UVC Disinfection Technologies: What We've Learned Webinar Toolkit

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UV-C Disinfection Technologies: *What We've Learned*

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Maureen Spencer is a Registered Nurse with a Master's Degree in Education, board certification in infection control and Fellow of the Association for Professionals in Infection Control and Epidemiology (FAPIC). She is currently an Independent Infection Preventionist Consultant.

Her previous positions included:

- IP Consultant for Commonwealth Medicine, UMass Medical School during the COVID pandemic
- Director, Clinical Implementation and Education at Accelerate Diagnostics, Tucson, AZ
- Corporate Director, Infection Prevention for Universal Health Services, King of Prussia, PA
- Infection Control Director, New England Baptist Hospital, Boston, MA
- Director, Infection Control Unit at Mass General Hospital, Boston, MA,
- And several other IP positions in the Boston area.

Peter Graves, BSN, RN, CNOR
Independent Perioperative Consultant

Peter Graves is a certified perioperative registered nurse with more than 35 years of experience. He is passionate about perioperative infection prevention and evidence-based best practices. He is currently an independent perioperative consultant and owner of Clinical Solution, LLC.

His previous positions included:

- Head, Clinical affairs, Zurex Pharma, Inc
- Sr. Director, Medical affairs, Pacira Biosciences
- Sr. Director, clinical, Irrimax Corp
- Clinical manager, Surgical Services, Baylor Scott & White Carrollton Medical Center
- OR Director and educator at other facilities in California
- National AORN Board of Director
- Secretary/Treasurer CCI Research Foundation

Sam Trapani
CEO – Steriliz, LLC

Sam Trapani is the CEO of Steriliz, LLC. He attended Cornell University and received a Bachelor of Science Degree in Electrical Engineering.

RD-UVC Disinfection Technologies, a division of Steriliz LLC, (rduvc.com) is a leading supplier of ultraviolet-C light disinfection technology with the specific goal of developing area and surface disinfection methods and processes that are science based, quantitative and traceable.

In addition, RD UVC has collected a significant amount of clinical data and has developed unique data analysis techniques, which provide closed loop feedback and management information for infection control practitioners. The company is based in Rochester, N.Y.

Objectives

- Discuss sources for pathogens in healthcare setting
- Describe how Ultraviolet (UV) radiation works
- Demonstrate the administration and execution of UV-C robots in healthcare settings
- Discuss sources for pathogens in operating room setting
- Discuss how room turnovers and terminal cleaning are performed in the OR
- Discuss ideas for a UV-C Air and Environmental Quality Plan

Photo credit: RD Disinfector

POLL QUESTION #1

Which of the following UV devices do you use? (Select all that apply)

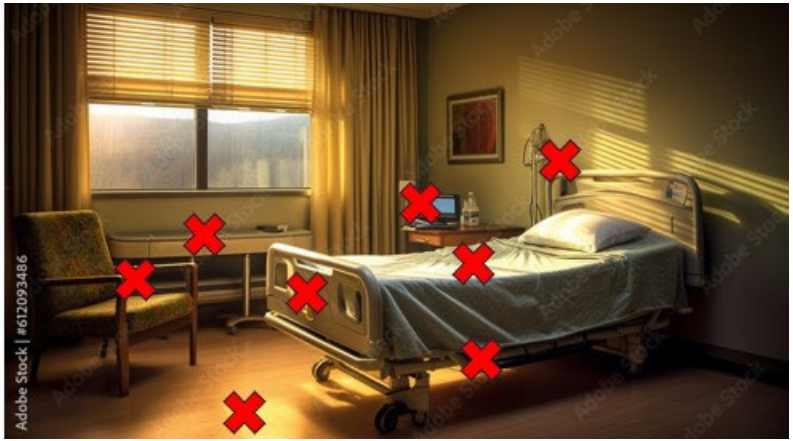
- ❑ Autonomous (self-propelled) UVC disinfection systems
- ❑ Portable (operator-propelled) UVC disinfection systems
- ❑ High Intensity (episodic) UVC fixed systems
- ❑ Low Intensity (always on) UVC fixed systems
- ❑ I don’t know

POLL QUESTION #2

What settings are you using them in? (Select all that apply)

- ❑ Operating Rooms
- ❑ Procedure Rooms (X-ray, CT, Endo, Cath, etc.)
- ❑ Isolation Discharges
- ❑ Critical Care Areas like NICU
- ❑ Other
- ❑ I don’t know

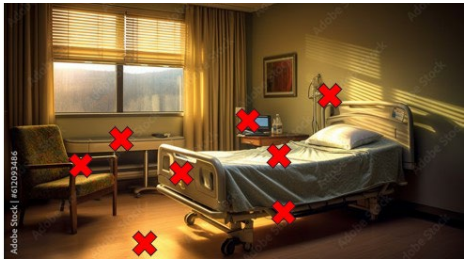
Do healthcare associated pathogens survive for long periods on environmental surfaces?



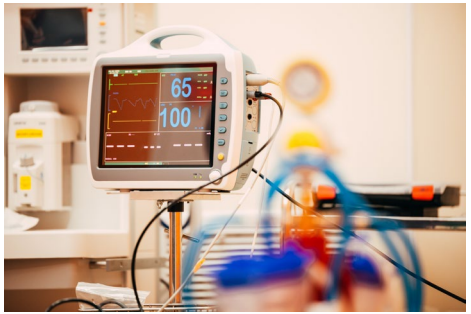
YES

Sources for Contamination in Patient Rooms

- Patient skin squames around bed, bed frame, bedrails, floor
- Microorganisms on high touch surfaces:
  - Bedrail, remotes, mattresses
  - IV poles, IV tubing, IV bags, urinary catheter bags, ventilators, monitors, Privacy curtains, workstations on wheels
  - Overhead lights, light switches, outlets, door handles
  - Bedside table, overhead table, chairs
  - Fans blowing contaminants around the room
  - Foot of bed, compression stocking equipment, slipper socks during removal
  - Supply carts in rooms (especially in ICU setting)
  - Vital sign monitoring equipment
  - Sinks, handwashing dispensers, glove dispensers
  - Toilet - common in ICUs no lids, water spray hose or wand for cleaning bedpans that contaminate the area
  - Emptying patient secretions in room sink (from brushing teeth, wash basins, irrigations)



Most contaminated area is within 3 feet around the bed[1]



Vital sign Monitoring equipment could contribute to cross contamination[2]

1. French, GL, Otter JA, et al. Tackling contamination of the hospital environment by methicillin-resistant Staphylococcus aureus (MRSA): a comparison between conventional terminal cleaning and hydrogen peroxide vapour decontamination, Journal of Hospital Infection, Volume 57, Issue 1, 2004, Pages 31-37
2. Davis C et al. Blood pressure cuffs and pulse oximeter sensors: A potential source of cross-contamination, Australasian Emergency Nursing Journal, Volume 12, Issue 3,2009, Pages 104-109

