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Major article

Impact of pulsed xenon ultraviolet light on hospital-acquired infection rates in a community hospital

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Background: The role of contaminated environments in the spread of hospital-associated infections has been well documented. This study reports the impact of a pulsed xenon ultraviolet no-touch disinfection system on infection rates in a community care facility.

Methods: This study was conducted in a community hospital in Southern Florida. Beginning November 2012, a pulsed xenon ultraviolet disinfection system was implemented as an adjunct to traditional cleaning methods on discharge of select rooms. The technology uses a xenon flashlamp to generate germicidal light that damages the DNA of organisms in the hospital environment. The device was implemented in the intensive care unit (ICU), with a goal of using the pulsed xenon ultraviolet system for disinfecting all discharges and transfers after standard cleaning and prior to occupation of the room by the next patient. For all non-ICU discharges and transfers, the pulsed xenon ultraviolet system was only used for *Clostridium difficile* rooms. Infection data were collected for methicillin-resistant *Staphylococcus aureus*, *C difficile*, and vancomycin-resistant *Enterococci* (VRE). The intervention period was compared with baseline using a 2-sample Wilcoxon rank-sum test.

Results: In non-ICU areas, a significant reduction was found for *C difficile*. There was a nonsignificant decrease in VRE and a significant increase in methicillin-resistant *S aureus*. In the ICU, all infections were reduced, but only VRE was significant. This may be because of the increased role that environment plays in the transmission of this pathogen. Overall, there were 36 fewer infections in the whole facility and 16 fewer infections in the ICU during the intervention period than would have been expected based on baseline data.

Conclusion: Implementation of pulsed xenon ultraviolet disinfection is associated with significant decreases in facility-wide and ICU infection rates. These outcomes suggest that enhanced environmental disinfection plays a role in the risk mitigation of hospital-acquired infections.

BACKGROUND

The Centers for Disease Control and Prevention estimated a national burden of 722,000 hospital-acquired infections (HAIs) occurring within acute care hospitals in 2011.[1] This estimation is house-wide, with over half of these infections occurring outside of the intensive care unit (ICU). Approximately 4% of all patients that are admitted will contract at least 1 HAI. Because >70% of gastrointestinal infections were caused by *Clostridium difficile*, the Centers for Disease Control and Prevention have recently changed their focus to understanding the factors that may contribute to HAIs beyond

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Conflicts of interest: As employees of Xenex Disinfection Services, LLC, C.R.D., S.S., and M.S. identify both financial and intellectual competing interests. P.G.V. and C.M.L. have not identified a competing interest regarding the study beyond working for the institution in which this study took place at (South Seminole Hospital, Orlando Health).

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actual operative procedures, with a particular emphasis given to understanding the role of contaminated surfaces within the patient room.[2,3]

Substantial evidence exists that air and surfaces within the patient room are regularly contaminated with multidrug-resistant organisms (MDROs).[4,5] Patients regularly shed organisms on skin squames that have the potential to disperse over a wide range.[6,7] Knelson et al[8] illustrated that both asymptomatic colonized patients and symptomatic patients were equally as likely to contribute to this environmental contamination with MDROs. Health care workers are just as likely to contaminate their gloved hands when touching inanimate surfaces as when touching the actual patient in a methicillin-resistant *Staphylococcus aureus* (MRSA)–, vancomycin-resistant *Enterococci* (VRE)–, or *Clostridium difficile*–positive patient room.[9-11] To make matters worse, the pathogens of common MDROs, particularly *C difficile* spores, have the potential to survive for months on dry surfaces if not adequately removed.[12]

Evidence supports what is known as prior room occupancy risk, or the increased risk of acquiring an infection after being admitted to a room with a previous MDRO-positive occupant rather than one who did not have an MDRO.[13] In fact, Shaughnessy et al[14] determined this prior room occupancy risk to be >2 times greater when the previous patient had *C difficile*. Because there is no physical contact between patients, the effects of this comparison can be isolated to that of environmental contamination.

