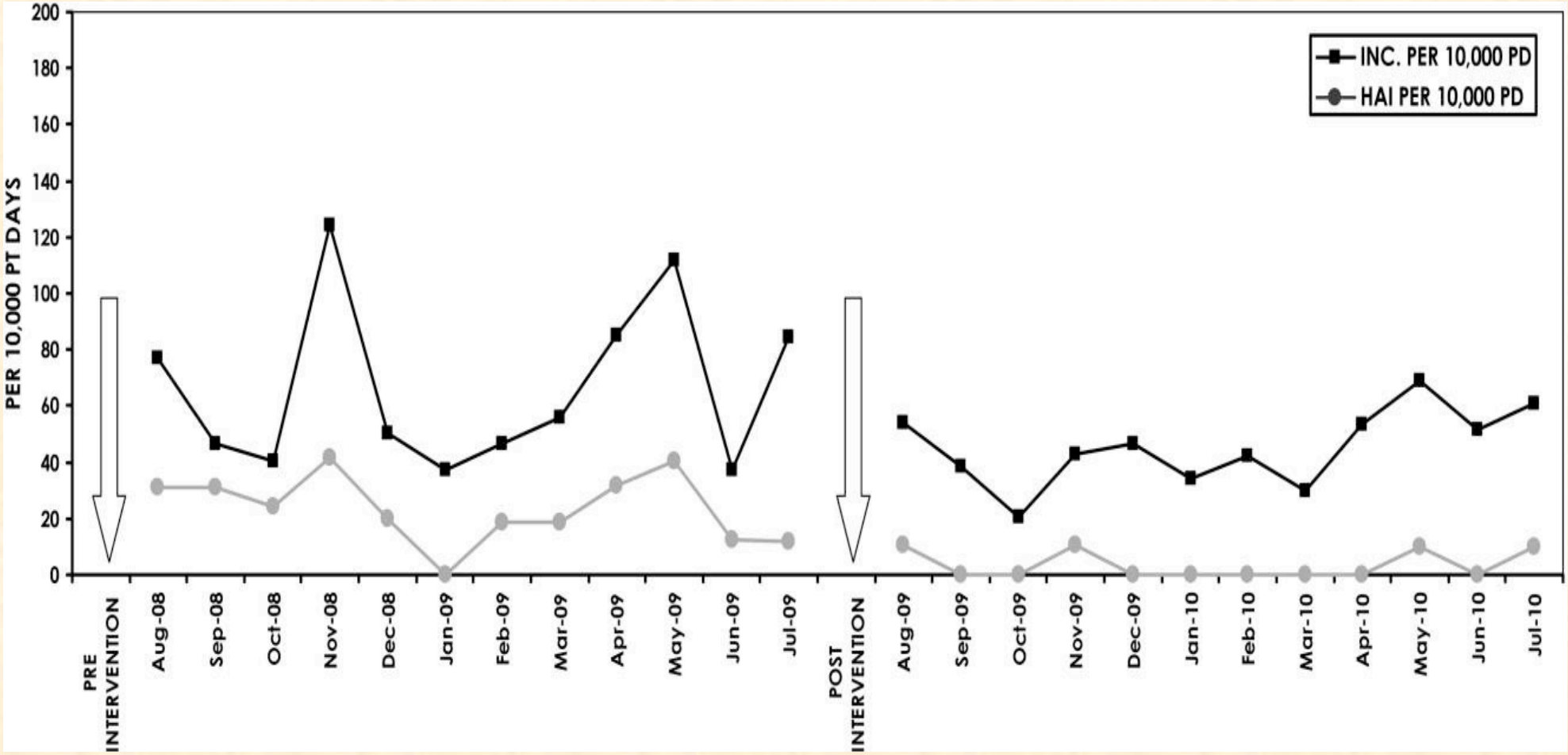
Keep your cleaning staff in-house!



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

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

Basic hygiene measures reduced VRE incidence

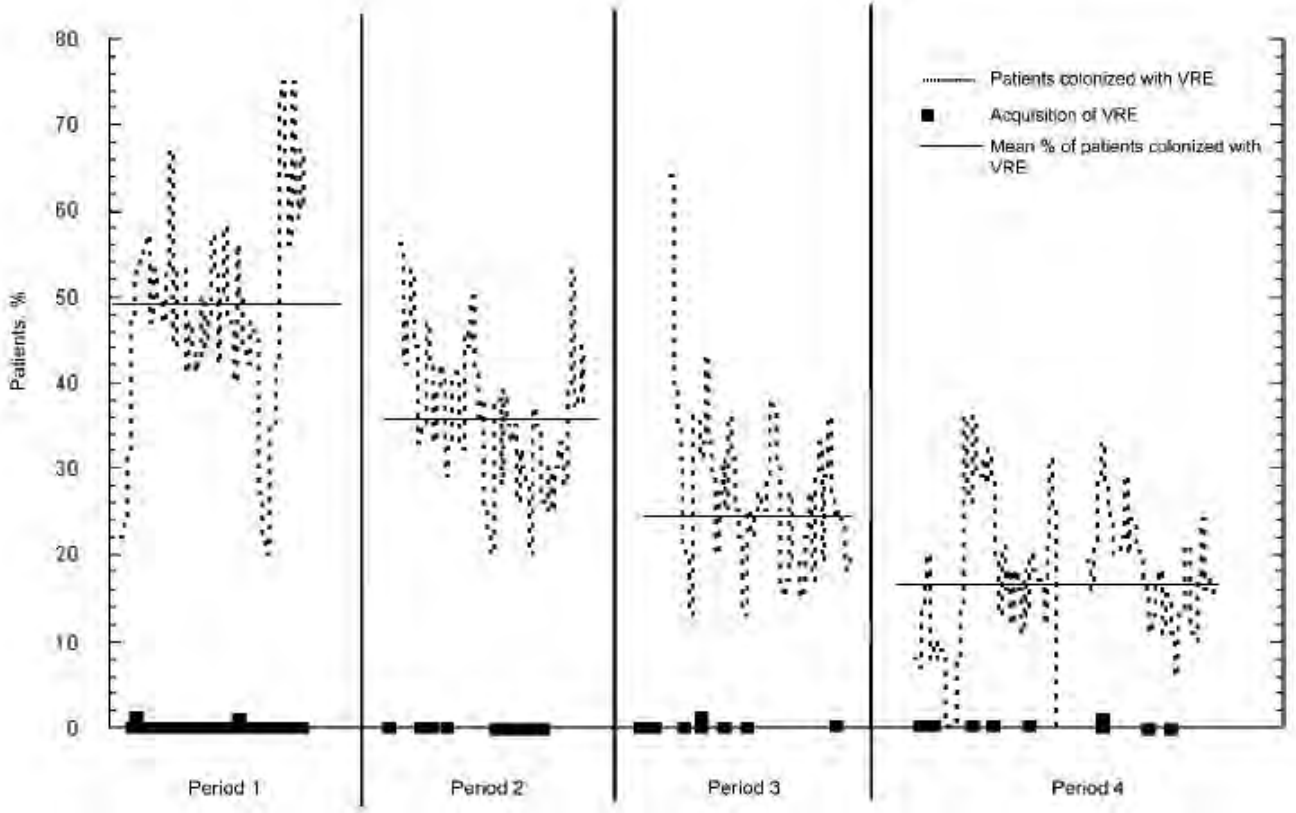


Figure 1. Daily percentage of patients colonized with vancomycin-resistant enterococcus (VRE), daily acquisition of rectal colonization with VRE, and mean percentage of patients colonized with VRE, by period. Period 1 was a baseline period (5 March–1 May 2001; duration, 58 days). Period 2 included environmental 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

The Hand-Touch equation:

