

**Enhanced Environmental Cleaning in Controlling *Clostridium difficile* Infections in the Hospital Setting**  
**Prof. Farrin A. Manian, Massachusetts General Hospital & Harvard Medical School**  
**A Webber Training Teleclass**

Enhanced Environmental Cleaning in Controlling *Clostridium difficile* Infections in the Hospital Setting: Does it Matter?

**Farrin A. Manian, MD, MPH**  
Department of Medicine,  
Massachusetts General Hospital,  
Visiting Associate Professor of Medicine,  
Harvard Medical School,  
Boston, Massachusetts

Hosted by Dr. Pierre Parneix  
Southwestern France Healthcare-Associated Infection Control Centre  
Bordeaux, France

www.webbertraining.com October 9, 2014

**Disclaimer**

*The content of this presentation is solely the responsibility of the speaker and does not necessarily represent the official view of Harvard Catalyst, Harvard University, its affiliate academic healthcare centers, or its corporate contributors.*

Manian, MGH 2

**Disclosure**

*The speaker has no relevant disclosure*

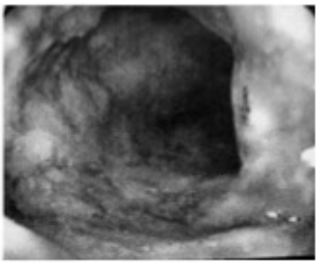
Manian, MGH 3

**Outline**

- The scope of the *Clostridium difficile* Infection (CDI)
- Preventive measure to reduce risk of transmission in healthcare settings
- Important role of the environment in CDIs
- Efficacy (or lack thereof) of routine cleaning of hospital room surfaces
- “Touchless” technologies as an adjunct to terminal cleaning and disinfection of hospital rooms
- Impact of intensive cleaning and disinfection on hospital CDI rates
- Conclusions

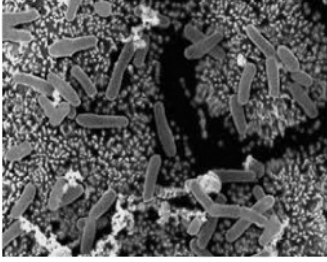
Manian, MGH 4

***C. difficile* Colitis**



Manian, MGH 5

***C. difficile***



Manian, MGH 6

**Hosted by Dr. Pierre Parneix, Bordeaux, France**  
**www.webbertraining.com**

# Enhanced Environmental Cleaning in Controlling *Clostridium difficile* Infections in the Hospital Setting

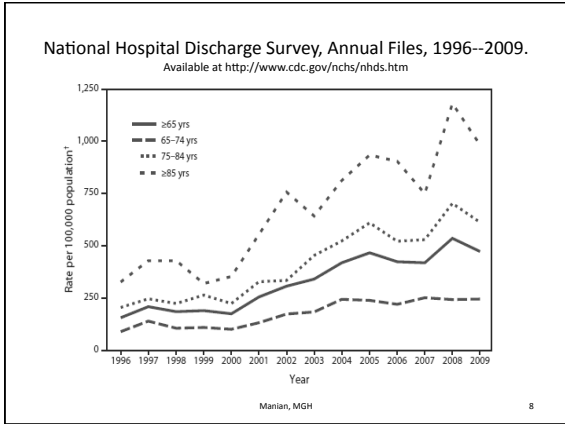
Prof. Farrin A. Manian, Massachusetts General Hospital & Harvard Medical School

## A Webber Training Teleclass

### The Scope of *C. difficile* Infection (CDI)

- CDI is the most common cause of nosocomial diarrhea in the industrialized world
- In some regions of the U.S. , CDI incidence is higher than MRSA healthcare-associated infections
- CDI is the most common infectious cause of diarrhea in nursing homes
- 94% of CDI cases in the U.S. are healthcare-associated

Manian, MGH 7



### The Scope of CDI

- CDI incidence has increased significantly in many countries
  - U.S.: 300% increase in the number of hospital days related to CDI from 1993-2008 (~1% of hospitalizations)
  - Austria: 255% increase in the rate of hospital-associated cases from 2003-2008
  - Spain: ~300% increase in the rate of hospital-associated cases from 1999-2007

Manian, MGH 9

### Severity and Burden of CDI

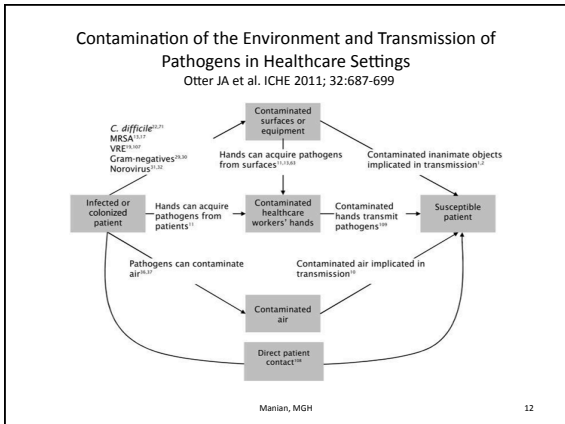
- U.S.
  - 5x increase in mortality (1993-2008)
  - Longer hospitalization (8 days more than average)
  - Excess healthcare cost: \$5,000-\$7,000/case
  - Annual cost ~ \$1 billion
- Europe
  - Estimated annual cost to E.U.: € 3 billion

Manian, MGH 10

### Prevention of CDI

- Improving antibiotic stewardship
- Early and reliable detection of CDI
- Infection control precautions in the care of patients with CDI
  - Private room if possible
  - Gown and gloves
  - Strict hand hygiene
  - Environmental source control

Manian, MGH 11



# Enhanced Environmental Cleaning in Controlling *Clostridium difficile* Infections in the Hospital Setting

Prof. Farrin A. Manian, Massachusetts General Hospital & Harvard Medical School

## A Webber Training Teleclass

### *C. difficile* and the Hospital Environment

- Patients with CDI can excrete up to 1 billion microorganisms/g of feces
- Asymptomatic patients may also contribute to environmental contamination
- Importance of spores
  - Not destroyed by usual detergents
  - Survive alcohol hand disinfectants

