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Wednesday 22nd February 2017

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No-Touch Disinfection: The New Frontier in Patient Safety

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No Touch Disinfection – The New Frontier in Patient Safety

Mark Stibich, PhD

Founder & Chief Scientific Officer - Xenex Disinfection Services, LLC

Visiting Scientist - MD Anderson Cancer Center

XENEX LIGHTSTRIKE™ GERM-ZAPPING ROBOTS™

THE UNIVERSITY OF TEXAS MD Anderson Cancer Center

Making Cancer History®

About Xenex Disinfection Services

- Founded in 2009 by Mark Stibich and Julie Stachowiak, two PhDs from Johns Hopkins
- Number of employees: ~125
- Over 740 robots disinfecting 375+ hospitals
- Distribution in 18 countries
- Peer reviewed studies: 9 outcome studies, 5 environmental studies and 1 patient Satisfaction (HCAHPS) Study – and multiple studies in preparation.
- Primary market: acute care, post-acute care; LTACs, SNFS and ASCs

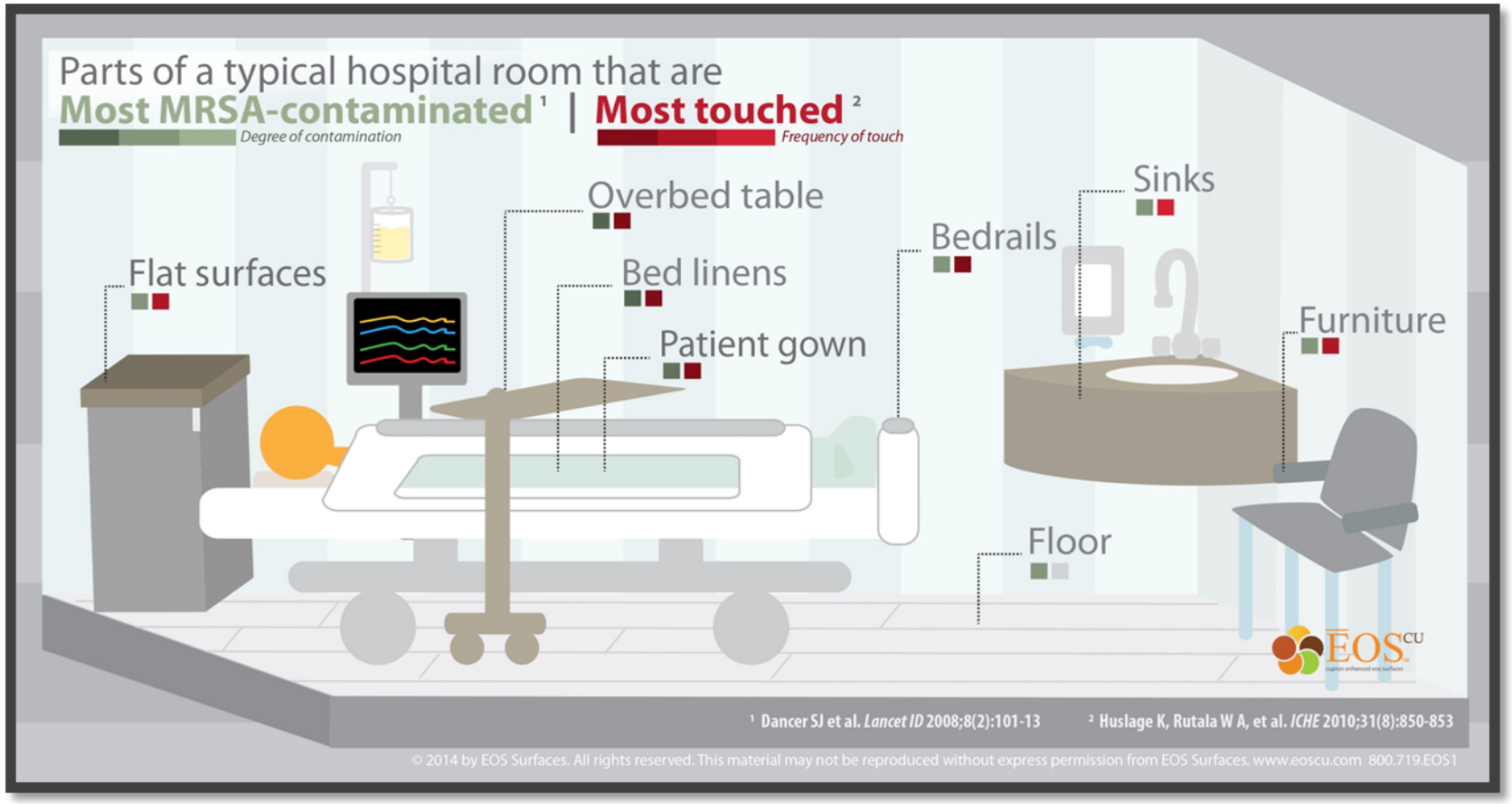
DISCLOSURES

- Shareholder and Chief Scientific Officer for Xenex Disinfection Services, San Antonio, Texas

