Use of Light for HAI Reduction

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BACKGROUND

- **Utilization of UV light devices for surface disinfection in healthcare facilities has grown in the last 10 years**

- **Factors leading to their introduction into healthcare:**
  - **Emergence of multidrug-resistant pathogens such as**
    - ***Clostridioides difficile* (formerly *Clostridium difficile*),**
    - **methicillin-resistant *Staphylococcus a*ureus (MRSA),**
    - **vancomycin-resistant enterococci (VRE)**

  - **Studies showing that only ~ 40% - 50% of surfaces in patient rooms that should be cleaned/disinfected are actually wiped by environmental services (EVS) personnel**

  - **Rooms that are inadequately disinfected at patient discharge by EVS personnel using routine manual methods put patients who are subsequently admitted to the room at increased risk of acquiring the same pathogen as the previous patient**

- **As a result, "no-touch" disinfection technologies have been introduced to supplement routine manual disinfection of hospital rooms**

Klevens RM et al. Clin Infect Dis 2005;41:848
Lessa FC et al. Clin Infect Dis 2012;55 Suppl 2: S65
Carling PC et al. Infect Control Hosp Epidemiol 2008;29:1035
Mitchell BG et al. J Hosp Infect 2015;91:211
Weber DJ et al. Am J Infect Control 2016;44:e77

Early Studies of Mobile UV Devices for Surface Disinfection in Healthcare

- **In 2010-2011, several studies utilizing a mobile UVC device with on-board sensors demonstrated its ability to reduce *C. difficile*, MRSA and VRE**
  - **On inoculated carriers and surfaces in patient rooms**

- **On average, when a minimum reflected dose of 22,000 uWsec/cm² was received by sensors, pathogens were reduced:**
  - **> 3-4 $\log_{10}$ for MRSA and VRE**
  - **> 2-3 $\log_{10}$ for *C. difficile***

- **Log_{10} reductions were greater on surfaces in direct line of sight of the device than on surfaces that received indirect light**

Nerandzic MM et al. BMC Infect Dis 2010;10:197
Rutala WA et al. Infect Control Hosp Epidemiol 2010;31:1025
Boyce JM et al. Infect Control Hosp Epidemiol 2011;32:737

UVC Light Room Decontamination Systems

- Automated mobile UV light units that emit UVC (254 nm range) became available in a variety of sizes, designs, and acquisition & maintenance costs
- Some units have built-in sensors, or separate sensors, or no sensors
- Some have software for tracking usage
- Automated fixed position UVC device can be used in bathrooms

Source: Mathur A IUVA News 2018;20:17

Pulsed Xenon Decontamination Systems

- **Pulsed xenon devices use short bursts of light, unlike continuous UVC devices**

- **Emit broad spectrum light**
  - **E.g., one device produces UVA, UVB, & UVC**

- **Bulbs do not contain mercury**

- **One device has been reported to reduce pathogens on surfaces in several published studies**

- **Yield lower doses of UVC and lower $\log_{10}$ reductions of pathogens than mobile UVC devices evaluated**

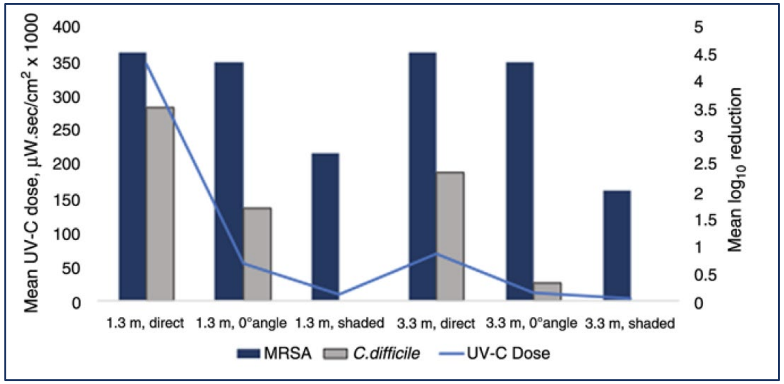
Stibich M et al. Infect Control Hosp Epidemiol 2011;32:286
Jindatha C et al. BMC Infect Dis 2014;14:187
Nerandzic MM et al. Infect Control Hosp Epidemiol 2015;36:192
Beal A et al. J Hosp Infect 2016;93:164
Zeber JE et al. Am J Infect Control 2018;46:668
Cadnum JL et al. Infect Control Hosp Epidemiol 2019;40:158

Subsequent Studies in Laboratory and Clinical Settings

- **Cadnum et al. demonstrated the effect that varying test methods can have on $\log_{10}$ reductions achieved**
  - **Strain variation, inoculum preparation, carrier type, distance from device, angle of light, cycle time, and organic load**

