

Strategies to Improve Environmental Hygiene

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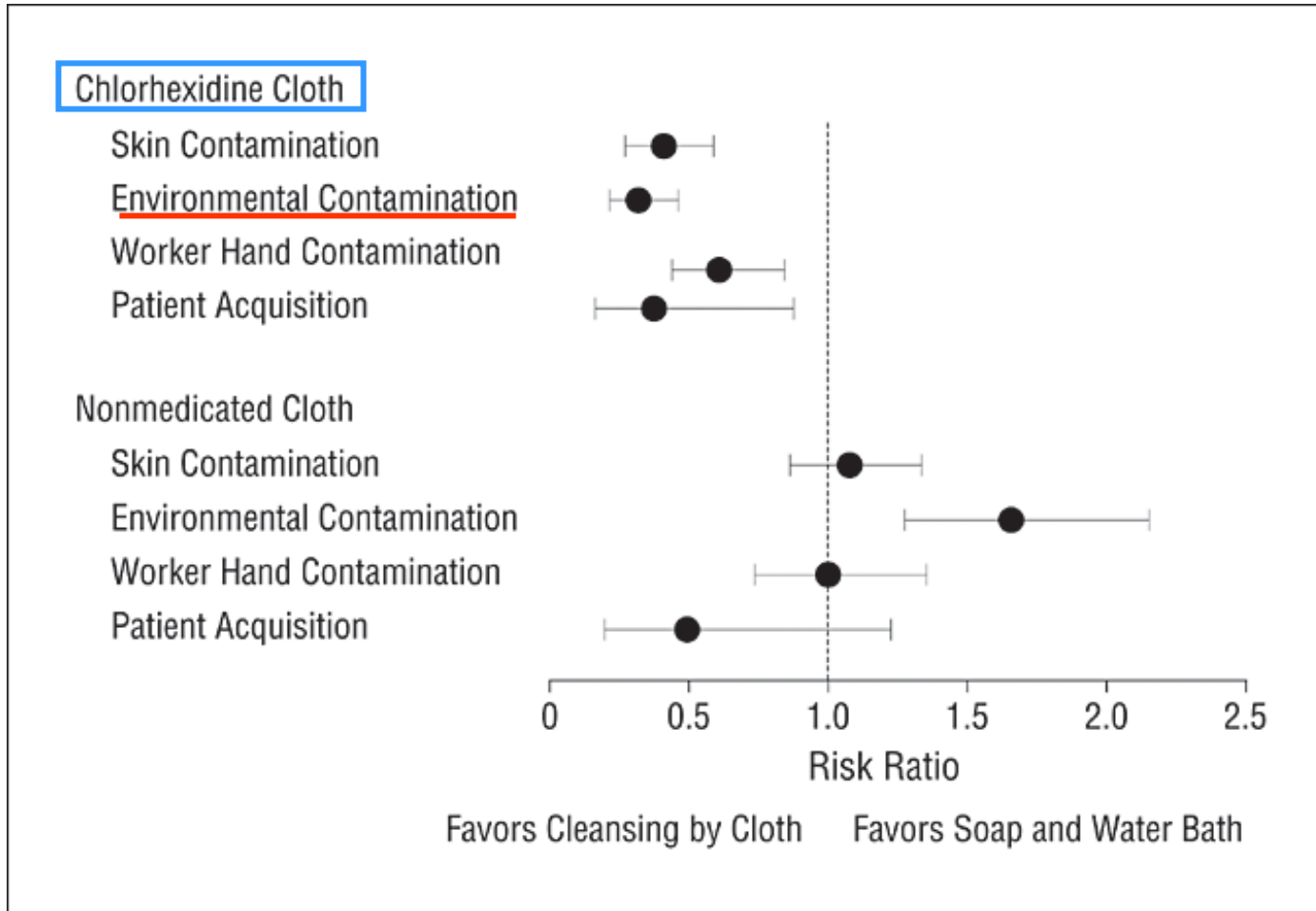
Strategies to Improve Environmental Hygiene