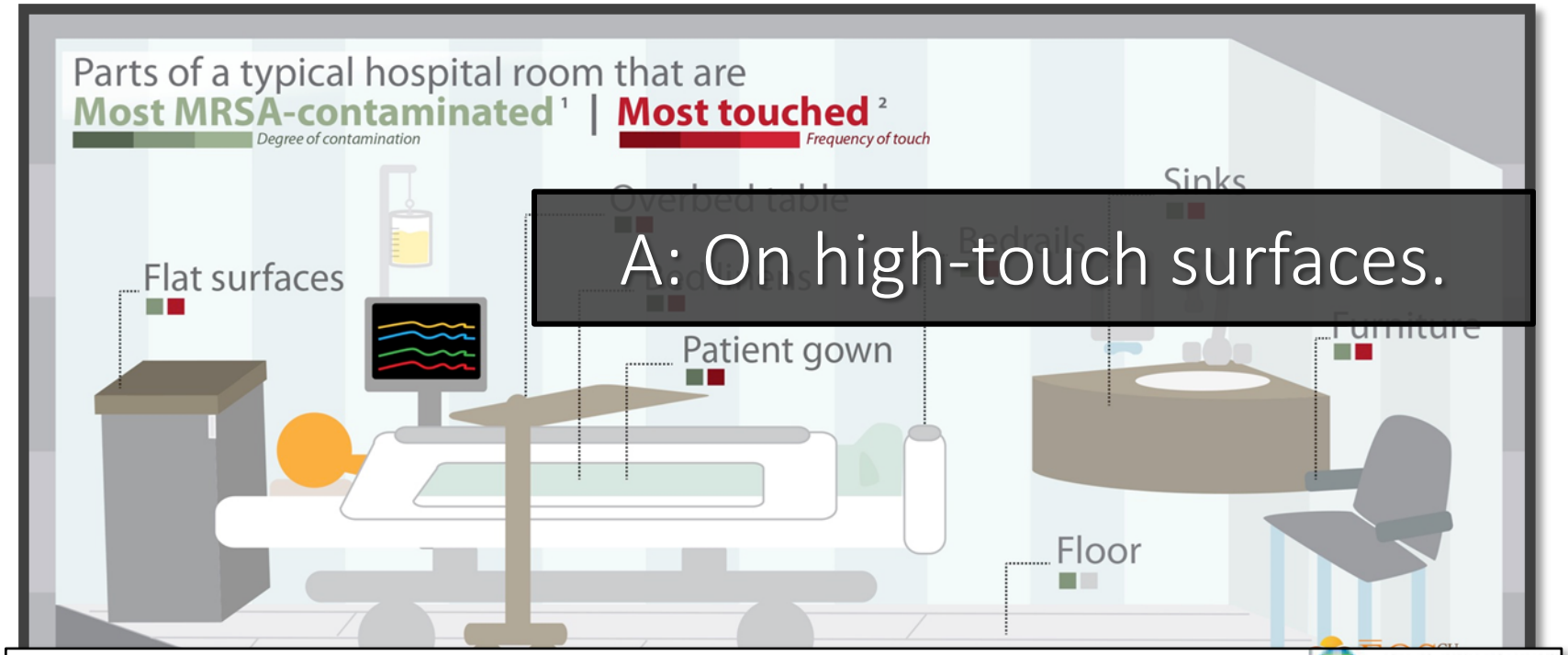
OUTLINE

- The Role of the Environment in Transmission of Pathogens
- Evidence for Automated Disinfection
- Outcomes Data
- MD Anderson Cancer Center Experience

WHERE ARE THE BUGS?



WHERE ARE THE BUGS?



Crit Care Med. 2010 Aug;38(8 Suppl):S335-44. doi: 10.1097/CCM.0b013e3181e6ab12.

Methicillin-resistant Staphylococcus aureus and vancomycin-resistant enterococcus: recognition and prevention in intensive care units.

Lin MY[1], Hayden MK.

