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Brief Report

The effect of pulsed xenon ultraviolet light disinfection on healthcare-associated *Clostridioides difficile* rates in a tertiary care hospital

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Ultraviolet (UV) light has destructive activity against pathogenic bacteria including *Clostridioides difficile* spores. Portable pulsed-xenon UV disinfecting devices were implemented for terminal room cleaning in 6 units of our academic hospital with high *C. difficile* infection (CDI) rates. CDI rates were measured in a 9-month period before and a 9-month period after device implementation. Despite documented administration of UV disinfection for 87% of terminal room cleaning, no impact on CDI rates was detected.

A 2008 national prevalence study conducted by the Association for Professionals in Infection Control found the overall prevalence rate of infections and colonization with *Clostridioides difficile* in U.S. health care facilities was 13.1 per 1,000 inpatients.[1] Almost half a million *Clostridioides difficile* infections (CDI) occurred among patients in the U.S. in a single year, according to estimates by a report from 2015.[2] Many hospitals and other clinical care settings have sought to employ a variety of modalities to curb the rates of CDI. Pulsed xenon ultraviolet light (UV), which can destroy a range of bacteria including *C. difficile* spores has been used in an effort to increase reliability of environmental decontamination and decrease rates of health care-associated (HA)-CDI.[3] Our tertiary care, 500-bed academic hospital implemented portable pulsed xenon UV disinfecting devices after manual sporicidal product terminal cleaning of patients' rooms in 6 hospital units with private rooms: Surgical Intensive Care Unit, Medical Intensive Care Unit, Medical Intermediate Care Unit, Adult Hematology-Oncology Unit, Pediatric Hematology-Oncology Unit, and a Pediatric Acute Unit.

MATERIALS AND METHODS

Per the hospital's terminal cleaning protocol, all rooms are manually cleaned with a sporicidal disinfectant cleaning product; sodium hypochlorite was used in 2016 and peracetic acid/hydrogen peroxide-based sporicidal was used in 2017. Appropriate room cleaning is evaluated on randomly selected rooms using fluorescent tagging. After patient discharge, Environmental Health Services (EHS) supervisors mark key surfaces with an invisible fluorescent marker prior to cleaning. After terminal cleaning is completed by an EHS staff member, the supervisor returns to assess if fluorescence is detectable with a black light. Immediate feedback is provided to the EHS staff member and the results are recorded and tracked for each unit.

Directly following room cleaning, UV disinfection devices are placed in the room to deliver UV in 2 or 3 positions, with a 5-minute run time per position. A room with a bathroom has three UV device positions per room (on either side of the bed and in the bathroom). If the room does not have a bathroom, 2 positions are used (on either side of the bed).

UV devices were not used during a 9-month baseline phase of the study, from January 2016 through September 2016. A transition to utilization of UV devices occurred from October 2016 through December 2016, with full implementation by January 2017, the start of the second 9-month study phase. Compliance reports for UV device utilization were generated automatically each time the device was used.

Per CDC's National Healthcare Safety Network (NHSN) surveillance case definition for health care-associated infection (HAI), the diagnosis of HA-CDI was based on molecular detection of toxin-producing *C. difficile* on an unformed stool specimen collected on or after the third calendar day of admission to an inpatient location where day of admission is calendar day one.[4] Since cases in this study were determined for NHSN HAI surveillance which requires the application of HAI definitions, the 'health care facility-onset' definition was not used.[4] The NHSN case

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definition and methods of diagnosis of CDI at our hospital did not change during the period of the study, January 2016 through September 2017.

Because the combined rates for the 6 patient units were compared pre- and postimplementation of UV devices and interunit comparisons were not performed, rates were not additionally adjusted. The rate of HA-CDI per 1,000 patient-days during January 2016 to September 2016 (prior to UV implementation) was compared with the rate during January 2017 to September 2017 (after full UV implementation).

RESULTS

Appropriate terminal cleaning evaluated by fluorescent marking environmental auditing did not significantly change over phase 1 and 2 study periods, with an average of 87% of 6,510 tested high-touch surfaces demonstrating adequate removal of fluorescent marker. Use of UV devices during the 9-month phase 2 study period in 2017 averaged 93.6% of 8,298 targeted terminal discharges without notable differences in use between units.

The rate of HA-CDI per 1,000 patient-days for the combined 6 units during phase 1 study period from January 2016 to September 2016 was 1.57 of 1,000 patient-days compared with 1.61 of 1,000 patient-days during phase 2 study period from January 2017 to September 2017 for the same units.