- **Source control**
 - **Reduce contamination of the environment by patients**
- **Improve compliance with recommended use of traditional or newly developed liquid disinfectants**
- **Utilize newer area decontamination technologies**
- **Coat environmental surfaces with biocidal metals**

Source Control to Reduce Bioburden of VRE

- **Prospective trial in an MICU with 3 study periods**
 - 1) **Soap and water bathing of patients**
 - 2) **Cleansing patients with 2% CHG-impregnated cloths**
 - 3) **Cleansing patients with cloths without CHG**
- **Cultures for VRE were obtained from**
 - **Patients' skin (86 patients)**
 - **Environmental surfaces (758 surfaces)**
 - **Healthcare worker hands (529 hands)**
- **VRE acquisition by patients was determined**

Risk ratios for skin contamination and environmental or health care worker contamination by or patient acquisition of vancomycin-resistant enterococci (VRE)



Vernon, M. O. et al. Arch Intern Med 2006;166:306-312.

Improve compliance with recommended use of traditional or newly developed liquid disinfectants

- **Pay close attention to cleaning and disinfection of high-touch surfaces in patient-care areas**
- **Ensure compliance by housekeeping staff with cleaning and disinfection procedures**
- **Disinfect (or clean) environmental surfaces on a regular basis, and when surfaces are visibly soiled**

Sehulster L et al. MMWR Recomm Rep 2003;52(RR-10):1

Rutala WA, Weber DJ et al. HICPAC Guideline for

Disinfection and Sterilization in Healthcare Facilities, 2008



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Assign Responsibility for Cleaning Procedures

- **Housekeepers and nursing staff often do not agree on who should clean what**
- **Housekeepers do not always understand**
 - **Which detergent/disinfectant to use**
 - **What concentration should be used**
 - **What contact times are recommended**
 - **How often to change cleaning cloths/mop heads**
- **Develop policies regarding who should clean what**

TYPE OF CLEANING	RESPONSIBLE SERVICE	ITEMS TO BE CLEANED	PRODUCTS USED TO CLEAN	COMMENTS
<p align="center"><u>ROUTINE DAILY CLEANING OF PATIENT ROOM</u></p>	<p>Environmental Services</p>	<ol style="list-style-type: none"> 1.dust window ledge 2.spot clean furniture (chairs) 3.wipe down over-bed table 4.wipe down side rails 5.wipe down TV control 6.wipe down bathroom fixtures (faucets, grab bar, shelf, etc.) 7.clean sink and toilet 8.wipe down door handles (room and bathroom) 9.mop bathroom and patient floor 10.remove trash 	<ol style="list-style-type: none"> 1. – 9. EPA/ICC hosp quat* or 1. - 8. EPA/ICC hosp bleach wipe** for Contact CD and Enteric Precautions 9. EPA/ICC hosp quat* 	<p>8 Step daily cleaning process</p>
<p><u>TRANSFER/DISCHARGE CLEANING OF PATIENT ROOM, AND ANY PATIENT ROOM AT NURSE'S REQUEST (WHEN ROOM IS EMPTY)</u></p>	<p>Environmental Services</p>	<ol style="list-style-type: none"> 1.clean bed frame, side rails, mattress (after nursing has stripped bed of all linen) 2.clean bedside table, over bed table, phone, call bell, TV control 3.wipe down flow meters 4.wipe down regulators 5.dust/clean lighting fixtures 6.clean outside canister (clean) of suction container 7.clean and wipe down IV poles and pumps that need to remain on the unit, apply sani-strip ☼¶ 8.wipe down furniture 9.dust all ledges 10.clean around sharps containers and glove boxes 11.wipe down step stools 12.wipe down walkers 13.wipe down canes 14.clean bedside commode, (once emptied by nursing) apply sani-strip☼ 15.clean bathroom fixtures, sink, shower, and toilet apply sani-strip ☼ 16.mop bathroom and patient floor 17.pull trash 18.change out privacy curtains if soiled or on request 	<ol style="list-style-type: none"> 1. - 16. EPA/ICC hosp quat* or 1-15. EPA/ICC hosp bleach wipe** for Contact CD and Enteric Precautions 16. EPA/ICC hosp quat* ¶ see cleaning instructions provided by Clinical Engineering, below ☼ apply sani-strip, see notes below 	<p>8 Step Discharge cleaning process</p>

