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Major Article

Effect of pulsed xenon ultraviolet room disinfection devices on microbial counts for methicillin-resistant *Staphylococcus aureus* and aerobic bacterial colonies

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Background: Inadequate environmental disinfection represents a serious risk for health care–associated infections. Technologic advancements in disinfection practices, including no-touch devices, offer significant promise to improve infection control. We evaluated one such device, portable pulsed xenon ultraviolet (PX-UV) units, on microbial burden during an implementation trial across 4 Veterans Affairs hospitals.

Methods: Environmental samples were collected before and after terminal room cleaning: 2 facilities incorporated PX-UV disinfection into their cleaning protocols and 2 practiced manual disinfection only. Specimens from 5 high-touch surfaces were collected from rooms harboring methicillin-resistant *Staphylococcus aureus* (MRSA) or aerobic bacteria colonies (ABC). Unadjusted pre-post count reductions and negative binomial regression modeled PX-UV versus manual cleaning alone.

Results: Seventy samples were collected. Overall, PX-UV reduced MRSA and ABC counts by 75.3% and 84.1%, respectively, versus only 25%-30% at control sites. Adjusting for baseline counts, manually cleaned rooms had significantly higher residual levels than PX-UV sites. Combined analyses revealed an incident rate ratio of 5.32 ($P = .0024$), with bedrails, tray tables, and toilet handrails also showing statistically superior PX-UV disinfection.

Conclusions: This multicenter study demonstrates significantly reduced disinfection across several common pathogens in facilities using PX-UV devices. Clinical impact of laboratory reductions on infection rates was not assessed, representing a critical future research question. However, such approaches to routine cleaning suggest a practical strategy when integrated into daily hospital operations.

BACKGROUND

Methicillin-resistant *Staphylococcus aureus* (MRSA) and *Clostridium difficile* are important pathogens that cause health care–acquired infection (HAI). These organisms can survive on high-touch surfaces in a hospital room for extended periods of time and contribute to occurrence of HAI.[1,2] The environment is now a very well-appreciated reservoir for these organisms, which are a significant cause of mortality and morbidity, resulting in $9.7 billion in additional health

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care costs annually in the United States.[3] An estimated 20%-40% of all HAIs result from cross-contamination via health care personnel either by direct patient contact or by touching contaminated environmental surfaces.[4] Patients admitted to a room previously occupied by a MRSA-positive patient also have significantly higher risk of acquiring that infection.[5] Additionally, new carriers have a higher risk of developing MRSA infections in the year after acquisition.[6] High-touch surfaces, such as patient bed rails or tray tables, present the biggest risk of HAI acquisition for patients; however, appropriately decontaminating these surfaces could possibly prevent future infections.[7] Manual cleaning with Environmental Protection Agency–approved disinfectants is the current standard of disinfection procedure; however, such disinfection effort requires supervision, frequent reinforcement, education, and performance feedback using a variety of techniques to ensure environmental management service (EMS) staff maintain effective cleaning results.[8]

No-touch surface decontamination technologies that use ultraviolet light may be effective at reducing microbial burden in the laboratory and controlled environments, with increasing inpatient efforts now being on such infection control strategies to decrease bioburden levels and potentially achieve lower HAI rates.[9,10] Although effective to varying degrees, many of the devices require additional time to complete disinfection, with estimates ranging from 15 minutes-1 hour per room, potentially restricting widespread routine hospital usage. Furthermore, there are numerous makers of no-touch devices with limited scientific evidence that may confuse users and impact adaptation within hospitals. Additionally, generalizability has been reduced by data limited to single hospital settings or in comparison with standard disinfection processes across many facilities. As such, previously published data on pulsed xenon ultraviolet (PX-UV) technology have lacked multicenter comparison and real-world effectiveness. Here we present our study that compares the adoption of PX-UV technology into standard terminal room cleaning protocols in 2 facilities with manual cleaning for reduction of bacteria frequently associated with HAI.