Manian, MGH 13

### Environmental Contamination of *C. difficile*

- Room contamination rate (McFarland LV et al. NEJM 1989;320:204-210)
  - 49% of rooms of symptomatic patients
  - 29% of rooms of asymptomatic patients
- Frequency of room surface contamination
  - Often range from 10%-50%; level correlates with frequency of *C. difficile* acquisition (Weber DJ et al. AJIC 2013; S105-S110)
  - BP cuffs 10% contamination rate (vs. 11.5% for bedside commodes) likely related to “overgloving” (Manian FA, et al. ICH 1996;17:180-182)
  - High rate of contamination prior to treatment as well as at the time of resolution of diarrhea (37%), lower at end of treatment, but increased again at 1-4 weeks after treatment (50%) (Sethi AK et al. ICH 2010;31:21-7)

Manian, MGH 14

### Environmental Contamination and Hands of Personnel

- Strong correlation between intensity of environmental contamination and hand contamination (Weber DJ et al. AJIC 2013; S105-S110)

Environment contamination	Hand contamination
0-25%	0%
26-50%	8%
>50%	36%

Manian, MGH 15

### Environmental Contamination and Hands of Personnel

- Acquisition of *C. difficile* spores on gloved hands may be as likely following contact with commonly touched surfaces as after contact with patient’s skin (Guerrero DM et al. AJIC 2012; 40:556-8)
- *C. difficile* frequently isolated from hands of healthcare personnel on wards without any known infected patient (Mutters R et al. J Hosp Infect 2009;71:43-48)

Manian, MGH 16

### *How good are we at cleaning hospital rooms?*

INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY NOVEMBER 2008, VOL. 33, NO. 11

ORIGINAL ARTICLE

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

Phillip C. Carling, MD; Michael M. Parry, MD; Mark E. Rupp, MD; John L. Po, MD, PhD; Brian Dick, MS, CIC; Sandra Von Behren, RN, BSN, MS, CIC; for the Healthcare Environmental Hygiene Study Group

**OBJECTIVE.** The prevalence of serious infections caused by multidrug-resistant pathogens transmitted in the hospital setting has reached alarming levels despite intensified interventions. In the context of mandates that hospitals ensure compliance with disinfection procedures of surfaces in the environment surrounding the patient, we implemented a multihospital project to both evaluate and improve current cleaning practices.

**DESIGN.** Prospective quasi-experimental, before-after, study.

**SETTING.** Thirty-six acute care hospitals in the United States ranging in size from 25 to 721 beds.

**METHODS.** We used a fluorescent targeting method to objectively evaluate the thoroughness of terminal room disinfection cleaning before and after structured educational and procedural interventions.

**RESULTS.** Of 20,646 standardized environmental surfaces (14 types of objects), only 9,910 (48%) were cleaned at baseline (95% confidence interval, 41.4–51.4). Thoroughness of cleaning at baseline correlated only with hospital expenditures for environmental services personnel ( $P = .02$ ). After implementation of interventions and provision of objective performance feedback to the environmental services staff, it was determined that 7,287 (77%) of 9,464 standardized environmental surfaces were cleaned ( $P < .001$ ). Improvement was unrelated to any demographic, fiscal, or staffing parameter but was related to the degree to which cleaning was suboptimal at baseline ( $P < .001$ ).

**CONCLUSIONS.** Significant improvements in disinfection cleaning can be achieved in most hospitals, without a substantial added fiscal commitment, by the use of a structured approach that incorporates a simple, highly objective surface targeting method, repeated performance feedback to environmental services personnel, and administrative interventions. However, administrative leadership and institutional flexibility are necessary to achieve success, and sustainability requires an ongoing programmatic commitment from each institution.

Infect Control Hosp Epidemiol 2008; 29:1035-1041  
Manian, MGH 18

# Enhanced Environmental Cleaning in Controlling *Clostridium difficile* Infections in the Hospital Setting

## Prof. Farrin A. Manian, Massachusetts General Hospital & Harvard Medical School

### A Webber Training Teleclass

Environmental Cleaning in Acute Care Hospitals  
Carling PC et al. ICHE 2008;29:1035-41

- Before and after intervention study
- Efficacy of cleaning evaluated
- Fluorescent targeting method
- “High-touch”/high-risk objects” only
- No microbiological data
- “Structured educational/procedural intervention”
- Feedback to personnel
- “Group one-on-one teaching”

Manian, MGH 19

Environmental Cleaning in Acute Care Hospitals  
Carling PC et al. ICHE 2008;29:1035-41

- Rate of baseline cleaning of high risk objects increased from 48% to 77% after intervention
- Lower range of all sites <50% even after intervention
- Bathroom light switch mean 64% (8-100%)
- 19% hospitals only had marginal improvement in cleaning rate (mean 61%-67%)
- Some hospitals implemented additional measures
- Sustainability of results not systematically studied
- Some hospitals observed a decrease in cleaning rates by 10-20% over 6-18 mos.

Manian, MGH 20

Research article Open Access

**Reduction of *Clostridium Difficile* and vancomycin-resistant *Enterococcus* contamination of environmental surfaces after an intervention to improve cleaning methods**

Brittany C Eckstein<sup>1</sup>, Daniel A Adams<sup>1</sup>, Elizabeth C Eckstein<sup>2</sup>, Agam Rao<sup>3</sup>, Ajay K Sethi<sup>4</sup>, Gopala K Yadavalli<sup>1</sup> and Curtis J Donskey<sup>\*1</sup>

Address: <sup>1</sup>Research Service, Louis Stokes Cleveland Veterans Affairs Medical Center, 10701 East Blvd., Cleveland, Ohio, USA; <sup>2</sup>Infection Control Department, Louis Stokes Cleveland Veterans Affairs Medical Center, 10701 East Blvd., Cleveland, Ohio, USA; <sup>3</sup>Department of Medicine, University Hospitals of Cleveland, 10000 Euclid Avenue, Cleveland, Ohio, USA and <sup>4</sup>Department of Epidemiology and Biostatistics, Case Western Reserve University School of Medicine, 10900 Euclid Avenue, Cleveland, Ohio, USA

Email: Brittany C Eckstein - bteckst16@gmail.com; Daniel A Adams - daa212@lombardi.cuhs.edu; Elizabeth C Eckstein - Elizabeth.Eckstein@va.gov; Agam Rao - agam.rao@case.edu; Ajay K Sethi - aks26@case.edu; Gopala K Yadavalli - gopal.yadavalli@med.vcu.gov; Curtis J Donskey - curind123@yahoo.com

\* Corresponding author

Published: 21 June 2007  
BMC Infectious Diseases 2007, 7:61 doi:10.1186/1471-2334-7-61  
Received: 4 December 2006  
Accepted: 21 June 2007

This article is available from: <http://www.biomedcentral.com/1471-2334/7/61>

© 2007 Eckstein et al; licensee BioMed Central Ltd.  
This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/2.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Manian, MGH 21

Impact of Terminal Cleaning on Room Surface Contamination with VRE and *C. difficile*.  
Eckstein BC et al. BMC infect Dis 2007; 7:61.