Use the Right Product at the Right Time

- For outbreaks or highly endemic levels of *C. difficile*-associated disease, disinfection of surfaces with sodium hypochlorite is recommended, and can reduce transmission
- Disinfection of surfaces with sodium hypochlorite is also recommended during Norovirus outbreaks

Mayfield JL et al. Clin Infect Dis 2000;31:995

McMullen KM et al. Infect Control Hosp Epidemiol 2007;28:205

Wener KM et al. Decennial 2010, Abstr 200

Consider Evaluating of Newer Disinfectants

- Accelerated hydrogen peroxide liquid products
- Novel highly charged copper-based disinfectants
- Peracetic acid-based disinfectant
 - Sporicidal, good materials compatibility
- Organosilane formulation
- Cationic ingredient + chlorhexidine

Perez J et al. Am J Infect Control 2005;33:320

Omidbakhsh N et al. Am J Infect Control 2006;34:251

Andrews BJ et al. Decennial 2010, Abstr 213

Gant VA et al. J Antimicrob Chemother 2007;60:294

Nerandzic MM et al. Decennial 2010, Abstr 61



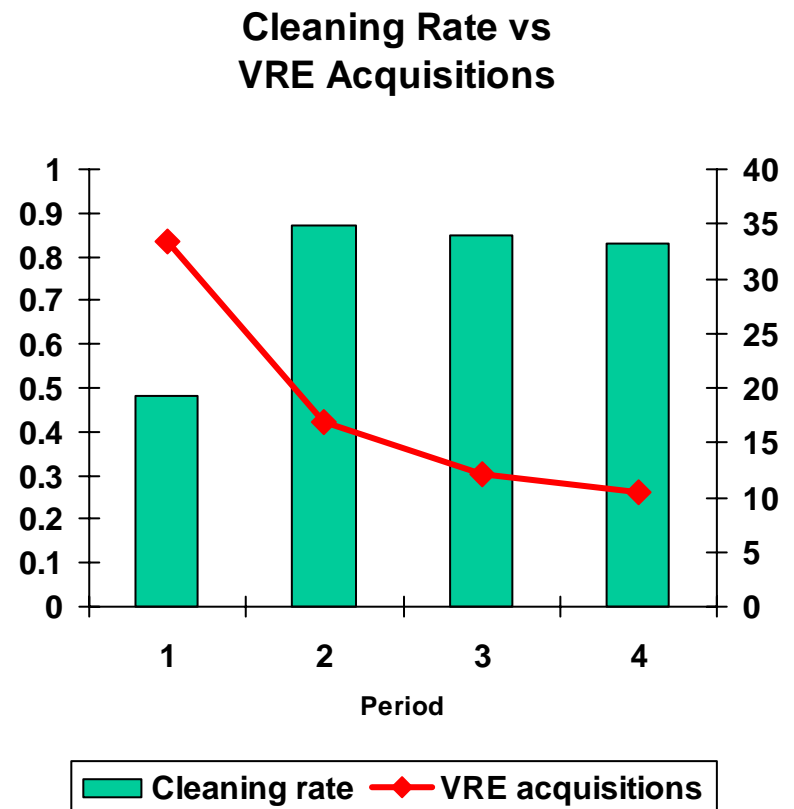
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Educate and Monitor Housekeepers, and Give them Feedback

- **Prospective, 9-month study in an MICU included**
 - Admission and daily screening of patients
 - Environmental and HCW hand cultures twice weekly
- **Study design included**
 - Baseline period (1)
 - Education/monitoring/feedback for housekeepers (2)
 - Wash-out period with no specific intervention (3)
 - Multimodal hand hygiene intervention (4)

Educate and Monitor Housekeepers, and Give them Feedback

- Environmental cleaning rate increased significantly
- VRE environmental contamination decreased significantly
- VRE acquisitions by patients decreased significantly
- Other factors analyzed could not explain decreased VRE acquisition rate