METHODS

PX-UV devices

The portable pulsed xenon ultraviolet light device is this study (Xenex Healthcare Disinfection Services, San Antonio, TX) measures approximately 76.2 × 50.8 × 96.6 cm, features a user-friendly touch screen interface, features an integrated cooling system, and features a reflector system to focus ultraviolet light on high-touch surfaces.[11] There are numerous safety features, including special glass to reduce visual light intensity and ultrasonic sensors to terminate pulsing, if movement is detected in the room. Briefly, PX-UV light is absorbed by and fuses with the microorganism DNA, resulting in its deactivation.

The devices are operated by EMS staff, who receive comprehensive training and monitoring, and are used in empty patient rooms during terminal discharge cleaning before the next patient is admitted; in shared rooms, the other patient is briefly relocated to avoid accidental ultraviolet exposure. First, EMS manually cleaned the bathroom using Environmental Protection Agency–approved disinfectant (eg, bleach, quaternary ammonium compounds) per local hospital protocol, and then placed the device in the bathroom to complete a 5-minute PX-UV cycle at roughly 450 flashes a cycle. Meanwhile, EMS staff manually cleaned the hospital main room with particular attention to visibly soiled areas. The device was then moved to the central room area for a second 5-minute cycle, after which the EMS staff member reentered the room to flip available surfaces, such as the phone and remote control, and the device was repositioned for a final 5-minute cycle. Device positioning within the room was based on suggested protocols by the manufacturer and the specific room design but generally involved device placement on either side of the bed (see Fig 1, with three cleaning cycle positions noted). We used this approach during our smaller single-site pilot study.[10] Therefore, total disinfection time is roughly 15 minutes per room.

This implementation study was conducted from February 2013-March 2015 at 4 Veterans Affairs facilities as one primary objective in a comprehensive study examining the overall effectiveness of PX-UV devices for reducing colony counts of important microbial pathogens. Two hospitals (Temple, TX Veterans Health Care System [CTX] and San Antonio, TX Veterans Health Care System [STX]) added the PX-UV devices to standard manual room cleaning on terminal cleaning and represented the intervention sites, whereas 2 other facilities served as control sites with standard manual cleaning only (Portland, OR and Birmingham, AL). All 4 facilities collected microbial samples from several high-touch surfaces of patient rooms as subsequently described, with the samples sent to an independent Veterans Affairs laboratory (Cleveland, OH). Per standard hospital protocols, all rooms were terminally disinfected after every patient discharge or transfer, with site researchers collecting microbial swabs of infectious agents before and after cleaning during the 2-year study

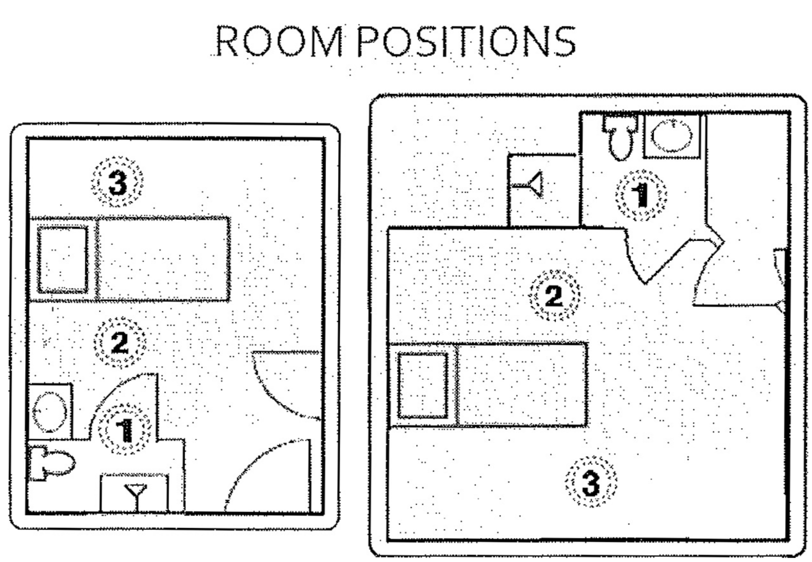

Fig 1. Schematic of 2 patient rooms showing positioning of portable pulsed xenon ultraviolet unit.