SPREAD OF MDROS:
ROLE OF THE HEALTHCARE ENVIRONMENT

- Issue: Patients shed important pathogens including VRE, *C. difficile*, MRSA, and *Acinetobacter baumannii* into their surrounding environment.
- Problem: These organisms remain viable on inanimate objects for days to months, and can be transferred from the environment to HCWs hands, and then to other patients.
- Inadequate infection control propagates MDROs.
- Another Problem: Contamination of hospital rooms and equipment can persist despite cleaning and disinfection.

KEY COMPONENTS OF AN INFECTION CONTROL PROGRAM

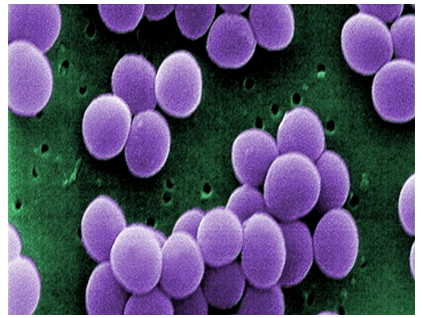
- **Surveillance Programs**
- **Implementation & Monitoring of Best Practices**
- **Environmental Cleaning**
- Antimicrobial Stewardship Program
- **Transmission-based Precautions**
- Patient-specific Factors
- Employees, Visitors and Caregivers

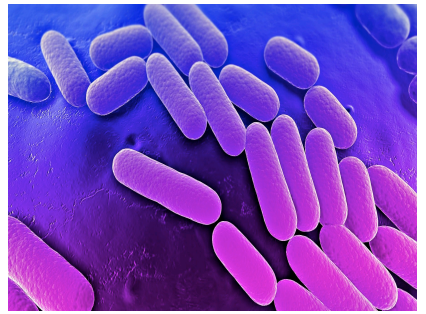
HOW LONG DO PATHOGENS SURVIVE?

Persistence of Microbes on Dry, Inanimate Surfaces

Pathogen	Duration of Persistence (range)
S. aureus, including MRSA	7 days – 7 months
Enterococcus spp., including VRE	5 days – 4 months
C. difficile spores	(5 months)
Acinetobacter spp., including MDR	3 days – 5 months
C. albicans	1 day – 4 months
E. coli, including ESBL	1.5 hours – 5 months
Klebsiella spp., including ESBL	2 hours – > 30 months
Herpes simplex virus type 1 and 2	4.5 hours – 2 months
Norovirus	8 hours – 7 days

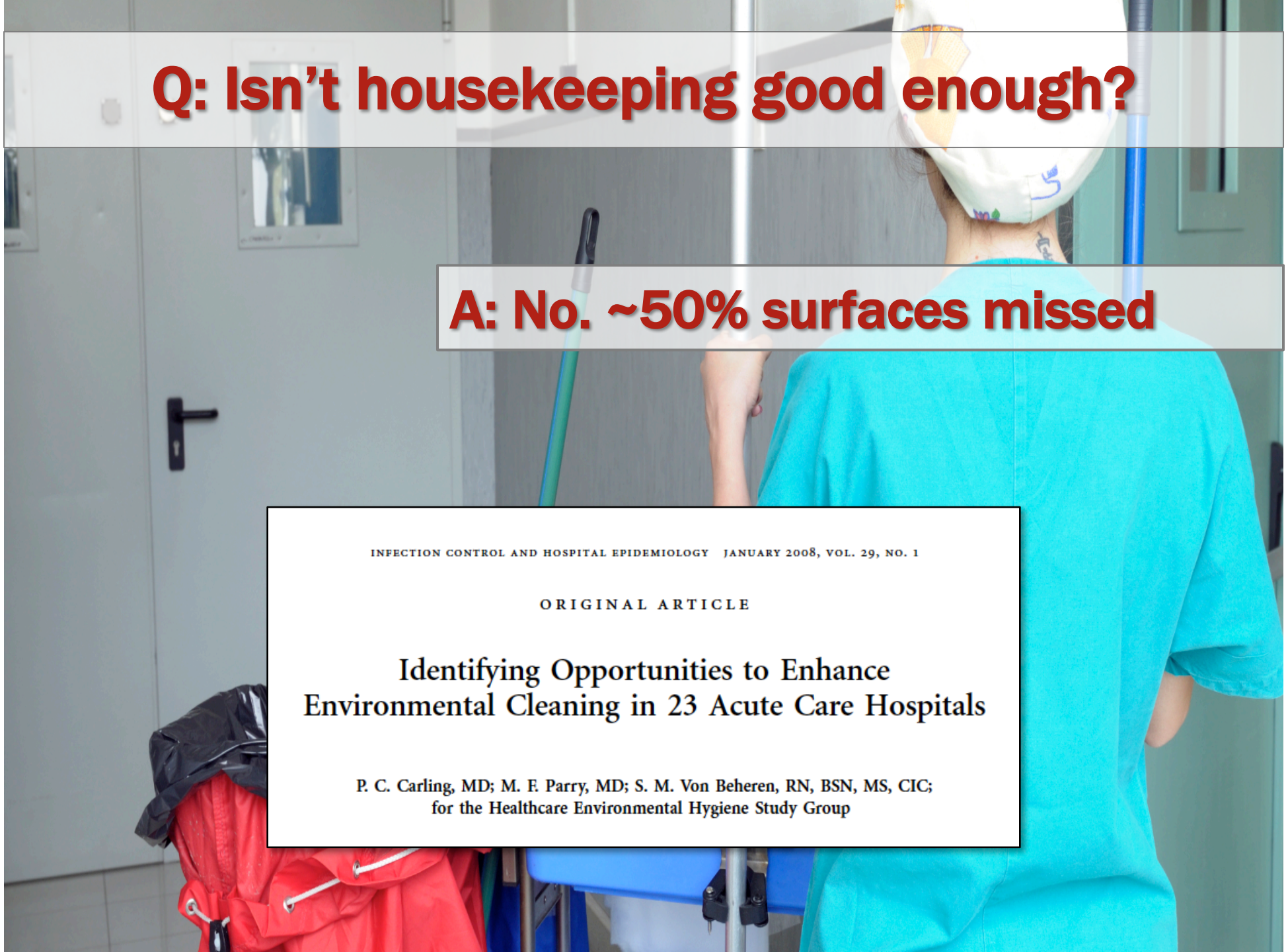
Modified from: Kramer A et al, BMC Infectious Diseases 2006, 6:130.





