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Brief Report

# Deployment of a touchless ultraviolet light robot for terminal room disinfection: The importance of audit and feedback

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Touchless ultraviolet disinfection (UVD) devices effectively reduce the bioburden of epidemiologically relevant pathogens, including *Clostridium difficile.* During a 25-month implementation period, UVD devices were deployed facilitywide for the terminal disinfection of rooms that housed a patient who tested positive for *C difficile*. The deployment was performed with structured education, audit and feedback, and resulted in a multidisciplinary practice change that maximized the UVD capture rate from 20% to 100%.



Recent literature indicates that ultraviolet (UV) light devices effectively destroy various microorganisms, including *Clostridium difficile*, a pathogen of growing concern across US hospitals.[1,2] Terminal disinfection of patient rooms with UV radiation can reduce environmental pathogen bioburden and reduce the risk of hospital-acquired infections.[3-5] In conventional manual cleaning, 50% of sites in a patient room may remain untouched during the cleaning process.[6] Enhanced room cleaning with UV disinfection (UVD) supplements manual cleaning of hospital environments.[4,7]

Sustainable deployment of UVD devices for terminal cleaning of rooms of patients who test positive for *C difficile* infection (CDPP) requires education, collaboration, and communication amongst a multidisciplinary team that includes infection preventionists (IPs) bed management personnel, and environmental services (EVS) personnel.[8] This study evaluated the influence of education with structured audit and feedback (A&F) for UVD during terminal cleaning of CDPP rooms facilitywide.

## METHODS

The study was conducted in an urban, 865-bed, academic medical center with private and semiprivate rooms. Data were collected and UVD capture rate ([number of UV device deployments / number of opportunities for deployment] × 100) was calculated during a 25-month period (February 1, 2015-February 28, 2017). During the study, there were 420,394 patient-days, and 99,184 admissions.

A multidisciplinary team adopted an evidence-based enhanced environment cleaning protocol that included UVD of rooms that previously housed a CDPP. After manual disinfection with a sporicidal agent by contracted EVS staff, UVD devices were deployed by supervisors or managers as the last step in terminal cleaning. EVS staff, supervisors, and managers received formal education about *C difficile*, and the importance of UVD; they were portrayed as critical team members of the hospital's safety mission. The implementation involved an A&F approach modeled after the Feedback Intervention Theory developed by Kluger and DeNisi.[9] This evidence-based theory focuses on goal setting, motivating, and maximizing effectiveness.

Collaboratively, members of the hospital Infection Prevention Program, BM staff, and EVS staff developed a notification paging process to ensure CDPP rooms had UVD at terminal discharge. Monday through Friday, Infection Prevention Program staff provided EVS staff an electronic list of all rooms that housed CDPP and patients with suspected *C difficile* infection. Daily, upon identification of a positive *C difficile* result, EVS staff were paged with the location and room number. At terminal clean, EVS staff members received a page from BM staff indicating UVD was required. From February 2015 to mid-January 2017, 2 single-position, automated UVD devices were used for all inpatient areas; as of mid-January 2017, 2 additional machines were purchased. Facilitywide, UVD time averages 36 minutes.

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A&F was conducted monthly by a retrospective manual review of CDPP room assignments and compared with an automated electronic report of UVD device deployment. Opportunities for UVD device deployment were defined as any room that was vacated via discharge or transfer by a CDPP. The goal for monthly capture rate was ≥90%. Monthly UVD capture rate and identification of noncompliant rooms were reported to EVS staff, BM staff, and unit leadership to review opportunity gaps. EVS leadership then disseminated the data to the EVS team responsible for UVD device deployment to promote behavior change and goal attainment.[8,10] The capture rate was also reported monthly to the hospital Infection Control Committee and hospital leadership.

## RESULTS

During the 25-month assessment period, UVD capture rate increased from a baseline of 20% (14 out of 70) to 100% (47 out of 47) (Fig 1). During the first month, there were 70 opportunities for UVD; 14 rooms were disinfected for a capture rate of 20% (Fig 2). During the final month of assessment, the capture rate for the UV disinfection was 100%: 47 rooms were disinfected and 47 rooms were eligible for disinfection. The UVD capture rate remained consecutively above 80% for 19 of the 25 months. During months 21-25, the capture rate remained above the goal of ≥90%. Tracking of UVD device use indicated that as the capture rate increased, the number of days the devices were not used decreased. The standardized in-