Methods for Monitoring Cleaning Practices

- **Visual inspection**
 - **Check lists sometimes used**
- **Fluorescent marker system**
- **ATP bioluminescence assays**
- **Aerobic colony counts**

Griffith CJ et al. J Hosp Infect 2000;45:19

Malik RE et al. Am J Infect Control 2003;31:181

Dancer SJ J Hosp Infect 2004;56:10

Sherlock O et al. J Hosp Infect 2009;72:140



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Fluorescent Dye Marker System for Monitoring Cleaning Practices

- Initial study conducted in 3 hospitals
- 12 high-touch objects in patient rooms were marked with invisible fluorescent solution after terminal cleaning
 - Marks moistened by disinfectant spray could be removed by wiping surface for 5 seconds with light pressure



Carling PC et al Clin Infect Dis 2006;42:385.

Monitoring Cleaning Practices

- **After at least 2 patients had occupied the rooms and rooms had been terminally cleaned, target surfaces were evaluated using a portable UV light to see if the marker had been wiped off**
- **Intervention: education and feedback given to cleaning staff**

Monitoring Cleaning Practices

- 1404 objects were evaluated before the intervention
- 744 objects were evaluated after the intervention
- Proportion of objects cleaned
 - Before intervention: 47%
 - After interventions: 76 - 92%
- Technique improved in all hospitals ($p < 0.001$)
- Technique has been adopted in numerous hospitals

Carling PC et al. Clin Infect Dis 2006;42:385

Carling PC et al. Infect Control Hosp Epidemiol 2008;29:1035

Carling PC et al. Crit Care Med 2010 (Epub)