- Single center, VA hospital
- Adequacy of cleaning of newly-vacated rooms of *C. difficile* and VRE positive patients
- Commonly touched items (i.e. bedrails, phones, call buttons, etc...) targeted
- Before and after housekeeping staff received education and feedback
- 10% bleach for all *C.difficile* rooms

Manian, MGH 22

Eckstein BC et al. BMC infect Dis 2007; 7:61.

Item	Before cleaning	After housekeeping cleaning	After disinfection by research team
Bedrail	70	30	10
Bedside table	30	10	0
Phone	30	10	0
Call button	30	10	0
Toilet	30	10	0
Door handle	30	10	0

**Figure 2**  
Percentage of positive environmental cultures for *Clostridium difficile* before and after housekeeping cleaning and after disinfection with 10% bleach by the research team. Nine rooms of patients with *Clostridium difficile*-associated disease were cultured.

Manian, MGH 23

Standard Procedure Before Intervention  
Eckstein BC et al. BMC infect Dis 2007

- No significant difference in the rate of VRE – or *C.difficile* positive rooms before vs after housekeeping cleaning (94% vs. 71% , 100% vs 78%, respectively) despite recent *C.difficile* outbreak in the setting of :
  - 2 yr old policy of cleaning *C. difficile* rooms with bleach
  - Inservices emphasizing the importance of cleaning in preventing transmission of *C. difficile*
  - Instruction on the use of 10% bleach for terminal disinfection of *C. difficile* rooms
  - Stressing the cleaning of the frequently touched objects high touch items
  - Periodic contact with housekeeping staff to reinforce the bleach disinfection policy

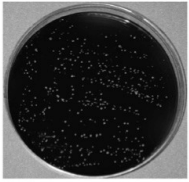
Manian, MGH 24

# Enhanced Environmental Cleaning in Controlling *Clostridium difficile* Infections in the Hospital Setting

Prof. Farrin A. Manian, Massachusetts General Hospital & Harvard Medical School

## A Webber Training Teleclass

Eckstein BC et al. BMC Infect Dis 2007



**Figure 3**  
Culture plate showing gross contamination of a call button with vancomycin-resistant Enterococcus (VRE) after completion of cleaning by housekeeping staff. The patient was a 68 year-old man with *Clostridium difficile*-associated disease and VRE resistant colonization. A sterile, pre-moistened cotton-tipped swab was applied to the surface of the call button and directly plated onto Enterococcal agar containing 30 µg per mL of vancomycin. The same call button yielded *C. difficile* by broth enrichment culture.

Manian, MGH 25

### Impact of Intervention on Surface Cultures

Eckstein BC et al. BMC Infect Dis 2007

- Intervention: more education/feedback on adequacy of cleaning etc...
- Outcome
  - 0% of the 10 rooms cultured had VRE
  - 20% of the 10 rooms still had 1 or more *C. difficile* contaminated surfaces

Manian, MGH 26

### Is 20% rate of persistent *C. difficile* contamination of patient rooms “good enough”?

INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY MARCH 2011, VOL. 32, NO. 3

ORIGINAL ARTICLE

### Evaluation of Hospital Room Assignment and Acquisition of *Clostridium difficile* Infection

Megan K. Shaughnessy, MD<sup>1</sup>; Renee L. Micelli, MD<sup>1</sup>; Daryl D. DePaola, PharmD<sup>2</sup>; Jennifer Arnold, MS<sup>2</sup>; Cathy L. Strachan, MSRN<sup>2</sup>; Kathy B. Welds, MS<sup>2</sup>; Carol E. Chenoweth, MD<sup>1,2</sup>

(See the commentary by Weber and Rutala, on pages 207–209.)

**BACKGROUND AND OBJECTIVE.** *Clostridium difficile* spores persist in hospital environments for an extended period. We evaluated whether admission to a room previously occupied by a patient with *C. difficile* infection (CDI) increased the risk of acquiring CDI.

**DESIGN.** Retrospective cohort study.

**SETTING.** Medical intensive care unit (ICU) at a tertiary care hospital.

**METHODS.** Patients admitted from January 1, 2005, through June 30, 2006, were evaluated for a diagnosis of CDI 48 hours after ICU admission and within 30 days after ICU discharge. Medical, ICU, and pharmacy records were reviewed for other CDI risk factors. Admitted patients who did develop CDI were compared with admitted patients who did not.

**RESULTS.** Among 1344 patients admitted to the ICU, 134 CDI cases were identified. After exclusions, 1,270 admitted patients remained for analysis. Of the patients who acquired CDI after admission to the ICU, 4.6% had a prior occupant without CDI, whereas 11.0% had a prior occupant with CDI ( $P = .002$ ). The effect of room on CDI acquisition remained a significant risk factor ( $P = .008$ ) when Kaplan-Meier curves were used. The prior occupant's CDI status remained significant ( $P = .01$ ; hazard ratio, 2.35) when controlling for the current patient's age, Acute Physiology and Chronic Health Evaluation III score, exposure to proton pump inhibitors, and antibiotic use.

**CONCLUSIONS.** A prior room occupant with CDI is a significant risk factor for CDI acquisition, independent of established CDI risk factors. These findings have implications for room placement and hospital design.