- **Multiple studies focused on the $\log_{10}$ reductions achieved using cycle times recommended by manufacturers**

- **More recent reports have correlated the intensity (fluence rate) and doses (fluence) achieved with UVC and pulsed xenon devices and resulting $\log_{10}$ reductions achieved in clinical settings**



Source: Infect Control Hosp Epidemiol 2019;40:1030

Cadnum JL et al. Infect Control Hosp Epidemiol 2016;37:555
Anderson DJ et al. Infect Control Hosp Epidemiol 2013;34:466
Boyce JM et al. Infect Control Hosp Epidemiol 2016;37:667
Tande BM et al. Infect Control Hosp Epidemiol 2018;39:1122
Cadnum JL et al. Infect Control Hosp Epidemiol 2019;40:158

Evidence of the Impact of UV Light on Healthcare-Associated Infections (HAIs)

- **9 trials have evaluated the impact of UV light on HAIs**
  - **3 utilized UVC devices**
  - **6 used a pulsed xenon device**

- **Outcome measures:**
  - **Colonization (acquisition) by multidrug-resistant organisms (MDROs)**
  - ***C. difficile* infection (CDI)**

- **8 studies were performed in single facilities**
  - **Employed a variety of study designs, clinical settings, and trial duration**

Sitzlar B et al. ICHE 2013;34:459; Pegues DA et al. ICHE 2017;38:39; Anderson DJ et al. Lancet 2017;389:805 and Anderson DJ et al. Lancet Infect Dis 2018;18:845; Levin J et al. AJIC 2013;41:746; Haas J et al. AJIC 2104;42:586 Miller R et al. AJIC 2015;43:1350; Vianna PG et al. AJIC 2016;44:299; Green C et al. Burns 2017;43:388; Brite J et al. ICHE 2018;39:1301

Prospective Randomized, Cluster-Controlled Cross-Over Trial (Benefits of Enhanced Terminal Room Disinfection "BETR" study)

- **Conducted in 9 hospitals using one type of UVC device**

- **Compared 4 terminal room disinfection strategies**
  - Standard "Quat" disinfectant; bleach in CDI rooms
  - Standard disinfection protocol + UV
  - Bleach
  - Bleach + UV

- **Assessed the impact of UVC on acquisition of MDROs or CDI**
  - Patients admitted to high-risk rooms that were disinfected with UVC vs patients admitted to high-risk rooms NOT disinfected with UVC

  - Evaluated the <u>hospital-wide</u> impact on
    - Acquisition of MDROs and CDI

Anderson DJ et al. Lancet 2017;389:805
Anderson DJ et al. Lancet Infect Dis 2018;18:845

Impact of UV Light Devices on HAIs

Year	First Author	UV Type	Setting	Findings
2013	Sitzlar	UV-C	Hospital-wide	UV disinfection did not contribute to reduced CDI; enhanced daily cleaning in CDI rooms yielded negative cultures BEFORE UV use
2017	Pegues	UV-C	3 Hem-Onc units	UV disinfection in CDI & Contact Precautions rooms reduced CDI incidence 25% vs 16% increase on non-study units (p = 0.03)
2017 2018	Anderson	UV-C	9-Hospital RCT	Acquisition of target organisms was reduced by UV in patients exposed to high-risk rooms (p = 0.036). Hospital-wide *C. difficile* (p = 0.03) and VRE (p = 0.048) were reduced significantly
2013	Levin	PX-UV	Hospital-wide	UV disinfection use in 56% of all discharges resulted in a 53% reduction in CDI incidence (9.46 to 4.45 HD-CDI cases/10,000 pt-d)
2014 2015	Haas Nagara	PX-UV	Hospital-wide	UV disinfection use in 76% of Contact Precaution room discharges & other high-risk areas significantly reduced MDROs + CDI by 20%. HA-CDI was reduced by 22% (p = 0.06)
2015	Miller	PX-UV	Long-term acute care facility	Use of a multidisciplinary team followed by UV disinfection of all discharges + communal areas reduced CDI incidence by 57%
2016	Vianna	PX-UV	Hospital-wide	UV of all discharges from ICU and non-ICU CDI rooms significantly reduced VRE in ICU, and CDI in non-ICU units
2017	Green	PX-UV	Burn unit	UV reduced environmental contamination, but did not significantly reduce HAIs
2019	Brite	PX-UV	Bone marrow transplant unit	UV did not significantly reduce VRE or CDI among stem cell transplant recipients