Pathogens Survive on Surfaces

Organism	Survival period
Clostridium difficile	35- >200 days.[2,7,8]
Methicillin resistant *Staphylococcus aureus* (MRSA)	14- >300 days.[1,5,10]
Vancomycin-resistant enterococcus (VRE)	58- >200 days.[2,3,4]
Escherichia coli	>150- 480 days.[7,9]
Acinetobacter	150- >300 days.[7,11]
Klebsiella	>10- 900 days.[6,7]
Salmonella typhimurium	10 days- 4.2 years.[7]
Mycobacterium tuberculosis	120 days.[7]
Candida albicans	120 days.[7]
Most viruses from the respiratory tract (eg: corona, coxsackie, influenza, SARS, rhino virus)	Few days.[7]
Viruses from the gastrointestinal tract (eg: astrovirus, HAV, polio- or rota virus)	60- 90 days.[7]
Blood-borne viruses (eg: HBV or HIV)	>7 days.[5]

1. Beard-Pegler et al. 1988.. *J Med Microbiol*. **26**:251-5.
2. BIOQUELL trials, unpublished data.
3. Bonilla et al. 1996. *Infect Cont Hosp Epidemiol*. **17**:770-2
4. Boyce. 2007. *J Hosp Infect.* **65**:50-4.
5. Duckworth and Jordens. 1990. *J Med Microbiol*. **32**:195-200.
6. French et al. 2004. *ICAAC*.
7. Kramer et al. 2006. *BMC Infect Dis*. **6**:130.
8. Otter and French. 2009. *J Clin Microbiol*. **47**:205-7.
9. Smith et al. 1996. *J Med*. **27**: 293-302.
10. Wagenvoort et al. 2000. *J Hosp Infect*. **45**:231-4.
11. Wagenvoort and Joosten. 2002. *J Hosp Infect*. **52**:226-7.

Prior Room Occupancy Increases Risk For HAIs

Study	Healthcare associated pathogen	Likelihood of patient acquiring HAI based on prior room occupancy (comparing a previously 'positive' room with a previously 'negative' room)
Martinez 2003[1]	VRE – cultured within room	2.6x
Huang 2006[2]	VRE – prior room occupant	1.6x
	MRSA – prior room occupant	1.3x
Drees 2008[3]	VRE – cultured within room	1.9x
	VRE – prior room occupant	2.2x
	VRE – prior room occupant in previous two weeks	2.0x
Shaughnessy 2008[4]	*C. difficile* – prior room occupant	2.4x
Nseir 2010[5]	*A. baumannii* – prior room occupant	3.8x
	P. aeruginosa – prior room occupant	2.1x

1. Martinez *et al. Arch Intern Med* 2003; 163: 1905-12.
2. Huang *et al. Arch Intern Med* 2006; 166: 1945-51.
3. Drees *et al. Clin Infect Dis* 2008; 46: 678-85.
4. Shaughnessy. ICAAC/IDSA 2008. Abstract K-4194.
5. Nseir et al. Clin Microbiol Infect 2010 (in press).

Two Basic Problems with Environmental Cleaning and Disinfection:

1. Episodic Cleaning – as soon as it is disinfected it immediately becomes contaminated
2. Studies show less than 50% of high touch surfaces are being cleaned

Microbial bioburden of inpatient and outpatient areas beyond patient hospital rooms

- Conducted 3 point-prevalence culture surveys for:
  - ✓ MRSA, VRE, C Diff, Candida spp,
  - ✓ Gram-negative bacilli including Enterobacteriaceae, Pseudomonas aeruginosa, Acinetobacter baumanii, and Stenotrophomonas maltophilia in each facility
- Inpatient: High-touch surfaces were sampled from radiology, physical therapy, and mobile equipment and in emergency departments, waiting rooms, clinics, and endoscopy facilities
- Outpatient facilities, surfaces were sampled in exam rooms including patient and provider areas, patient bathrooms, and waiting rooms and from portable equipment
- Fluorescent markers were placed on high-touch surfaces and removal was assessed 1 day later

Otter JA, Yezli S, Salkeld JA, French GL. Evidence that contaminated surfaces contribute to the transmission of hospital pathogens and an overview of strategies to address contaminated surfaces in hospital settings. Am J Infect Control. 2013 May;41(5 Suppl):S6-11. doi: 10.1016/j.ajic.2012.12.004. PMID: 23622751.

Table 1. Environmental Contamination in 4 Hospitals in Areas Outside Patient Rooms

Organism	Hospital 1 (N=327)	Hospital 2 (N=291)	Hospital 3 (N=300)	Hospital 4 (N=277)	Total Hospitals (N=1,195)
Any MRSA, VRE, *C. difficile*, GNB[a]	36 (11.0)	16 (5.5)	15 (5.0)	42 (15.2)	109 (9.1)
MRSA	15 (4.6)	1 (0.3)	4 (1.3)	10 (3.6)	30 (2.5)
VRE	10 (3.1)	2 (0.7)	2 (0.7)	3 (1.1)	17 (1.4)
C. difficile	5 (1.5)	8 (2.7)	5 (1.7)	5 (1.8)	23 (1.9)
GNB[a]	10 (3.1)	9 (3.1)	5 (1.7)	29 (10.5)	53 (4.4)
Candida spp	17 (5.2)	13 (5.9)	10 (3.3)	8 (2.9)	48 (4.0)
Marker removal, no. removed/no. placed (%)	82/285 (28.4)	87/274 (31.8)	N/A	92/232 (39.7)	261/791 (33.0)

Note. GNB, gram-negative bacilli; MRSA, methicillin-resistant *Staphylococcus aureus*; *C. difficile*, *Clostridioides difficile*; VRE, vancomycin-resistant enterococci.
[a]GNB included Enterobacteriaceae, *Pseudomonas aeruginosa*, *Acinetobacter baumannii*, and *Stenotrophomonas maltophilia*.

Table 2. Environmental Contamination in 4 Hospitals by Areas Sampled

Organism	Radiology (N=195)	Portable Equipment (N=282)	Emergency Department (N=226)	Physical Therapy (N=81)	Endoscopy (N=113)	Waiting Rooms (N=190)	Clinics (N=127)
Any MRSA, VRE, *C. difficile*, GNB[a]	19 (9.8)	15 (5.3)	18 (8.0)	10 (12.3)	14 (12.4)	27 (14.2)	6 (4.7)
MRSA	4 (2.1)	3 (1.1)	3 (1.3)	6 (7.4)	4 (3.5)	8 (4.2)	2 (1.6)
VRE	2 (1.1)	2 (0.7)	0 (0)	6 (7.4)	2 (1.8)	5 (2.6)	0 (0)
C. difficile	4 (2.1)	4 (1.4)	5 (2.2)	1 (1.2)	3 (2.7)	5 (2.6)	1 (0.8)
GNB[a]	10 (5.1)	8 (2.8)	10 (4.4)	0 (0)	6 (5.3)	15 (7.9)	4 (3.1)
Candida spp	9 (4.6)	6 (2.1)	8 (3.5)	4 (4.9)	7 (6.2)	11 (5.8)	3 (2.4)
Marker removal, no. removed/no. placed (%)	38/116 (31.0)	52/164 (31.3)	60/131 (45.8)	20/69 (30.0)	25/107 (23.4)	39/128 (30.5)	27/76 (34.7)

Note. GNB, gram-negative bacilli; MRSA, methicillin-resistant *Staphylococcus aureus*; *C. difficile*, *Clostridioides difficile*; VRE, vancomycin-resistant enterococci.
[a]GNB included Enterobacteriaceae, *Pseudomonas aeruginosa*, *Acinetobacter baumannii*, and *Stenotrophomonas maltophilia*.