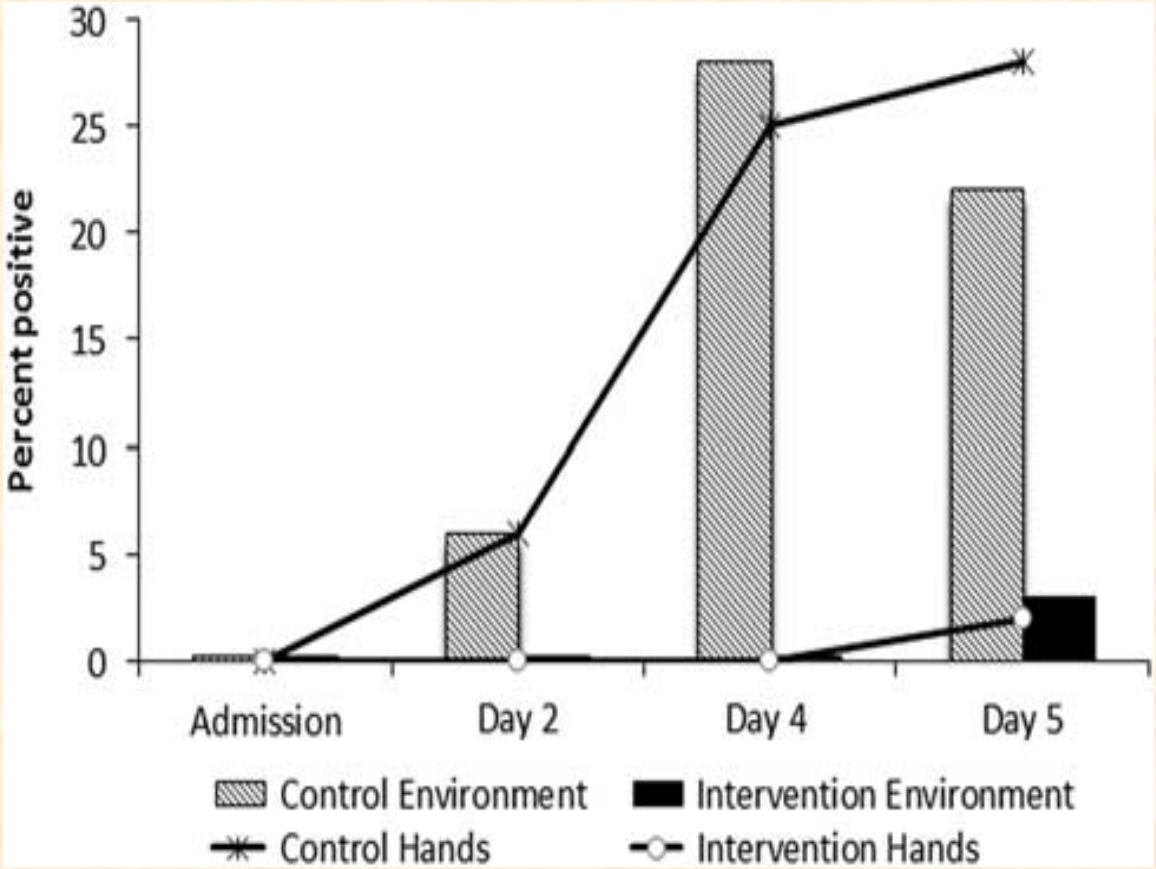
=

Hand **Hand-touch site**

...is equal and opposite

Dancer SJ, ICHE 2010

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……

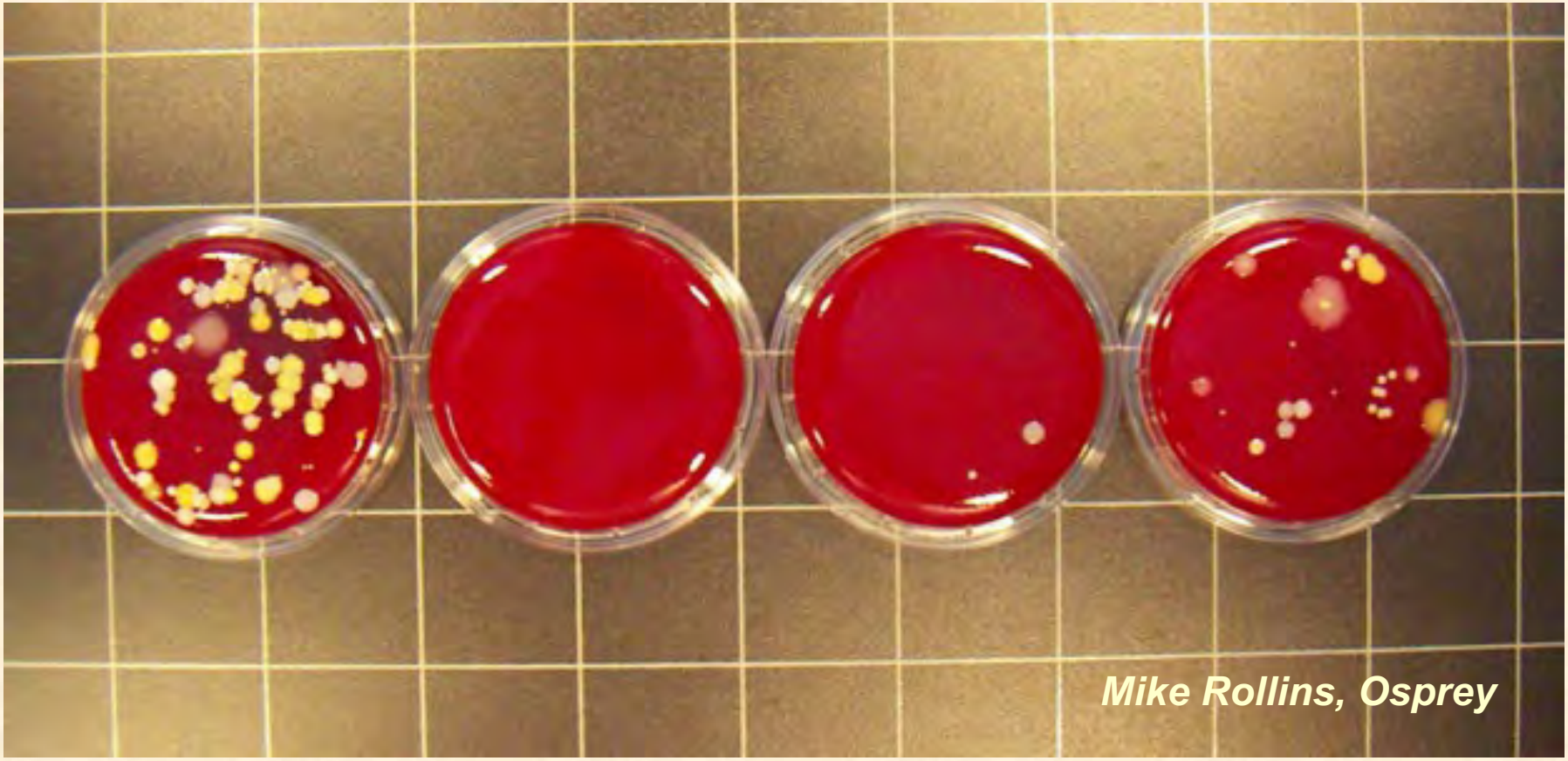
Sunkesula et al, ICHE 2016

Daily cleaning?

The Telegraph, UK, 2008

How long do hospital surfaces stay 'clean'?