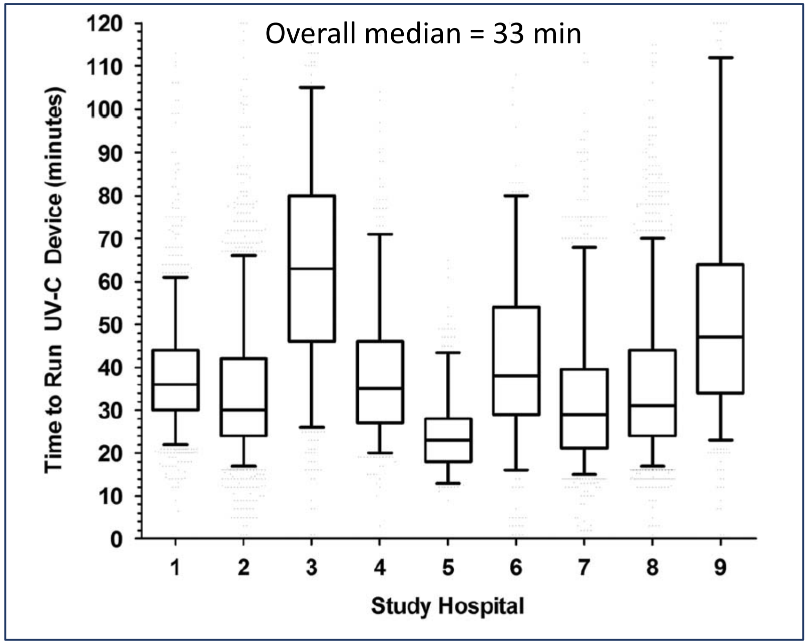
Limitations of the Evidence of UV Light Impact on HAIs

- **8/9 studies had important limitations**
  - **Performed in single facility (7 hospitals and 1 LTACF)**
  - **Differing criteria for the types of rooms to disinfect with UV**
    - **Only rooms vacated by patients with CDI**
    - **CDI rooms plus rooms of patients on isolation precautions for MDROs**
    - **Additional clinical areas in some studies**
  - **Hospital-wide (3 studies); single nursing unit (3 studies)**
  - **Variable number of devices employed in the facility**
  - **Differing number of UV cycles and number of locations in room**
  - **Duration of each trial: 3 months to 22 months**
  - **Potential confounding variables often not included in analysis**
    - **Type(s) of liquid disinfectants used and routine manual disinfection practices**
    - **Compliance of EVS personnel with cleaning/disinfection protocols**
    - **Various antimicrobial stewardship programs**
    - **Used in conjunction with *C. difficile* team interventions**

Barriers Encountered in Implementing Use of UV Light Devices in Healthcare Facilities

- **Time pressure from bed control dept.**
    - Impact on room turn-around time
    - Target room needed immediately for new patient
- **Efficient identification of target rooms**
    - Required improved communication between bed control, EVS & hospital administration
- **Volume of patient discharges**
- **Variation in time needed to deploy device** ➡
    - Differences in room size and configuration
    - Number of items in room
- **Attitudes of some healthcare personnel and patients regarding UV disinfection**
- **Need to educate involved staff**
- **Adequate number of devices and staff**
- **Need for audit and feedback**

Median Time Required to Complete UV Disinfection Device Cycles in 9 Study Hospitals



Anderson DJ et al. Infect Control Hosp Epidemiol 2018;39:157

Anderson DJ et al. Infect Control Hosp Epidemiol 2018;39:157
Fleming M et al. Am J Infect Control 2018;46:241
Dunn AN et al. Am J Infect Control 2019;47:1290

Research Needs

- **Additional studies of the ability of various UV devices to**
  - Deliver doses that effectively reduce healthcare-associated pathogens
  - On fixed and portal equipment located in patient rooms & other clinical areas

- **More standardized methods for comparing device efficacy**
  - Assist facilities in choosing the most appropriate device

- **Practical methods of monitoring the doses delivered, especially for devices without accompanying UV sensors**

- **Additional prospective trials of the impact of UV light on HAIs are needed, preferably using a variety of devices**
  - Consider head-to-head comparison of impact of different devices
  - Data on cost-effectiveness of UV disinfection programs are needed

- **Assess other light modalities (e.g., 405 nm; continuous UVA)**

Rutala WA et al. Infect Control Hosp Epidemiol 2018;39:1250
Weber DJ et al. Am J Infect Control 2019;47S: A72
Donskey CJ Am J Infect Control 2019;47S:A23
Livingston SH et al. Am J Infect Control 2019 [Epub ahead of print]

Thank you for your attention