Table 3. Environmental Contamination in Outpatient Clinics

Organism	Clinic 1 (N=104)	Clinic 2 (N= 66)	Clinic 3 (N=55)	Clinic 4 (N=55)	Surgery Center (N=205)	Total Samples (N=485)
Any MRSA, VRE, *C. difficile*, GNB	16 (15.4)	4 (6.1)	5 (9.1)	1 (1.9)	4 (2.0)	30 (6.2)
MRSA	3 (2.9)	0 (0)	0 (0)	0 (0)	1 (0.5)	4 (0.8)
VRE	5 (4.8)	0 (0)	1 (1.9)	0 (0)	0 (0)	6 (1.2)
C. difficile	5 (4.8)	0 (0)	2 (3.6)	1 (1.9)	1 (0.5)	9 (1.9)
GNB[a]	3 (2.9)	4 (6.1)	2 (3.6)	0 (0)	2 (1.0)	11 (2.3)
Candida spp	22 (21.2)	5 (7.6)	4 (7.3)	6 (10.9)	8 (3.9)	45 (9.3)
Marker removal (%), no. removed/no. placed (%)	4/54 (7.4)	35/98 (35.7)	21/61 (34.4)	28/44 (63.6)	82/99 (82.8)	170/367 (46.3)

Note. GNB, gram-negative bacilli; MRSA, methicillin-resistant *Staphylococcus aureus*; *C. difficile*, *Clostridioides difficile*; VRE, vancomycin-resistant enterococci.

Table 4. Environmental Contamination in Outpatient Clinics by Areas Sampled

Organism	Exam Room Patient Area (N=101)	Exam Room Provider Area (N=162)	Waiting Room (N=70)	Bathroom (N=13)	Portable Equipment (N=139)
Any MRSA, VRE, *C. difficile*, GNB[a]	11 (10.9)	4 (2.5)	7 (10.0)	2 (15.4)	6 (4.3)
MRSA	2 (2.0)	0 (0)	1 (1.4)	1 (7.7)	0 (0)
VRE	3 (3.0)	1 (0.6)	1 (1.4)	0 (0)	1 (0.7)
C. difficile	5 (5.0)	1 (0.6)	2 (2.9)	0 (0)	1 (0.7)
GNB	1 (1.0)	2 (1.2)	3 (4.3)	1 (7.7)	4 (2.9)
Candida spp.	9 (8.9)	16 (12.9)	8 (11.4)	2 (15.4)	9 (6.5)
Marker removal, no. removed/no. placed (%)	34/99 (39.1)	54/95 (56.8)	18/54 (32.1)	13/13 (100)	51/106 (48.1)

Note. GNB, gram-negative bacilli; MRSA, methicillin-resistant *Staphylococcus aureus*; *C. difficile*, *Clostridioides difficile*; VRE, vancomycin-resistant enterococci.
[a]GNB included Enterobacteriaceae, *Pseudomonas aeruginosa*, *Acinetobacter baumanii*, and *Stenotrophomonas maltophilia*.

Solution

Ultraviolet-C Devices as an Adjunctive Technology for Air and Environmental Disinfection

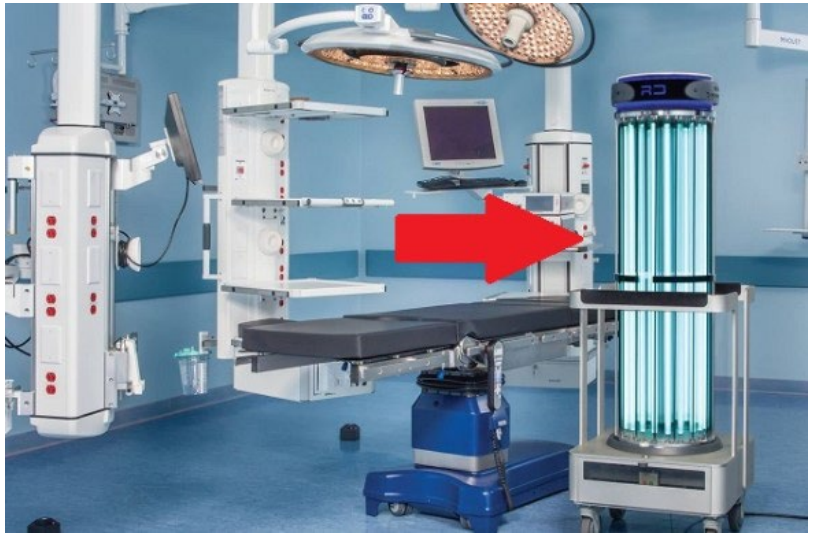
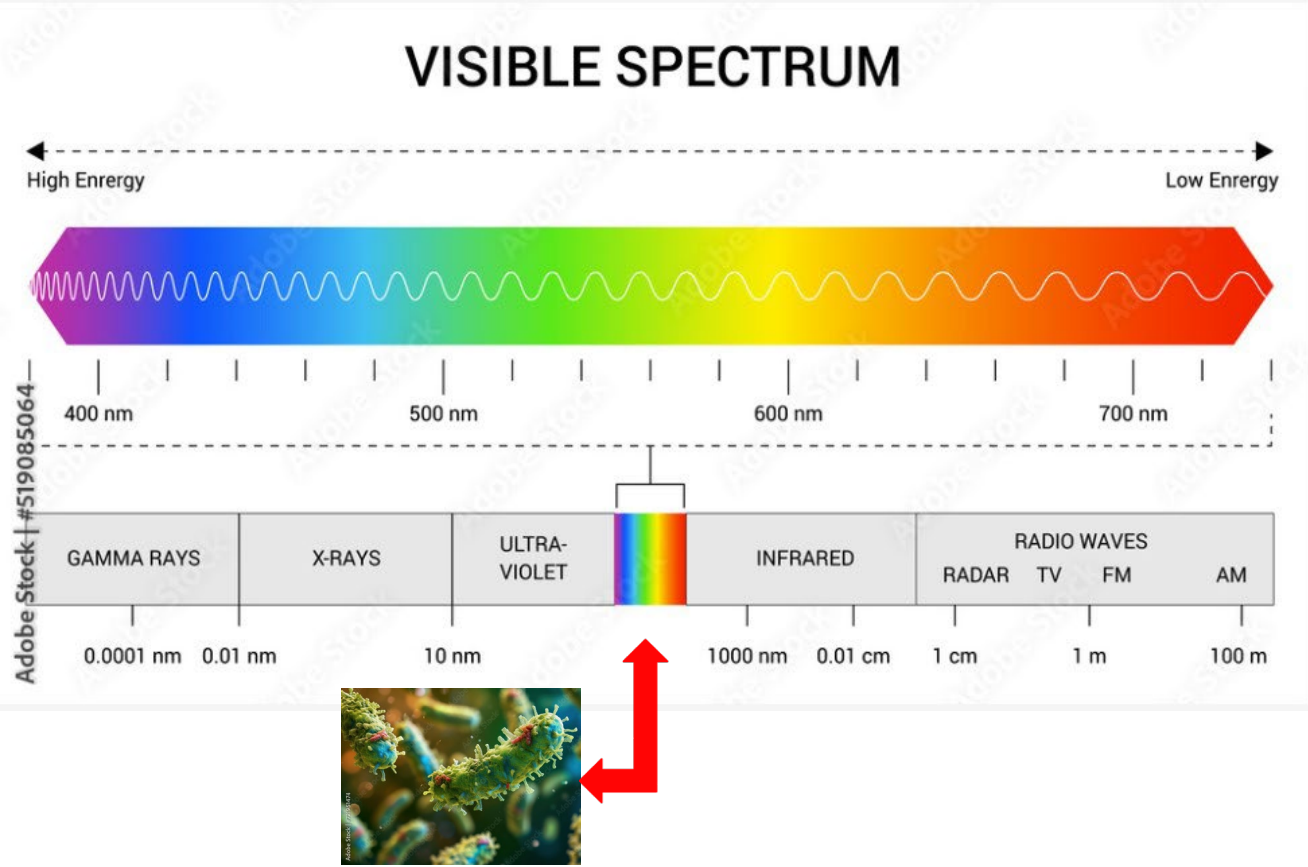