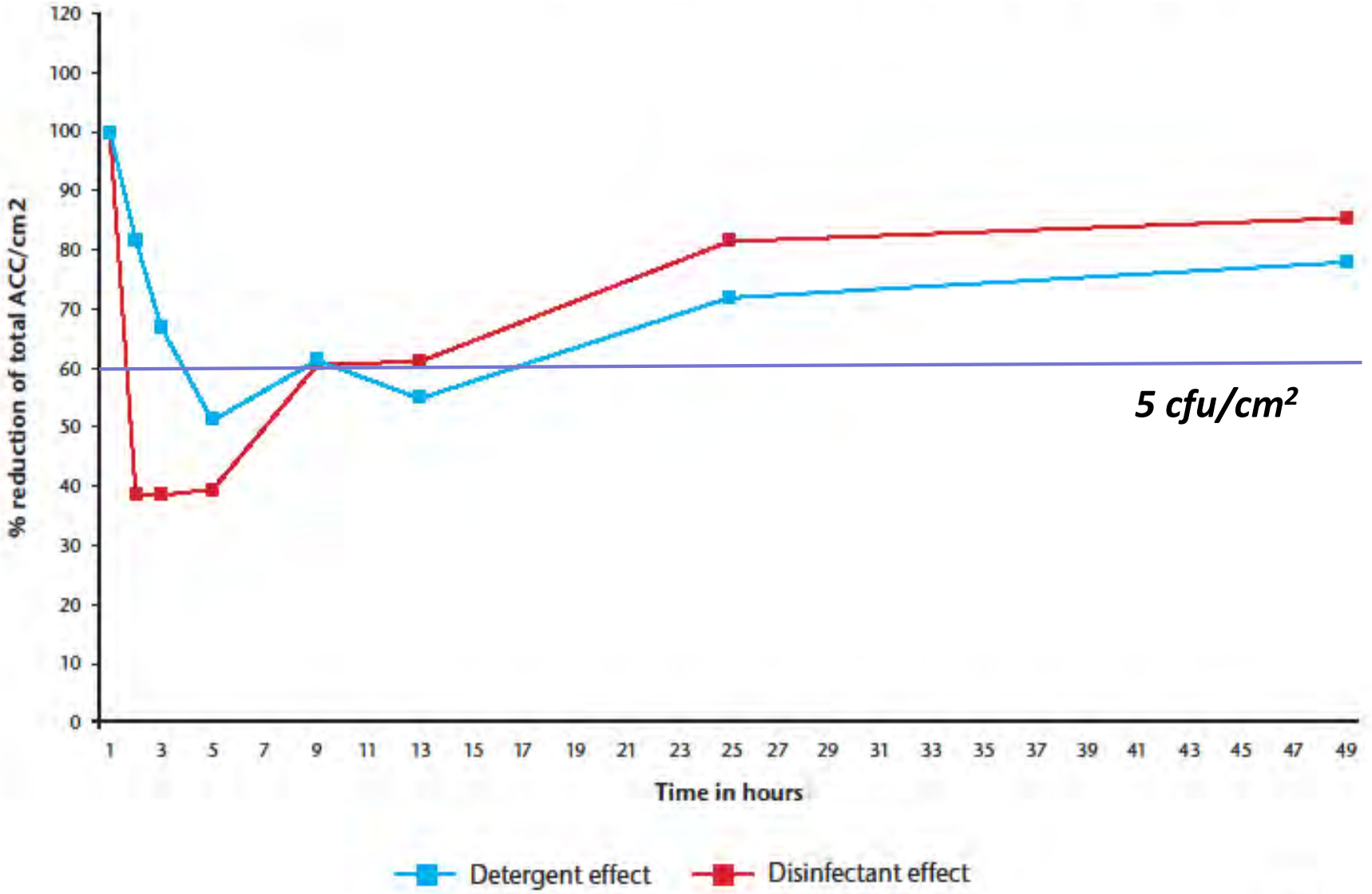
Contact plates from patient locker surface
Left to right: Pre clean, 1 hour, 2 hour, 3 hour assessment