Q: Isn't housekeeping good enough?

A: No. ~50% surfaces missed



INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY JANUARY 2008, VOL. 29, NO. 1

ORIGINAL ARTICLE

Identifying Opportunities to Enhance Environmental Cleaning in 23 Acute Care Hospitals

P. C. Carling, MD; M. F. Parry, MD; S. M. Von Beheren, RN, BSN, MS, CIC;
for the Healthcare Environmental Hygiene Study Group

ROOM CONTAMINATION
Post-Discharge Cleaning

PATHOGEN	% CONTAMINATED AFTER DISCHARGE CLEANING
MRSA [1]	74% of Surface Cultures
MRSA [2]	46% of Rooms
MRSA [3]	24% of Rooms
VRE [3]	22% of Rooms
VRE [4]	16% of Rooms

[1] French GL et al. J Hosp Infect 2004;57:31-7
[2] Blythe D et al. J Hosp Infect 1998;38:67-70
[3] Goodman ER et al. ICHE 2008; 29:593-9
[4] Byers KE. ICHE 1998;19:261-4.

EVIDENCE FOR AUTOMATED DISINFECTION

ENHANCED ROOM DISINFECTION SYSTEMS

- Automated systems do not rely on the operator to ensure all surfaces are disinfected and adequate contact time is achieved
- However, it must be applied in addition to standard cleaning
- Require areas to be temporarily vacated of patients and staff and incur additional expense
- **TYPES:** Hydrogen Peroxide Vapor, Mercury UV light, Pulsed Xenon UV Light

HYDROGEN PEROXIDE VAPOR (HPV)

- Reduces the risk of MDRO acquisition among high-risk patients who 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 could be implemented in high-risk environments to maximize patient safety

DRAWBACKS:

- The time for disinfection is 1.5-3 hours per room[1]
- Did not reach statistically significant reduction in *C. diff*, MRSA or MDR-GNR[1]

1. *Passaretti, et al. An Evaluation of Environmental Decontamination with Hydrogen Peroxide Vapor for Reducing the Risk of Patient Acquisition of Multidrug-Resistant Organisms. Clinical Infectious Diseases (CID), January 2013*

UV LIGHT TECHNOLOGY

Xenon vs. Mercury: Is All UV the Same?

	XENON	MERCURY
Bulb Type	Pulsed Xenon (non-toxic)	Mercury (toxic)
***C. diff* Kill Time**	5 minutes	5 min. warm up + 45 min. + 15 min. cool down
MRSA Kill Time	2 minutes	5 min. warm up + 25 min. + 15 min. cool down
Intensity	High Intensity	Low Intensity
Spectrum	Wide Spectrum*	Narrow Spectrum