Infect Control Hosp Epidemiol 2011;32(3):201-206

Manian, MGH 28

### Evaluation of Hospital Room Assignment and Acquisition of *C. difficile* Infection

Shaughnessy MK, et al. ICHE 2011;32:201-206

- Retrospective cohort study, 2005-2006
- All patients evaluated for diagnosis of CDI 48 h after ICU admission and within 30 days after ICU discharge
- Examined many risk factors incl. age, APACHE score, antibiotics, proton pump inhibitor use, and prior room occupant with CDI
- Results
  - Strongest risk factor for acquisition of CDI in a multivariate analysis (Hazard ratio 2.351.21-4.54) was room previously occupied by CDI patient
  - Admission to room previously occupied by CDI 11% vs 4.6% not previously occupied by CDI

Manian, MGH 29

### Shaughnessy MK, et al. ICHE 2011;32:201-206

**TABLE 3. Multivariate Analysis of Risk Factors for Acquisition of *Clostridium difficile* Infection (CDI)**

Risk factor	HR (95% CI)	P
Prior room occupant with CDI	2.35 (1.21-4.54)	.01
Greater age	1.00 (0.99-1.01)	.71
Higher APACHE III score	1.00 (1.00-1.01)	.06
Proton pump inhibitor use	1.11 (0.44-2.78)	.83
Antibiotic exposure		
Norfloxacin	0.38 (0.05-2.72)	.33
Levofloxacin	1.08 (0.67-1.75)	.75
Ciprofloxacin	0.49 (0.15-1.62)	.23
Fluoroquinolones	1.17 (0.72-1.91)	.53
Clindamycin	0.45 (0.14-1.42)	.17
Third- or fourth-generation cephalosporins	1.17 (0.76-1.79)	.48
Carbapenems	1.05 (0.63-1.75)	.84
Piperacillin-tazobactam	1.31 (0.82-2.10)	.27
Other penicillin	0.47 (0.23-0.98)	.04
Metronidazole	1.33 (0.83-2.07)	.24
Vancomycin		
Oral	1.38 (0.32-5.89)	.67
Intravenous	1.55 (0.88-2.73)	.13
Aminoglycosides	1.27 (0.78-2.06)	.35
Multiple (≥3 antibiotic classes)	1.28 (0.75-2.21)	.37

**NOTE.** APACHE, Acute Physiology and Chronic Health Evaluation; CI, confidence interval; HR, hazard ratio.

Manian, MGH 30

**Enhanced Environmental Cleaning in Controlling *Clostridium difficile* Infections in the Hospital Setting**  
**Prof. Farrin A. Manian, Massachusetts General Hospital & Harvard Medical School**  
**A Webber Training Teleclass**

*Are there alternative ways of decontaminating hospital rooms?*

**“Touchless”  
Disinfection Technologies**

- Hydrogen peroxide vapor
- Ultraviolet light

Manian, MGH 32

**Potential Advantages of “Touchless”  
Disinfection Technology**

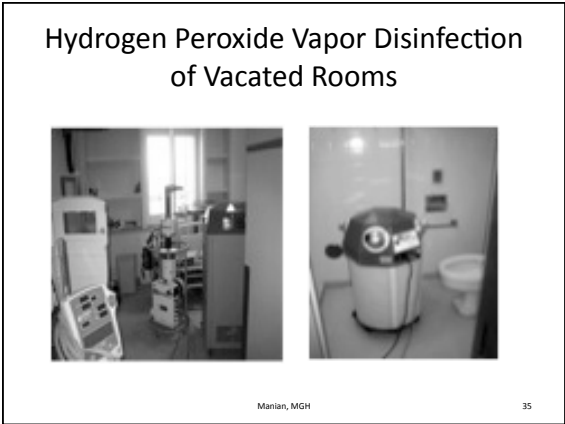
- Consistent disinfection regardless of case load, “urgency”; less likely to be hurried through
- Not affected by “human factors”
- Clinical/electronic equipment disinfection
- No risk of spreading pathogens from one area to another in the room
  - After 1 round of cleaning/disinfection with bleach, several previously culture negative sites grew MRSA or *Acinetobacter baumannii* complex (Manian FA et al. ICHE 2011;32:667-72)

Manian, MGH 33

**Hydrogen Peroxide Vapor/Dry Mist vs Selected Pathogens**

Type of study	Pathogens	Results
Experimental (HPV) (J Clin Microbiol 2009)	MRSA/VRE/ABC/K. pneumoniae/C. difficile	6-7 log CFU/ all inactivated within 90 min exposure
In situ (dry mist) (J Hosp Infect 2008)	<i>C. difficile</i>	24% room sites + post 1 x C/D (1% hypochlorite) vs 3%
In situ (dry mist) (ICHE 2009)	<i>C. difficile</i> spores	12% sites+ post C/D 0.5% hypochlorite) vs 2%
In situ (HPV) (J Hosp Infect 2004)	MRSA	Standard: 66% + sites HPV 1.2% + sites

Manian, MGH 34



*But does it impact CDI rates?*

Manian, MGH 36

# Enhanced Environmental Cleaning in Controlling *Clostridium difficile* Infections in the Hospital Setting

## Prof. Farrin A. Manian, Massachusetts General Hospital & Harvard Medical School

### A Webber Training Teleclass

INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY AUGUST 2008, VOL. 29, NO. 8

ORIGINAL ARTICLE

### Impact of Hydrogen Peroxide Vapor Room Decontamination on *Clostridium difficile* Environmental Contamination and Transmission in a Healthcare Setting

John M. Boyce, MD; Nancy L. Havill, MT; Jonathan A. Otter, BSc; L. Clifford McDonald, MD; Nicholas M. T. Adams, BSc; Timothea Cooper, RN; Angela Thompson, MSc; Lois Wiggie; George Killgore, DPHI; Allison Tauman, PharmD; Judith Noble-Wang, PhD

**OBJECTIVE.** To determine whether hydrogen peroxide vapor (HPV) decontamination can reduce environmental contamination with and nosocomial transmission of *Clostridium difficile*.

**DESIGN.** A prospective before-after intervention study.

**SETTING.** A hospital affected by an epidemic strain of *C. difficile*.

**INTERVENTION.** Intensive HPV decontamination of 5 high-incidence wards followed by hospital-wide decontamination of rooms vacated by patients with *C. difficile*-associated disease (CDAD). The preintervention period was June 2004 through March 2005, and the intervention period was June 2005 through March 2006.