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

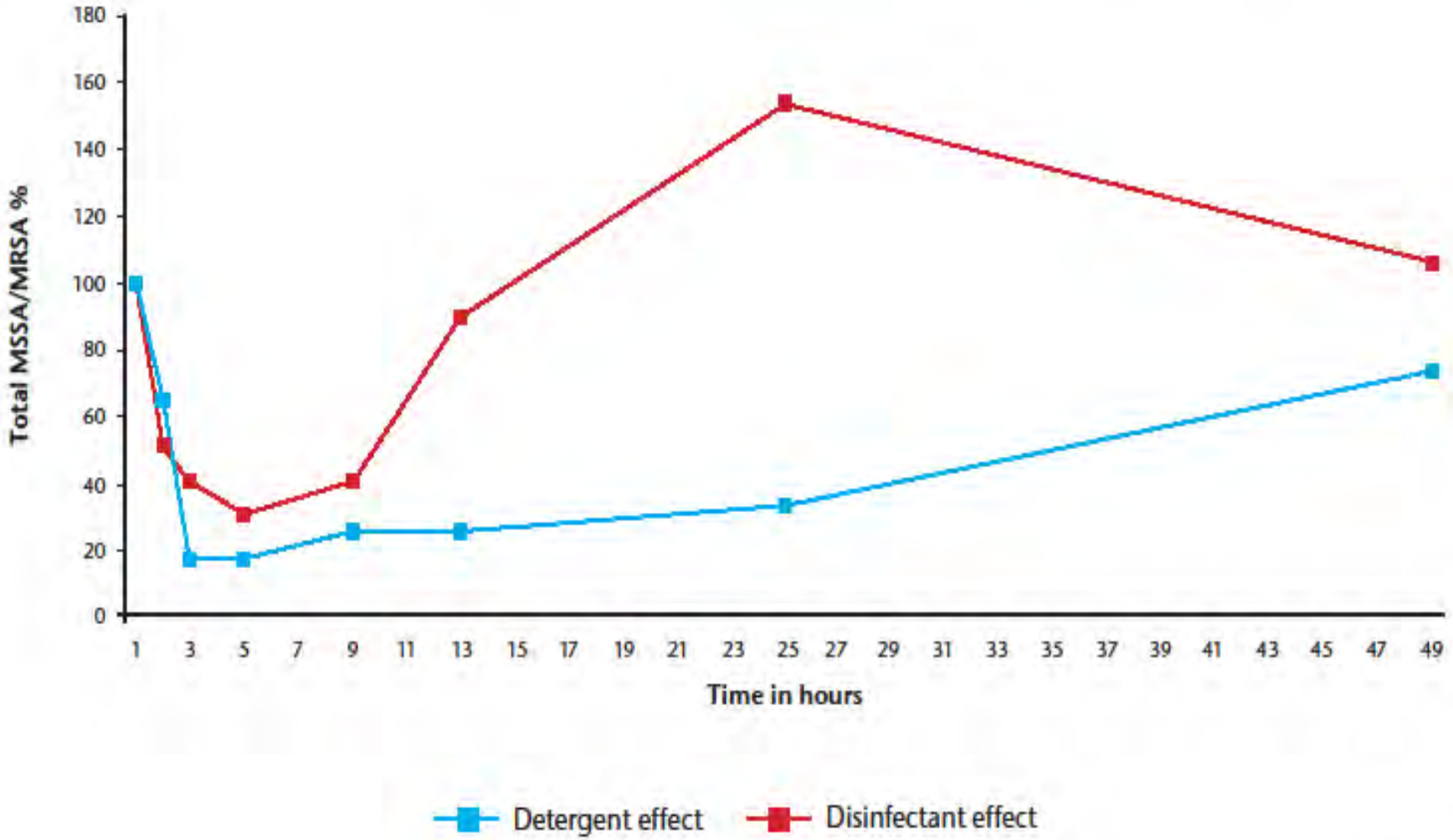
Hardy KJ et al, JHI 2007

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

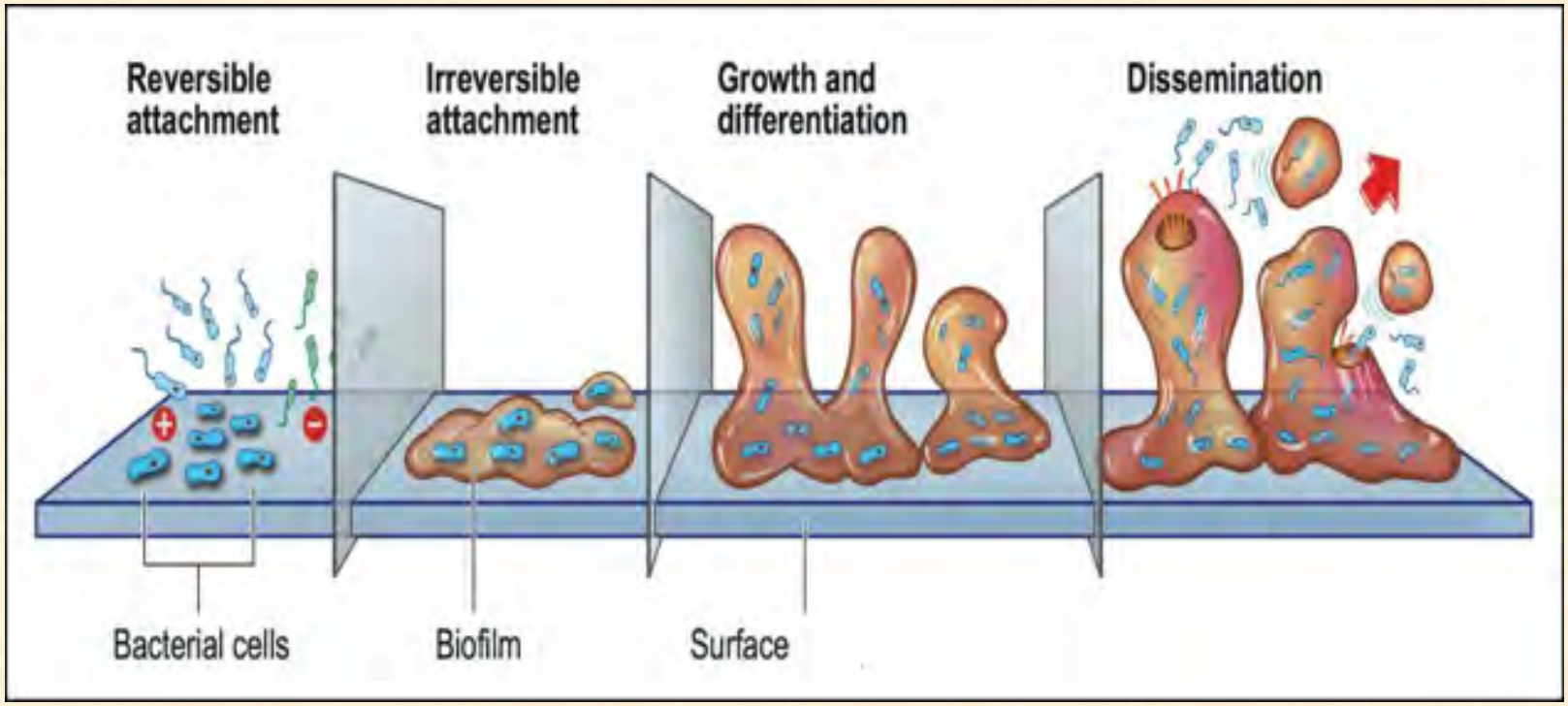


Stewart et al, ICHE 2014

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



Do biofilms on hospital surfaces protect viable pathogens from cleaning?

Vickery et al, J Hosp Infect 2015

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

Electrolysed water

What is it?

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

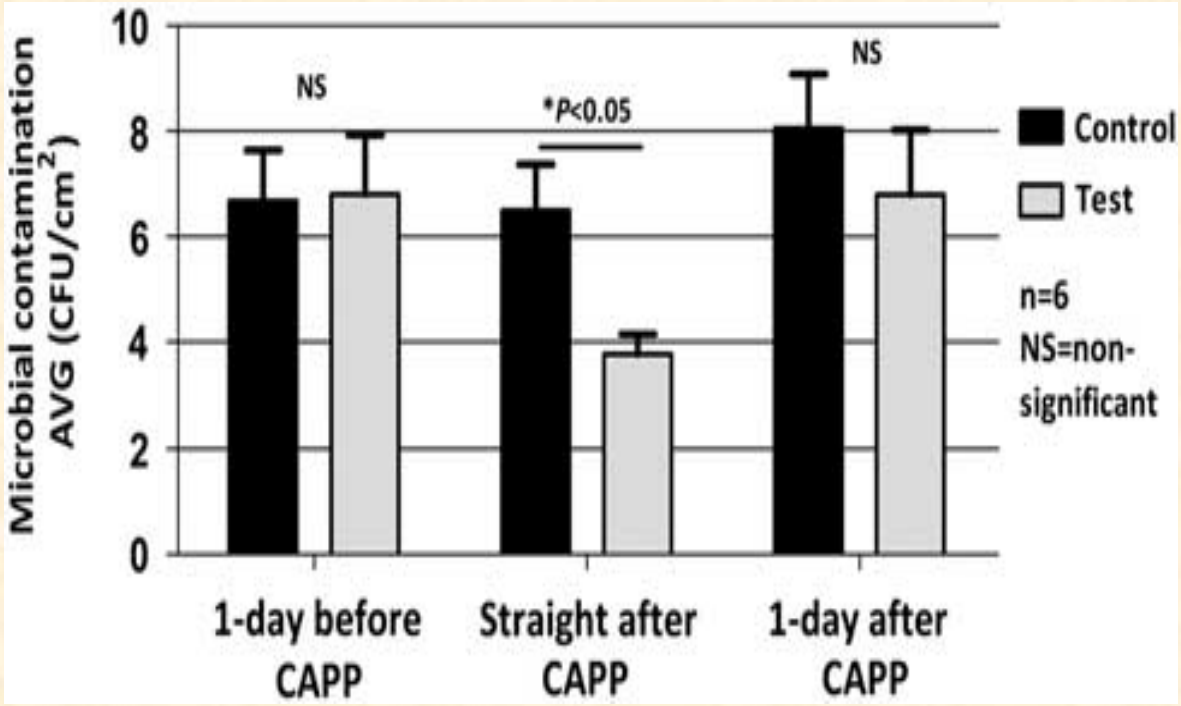
It is microbiocidal due to the presence of hypochlorous acid. This acid is only present in very low concentrations so that the product has a neutral pH, the same as ordinary water.

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

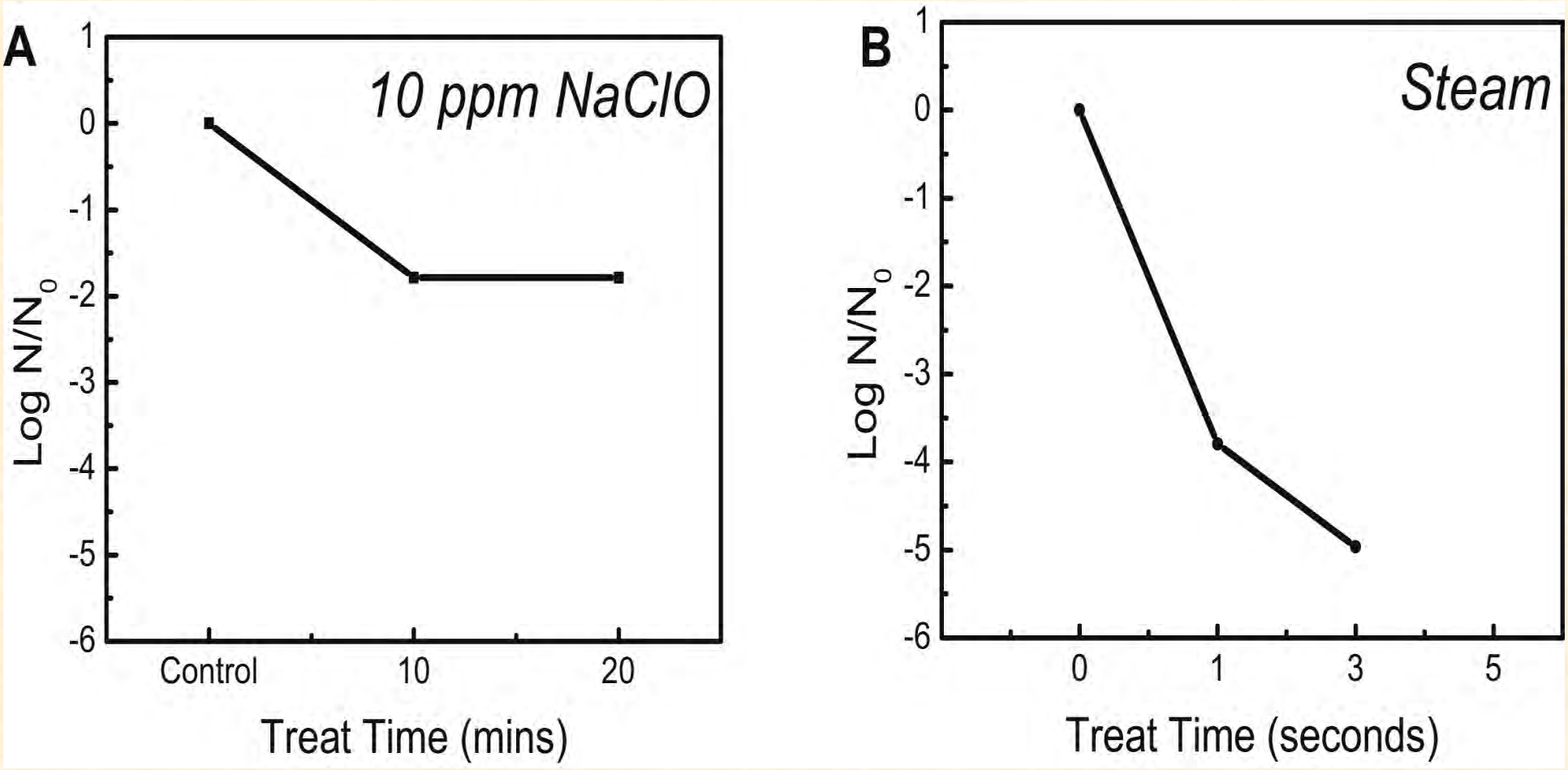
Cold Plasma Technology reduces surface bacterial counts