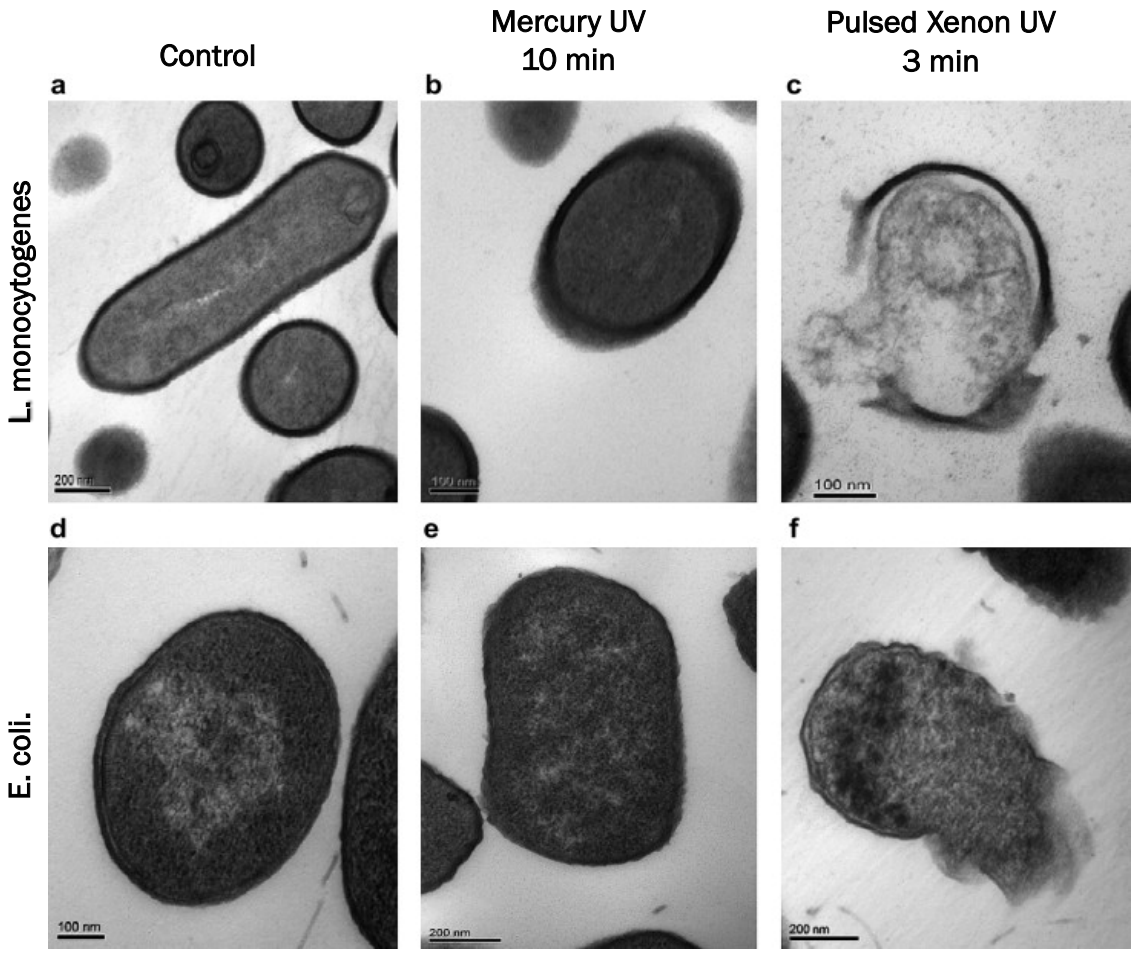
**Xenon emits light across full germicidal spectrum.*

IS ALL UV THE SAME?

Difference in Cell Damage

STUDY OBSERVATIONS

- Pulsed xenon caused irreparable cell membrane damage (lysing).
- Pulsed xenon UV disinfected faster than mercury UV.



Cheigh C-I, Park M-H, Chung M-S, Shin J-K, Park Y-S: Comparison of intense pulsed light- and ultraviolet (UVC)-induced cell damage in Listeria monocytogenes and Escherichia coli O157:H7. Food Control 2012, 25:654-659.

DUKE/UNC (BETR-D) STUDY

BACKGROUND:

In 2010 CDC Prevention Epicenters Program approved funding for a study structured by Duke and overseen by researchers at Duke, DICON and UNC Chapel Hill. The study began in April of 2012.