**RESULTS.** Eleven (25.6%) of 43 cultures of samples collected by sponge from surfaces before HPV decontamination yielded *C. difficile*, compared with 0 of 37 cultures of samples obtained after HPV decontamination ( $P < .001$ ). On 5 high-incidence wards, the incidence of nosocomial CDAD was significantly lower during the intervention period than during the preintervention period (1.28 vs 2.28 cases per 1,000 patient-days;  $P = .047$ ). The hospital-wide CDAD incidence was lower during the intervention period than during the preintervention period (0.84 vs 1.36 cases per 1,000 patient-days;  $P = .26$ ). In an analysis limited to months in which the epidemic strain was present during both the preintervention and the intervention periods, CDAD incidence was significantly lower during the intervention period than during the preintervention period (0.88 vs 1.89 cases per 1,000 patient-days;  $P = .047$ ).

**CONCLUSIONS.** HPV decontamination was efficacious in eradicating *C. difficile* from contaminated surfaces. Further studies of the impact of HPV decontamination on nosocomial transmission of *C. difficile* are warranted.

Manian, MGH  
Infect Control Hosp Epidemiol 2008; 29:723-729

### Impact of HPV room decontamination on *C. difficile* environmental contamination and transmission in a healthcare setting

Boyce JM et al. ICHE 2008; 29:723-729.

- Single center, university-affiliated hospital
- Prospective before-after intervention study
- Epidemic strain of *C. difficile*
- Intervention: hydrogen peroxide vapor (HPV) decontamination of 5 high-incidence wards, followed by hospital-wide decontamination of rooms vacated by patient with CDI
- Pre-intervention (6.2004-3.2005) vs intervention (6.2005-3.2006)

Manian, MGH 38

### Impact of HPV room decontamination on *C. difficile* environmental contamination and transmission in a healthcare setting

Boyce JM et al. ICHE, 2008

- Microbiological sampling of surfaces
  - 11/43 (25.6%) of surfaces grew *C. difficile* before HPV decontamination
  - 0/37 of surfaces grew *C. difficile* after HPV decontamination
- CDI incidence among hospitalized patients
  - 5 “high-incidence” wards, dropped significantly (1.28 vs 2.28 cases/1000 patient-days,  $P=0.047$ )
  - Hospital wide dropped but not significantly (0.84 vs 1.36 cases/1000 patient-days,  $P=0.26$ )

Manian, MGH 39

Passaretti CL et al. Clin Infect Dis 2013; 56:27-35

MAJOR ARTICLE

### An Evaluation of Environmental Decontamination With Hydrogen Peroxide Vapor for Reducing the Risk of Patient Acquisition of Multidrug-Resistant Organisms

Catherine L. Passaretti,<sup>1,2,3</sup> Jonathan A. Otter,<sup>4</sup> Nicholas G. Reich,<sup>5,6</sup> Jessica Myers,<sup>3</sup> John Shepard,<sup>1</sup> Tracy Ross,<sup>7</sup> Karen C. Carroll,<sup>8</sup> Pam Lipsitt,<sup>9</sup> and Trish M. Perle<sup>10,11</sup>

<sup>1</sup>Division of Infectious Diseases, Department of Medicine, Johns Hopkins University School of Medicine, <sup>2</sup>Department of Hospital Epidemiology and Infection Control, The Johns Hopkins Hospital, Baltimore, Maryland, <sup>3</sup>Division of Infectious Diseases, Department of Medicine, Carver Medical Center, Charlotte, North Carolina, <sup>4</sup>Bosqell Inc, Hordley, Pennsylvania, <sup>5</sup>Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Johns Hopkins University, Baltimore, Maryland, <sup>6</sup>Division of Biostatistics and Epidemiology, School of Public Health and Health Sciences, University of Massachusetts, Amherst, <sup>7</sup>Department of Pathology, and <sup>8</sup>Department of Surgery, Johns Hopkins University School of Medicine, Baltimore, Maryland

Manian, MGH 40

### An evaluation of environmental decontamination with hydrogen peroxide vapor for reducing the risk of patient acquisition of multidrug-resistant organisms.

Passaretti CL et al. Clin Infect Dis 2013; 56:27-35.

- Single center, tertiary care hospital
- 30-month prospective cohort intervention study
- 6 “high-risk” units
- Standard cleaning with hydrogen peroxide-containing liquid cleaner/disinfectant used for rooms of patient with CDI
- Intervention: HPV used in addition to standard cleaning/disinfection
- 12 month pre-intervention phase (Jan-Dec, 2007) vs. 18 month intervention phase (1.2008-6.2009)

Manian, MGH 41

### An evaluation of environmental decontamination with hydrogen peroxide vapor for reducing the risk of patient acquisition of multidrug-resistant organisms

Passaretti CL et al. Clin Infect Dis , 2013

- Assessed impact on MDRO (VRE, MRSA, MDR-GNR, *C. difficile*) acquisition in subsequent room occupants
- Results
  - Incidence rate ratio (IRR) for any MDRO (combined): 0.36 (0.19-0.70,  $P<0.01$ )
  - Incidence rate ratio for CDI:
    - Standard cleaning: rooms not known to have housed CDI pts vs rooms known to have housed CDI pts: 0.95 (.60-1.51,  $P=0.83$ )
    - Rooms known to have housed CDI pts: standard vs. HPV disinfection, IRR 0.49 (0.16-1.47,  $P=0.19$ )

Manian, MGH 42

# Enhanced Environmental Cleaning in Controlling *Clostridium difficile* Infections in the Hospital Setting

## Prof. Farrin A. Manian, Massachusetts General Hospital & Harvard Medical School

### A Webber Training Teleclass

An evaluation of environmental decontamination with hydrogen peroxide vapor for reducing the risk of patient acquisition of multidrug-resistant organisms  
Passaretti CL et al. Clin Infect Dis, 2013

- **Conclusions**
  - HPV decontamination used as an adjunct to standard cleaning and disinfection reduced the risk of MDRO acquisition among high-risk patients when patients are admitted to a room previously occupied by a patient infected or colonized with an MDRO
  - HPV in addition to a thorough infection prevention program should be implemented in high-risk environments to maximize patient safety