Photo credit: RD Disinfector

UV-C Wavelength



- **<u>UVA</u>** light has a wavelength from 315 to 400 nm
- **UVB** wavelength is from 280 to 315 nm
- **<u>UVC</u> wavelength is from 100 to 280 nm**

What is Ultraviolet-C Energy?

UV-C: short-wave ultraviolet radiation:

- Specific wavelength of 253.7 nanometers (nm)
- Destroys bacteria, mold, viruses and other biological contaminants in the air, liquids, surfaces
- UV-C rays break through the outer membrane of microbe and transmits incorrect information that results in death
- UV irradiance (also called fluence rate) is often expressed as microwatts per square centimeter (uW/cm2)
- Dose of UV received at a surface during a specific time (fluence) is calculated by multiplying the irradiance times the number of seconds of exposure at a surface

Photo credit: RD Disinfector

Ultraviolet-C Disinfection: Pros

Pro

- UV-C known disinfectant for air, water, and nonporous surfaces and may be included in air and water management programs
- Highly effective at eliminating both vegetative pathogens, including MRSA, VRE, carbapenem-resistant Enterobacteriaceae (CRE), and multidrug-resistant Acinetobacter baumannii, and spores, such as C difficile, and most viruses

https://www.cdc.gov/nceh/features/uv-radiation-safety/index.html
https://www.cdc.gov/coronavirus/2019-ncov/community/ventilation/UVGI.html

Ultraviolet-C (UV-C) Disinfection: Cons

Con

- UV-C radiation can only inactivate bacteria and viruses if directly exposed to the radiation
- Inactivation may not be effective due to blocking of the UV radiation by shadows, soil, dust, or other contaminants such as bodily fluids
- Efficacy degrades with distance from the source – therefore need to reposition device
- Direct exposure of skin and eyes to UV-C radiation may cause painful eye injury and burn-like skin reactions
- Requires staff to maintain, move and store UV-C robot
- Substantial capital equipment cost and maintenance contracts
- Open loop systems on most devices vs closed loop
    - ✓ Lack of quality control for correct dose/pathogen in systems on the market

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Major articles

Postdischarge decontamination of MRSA, VRE, and *Clostridium difficile* isolation rooms using 2 commercially available automated ultraviolet-C–emitting devices

Titus Wong MD, MHSc, FRCPC [a,b,1], Tracey Woznow BSc, BEd(Sec) [a], Mike Petrie [c], Elena Murzello BScN, MBA [d], Allison Muniak MASc [d], Amin Kadora MBA [e], Elizabeth Bryce MD, FRCPC [a,b,*,1]

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[d] *Quality and Patient Safety, Vancouver Coastal Health, Vancouver, BC, Canada*
[e] *School of Business, Capilano University, North Vancouver, BC, Canada*

Tru-D UVC Disinfector

- UVC light automatically delivers lethal UV doses using a 360^0 sensor
- Two settings:
  - Bacterial
  - sporicidal
- Machines uses reflected and direct UVC

RD – UVC Disinfector

- Similar technology but:
  - Allows repositioning of the machine
  - Only one setting for all organisms

Post discharge decontamination of MRSA, VRE, and Clostridium difficile isolation rooms

Table 3
Percentages of surfaces contaminated with MRSA, VRE, or CD before and after manual cleaning and UVC disinfection

Organism	Before manual cleaning	After manual cleaning	*P* value*	OR (95% CI)	After UVC disinfection	*P* value*	OR (95% CI)
MRSA	50/360 (13.9)	21/360 (5.8)	<.00001	0.28 (0.127-0.546)	2/360 (0.55)	<.00001	0.00 (0.000-0.214)
VRE	41/360 (11.4)	25/360 (6.9)	.012	0.39 (0.166-0.824)	3/360 (0.83)	<.00001	0.00 (0.000-0.183)
CD	9/125 (7.2)	5/125 (4)	.343	0.43 (0.072-1.877)	0/125 (0)	.0736	0.00 (0.000-1.091)

NOTE. Values are n/N (%) or as otherwise indicated.
Abbreviations: *CD*, *Clostridium difficile*; *CI*, confidence interval; *MRSA*, methicillin-resistant *Staphylococcus aureus*; *OR*, odds ratio; *UVC*, ultraviolet-C; *VRE*, vancomycin-resistant enterococci.
*McNemar test for paired samples, 2-tailed *P* value.

	Tru-D		R-D	
	MRSA/VRE	C. difficile	MRSA/VRE	C. difficile
Time to UVC disinfect	35 min	57 min	14 min	13 min

Wong, Titus, et al. "Post discharge decontamination of MRSA, VRE, and Clostridium difficile isolation rooms using 2 commercially available automated ultraviolet-C–emitting devices." *American journal of infection control* 44.4 (2016): 416-420.

Results: Evaluation of the Two UV Disinfectors

- Both machines are microbiologically effective
- Functionality and integration into workflow became the primary determinants
- RD was the preferred machine because:
  - ✓ Ability to reposition the sensor and decrease operating time
  - ✓ Wi-Fi tracking of rooms with software system to record and monitor results – “Quality Control”
  - ✓ Single cycle option
  - ✓ Ergonomic considerations
  - ✓ Results: faster kill times

Wong, Titus, et al. "Post discharge decontamination of MRSA, VRE, and Clostridium difficile isolation rooms using 2 commercially available automated ultraviolet-C–emitting devices." American journal of infection control 44.4 (2016): 416-420.

My Experience with RD Disinfector UV-C robot

- 2008 – first tested a UV robot in a hospital vacant nursing unit with application of 0.5 McFarland broth of Staph aureus and E.coli. Showed significant log reduction after treatment
- 2011 – presented at APIC on Environmental Decontamination with Innovative EVS Technology
- 2012 –APIC Rochester Chapter conference, met Steriliz company at their exhibit and was very impressed with their quality control system:
  - ✓ 4 sensors
  - ✓ software to monitor adherence to the proper use of the equipment by EVS staff to assure adequate dosing for C difficile spores
- 2014 - Initiated a UHS corporate contract with Steriliz RD Disinfector.