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

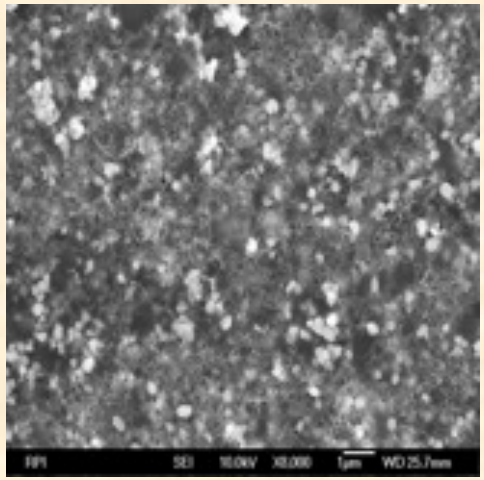
Effect of bleach vs steam against *E.coli* biofilm



<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 (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

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

‘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

Disinfect everything…..

Dancer SJ, Clin Micro Rev 2014;

Po & Carling, ICHE 2010

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

Terminal decontamination of rooms using H202 vapour

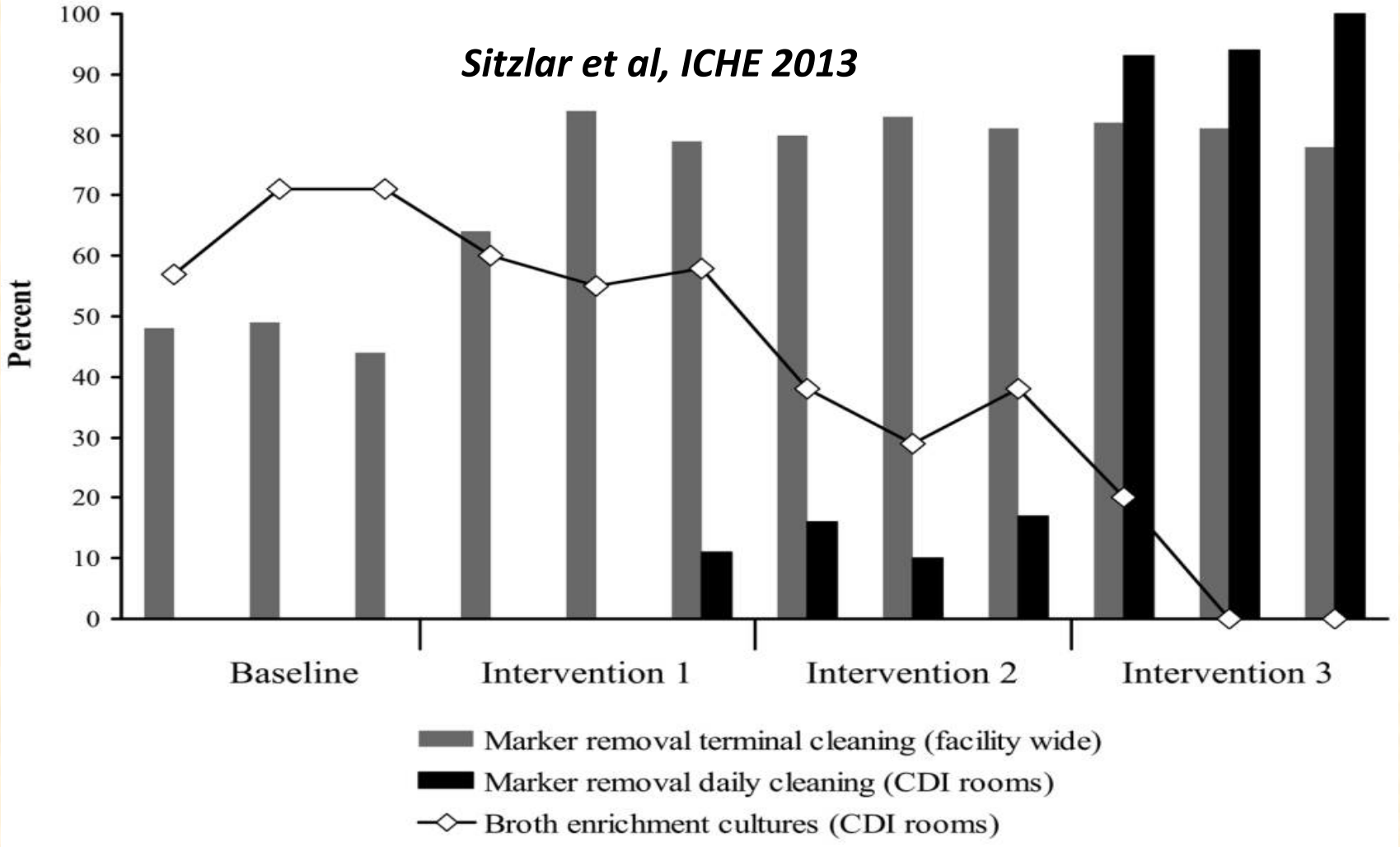
Patients were 64% less likely to acquire MDROs and 80% less likely to acquire VRE ($P < 0.001$) following H_20_2 terminal cleaning……..