Manian, MGH 43

American Journal of Infection Control 41 (2013) 537–41  
Contents lists available at ScienceDirect  
American Journal of Infection Control  
journal homepage: www.ajicjournal.org

Major article  
Implementation of hospital-wide enhanced terminal cleaning of targeted patient rooms and its impact on endemic *Clostridium difficile* infection rates  
Farrin A. Manian MD, MPH<sup>a,\*</sup>, Sandra Griesnauer RN, MSN<sup>a</sup>, Alex Bryant PharmD<sup>b</sup>

<sup>a</sup>Department of Infection Control, Massachusetts General Hospital, Boston, MA  
<sup>b</sup>Department of Pharmacy, Massachusetts General Hospital, Boston, MA

**Background:** Implementation of a hospital-wide program of terminal cleaning of patient rooms involving around hydrogen peroxide vapor (HPV) technology and evaluation of its impact on endemic nosocomial *Clostridium difficile* (CDI) have not been previously reported.  
**Methods:** This was a retrospective quasi-experimental study involving a 900-bed community hospital. During the preintervention period (January 2007–November 2008), rooms vacated by patients with CDI or on contact precautions for other targeted pathogens underwent 1 or more rounds of cleaning with bleach. During the intervention period (January–December 2009), targeted newly vacated rooms underwent “enhanced cleaning” consisting of use of bleach followed by HPV decontamination utilizing a priority scale based on the pathogens and room location. Rooms vacated by patients with CDI but for which HPV decontamination was not possible the same day underwent 4 rounds of cleaning with bleach instead.  
**Results:** During the intervention period, 123 HPV decontamination rounds were performed involving 96.7% of hospital rooms. Of 218 rooms vacated by patients with CDI (May–December 2009), 180 (82%) underwent HPV decontamination. The rate of nosocomial CDI rate dropped significantly from 0.88 cases/100 patient-days to 0.55 cases/100 patient-days (rate ratio, 0.63; 95% confidence interval, 0.50–0.79;  $P < .0001$ ).  
**Conclusion:** A hospital-wide program of enhanced terminal cleaning of targeted patient rooms involving around HPV technology was practical and was associated with a significant reduction in CDI rates.  
Copyright © 2013 by the Association for Professionals in Infection Control and Epidemiology, Inc. Published by Elsevier Inc. All rights reserved.

Manian, MGH 44

Implementation of hospital-wide enhanced terminal cleaning of targeted patient rooms and its impact on endemic *Clostridium difficile* infection rates  
Manian FA et al. AJIC 2013;41:537-41

- Single center, 900-bed tertiary care community teaching hospital
- Hospital wide (not just “high-risk” units); Pediatrics and Rehabilitation units excluded
- Performed in the absence of an outbreak i.e. impact on endemic rate
- Quasi-experimental: CDI rates before and after intervention
  - Preintervention: 1.2007-11.2008, 365,926 hospital days
  - Intervention: 1.2009-12.2009, 196,313 hospital days

Manian, MGH 45

Implementation of hospital-wide enhanced terminal cleaning of targeted patient rooms and its impact on endemic *Clostridium difficile* infection rates  
Manian FA et al. AJIC, 2013

- CDI: Onset of diarrhea with positive stool cytotoxin A or B by EIA between 72 hrs following admission up to and including 7 days following discharge
- Pre-intervention
  - Occupied rooms: daily cleaning with bleach (1:10 dilution)
  - Newly-vacated rooms: terminal cleaning with bleach x 1 (19 mos), x4 (3.5 mos.)

Manian, MGH 46

### Intervention Phase

Manian FA et al. AJIC, 2013

- Occupied rooms: daily cleaning with bleach
- Newly-vacated rooms: 1 round of cleaning with bleach followed by HPV disinfection
- Use of a priority scale for daily selection of rooms for HPV disinfection

Priority scale<sup>a</sup> for hydrogen peroxide vapor decontamination of newly vacated rooms of patients based on targeted pathogen and hospital ward, January through December 2009

Factor	Assigned score
Pathogens	
<i>Clostridium difficile</i>	4
MRSA	4
VRE	4
MRBCNP <sup>b</sup>	1
Others	0
Hospital ward	
ICU, including step-down units	2
Outpatient	1
Others	0

MRBCNP: Multidrug resistant gram-negative bacilli, MRSA, methicillin-resistant *Staphylococcus aureus*; VRE, vancomycin-resistant *Enterococcus* spp.  
<sup>a</sup>Priority was given to rooms with the highest cumulative score based on the sum of assigned pathogens and ward score on a particular day. Assigned pathogen points were counted only once (the pathogen with the highest score) irrespective of the number of different organisms colonizing and/or infecting the previous room occupant.  
<sup>b</sup>Multidrug-resistant gram-negative bacilli, excluding *Acinetobacter baumannii* complex rooms that routinely underwent HPV decontamination.

Manian, MGH 47

### Priority Scale for Daily Implementation of HPV for Terminal Disinfection of Hospital Rooms

Manian FA et al. AJIC, 2013

1. All MDRABC+ (multi-drug resistant *Acinetobacter*) rooms
2. All burn unit rooms
3. For all other rooms use a scoring system based on the targeted pathogen and location of room in the hospital