Photo credit: RD Disinfector

Reason: Quality Assurance that it Delivers the Correct UVC Dose/Pathogen

?REACH SHADOWED AREAS

- ✓ Proper UVC dosing reaches all points of interest in your desired areas, including those in shadowed areas

?MEASURE THE REQUIRED DOSE

- ✓ Patented, wireless, remote sensors confirm that the RD UVC System delivers the required amount of total UVC light to eradicate pathogens

?OFFER THE FASTEST THROUGHPUT

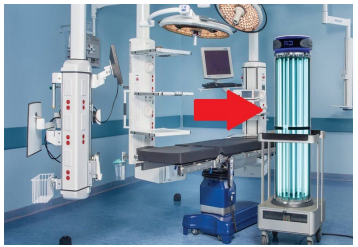
- ✓ RD UVC System's proprietary "pause and reposition" feature significantly reduces treatment time to ensure that you are ready for your next patient

?RECORD COMPREHENSIVE DATA

- ✓ RD UVC System records the UV dose delivered to the target and automatically uploads comprehensive job data and proof of compliance to your secure portal

?DELIVER DISINFECTION PROOF

- ✓ Utilization data lets you know which areas have been treated — by whom, how often, and the time spent per area



Pathogens Require Different Doses of UV-C to Deactivate

1 – E.coli (7,000µWs/cm²)

- Found in cattle, lives in the intestines of healthy cattle and other animals. E. coli O157 can be found in water, food, soil, or on surfaces that have been contaminated with animal or human feces

2 – SARS-CoV-2 (10,000µWs/cm²)

- Virus responsible for the COVID19 infection

3 – MRSA (11,000µWs/cm²)

- Common skin and environmental bacteria that has become resistant to many antibiotics.

4 – Influenza Virus (26,100µWs/cm²)

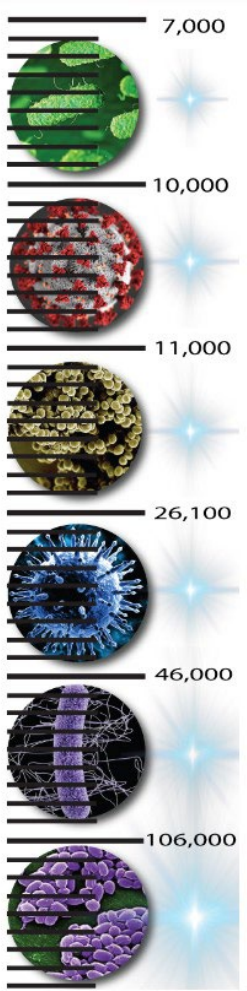
- Patients who are shedding large amounts could cause virus to contaminate for 2–8 hr. via stainless steel surfaces and for a few minutes via paper tissues.

5 – C. diff Spores (46,000µWs/cm²)

- Clostridioides difficile (C. diff) is a spore-forming organism that can contaminate hospital environments, including surfaces, patient skin, and healthcare worker hands

6 – Anthrax Spores (106,000µWs/cm²)

- RD UVC can push a higher energy setting to any client instantly to address emerged agents.



Open vs Closed Loop in UV-C Devices

Open Loop is the most basic of UV disinfection methods

- Timer-based, operates for a set time based upon the targeted pathogen type and room dimensions
- Lidar-based, which uses laser technology to measure distances to objects or surfaces (mapping) to calculate the treatment time accordingly
- Typically, lidar-based system requires three tower units to be deployed per room, per job – making transport and positioning time-consuming, cumbersome, and inefficient
- Neither type uses sensor technology to measure in real time the dosage levels.

Closed Loop:

- Closed-loop machines have at least one measurement capability, emitter-mounted sensors or **remote sensors** that enables measurement of delivery dose
- Emitter-mounted sensors are of limited efficacy as they rely on reflections from targeted surfaces, such as walls, to gauge the dosage delivered to a targeted area.

What we've learned over the past 15 years with UV disinfection

- Facilities need more systems: nursing units, ICU, departments
- May be cost-prohibitive for hospital capital budgets
- FTE requirements for using portable UV disinfection robots, education, reinforcement of IFUs
- UV autonomous disinfection robots – the real cost
  - ✓ Capital equipment, cost very high
  - ✓ Still need FTEs to operate:
    - ➢ Limited UV output due to battery life
    - ➢ Disinfection treatment greatly reduced and limited to system battery life
    - ➢ Charging time more than double the actual utilization time

Ishaan Mehta, et al. UV Disinfection Robots: A Review, Robotics and Autonomous Systems, Volume 161,2023,104332, ISSN 0921-8890, https://doi.org/10.1016/j.robot.2022.104332.

Model for Choosing UV-C System

- Evidence demonstrates persistence of contamination of environmental surfaces despite traditional cleaning and disinfection
- Need for adjunctive secondary disinfection technologies
- Ultraviolet-C (UV-C) disinfection is one type of no-touch technology shown to be a successful adjunct to manual cleaning in reducing environmental bioburden
- Dilemma for the infection preventionist is how to choose the system best suited for their facility among the many UV-C surface disinfection delivery systems
- Build a case for acquisition to present to the hospital administration/C-suite

American Journal of Infection Control ■■ (2016) ■■-■■

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AJIC American Journal of Infection Control

Practice Forum

A model for choosing an automated ultraviolet-C disinfection system and building a case for the C-suite: Two case reports

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Spencer M, et al: A model for choosing an automated ultraviolet-C disinfection system and building a case for the C-suite: Two case reports. AJIC 2016

Business Case for UV-C System Using a 20% Reduction Model

- Engaging an executive champion – education and serve as an inside sponsor to the entire executive team
- Create a multidisciplinary team by bringing on board key leaders:
  - ✓ infection prevention, EVS, pharmacy, nursing, microbiology
- Proposing how UV-C disinfection would deliver a measurable return to the organization
- Share current rates for high-risk pathogens (C diff, MRSA, VRE, CRE)

Spencer M, et al: A model for choosing an automated ultraviolet-C disinfection system and building a case for the C-suite: Two case reports. AJIC 2016

Key Steps in the UV-C Device Selection Process

Education on the options and their attributes:

- Consider creating a checklist of attributes and specifications to facilitate comparison of systems

Analyze facility's needs:

- Human factors' engineer to determine the system most compatible with your facility's workflow, design, and staffing practices
- Use publicly available templates for evaluating new technologies
- Engage other departments for feedback on the usability of the systems you are considering

Building a comprehensive business case:

- Developed on cost avoidance or return on investment, including:
  - ✓ reduced hospitalization costs (eg, antibiotics, excess length of stay, ICU stay, care stay, test costs, isolation room time, staffing time, disposable equipment costs)
  - ✓ reduced emergency room divert time
  - ✓ reduced operating room case cancellations
  - ✓ reduced CMS penalties, among others

Spencer M, et al: A model for choosing an automated ultraviolet-C disinfection system and building a case for the C-suite: Two case reports. AJIC 2016

Example of System Specification Comparison Checklist

Table 2
Example of system specification comparison checklist

Attribute/ specification	System A	System B	System C
Capital cost	$x	$y	$z
Service and support agreement	$y annually	$x annually	Included in price
UV-C lamp cost	Included	$xyz for 4-pack	Included
UV-C dose measurement	Yes: reflective light measurement	No	Yes: delivered dose measurement
Data capturing capability	Yes	Yes: compatible with EPIC	Yes: compatible with Cerner and EPIC
UV-C dose-based repositioning capability	No	No	Yes
Estimated treatment time	X minutes	Y minutes	Z minutes
Physical footprint of system	X × Y units	Y × Z units	X × Z units

UV-C, ultraviolet-C.