- 9 devices
- 9 hospitals
- Randomized trial
- Isolation case focus


Articles

Enhanced terminal room disinfection and acquisition and infection caused by multidrug-resistant organisms and *Clostridium difficile* (the Benefits of Enhanced Terminal Room Disinfection study): a cluster-randomised, multicentre, crossover study

Deverick J Anderson, Luke F Chen, David J Weber, Rebekah W Moehring, Sarah S Lewis, Patricia F Triplett, Michael Blocker, Paul Becherer, J Conrad Schwab, Lauren Pit Nelson, Yuliya Lokhnygina, William A Rutala, Hajime Kanamori, Maria F Gergen, Daniel J Sexton; for the CDC Prevention Epicenters Program

RESULTS:

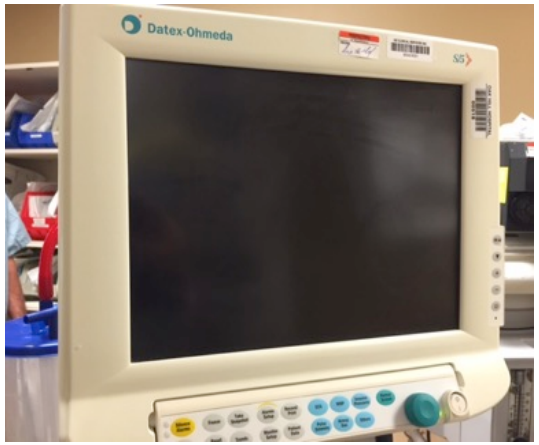
- No impact to *C. diff*
- The decrease in MRSA infections was not statistically significant
- Statistical significance for cumulative MDROs was driven by reductions in VRE

Author's Commentary:

"Of four published studies on the clinical effectiveness of UV devices, one showed a 20% decrease in hospital-acquired multidrug-resistant organisms 23 and three showed 22–53% decreases in *C. difficile* infection.24–26 In light of these results, we were surprised by the lack of change in rates of *C. difficile* among exposed patients."

IS ALL UV THE SAME?

Material Compatibility is Different

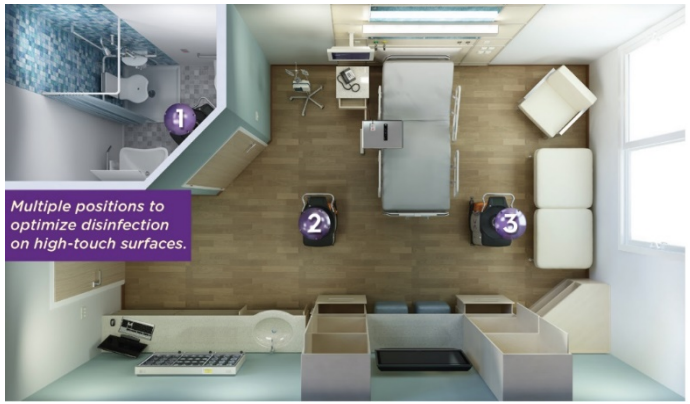


PULSED XENON UV LIGHT (PX-UV)

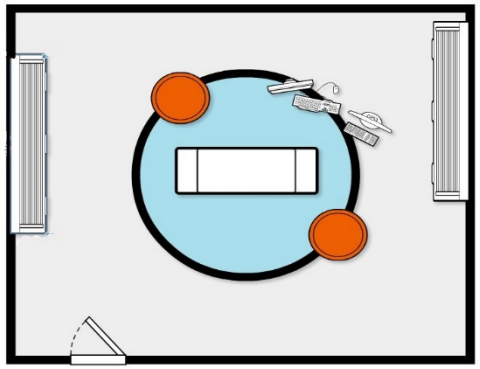
- 5-minute Sporicidal Cycle
- Outcome data on VRE, *C. diff*, SSI, MDROs and MRSA infection rate reductions

Levin AJIC 2013; Simons JIP 2013; Haas AJIC 2013; Miller, AJIC 2015; Fornwalt, AJIC 2015; Vianna, AJIC 2015

ULTRAVIOLET DISINFECTION BEST PRACTICES



5 MINUTES IN EACH POSITION FOR PATIENT ROOMS



10 MINUTES IN EACH POSITION FOR OPERATING ROOMS

DISINFECTING WITH LIGHT

Studies explain why multiple positions in a room are necessary for optimal room disinfection of high-touch surfaces.[1]

1-Boyce, J.M.,N.L. Havill, and B.A. – Moore, Terminal decontamination of patient rooms using an automated room UV light unit. Infect Control Hosp Epidemiol, 2011 32(8): p. 737-42.

Q: Is pulsed xenon UV dependent on housekeeping?

A: No, pulsed xenon UV is effective in absence of manual cleaning.

American Journal of Infection Control xxx (2015) 1-4

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major article

Is the pulsed xenon ultraviolet light no-touch disinfection system effective on methicillin-resistant *Staphylococcus aureus* in the absence of manual cleaning?