Manian, MGH 48



# Enhanced Environmental Cleaning in Controlling *Clostridium difficile* Infections in the Hospital Setting

## Prof. Farrin A. Manian, Massachusetts General Hospital & Harvard Medical School

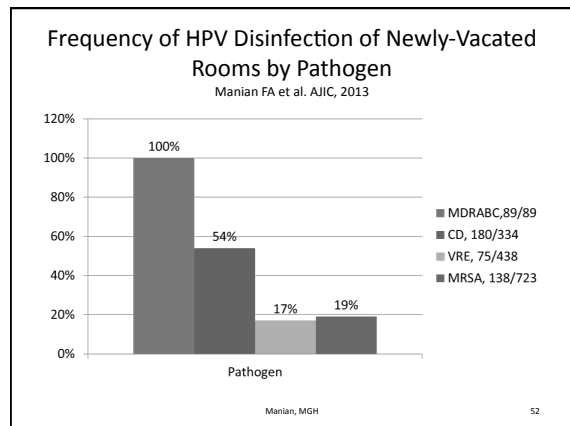
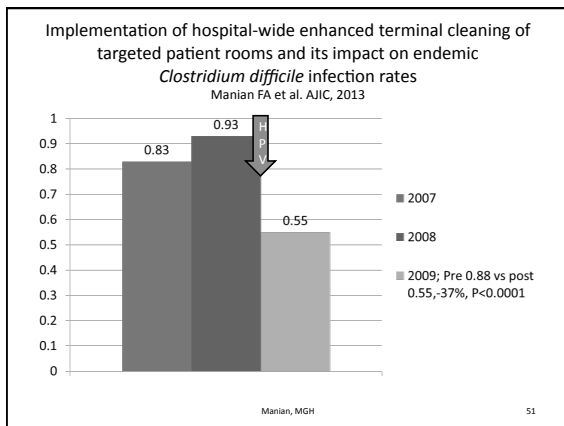
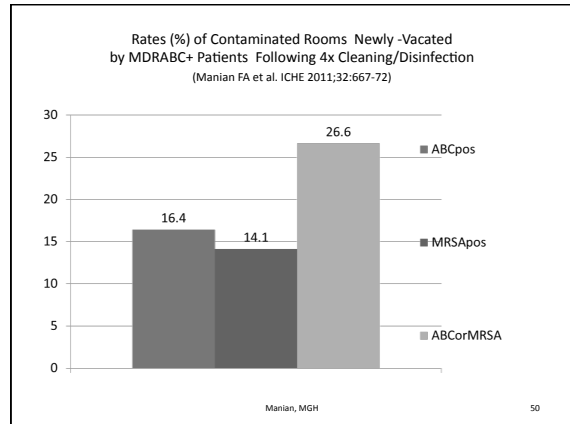
### A Webber Training Teleclass

**Priority Scale for Daily HPV Decontamination of Newly-Vacated Hospital Rooms: Scoring System**  
Manian FA et al. AJIC, 2013

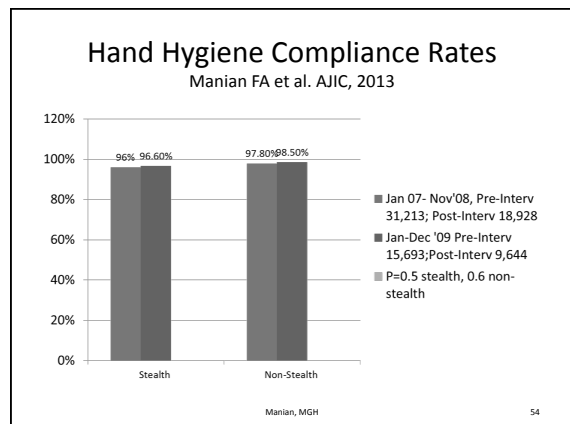
Variable	Score
<b>Targeted pathogen</b>	
<i>C. difficile</i> *	4
MRSA	4
VRE	4
Other MDROs	1
<b>Location of room</b>	
ICUs	2
Oncology	1

\*4 rounds of cleaning/disinfection with bleach if unable to use HPV

Manian, MGH 49



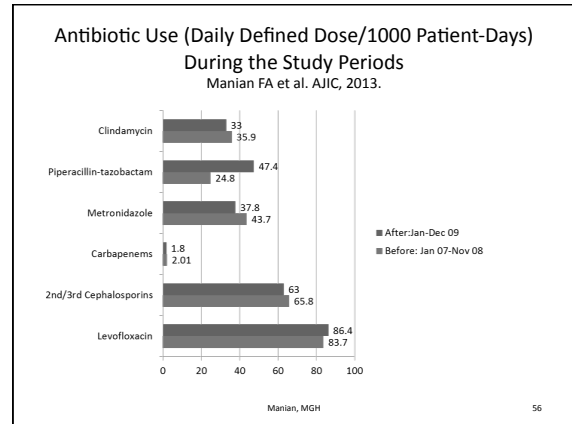
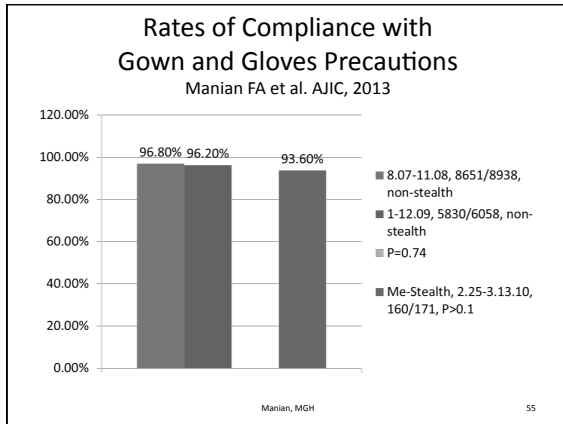
But what about other factors?



# Enhanced Environmental Cleaning in Controlling *Clostridium difficile* Infections in the Hospital Setting

Prof. Farrin A. Manian, Massachusetts General Hospital & Harvard Medical School

## A Webber Training Teleclass



### Study Limitations

- Not a randomized controlled or concurrent cohort study
- Study did not involve nosocomial colonization/acquisition rates
- Only assessed impact of intensive terminal cleaning and disinfection in the setting of relatively high compliance with hand hygiene and isolation precautions.
- Single center

Manian, MGH 57

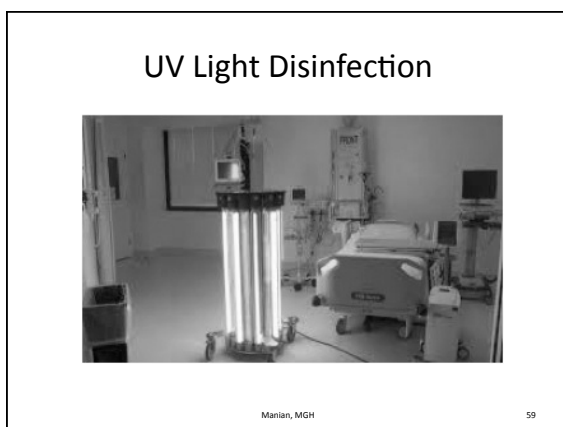
### Conclusion

Manian FA et al. AJIC, 2013.