Develop a strong implementation plan:

- Once you've selected your technology, engage the manufacturer to help you create an implementation plan designed to optimize utilization for your specific facility
- Request training sessions, not just for operators but also for directors and other departments (EVS, nursing, infectious disease, and corporate) so that everyone involved is aware of the why, the when, and the how of the UV-C disinfection systems

Spencer M, et al: A model for choosing an automated ultraviolet-C disinfection system and building a case for the C-suite: Two case reports. AJIC 2016

IN-TRAK™ (patent pending) infection tracking software

HOME | REPORTS | ADMIN | ACCOUNTS | HELP | LOGOUT

Reports

Reports : Room Disinfection Job Summary

Display a history of disinfections of individual rooms or whole units.

Customer

Aiken Regional Medical Center (UHS)

Aiken Regional Medical Center (UHS)

Date Range

From: 6/1/2016

To: 6/30/2016

Mon Tue Wed Thr Fri Sat Sun

☑ ☑ ☑ ☑ ☑ ☑ ☑

Location

Site: Site

Unit: All

Room: All

Category: All

Job Status

☑ Completed Jobs

☐ Cancelled Jobs

Devices

☑ RD2 221

☑ RD2 222

☑ RD2 225

Dose

All

Sorted By Create Time Ascending

Submit Export

Aiken Regional Medical Center (UHS)				Job Report: 6/1/2016 to 6/30/2016				
Device	**Job ID**	**Create Time**	**Operator**	**Location**	**Dose**	**Sensor Readings**	**Elapsed Time**	**Final Status**

Job Report: 6/1/2016 to 6/30/2016

Device	Job ID	Create Time	Operator	Location	Dose	Sensor Readings	Elapsed Time	Final Status
RD2 221	1258	2016-06-01 14:40:05	lrobinson	OR::OR 8	Spore (46000)	(2211) 57608 (2212) 55020 (2213) 54270 (2214) 46003	4m 51s	Completed
RD2 221	1259	2016-06-01 14:46:57	lrobinson	OR::OR 8	Spore (46000)	(2211) 46004 (2212) 50005 (2213) 47209 (2214) 50001	3m 31s	Completed
RD2 221	1260	2016-06-01 14:52:50	lrobinson	OR::OR 8	Spore (46000)	(2211) 46954 (2212) 54001 (2213) 50516 (2214) 46005	3m 47s	Completed
RD2 221	1261	2016-06-01 15:20:25	lrobinson	OR::OR 8	Spore (46000)	(2211) 49672 (2212) 54802 (2213) 50813 (2214) 46099	4m 1s	Completed
RD2 221	1262	2016-06-01 15:38:43	lrobinson	OR::OR 7	Spore (46000)	(2211) 65498 (2212) 79022 (2213) 66079 (2214) 46065	5m 39s	Completed
RD2 221	1263	2016-06-01 15:53:53	lrobinson	OR::OR 7	Spore (46000)	(2211) 65005 (2212) 77996 (2213) 65738 (2214) 46050	5m 39s	Completed
RD2 221	1264	2016-06-01 16:01:20	lrobinson	OR::OR 7	Spore (46000)	(2211) 49342 (2212) 52977 (2213) 50636 (2214) 46052	3m 46s	Completed
RD2 221	1265	2016-06-01 16:05:38	lrobinson	OR::OR 7	Spore (46000)	(2211) 48301 (2212) 52504 (2213) 49568 (2214) 46045	3m 41s	Completed
RD2 221	1266	2016-06-01 16:13:39	lrobinson	OR::OR 4	Spore (46000)	(2211) 49498 (2212) 54244	3m 52s	Completed

Conclusion

- Continuous UV-C room decontamination works effectively in reducing contaminants left in the environment after routine cleaning and disinfection
- RD Disinfector UV-C robot room decontaminator:
  - ✓ quality control program with 4 remote UVC challenge sensors that assure the correct dosage of UV is achieved during treatments
- Steriliz is faster and more efficient than other models
- Software helps IP, EVS and departments monitor compliance with use of the technology to treat rooms and surfaces

Patented Remote Challenge Device UVC Sensors

Operating Room Disinfection Procedures and the use of UV-C Disinfection

Peter Graves, BSN, RN, CNOR
Independent Perioperative Consultant

OR Environmental Cleaning Studies

Only 47% of surfaces in 43 ORs of large urban hospital were cleaned	Munoz-Price LS, Birnbach DJ, Lubarsky DA, et al. Decreasing operating room environmental pathogen contamination through Improved cleaning practice. Infect Control Hosp Epidemiol. 2012;33(9):897-904.
Mean cleaning rate of 25% for objects in ORs of 6 acute care hospitals	Jefferson J, Whelan R, Dick B, Carling P. A novel technique for identifying opportunities to improve environmental hygiene in the operating room. *AORN J*. 2011;93(3):358-364.

INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY SEPTEMBER 2012, VOL. 33, NO. 9

ORIGINAL ARTICLE

Decreasing Operating Room Environmental Pathogen Contamination through Improved Cleaning Practice

L. Silvia Munoz-Price, MD;[1,2,3] David J. Birnbach, MD, MPH;[2,4] David A. Lubarsky, MD, MBA;[4] Kristopher L. Arheart, EdD;[2,5] Yovanit Fajardo-Aquino, MD;[3] Mara Rosalsky, RN;[3] Timothy Cleary, PhD;[6] Dennise DePascale, MT;[3] Gabriel Coro, MD;[3] Nicholas Namias, MD;[7] Philip Carling, MD[8,9]

Baseline cultures

Follow-up cultures

Variable	No. (%) of samples with pathogens	No. (%) of samples with skin flora	of samples with negative culture result	Total samples cultured	No. (%) of samples with pathogens	No. (%) of samples with skin flora	of samples with negative culture result	Total samples cultured	P[a]
Anesthesia equipment[b]	6 (11.3)	25 (47.2)	22 (41.5)	53	3 (12.5)	13 (54.2)	8 (33.3)	24	.884
Bed[c]	5 (11.9)	23 (54.7)	14 (33.3)	42	2 (8.3)	12 (50)	10 (41.7)	24	.660
Mayo stands	3 (8.5)	13 (37.1)	19 (54.3)	35	0	7 (58.3)	5 (41.7)	12	.985
Intravenous pumps and poles	8 (17.4)	26 (56.5)	12 (26.1)	46	2 (8.3)	11 (45.8)	11 (45.8)	24	.334
Circulating nurse area	11 (17.5)	47 (74.6)	5 (7.9)	63	2 (5.6)	26 (72.2)	8 (22.2)	36	.136
Operating room entry door	0	21 (95.5)	1 (4.5)	22	1 (8.3)	11 (91.7)	0	12	.980
All objects (excluding floors)	33 (12.6)	155 (59.3)	73 (27.9)	261	10 (7.6)	80 (60.6)	42 (31.8)	132	.998
Floor	14 (63.6)	8 (36.4)	0	22	8 (66.7)	3 (25)	1 (8.3)	12	.863
All objects (including floors)	47 (16.6)	163 (57.6)	73 (25.8)	283	18 (12.5)	83 (25)	43 (29.9)	144	.998

[a] Pathogens at baseline versus pathogens at follow-up.