But the risk of acquiring *Clostridium difficile*, MRSA and multidrug-resistant Gram-negative bacilli was '*not significantly reduced*';

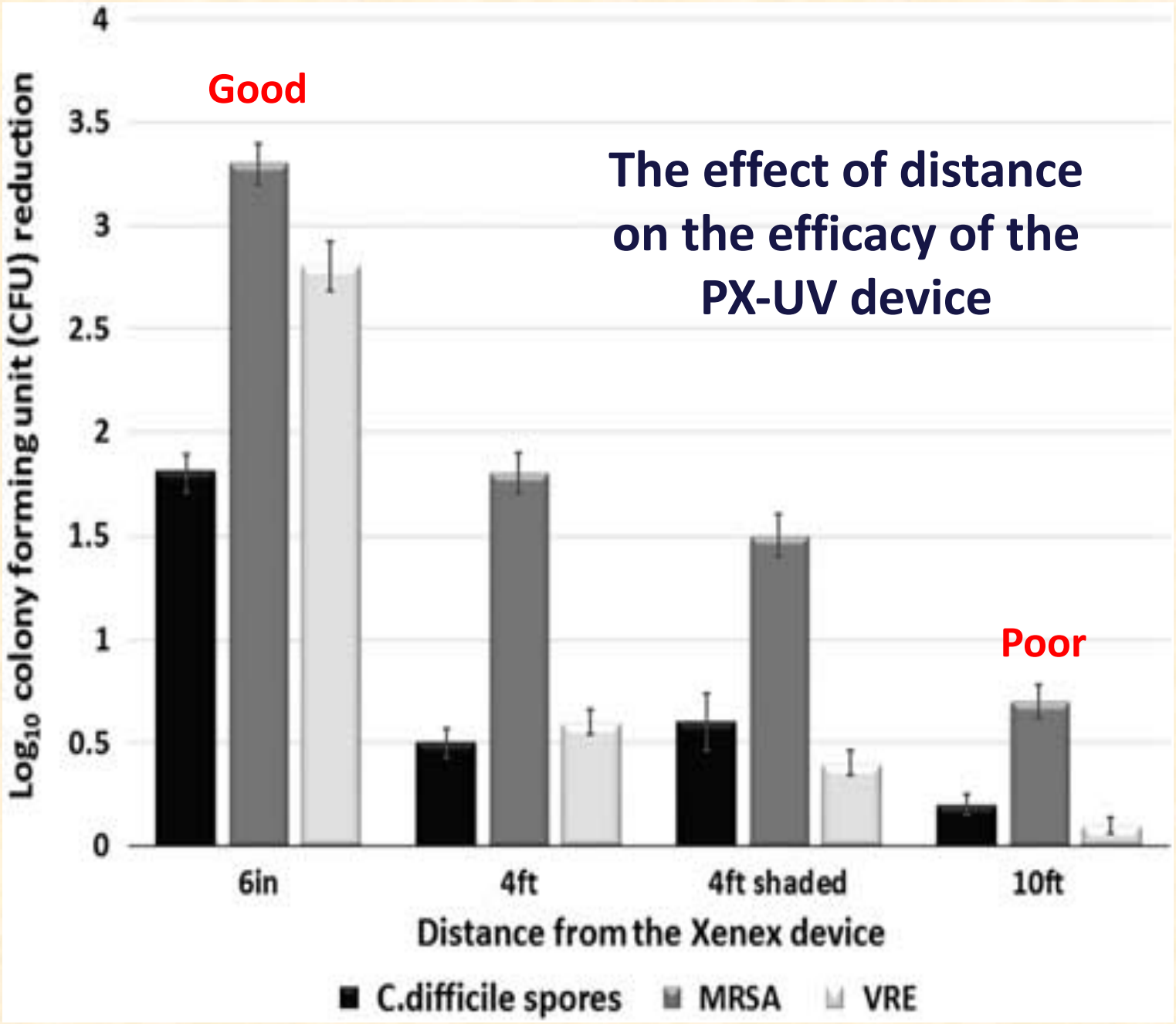
The significance quoted for the overall result came from the VRE data only.

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

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

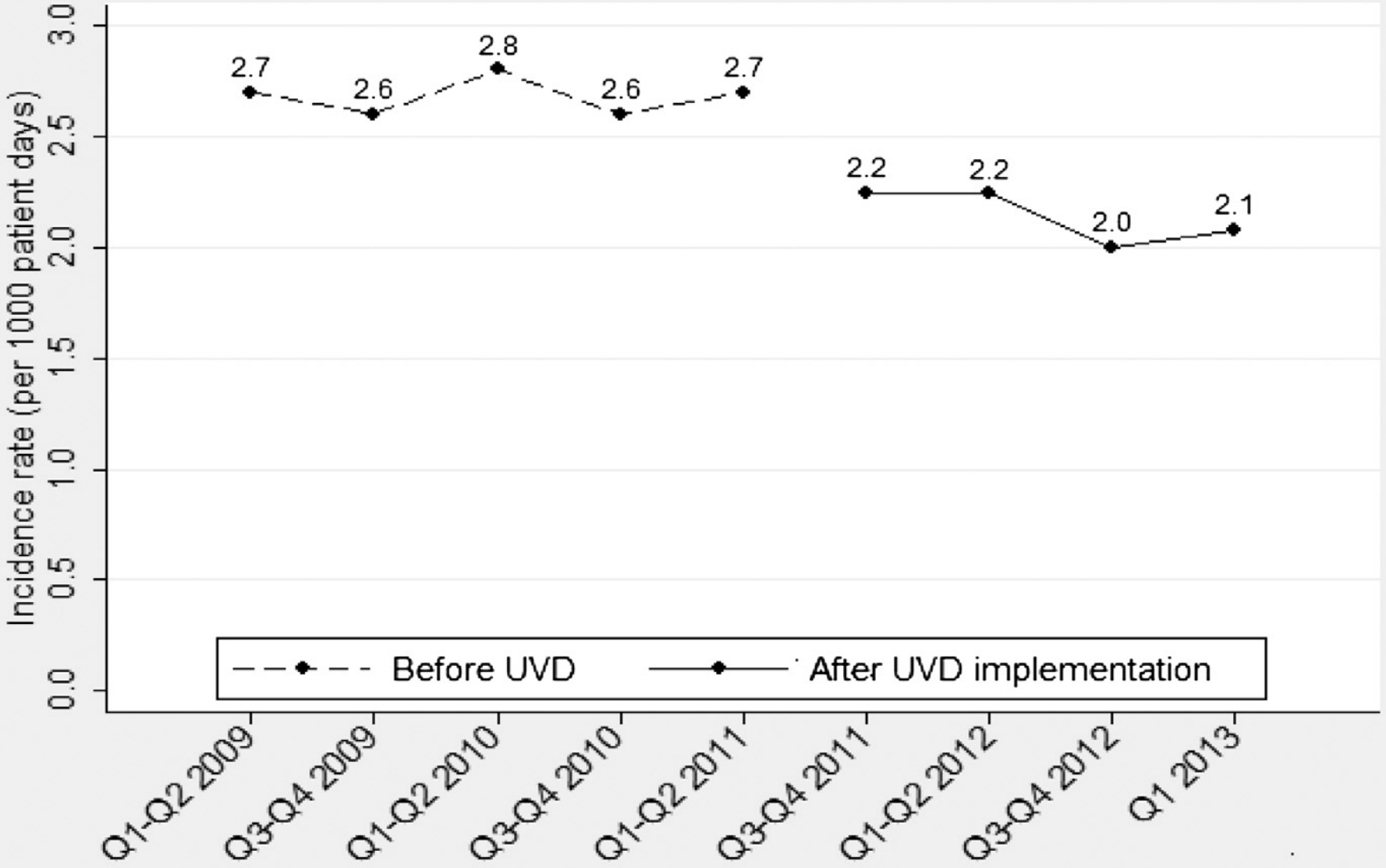


35% of rooms remained culture positive for *C. difficile* after use of UV devices