*“Implementation of an enhanced hospital-wide terminal cleaning program\* revolving around HPV decontamination of targeted hospital rooms was practical, safe, and associated with a significant reduction in the endemic rate of CDAD at our hospital”*

\*46% of CDI rooms cleaned and disinfected manually with 4 rounds of bleach

Manian, MGH 58



### Ultraviolet Light Technology

- Reduces *C. difficile* spore counts on surfaces by 2-4 logs (Boyce JM et al. ICHE 2011;32:737-742)
- Surfaces must be in direct path of the UV light for optimal disinfection
- Shorter disinfection time
- No need for constant monitoring
- No studies demonstrating clinical efficacy in reducing transmission of *C. difficile* in healthcare settings

Manian, MGH 60

Hosted by Dr. Pierre Parneix, Bordeaux, France  
[www.webbertraining.com](http://www.webbertraining.com)

**Enhanced Environmental Cleaning in Controlling *Clostridium difficile* Infections in the Hospital Setting**  
**Prof. Farrin A. Manian, Massachusetts General Hospital & Harvard Medical School**  
**A Webber Training Teleclass**

INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY MAY 2012, VOL. 33, NO. 5

ORIGINAL ARTICLE

**Comparison of the Microbiological Efficacy of Hydrogen Peroxide Vapor and Ultraviolet Light Processes for Room Decontamination**

Nancy L. Havill, MT<sup>1</sup>; Brent A. Moore, PhD<sup>2</sup>; John M. Boyce, MD<sup>1,2</sup>

---

**OBJECTIVE.** To compare the microbiological efficacy of hydrogen peroxide vapor (HPV) and ultraviolet radiation (UVC) for room decontamination.

**DESIGN.** Prospective observational study.

**SETTING.** 500-bed teaching hospital.

**METHODS.** HPV and UVC processes were performed in 15 patient rooms. Five high-touch sites were sampled before and after the processes and aerobic colony counts (ACCs) were determined. Carrier disks with  $\sim 10^6$  *Clostridium difficile* (CD) spores and biological indicators (BIs) with  $10^6$  and  $10^7$  *Geobacillus stearothermophilus* spores were placed in 5 sites before decontamination. After decontamination, CD log reductions were determined and BIs were recorded as growth or no growth.

**RESULTS.** 93% of ACC samples that had growth before HPV did not have growth after HPV, whereas 52% of sites that had growth before UVC did not have growth after UVC ( $P < .0001$ ). The mean CD log reduction was  $\geq 6$  for HPV and  $\sim 2$  for UVC. After HPV 100% of the  $10^6$  BIs did not grow, and 22% did not grow after UVC, with a range of 7%–53% for the 5 sites. For the  $10^7$  BIs, 99% did not grow after HPV and 0% did not grow after UVC. Sites out of direct line of sight were significantly more likely to show growth after UVC than after HPV. Mean cycle time was 153 (range, 140–177) min for HPV and 73 (range, 59–100) min for UVC ( $P < .0001$ ).

**CONCLUSION.** Both HPV and UVC reduce bacterial contamination, including spores, in patient rooms, but HPV is significantly more

**Comparison of HPV and UV Against *C. difficile* Spores**  
 Havill NL et al. ICHE 2012;33:507-12

- 15 hospital rooms
- Carrier disks with  $\sim 1$  M *C. difficile* spores place on 5 sites (overbed table, chair, floor under bed, toilet seat, shower floor)
- HPV 6-log reduction in *C. difficile* spores, all sites
- UV 2.2 log reduction in *C. difficile* spores
- 6-log reduction in biological indicator in 99% of HPV vs 0% for UV
- UV less effective for sites that are out of direct line of sight

Manian, MGH 62

*So Does Enhanced Environmental Cleaning in Controlling Clostridium difficile Infections in the Hospital Setting Really Matter?*

*I Believe it Does!*

**Patient Room: a Hospital Area in Need of Disinfection: The Neglected Giant H.A.N.D?**



Manian, MGH 65


**Conclusions**

- *C. difficile* infection is an important cause of healthcare associated infections
- Environmental contamination due to *C. difficile* is common and may serve as source of infection either directly or via hands of personnel
- Standard terminal cleaning of hospital rooms is often inadequate
- Intensive cleaning and disinfection may reduce the risk of CDI in hospitalized patients

Manian, MGH 66

**Hosted by Dr. Pierre Parneix, Bordeaux, France**  
**www.webbertraining.com**

**Enhanced Environmental Cleaning in Controlling *Clostridium difficile* Infections in the Hospital Setting**  
**Prof. Farrin A. Manian, Massachusetts General Hospital & Harvard Medical School**  
**A Webber Training Teleclass**

  
**Coming Soon**

October 16 **HEALTHCARE LAUNDRY: EPIDEMIOLOGY AND MICROBIOLOGY ISSUES**  
*Dr. Lynne Schulster, Division of Healthcare Quality Promotion, Centers for Disease Control and Prevention*

October 23 **INFECTION PREVENTION IN OUTPATIENT ONCOLOGY SETTINGS**  
*Dr. Alice Guh, Division of Healthcare Quality Promotion, Centers for Disease Control and Prevention*

November 5 *(Free WHO Teleclass – Europe)*  
**PUBLIC REPORTING AND DISCLOSURE OF HAI RATES: POSITIVE IMPACT OR CONFUSION?**  
*Dr. Michael Borg, St. Luke's Hospital, Malta*  
*Sponsored by the World Health Organization*

November 6 *(Free Teleclass)*  
**CBIC IS MAKING THE CERTIFICATION PROCESS WORK FOR ALL !**  
*Craig H Gilliam and Lita Jo Henman, Certification Board of Infection Control*

[www.webbertraining.com/schedule1.php](http://www.webbertraining.com/schedule1.php)

Thanks to Teleclass Education  
**PATRON SPONSORS**

  
**VIROX**  
FORANOLDEX 100  
[www.virox.com](http://www.virox.com)

  
**World Health Organization**  
Clean Care is Safer Care  
[www.who.int/gpsc/en](http://www.who.int/gpsc/en)

**Hosted by Dr. Pierre Parneix, Bordeaux, France**  
[www.webbertraining.com](http://www.webbertraining.com)