Munoz-Price LS, Birnbach DJ, Lubarsky DA, et al. Decreasing Operating Room Environmental Pathogen Contamination through Improved Cleaning Practice. Infection Control. 2012;33(9):897-904. doi:10.1086/667381

Infection Prevention in Anesthesia Work Area

Infection Control & Hospital Epidemiology (2019), **40**, 1–17
doi:10.1017/ice.2018.303

SHEA Expert Guidance

Infection prevention in the operating room anesthesia work area

L. Silvia Munoz-Price MD, PhD[1], Andrew Bowdle MD, PhD[2], B. Lynn Johnston MD[3], Gonzalo Bearman MD, MPH[4], Bernard C. Camins MD, MSc[5], E. Patchen Dellinger MD[2], Marjorie A. Geisz-Everson PhD, CRNA[6], Galit Holzmann-Pazgal MD[7], Rekha Murthy MD[8], David Pegues MD[9], Richard C. Prielipp MD, MBA, FCCM[10], Zachary A. Rubin MD[11], Joshua Schaffzin MD, PhD[12], Deborah Yokoe MD, MPH[13] and David J. Birnbach MD, MPH[14]

[1]Froedtert & the Medical College of Wisconsin, Milwaukee, Wisconsin, [2]University of Washington, Seattle, Washington, [3]Dalhousie University, Halifax, Nova Scotia, [4]Virginia Commonwealth University School of Medicine, Richmond, Virginia, [5]University of Alabama at Birmingham, Birmingham, Alabama, [6]University of Southern Mississippi, Hattiesburg, Mississippi, [7]Baylor College of Medicine, Houston, Texas, [8]Cedars-Sinai Medical Center, Los Angeles, California, [9]University of Pennsylvania, Philadelphia, Pennsylvania, [10]University of Minnesota, Minneapolis, Minnesota, [11]David Geffen School of Medicine at UCLA, Los Angeles, California, [12]Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio, [13]University of California San Francisco School of Medicine, San Francisco, California and [14]University of Miami Miller School of Medicine, Miami, Florida

(Received 15 October 2018; accepted 19 October 2018)

Munoz-Price LS, Bowdle A, et al. Infection prevention in the operating room anesthesia work area. Infect Control Hosp Epidemiol. 2019 Jan;40(1):1-17.

SHEA Guideline for Anesthesia Work Areas – Environmental Recommendations

- Should anesthesia machines be partially or completely covered with disposable covers to prevent contamination?
- When ORs are prepared between uses, what cleaning and disinfection of the anesthesia machine and anesthesia work area should take place?
- What measures should be taken to protect clean supplies in the anesthesia cart from contamination? Should the anesthesia supply cart be cleaned between cases?
- How should keyboards and touch screens in the anesthesia work area be cleaned and protected from contamination?
- What infection prevention and control modifications should be made, if any, for patients in contact isolation?
- Environmental cleaning: practices for the cleaning, handling, and processing of anesthesia equipment have been published by AORN

Munoz-Price LS, Bowdle A, et al. Infection prevention in the operating room anesthesia work area. Infect Control Hosp Epidemiol. 2019 Jan;40(1):1-17.

AORN Guideline: Environmental Cleaning

Room turnover: in-between cases

- OR turnover time is defined as the time from when the wheels of a patient's bed exited the operating room to the time when the wheels of the next patient's bed entered the operating room
- National benchmarks for operating room turnover time may range from 20 minutes to 45 minutes, depending on the complexity of the surgical procedures and the facility's resources

AORN Guideline for Environmental Cleaning Guideline. 2024

Room Turnover: Post Procedure Cleaning

- Clean and disinfect items that are used during a surgical or invasive procedure, including
  - ✓ OR bed attachments (arm boards, stirrups, head rests)
  - ✓ positioning devices (viscoelastic polymer rolls, vacuum pack positioning devices)
  - ✓ patient transfer devices (roll boards)
  - ✓ overhead procedure lights
  - ✓ tables and Mayo stands
  - ✓ mobile and fixed equipment
- Clean and disinfect the floors and walls of operating and procedure rooms after each surgical or invasive procedure if soiled or potentially soiled (e.g., by splash, splatter, or spray)

AORN Guideline for Environmental Cleaning Guideline. 2024

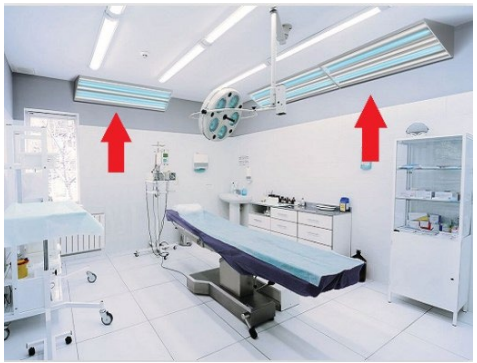
End of Day or Night Shift Terminal Cleaning

Approx 45 min – 1hr

- Terminally clean and disinfect perioperative areas daily when the areas are being used.
- Disinfect all floors in the perioperative and sterile processing areas.
- Terminally clean floors with either a wet vacuum or a single-use mop and a disinfectant.
- Clean from the cleanest to dirtiest areas of the floor.
- Disinfect floor surfaces at the perimeter of the room before floor surfaces in the center of the room.
- Disinfect the entire floor surface, including areas under the OR bed and mobile equipment.
- Terminally clean and disinfect all exposed surfaces, including wheels and casters, of all items

Adjunctive RD-Fx™ Fixed Mount System

- Fixtures mounted in optimal locations to flood a room with enough UVC energy to provide the dose necessary to achieve a 3+ logl0 reduction of the targeted pathogen
- System can be programmed to include multiple doses for specific pathogens
  - ✓ After each procedure, complete a manual clean
  - ✓ Exit the room, close the door, enter a user-specific PIN,
  - ✓ Select the dose desired (if you have programmed multiple doses for specific pathogens), and press ‘Start’ to begin the disinfection cycle
  - ✓ Display shows a countdown and indicates when the process is complete
  - ✓ Disinfection data (room, date, time, user, duration, delivered dose, etc.) is posted to your cloud portal in real time
  - ✓ When completed, the room is immediately available for your next patient