Carling PC et al. Decennial 2010, Abstr 58

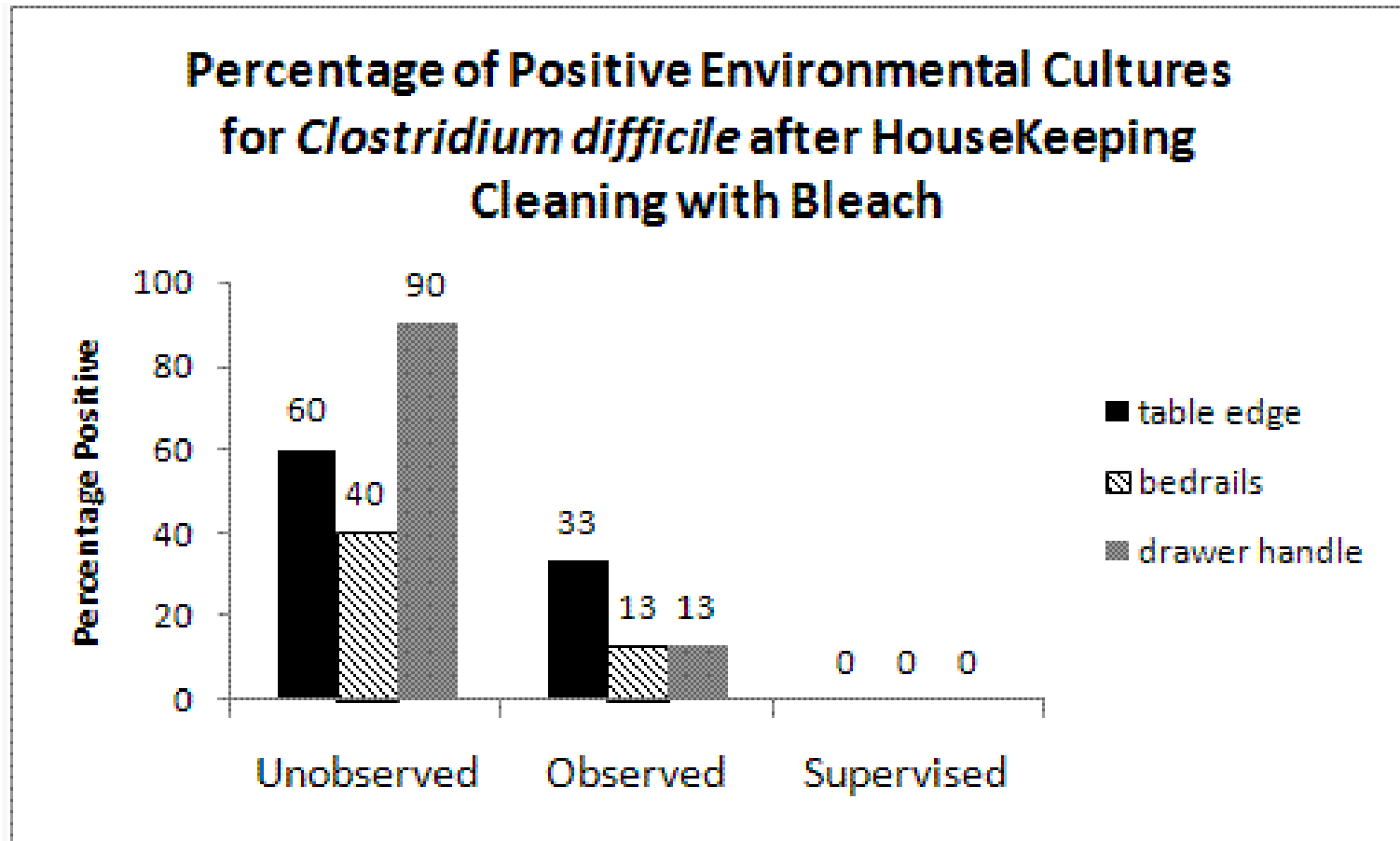


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Educate, Observe, and Supervise Housekeepers

- **3-Phase prospective study in one hospital**
- **Study design**
 - **Baseline observation of cleaning practices**
 - **Education of housekeepers + direct observation**
 - **Direct supervision of housekeepers**
- **Non-toxigenic *C. difficile* applied to 3 high-touch surfaces in patient rooms before cleaning**
- **Commercial bleach product with 18,400 ppm of sodium hypochlorite used to disinfect surfaces**

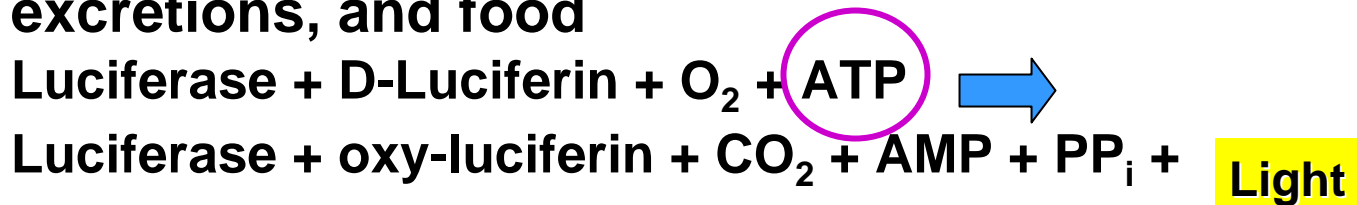
Educate, Observe, and Supervise Housekeepers



Monitoring Cleaning Practices

- ATP bioluminescence methods have been used for years to monitor adequacy of cleaning procedures
 - in beverage and food processing industries