Nerandzic et al, ICHE 2015

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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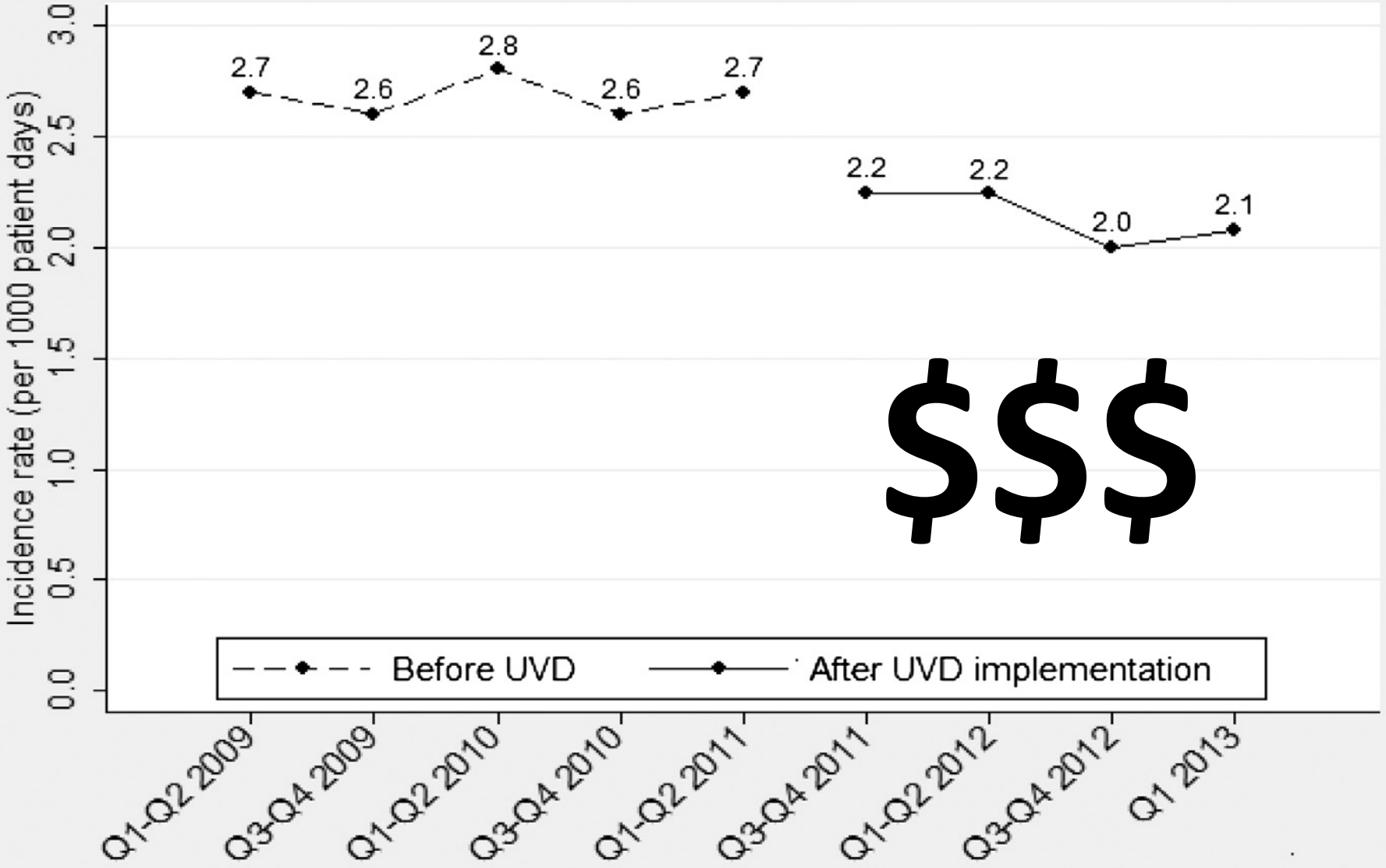

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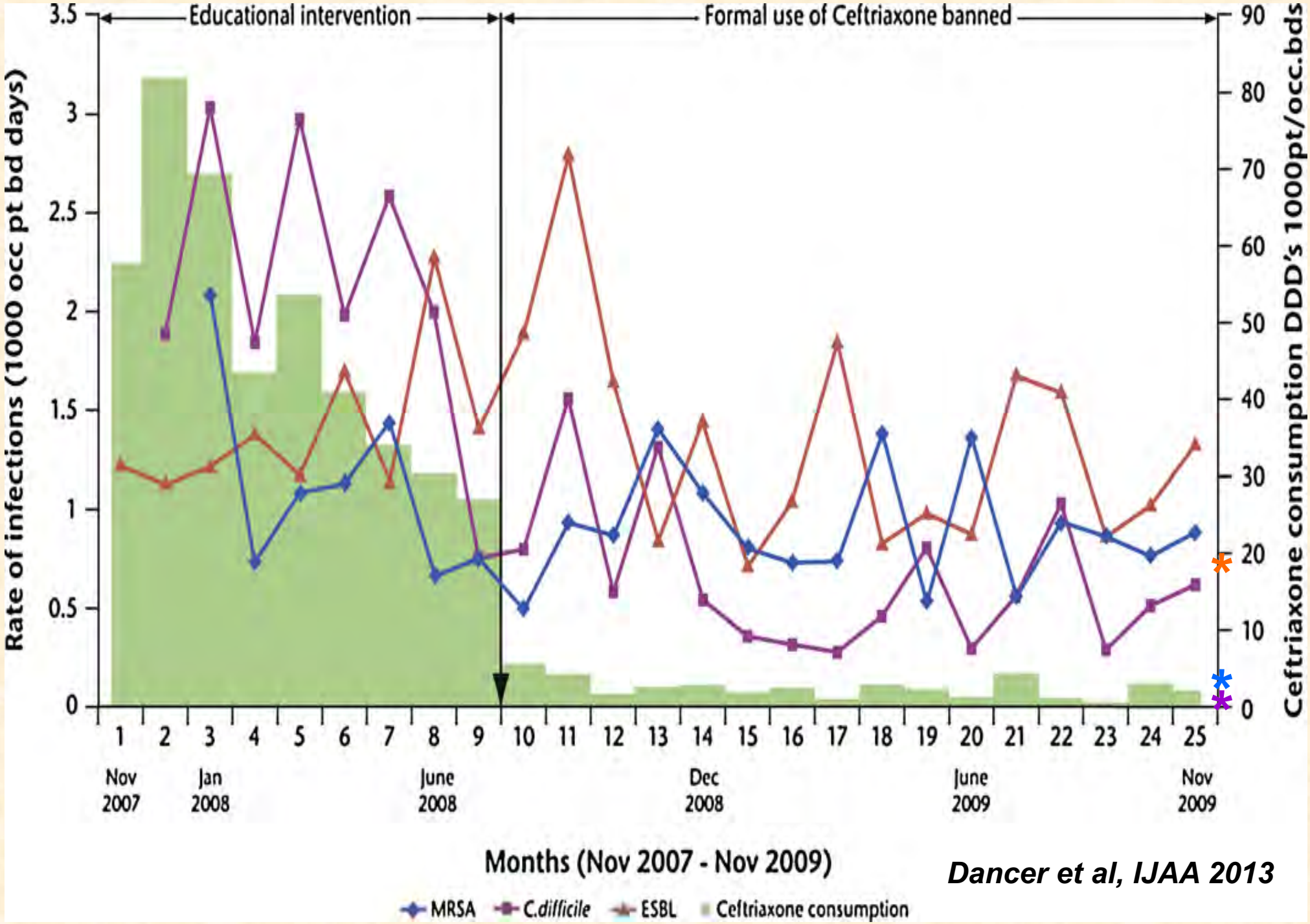
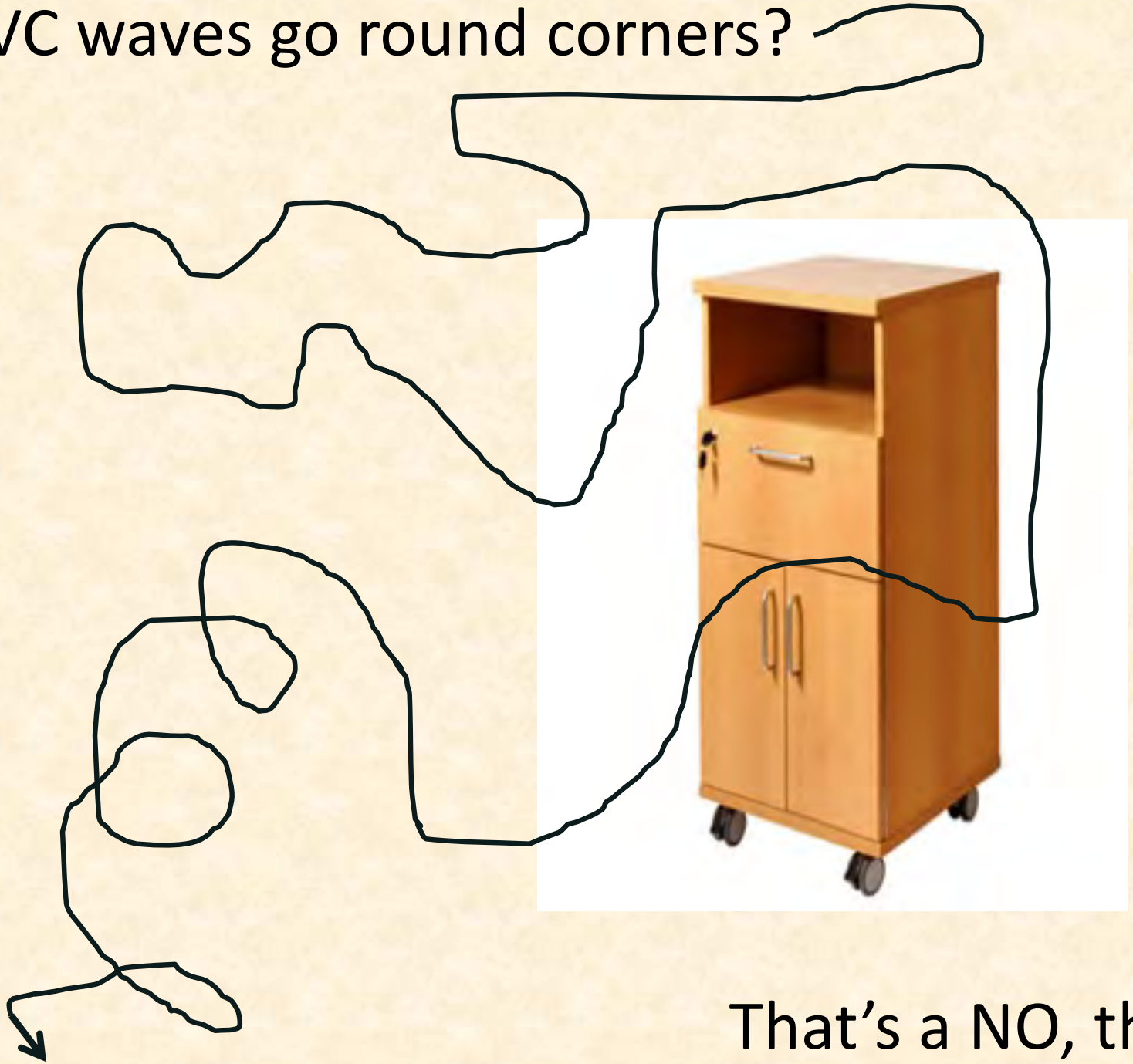