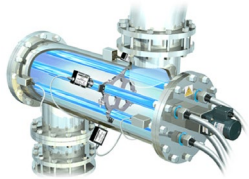
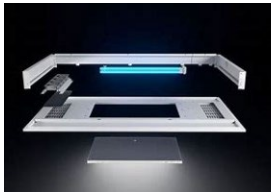
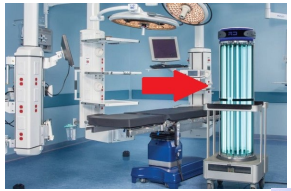


RD-Fx™ UV Disinfection Fixed System | RD UVC System

UV-C Quality Management Program

UV-C Products That Might be Used in Facilities

- **Water disinfection**
  - ✓ water treatment plants, drinking water, water reclamation, life sciences, aquariums, pools and spas, ballast water treatment systems and more.
- **Surface disinfection**
  - ✓ hospitals, nursing homes, daycare centers, restaurants, food buffets, grocery stores, food irradiation, medical supply manufacturing, many others.
- **Air purification**
  - ✓ air disinfection in hospitals, healthcare facilities, commercial and industrial air purification applications, ozone disinfection with odor control, air purification in HVAC units, many other air disinfection applications.
- **Medical equipment disinfection**
  - ✓ Stethoscopes, ultrasound equipment, keyboards, computers, etc.

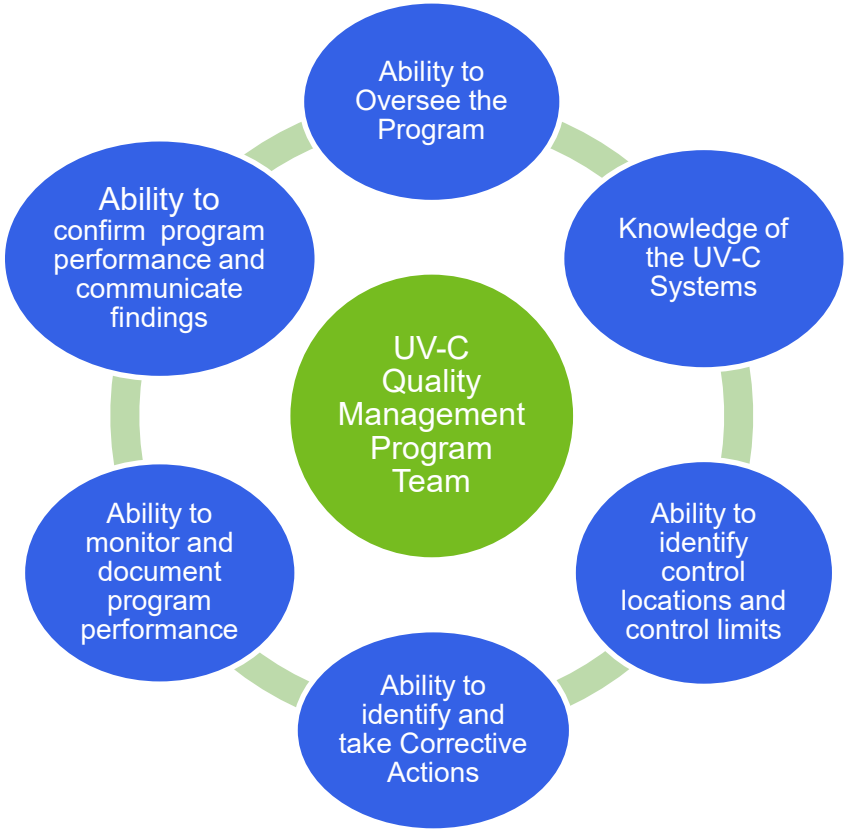






Propose: UV-C Quality Management Program

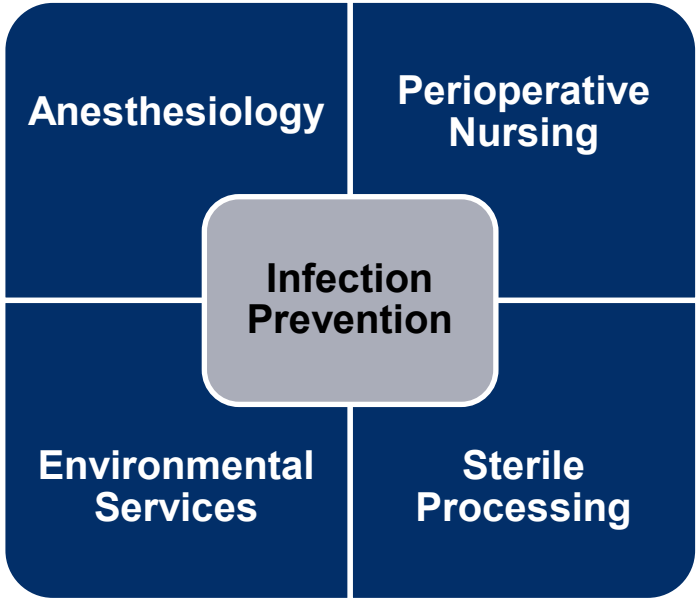
- Carefully select UV-C devices and equipment and application methods for use in healthcare facilities to ensure that you can clean and disinfect safely and effectively.
- Carefully review and evaluate level of evidence
  - ✓ Manufacturers info
  - ✓ Laboratory
  - ✓ Clinical outcomes
- Device potential hazards
- Device installation/logistics
- Vendor support/service plans
- Consumables – replacement of bulbs, maintenance, upgrades
- Equipment selected, where utilized, by whom, where stored, in-service education, preventive maintenance plan, analysis of treatments and reduction in HAIs and MDROs

Model for a UV-C Quality Management Team



Formation of Interdisciplinary Team for Clinical Implementation

- Selection of:
  - ✓ Cleaning products
  - ✓ Disinfectants with short contact times
  - ✓ Cleaning equipment (mops, cloths vs wipes)
  - ✓ Turnover packs/kits
  - ✓ Adjunctive technology (UV-C devices)
- Policies and Procedures
- In-services education
- Staff competencies
- Quality monitor system



Havill NL. Best practices in disinfection of noncritical surfaces in the health care setting: creating a bundle for success. Am J Infect Control. 2013 May;41(5 Suppl):S26-30.

What We Covered

- Discussed sources for pathogens in the healthcare setting –inpatient and outpatient
- Reviewed how Ultraviolet (UV) radiation works
- Demonstrated how to administer and execute it in various healthcare settings
- Discussed sources for pathogens in operating room setting
- Reviewed room turnover and terminal disinfection procedures in the OR
- Illustrated how a fixed ceiling UV-C system can be used in the OR and other clinical settings
- Discussed a UV-C Plan and Interdisciplinary Team for implementation

Polling Question #3
Usage

Are you utilizing your UVC Equipment as much as possible?

- ❑ Yes
- ❑ No
- ❑ I don’t know

Polling Question #4
Usage

Does your organization review UVC treatment reports?

- ❑ Yes
- ❑ No
- ❑ I don’t know

Polling Question #5
Usage

Do the treatment reports provide meaningful metrics that trigger action when limits are reached?

- ❑ Yes
- ❑ No
- ❑ I don’t know

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UV-C - Updated Technology in the Future and FDA 510K issues

Sam Trapani, CEO
Steriliz, LLC


Q&A

A copy of this presentation will be sent to all participants