Chetan Jinadatha MD, MPH [a,b,*], Frank C. Villamaria BS, MPH [a,c], Marcos I. Restrepo MD [d,e], Nagaraja Ganachari-Mallappa PhD [a], I-Chia Liao BS [a,c], Eileen M. Stock PhD [f], Laurel A. Copeland PhD [a,b,f], John E. Zeber PhD [a,b,f]

[a] Department of Medicine, Central Texas Veterans Healthcare System, Temple, TX
[b] Department of Medicine, College of Medicine, Texas A&M Health Science Center, Bryan, TX
[c] School of Public Health, Texas A&M University, College Station, TX
[d] Department of Medicine, South Texas Veterans Health Care System
[e] University of Texas Health Science Center San Antonio, San Antonio, TX
[f] Center for Applied Health Research, Temple, TX

OUTCOMES DATA

Peer Reviewed Published Infection Rate Reduction Studies

AUTHOR / YEAR / JOURNAL	ORGANISM	SETTING	INFECTION REDUCTION	SPECIAL CONSIDERATIONS
Miller et al, 2015. American Journal of Infection Control	*Clostridium difficile*	LTAC	56.90%	Estimated 29 cases prevented in 15 months
Nagaraja et al, 2015. American Journal of Infection Control	*Clostridium difficile*	ICU	70%	Estimated 30 cases prevented in 12 months
Haas et al, 2014. American Journal of Infection Control	Multiple MDROs	Whole House	20%	19% Gram- reduction, Estimated 185 cases prevented in 22 months
Levin et al, 2013. American Journal of Infection Control	*C. difficile*	Whole House	53%	Only 56% compliance to protocol
Simmons et al, 2013. Journal of Infection Prevention	MRSA	Healthcare System	57%	50:1 ROI, Estimated 58 cases prevented in 18 months
Vianna et al, 2015. American Journal of Infection Control	Multiple MDROs, *C. difficile*	Whole House	29%, 41%	All ICU discharges, *C. difficile* isolation facility wide
Catalanotti et al, 2016. American Journal of Infection Control	Class I SSIs	Operating Room	46%	Estimated 23 infections prevented over 21 months
Fornwalt et al, 2015. American Journal of Infection Control	Hip/Knee SSIs (Class I)	Operating Room	100%	Xenex used nightly after terminal cleaning

A TRIAL OF PULSED XENON UV DISINFECTION TO REDUCE *C. DIFFICILE* INFECTION

(MAYO CLINIC, ROCHESTER, MN)

- 39% decrease in CDI incidence on Xenex Units (p=0.03)
- No significant reduction in CDI incidence on control units.

	BEFORE INTERVENTION (6 MONTHS) April 2014 - September 2014				INTERVENTION (6 MONTHS) October 2014 - March 2015			
UNIT	**CDI INCIDENCE**	**PATIENT DAYS**	**CDI RATE PER 10,000 PATIENT DAYS**	**P-VALUE**	**CDI INCIDENCE**	**PATIENT DAYS**	**CDI RATE PER 10,000 PATIENT DAYS**	**P-VALUE**
PX-UV	15	8217	18.3	0.28	10	8958	11.2	0.03
CONTROL	11	5483	20.1		15	5219	28.7	

TIMELINE FOR USE AT MD ANDERSON

- 2010 - Research
- 2011 - VRE Isolation Discharges (Three 5-minute Positions)
- 2012 - All Isolation Discharges Institution-wide (VRE, *C. diff*, MDR GNB)
- 2013 - All ICU Discharges
- 2013 - Elimination of Bleach for *C. diff* Terminal Clean
- 2014 - Continued Usage
- 2015 - ORs at Terminal Clean (Two 10-minute Positions)

ENVIRONMENTAL STUDY:
ELIMINATION OF VRE

CURRENT HOUSEKEEPING METHODS VS. PULSED XENON UV FOR VRE ISOLATION ROOMS

ROOM STATUS	OBSERVATIONS	HPC MEAN ($CFU/INCH^2$)	CONFIRMED VRE
PRE-CLEAN	75	213.7	17 (23%)
POST-HOUSEKEEPING	49	178.5	4 (8%)
POST-XENEX	75	7.8	0

P = 0.0001

Stibich M, Stachowiak J, Tanner B, Berkheiser M, Moore L, Raad I, Chemaly RF. (2011). Infect Control Hosp Epidemiol. 32(3):286-8.