- Methods detect ATP from microorganisms, secretions and excretions, and food



- Amount of light is proportional to concentration of ATP present

Griffith CL et al. J Hosp Infect 2000;45:19

Malik RE et al. Am J Infect Control 2003;31:181

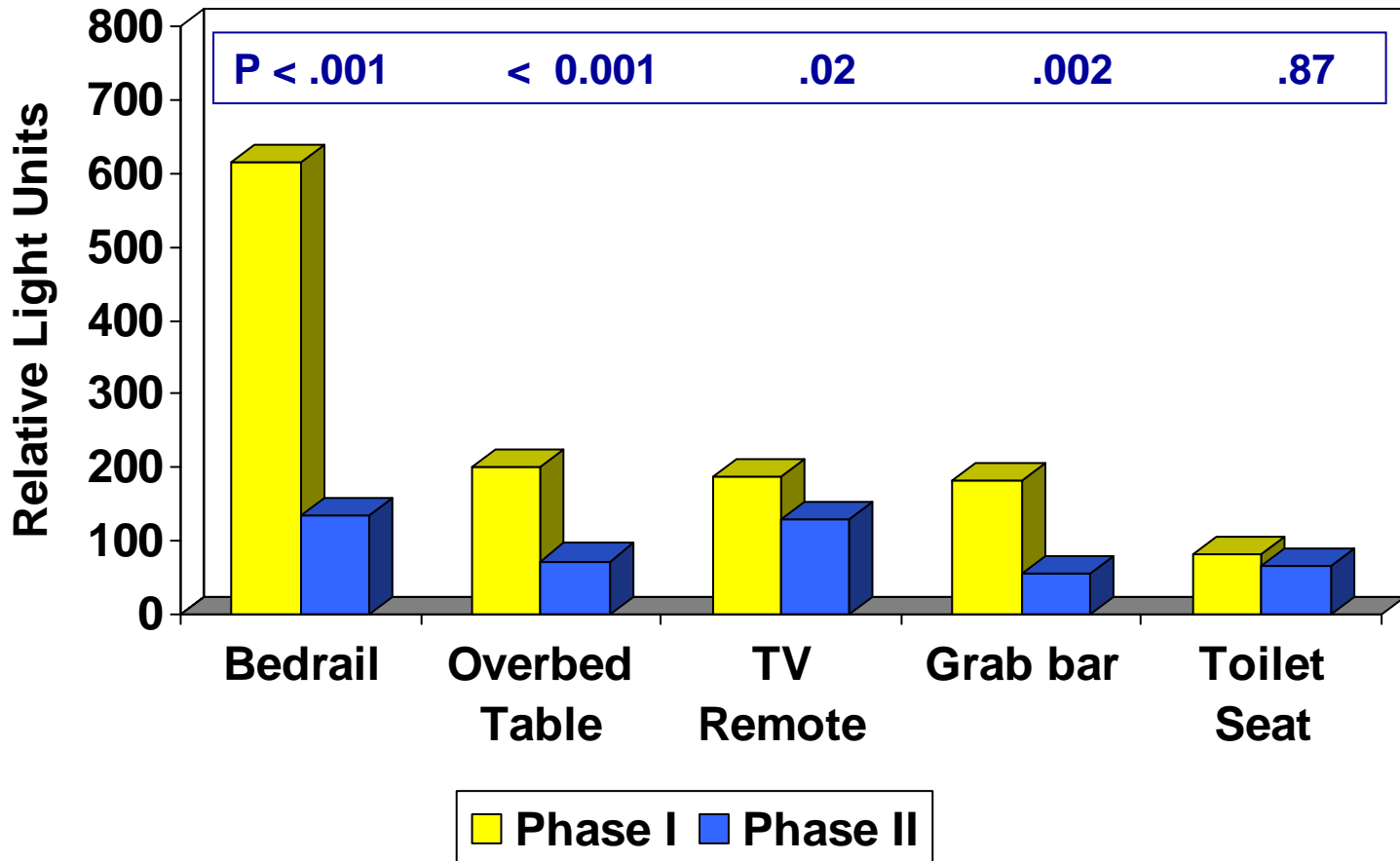


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Monitoring Cleaning Practices Using ATP Bioluminescence Assay System

- **Prospective trial in community-teaching hospital**
- **Phase I: ATP bioluminescence method was used to sample 5 high-touch surfaces before/after daily cleaning in 20 rooms**
 - **Housekeepers were unaware that cleaning was being monitored**
- **Phase II: ATP readings were obtained from same 5 high-touch surfaces before/after daily cleaning in 101 patient rooms on randomly selected nursing units hospital-wide**
 - **Housekeepers were aware that they would be monitored**

Median Relative Light Unit Readings, After Daily Cleaning, Phases I and II



Monitoring Cleaning Practices Using ATP Bioluminescence Assay System

- **ATP bioluminescence assay systems have been used in a variety of settings**
 - **Assessing variations in daily cleaning practices**
 - **Assess adequacy of terminal room cleaning**
 - **Evaluate level of contamination of portable equipment**
 - **Education of housekeepers**