DISCUSSION

In aggregate, in 6 patient units over a 9-month time period, we did not detect an impact on HA-CDI rates after implementation of pulsed-xenon UV disinfection for the final stage of terminal room cleaning. By contrast, there are other studies that have demonstrated decreases in HA-CDI with usage of UV devices. However, the studies reviewed were limited by reliance on historical controls or comparison with concurrent units with different patient population mixes.[5-7] While it is likely that UV kills additional spores that may have been missed by manual sporicidal disinfectant cleaning, there are numerous other factors that influence HA-CDI rates.[8] For example, surges in HA-CDI during 2 months of 2017 theoretically could have been related to additional transmission circumstances that would not be affected by UV devices regardless of how well terminal disinfection was performed. There is also some uncertainty as to the potential negative impact of shadows, room configuration, and room size on the effectiveness of UV disinfection given that treatments were not meticulously tailored to these unique parameters.

Limitations of our study include our use of historical controls which would not take into account potential changes in practices over time, lack of specific antimicrobial use data, and our inability to fully regulate other factors that could contribute to HA-CDI, such as health care worker hand hygiene compliance. In addition, the adequacy of terminal manual cleaning was qualitative and not fully standardized—variability may have existed in the conduct of the evaluation by different supervisors (Fig 1 and Table 1).

CONCLUSION

Pulsed-xenon UV disinfection, as the final stage of terminal room cleaning, did not have a discernable impact on HA-CDI rates in our hospital. The control of HA-CDI likely requires optimization of a multifaceted approach, including: excellent hand hygiene compliance, early identification of those with CDI and possibly also those with *C. difficile* colonization, optimal environmental cleaning, dedicated medical equipment, excellent antimicrobial stewardship, and other measures that may enhance maximal decontamination of the environment. It is possible that one or more of these factors, if suboptimal, negated any positive

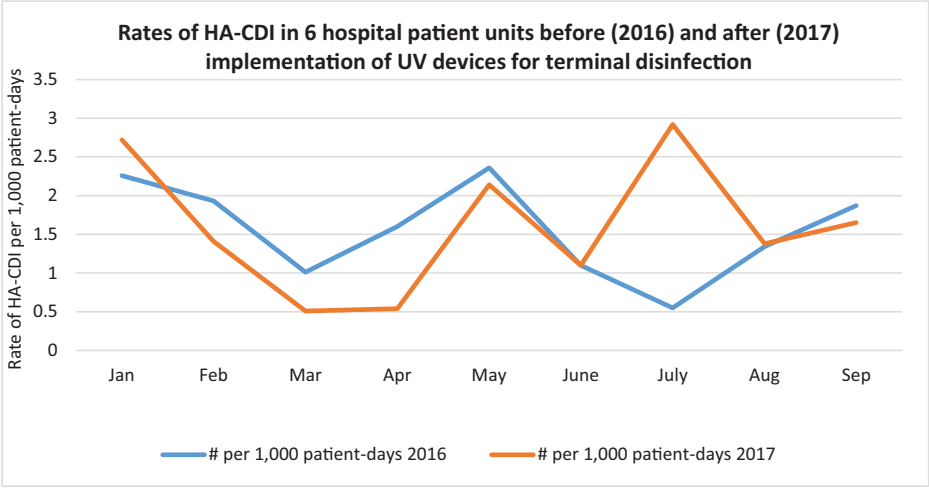

Fig 1. HA-CDI per 1,000 patient-days, 2016 and 2017. HA-CDI, health care-associated *Clostridioides difficile* infections.

Table 1
HA-CDI per 1,000 patient-days for 2016 & 2017 in 6 hospital units—SICU, MICU, MIMCU, adult Heme-Onc, Peds Heme-Onc, and Peds acute

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Total patient-days 2016	3,982	3,627	3,945	3,758	3,818	3,648	3,653	3,641	3,737	33,809
# cases per 1,000 patient-days 2016	2.26	1.93	1.01	1.60	2.36	1.10	0.55	1.34	1.87	1.57
Total patient-days 2017	4,037	3,540	3,894	3,703	3,731	3,629	3,763	3,613	3,632	33,542
# cases per 1,000 patient-days 2017	2.72	1.41	0.51	0.54	2.14	1.10	2.92	1.38	1.65	1.61

Adult Heme-Onc, Adult Hematology-Oncology Unit; *HA-CDI*, health care-associated *Clostridioides difficile* infections; *MICU*, Medical Intensive Care Unit; *MIMCU*, Medical Intermediate Care Unit; *Peds acute*, Pediatric Acute Unit, *Peds Heme-Onc*, Pediatric Hematology-Oncology Unit; *SICU*, Surgical Intensive Care Unit.

effect of the UV device at our hospital. Since this complexity is likely to be present in many health care facilities, we recommend vigilant attention to all aspects of HA-CDI control without undue reliance on new technologic measures over and above basic infection prevention practices and antimicrobial stewardship.

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