HOSPITAL OPERATIONAL STATISTICS FOR 8 PULSED XENON TREATED ROOMS

ACTIVITY	MINUTES
PX-UV travel time to room	3:48
Preparing the room	:15
PX-UV emittance	12:00
Safety countdown	1:30
Repositioning the PX-UV device	:31
Room exit	:44
TOTAL PULSED XENON DISINFECTION TIME	**18:48**

Stibich M, et al. Infect Control Hosp Epidemiol. 2011; 32(3):286-288

ENVIRONMENTAL STUDY:

Reducing *C. diff* Contamination Without Bleach

Table 1. Impact of standard cleaning and PX-UV disinfection on *Clostridium difficile* counts in patient rooms

Room status	Samples taken (*n*)	Samples positive for *C. difficile* [*n* (%)]	c.f.u.					Reduction (%)	*P*-value
			Min.	Mean	Median	Max.	IQR		
Pre-bleach cleaning	74	26 (35)	0	2.39	0	81	11	70	0.13
Post-bleach cleaning	74	18 (24)	0	0.71	0	18	0		
Pre-PX-UV Cleaning	70	29 (41)	0	4.61	0	71	2	83	0.007
Post-PX-UV	70	16 (23)	0	0.80	0	13	0		

IQR, Interquartile range.

Ghantoji SS, Stibich M, Stachowiak J, Cantu S, Adachi JA, Raad II, Chemaly RF. Journal of Medical Microbiology 2015, 64:191-194.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COMPLIANCE - EVS

- **WHO:** All rooms that housed patients with VRE, *C. difficile*, & Norovirus. All ICU patients. Also clusters or other situations, as deemed necessary by Infection Control.
- **WHERE:** Inpatient areas only
- **WHEN:** UV cleaning is auto assigned to patient room at discharge or transfer (via OneConnect), based on organism present at time of discharge. Most inpatient areas require 3 cycles at 4 minutes each cycle. Compliance measured monthly via device log upload to "Xenex portal".
- **NOTE:** User ID must be entered for accountability.

Month	Total Patients Discharged Requiring PXUV	PXUV Performed When Required	% Compliant With Performing PXUV When Required	PXUV Performed Accurately (# of events/cycles)	% Compliant With PXUV Performed Correctly
AUG – 16	122	96	79%	65	68%
SEP – 16	77	69	90%	51	74%
OCT – 16	110	78	71%	59	76%
NOV – 16	98	87	89%	80	92%

INCIDENCE OF ALL NOSOCOMIAL MDRO INFECTIONS

FY11 to FY16

	FY11 NI	MDR NI/1000 pt days	FY12 NI	MDR NI/1000 pt days	FY13 NI	MDR NI/1000 pt days	FY14 NI	MDR NI/1000 pt days	FY15 NI	MDR NI/1000 pt days	FY16 NI	MDR NI/1000 pt days
VRE	38	0.211	32	0.167	32	0.158	42	0.207	29	0.143	17	0.086
MRSA	58	0.322	48	0.25	34	0.168	26	0.128	40	0.198	35	0.177
MDR-Ps. aerug	29	0.161	19	0.099	18	0.089	18	0.088	6	0.029	12	0.061
ESBL-GNR	42	0.233	42	0.219	39	0.193	40	0.197	45	0.222	44	0.223
nonESBL GNR/CRE	19/11	0.105	14/9	0.073	16/7	0.079	19/5	0.094	16/8	0.079	12/3	0.060
Total MDR Nosocomial Infections	186	1.031	155	0.808	139	0.686	145	0.715	136	0.672	120	0.608

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INCIDENCE OF ALL NOSOCOMIAL MDRO INFECTIONS

FY11 to FY16

	FY11 NI	MDR NI/1000 pt days	FY12 NI	MDR NI/1000 pt days	FY13 NI	MDR NI/1000 pt days	FY14 NI	MDR NI/1000 pt days	FY15 NI	MDR NI/1000 pt days	FY16 NI	MDR NI/1000 pt days
VRE	38	0.211	32	0.167	32	0.158	42	0.207	29			0.086
MRSA	58	0.322	48	0.25	34	0.168	26				35	0.177
MDR-Ps. aerug	29	0.161	19	0.099					6	0.029	12	0.061
ESBL-GNR	42	0.233				0.193	40	0.197	45	0.222	44	0.223
nonESBL GNR/CRE				0.073	16/7	0.079	19/5	0.094	16/8	0.079	12/3	0.060
Total MDR Nosocomial Infections	186	1.031	155	0.808	139	0.686	145	0.715	136	0.672	120	0.608

FY11 (1.031) TO FY16 (0.608) = 41% DECREASE IN RATE
***P* <0.001**

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CONCLUSIONS

- Manual cleaning is not adequate.
- The answer is not a single approach.
- We must blend technical knowledge with socio-adaptive skills.
- We must create a vision where prevention of harm, quality and safety is everyone's responsibility.

THANK YOU!

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