Boyce JM et al. ICHE 2010;31:99

Havill N et al. Decennial 2010, Abstr 211

Bannister S et al. Decennial 2010, Abstr 184

Zambrano A et al. Decennial 2010, Abstr 187



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Area Decontamination Technologies

- **Hydrogen peroxide vapor technologies**
 - **Micro-condensation process (BIOQUELL)**
 - **“Dry gas” process (Steris)**
- **Both technologies have been validated as effective**
 - **Most experience in healthcare settings is with the micro-condensation process**
- **Require room to be vacated and sealed**
- **No toxic residuals following decontamination cycle**

McAnoy AM: Australian Government DSTO 2006

Fisher J et al. Pharmaceutical Technology 2004, pg. 68

Pottage T et al. J Hosp Infect 2010;74:55



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Hydrogen Peroxide Vapor Micro-Condensation Process

- Hydrogen peroxide vapor micro-condensation process has been used in hospitals with epidemic or endemic problems with MRSA, VRE, *C. difficile*, *Acinetobacter* or other multidrug-resistant Gram negative pathogens
- Effective against a broad range of healthcare-associated pathogens including *C. difficile* spores

French GL et al. J Hosp Infect 2004;57:31

Boyce JM et al. ICHE 2008;29:723

Passaretti C et al. 2008 IDSA/ICAAC meeting, Abstr K-4124b

Dryden M et al. J Hosp Infect 2008;68:190

Otter JA et al. J Clin Microbiol 2009;47:205



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Hydrogen Peroxide Vapor

- When combined with other measures, has helped reduce infections due to *C. difficile*, VRE, MRSA and Acinetobacter
- Feasible in hospitals with high census
- Can be used to decontaminate unused contaminated supplies in hospital setting

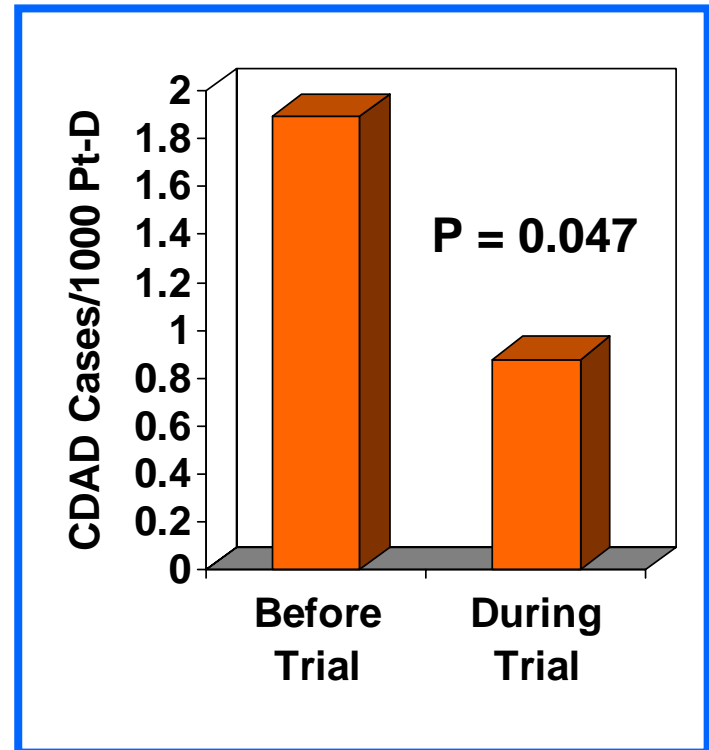
Boyce JM et al. ICHE 200829:723

Otter JA et al. ICHE 2009;30:574

Manian F et al. Decennial 2010, Abstr LB 6

Donegon N et al. Decennial 2010, Abstr 207

Otter JA et al. Decennial 2010, Abstr 62



Analysis only for months when epidemic strain was present

Hydrogen Peroxide “Dry-Mist” System

- Hydrogen peroxide “dry mist” system (Sterinis) injects particles of 8 – 12 microns into room
- Disinfectant: 5% H₂O₂ + silver ions + phosphoric acid
- Reduces bacterial contamination in hospital rooms
- Appears to be less efficacious against *C. difficile* spores than hydrogen peroxide vapor