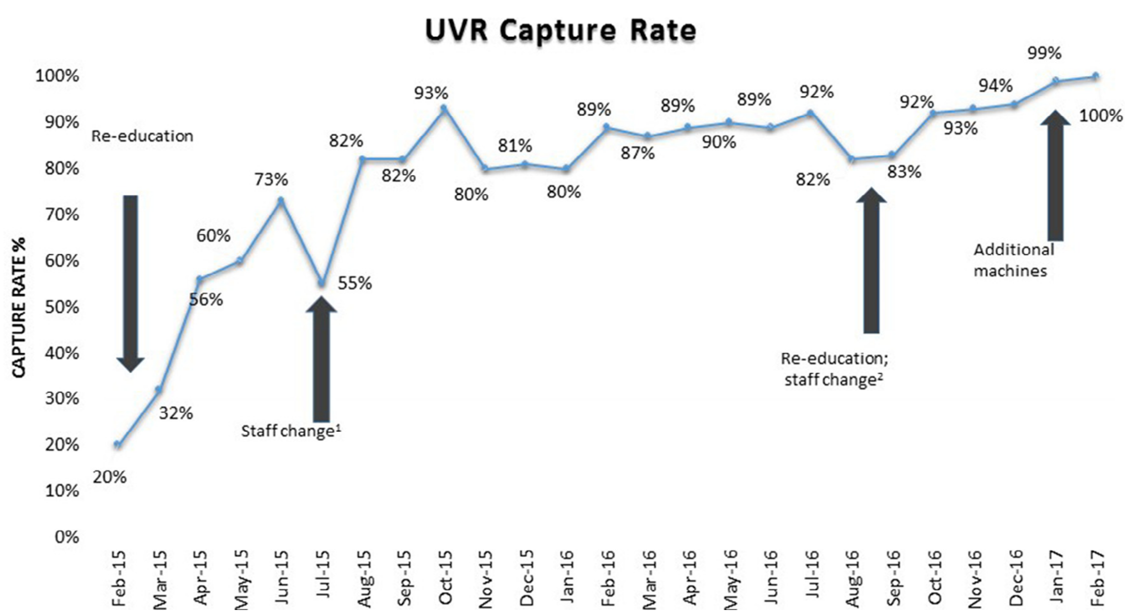


**Fig 1.** Ultraviolet radiation (UVR) capture rate during the deployment assessment period. Both re-education events were conducted by the vendor surrounding use and purpose of ultraviolet disinfection (UVD); the first re-education event also included information on *Clostridium difficile* and the role of environmental services staff in infection prevention. [1]The environmental services manager responsible for UVD resigned and new staff as hired. [2]The top-performing manager resigned and new mangers were hired. Additional machines = Two additional machines were purchased for use in the inpatient area.

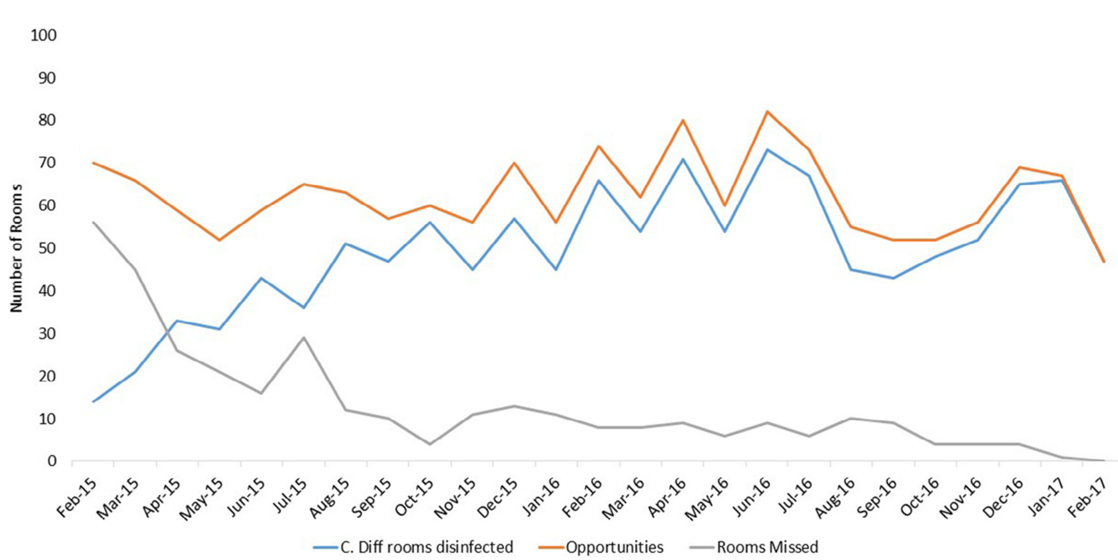


**Fig 2.** Convergence of opportunities and ultraviolet disinfection. C. Diff = *Clostridium difficile*.

fection ratio for National Healthcare Safety Network Lab ID *C difficile* decreased from 1.283 in 2015 to 1.212 in 2016. This result was not statistically significant ($P$ = .6067).

## DISCUSSION

Over a 25-month period, UVD of CDPP rooms improved from 20% to 100% with targeted education and A&F. Although there was a decrease in the Lab ID *C difficile* standardized infection ratio from 2015 to 2016, the decrease was not statistically significant. Key elements included EVS notification regarding CDPP rooms, tracking the movements of all CDPP across the facility, determining whether UVD occurred in the CDPP room via an ongoing audit, and feeding the information back to end users. Auditing of UVD capture rate with feedback to end users, BM staff, and leadership permitted cross-facility collaboration of this safety initiative. Providing end users with feedback allowed for a refocusing of efforts and a positive behavior change to reach the defined goal.[8] Supplying a line graph to track the capture rate provided a visual illustration of the velocity of change that enhanced the verbal and electronic feedback.

The effectiveness of UVD has been cited at 99.8% in the reduction of environmental *C difficile*.[2] Setting a defined goal for a capture rate of ≥90% and educating key partners and end users about the rational for UVD and the expected goal, provided a strategic plan for success.[8,10] EVS staff, supervisor, and manager education focused primarily on a message of patient safety: UVD deployment not only enhances cleanliness but also decreases the risk of hospital infections, making members of EVS staff important, frontline collaborators in the hospital's patient safety mission.

Strengths of this program include the willingness of leadership to support the program, EVS staff collaboration and determination to meet the defined goal and the input of BM staff. The opportunity for sustainable capture rates rests with an automated system of reporting CDPP rooms to the end users and immediate feedback of missed opportunities. The study was performed in a single center, thus the results may not be generalized. This study adds to the body of literature on UVD and illustrates the importance of education and formal A&F for high reliability implementation of new technology.

## CONCLUSIONS

Multidisciplinary collaboration, education, and structured A&F improve fidelity with UVD of rooms of patients with a history of *C difficile* infection.

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