Although interventions focusing on improved thoroughness and adherence and manual cleaning protocols has decreased this environmental burden,[15,16] there remains difficulty in sustaining improved cleaning compliance. Carling et al[17] demonstrated that only 47% of intended surfaces are actually contacted by a disinfectant on a routine cleaning basis. Additionally, confusion in cleaning roles between nursing and environmental surfaces can lead to inadequate disinfection of mobile medical devices used in multiple patient rooms.[18]

Pulsed xenon ultraviolet (PX-UV) disinfection is a non–user-dependent technology that can be an additional adjunct to cleaning regimens. Full-spectrum ultraviolet light has been found to improve environmental cleanliness to a significant degree, even eliminating MDROs, such as VRE, completely from selected high-touch surfaces.[19] Most importantly, hospitals that use PX-UV have actually significantly mitigated infection risks associated with environmentally mediated transmission routes, decreasing hospital-acquired *C difficile* and MRSA rates by 53% and 56%, respectively, facility-wide.[20,21]

Although PX-UV can be of particular relevance within the ICU, where patients have higher acuity and an increased utilization of indwelling medical devices, these studies also suggest that this technology could be extended to acute care, non-ICU inpatient settings where evidence based-literature is currently lacking.[22] In this article we describe the feasibility and impact of implementing a no-touch PX-UV disinfection system within the ICU and non-ICU setting of an acute care hospital in an attempt to identify significant changes in the rates of hospital-acquired MDROs (particularly *C difficile*).

METHODS

Facility and technology

South Seminole Hospital is a community hospital that is part of Orlando Health, with 126 medical-surgical beds located in Central Florida. The facility also houses an 80-bed psychiatric care unit. For the duration of the study, infection data were collected and calculated using the National Healthcare Safety Network criteria.

Beginning in November 2012, a PX-UV disinfection system was implemented as an adjunct to traditional cleaning methods on discharge of select rooms. The technology uses a xenon flashlamp to generate full-spectrum germicidal light that damages the DNA or RNA of pathogenic organisms. The full-spectrum, high-intensity characteristics of PX-UV light emission allow for rapid disinfection of patient care areas.[19]

ICU implementation

In the ICU, the goal was for all room discharges and transfers to be treated with no-touch disinfection after standard cleaning and prior to the next patient occupying the room. This methodology was selected because there is evidence showing that rooms can become contaminated with pathogenic organisms regardless of the infection or colonization status of the previous patient[23]; therefore, implementation of a no-touch disinfection program should not be limited to disinfection of rooms that previously housed only isolation patients. The impact of colonized or infected patients will extend beyond the room used for direct care because pathogenic organisms will be transmitted to other rooms by contaminated mobile medical equipment and on the hands of health care workers.[24]

Non-ICU implementation

For all non-ICU discharges and transfers, the no-touch disinfection system was only used for *C difficile* discharges. This methodology was selected because transmission of *C difficile* was the most prevalent hospital-associated infection, and it was not feasible to disinfect all discharges throughout the facility because of limitations on device availability and proximity of location.

Pulsed xenon disinfection

PX-UV disinfection systems are used after the room has undergone standard terminal cleaning practices including the use of bleach for *C difficile* isolation rooms. To maximize the distribution of light throughout a room, multiple positions are used when performing no-touch disinfection. Based on previous studies, the following protocol was used: in a standard patient room with an integrated private bathroom, the device is run for 1 cycle in the bathroom and 1 cycle on both sides of the bed, for a total of 3 cycles, each lasting 5 minutes. If the room does not have a separate bathroom, only 2 cycles are required.[19] An onboard data log allows the hospital service team to track which specific room is being disinfected at specific times and notifies the user when a disinfection cycle has been successfully completed.

Statistical analysis

Infection rates (incidence divided by patient days) for the PX-UV intervention were compared with infection rates before implementation. Because the data were not normally distributed, a 2-sample Wilcoxon rank-sum test indicated the significance of changes occurring (Stata Corp, College Station, TX).

RESULTS

PX-UV disinfection was implemented in >200 patient rooms per month from November 2012-August 2014 (>4,400 rooms total) and compared with January 2011-October 2012 (Table 1–3).

A significant 29% facility-wide decrease in all 3 MDROs (*C difficile*, MRSA, and VRE) was determined ($P = .01$), statistically driven by a 41% decrease in *C difficile* infection ($P = .01$). Although only moderately significant, the greatest decrease in facility-wide incident rates was seen with VRE, shifting from 34 to 15 infections within the PX-UV disinfection period ($P = .070$).