Andersen BM et al. J Hosp Infect 2006;62:149

Bartels MD et al. J Hosp Infect 2008;70:35

Shapey S et al. J Hosp Infect 2008;70:136

Barbut F et al. ICHE 2009;30:507

Mikkelsen R et al. Decennial 2010, Abstr 196

Other Gas, Mist or Fogging Technologies for Area Decontamination

- **Low-level (0.02 ppm) hydrogen peroxide gas**
 - Muto CA et al. Decennial 2010, Abstr 208 and 209
- **Gaseous ozone**
 - Sharma M et al. AJIC 2008;36:559
- **Super-oxidized water fogging**
 - Clark J et al. J Hosp Infect 2006;64:386
- **Alcohol/Quaternary ammonium mist system**
 - Jury LA et al. 2009 SHEA meeting, abstr 278
- **Quaternary ammonium fogging system**
 - Cadnam JL et al. Decennial 2010, Abstr 205

Automated mobile ultraviolet light surface decontamination unit

- On laboratory surfaces, reduced VRE and MRSA by > 3-4 logs in 45 min
- In hospital rooms, reduced frequency of MRSA and VRE by 89% and *C. difficile* by 83%
- No cultures of portable equipment treated yielded growth after UV-C treatment
- Significantly reduced level of *S. warneri* inoculated onto surfaces in hospital rooms



Nerandzic MM et al. 49th ICAAC, 2009, Abstr K-2107a
Nerandzic MM et al. Decennial 2010, Abstr 214

Automated mobile ultraviolet light surface decontamination unit

- MRSA, VRE, *Acinetobacter* or *C. difficile* were inoculated onto carrier materials in hospital rooms
 - Reduced MRSA, VRE and *Acinetobacter* by >99.9% in 15 min, and *C. difficile* by 2-3 logs in 50 min
 - In another study, surfaces in 25 hospital rooms were cultured before/after UV light treatment, and log reductions of *C. difficile* on carrier disks were determined
 - Significant reductions of microorganisms were achieved
-
- A different pulse xenon UV light unit has reduced levels of MRSA, VRE and *C. difficile* in a laboratory study

Coat Surfaces with Biocidal Metals

- **Multicenter study to assess the ability of copper to reduce microbial burden on patient care items**
- **282 copperized objects in 32 rooms and 288 non-copper objects in 27 rooms were cultured weekly**
- **Aerobic colony counts were performed**
- **Total mean colony counts in patient ICU rooms with copperized objects were reduced by 87%**
- **MRSA and VRE were frequently recovered from non-copper objects, but never from copperized objects**

Summary

- **Improving cleaning/disinfection practices in hospitals requires**
 - **Developing detailed protocols, educating housekeepers**
 - **Monitoring cleaning, providing feedback to housekeepers**
- **Methods of monitoring the adequacy of cleaning**
 - **Visual inspection**
 - **Using fluorescent markers**
 - **ATP bioluminescence methods**
 - **Surface cultures (colony counts)**

Summary

- **New and investigational liquid disinfectants:**
 - Sodium hypochlorite formulation with *C. difficile* spore claim
 - Accelerated hydrogen peroxide liquid formulations
 - Copper-based liquid biocides
 - Peracetic acid-based disinfectant
- **New and investigational area decontamination methods**
 - Hydrogen peroxide vapor, hydrogen peroxide dry mist
 - Low-level hydrogen peroxide gas
 - UV-C light systems
- **Surface-bound biocides (copper)**

Resources Available on Internet

- **HICPAC Environmental guideline**
www.cdc.gov/ncidod/dhqp/pdf/guidelines/Enviro_guide_03.pdf
- **HICPAC Disinfection and Sterilization guideline**
www.cdc.gov/ncidod/dhqp/pdf/guidelines/Disinfection_Nov_2008.pdf
- **Canadian Hand Hygiene, Disinfection & Sterilization guideline** www.phac-aspc.gc.ca/publicat/ccdr-rmtc/98pdf/cdr24s8e.pdf
- www.disinfectionandsterilization.org
- www.cleanhospitals.net