Dancer et al, IJAA 2013

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

Can UVC waves go round corners?



That’s a NO, then?

Toxicity?

Humans
Surfaces
Plastics
Plants
Animals

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;

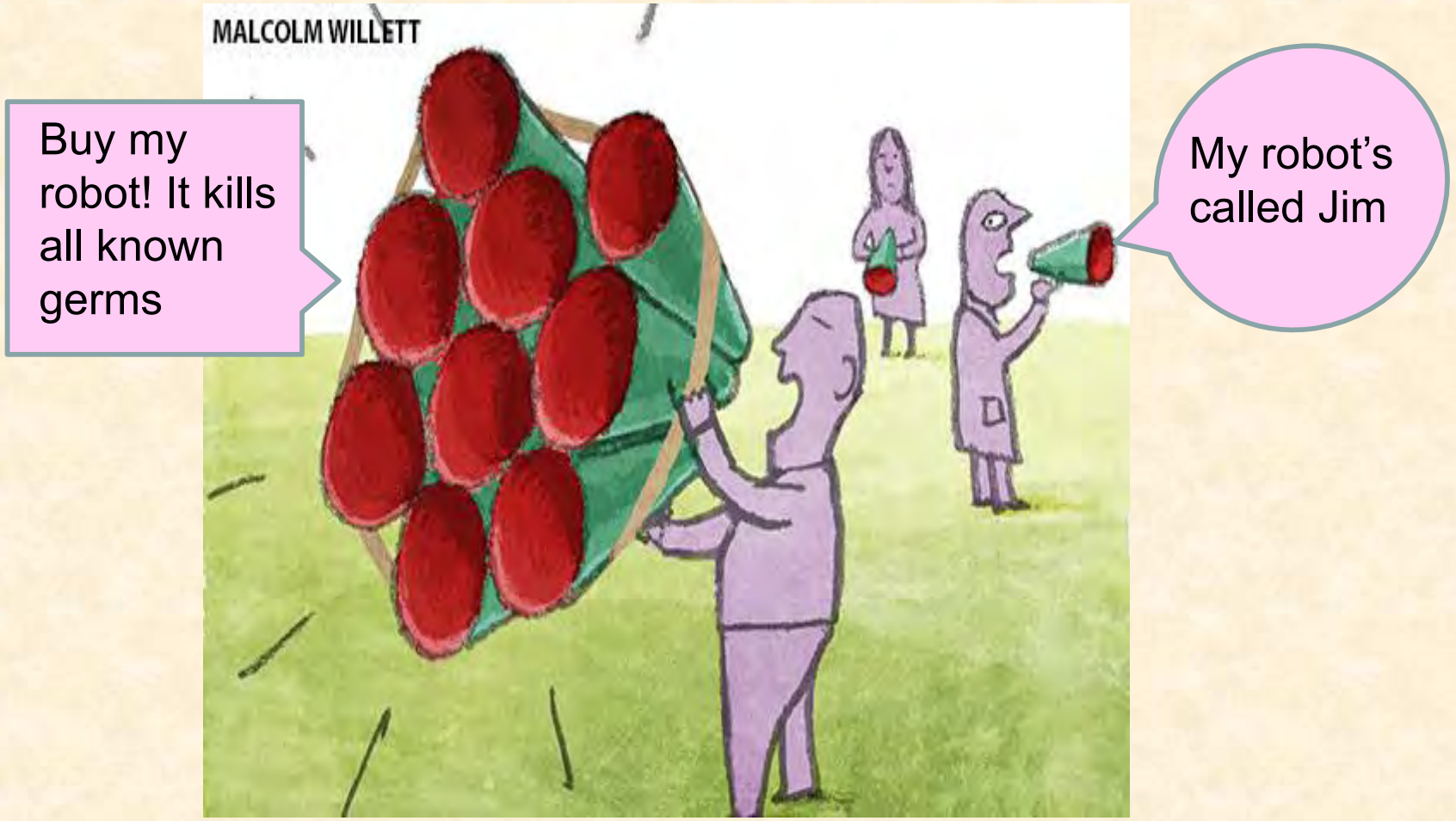
Need to train staff;
Need to prepare room;
Need to remove soft furnishings;

Can’t do open plan….

‘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***

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?

true

true

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

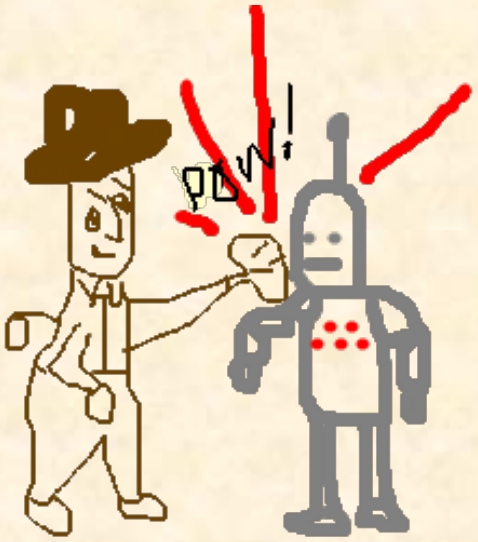
Alfa MJ et al, BMC Infect Dis 2010,10:268

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

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

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

www.webbertraining.com/schedulep1.php

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