ICT INFECTION CONTROL TODAY

October 2015 US $39.00

SPECIAL REPORT

Pulsed Xenon Technology: Summary of Studies

At the core of pulsed xenon technology is high-intensity ultraviolet light produced by xenon flash lamps across the entire disinfecting spectrum known as UV-C. This UV-C energy passes through the cell walls of bacteria, viruses and bacterial spores. The DNA, RNA and proteins inside the microorganism absorb this intense UV-C energy, thus destroying pathogens on a submicroscopic DNA level. Pulsed xenon technology has been shown to work in a lab setting, but it is also supplementing manual cleaning and making a difference in the healthcare environment. We take a look at various studies that have examined pulsed xenon technology.

informa exhibitions

Pulsed Xenon Technology: Summary of Studies

At the core of pulsed xenon technology is high-intensity ultraviolet light produced by xenon flash lamps across the entire disinfecting spectrum known as UV-C. This UV-C energy passes through the cell walls of bacteria, viruses and bacterial spores. The DNA, RNA and proteins inside the microorganism absorb this intense UV-C energy, thus destroying pathogens on a submicroscopic DNA level in several ways; these four mechanisms of destruction are:

- Photodimerization: DNA bond damage
- Photosplitting: DNA strand broken
- Photohydration: Inhibits DNA functions
- Photocrosslinking: Cell wall damage and lysis

Disinfecting across the entire spectrum helps prevent pathogens from repairing themselves.

Pulsed xenon technology has been shown to work in a lab setting, but it is also supplementing manual cleaning and making a difference in the healthcare environment. Let's take a look at various studies that have examined pulsed xenon technology.

Jinadatha, et al. (2015) say that the doffing of personal protective equipment (PPE) after contamination with pathogens such as Ebola poses a risk to healthcare workers. Pulsed xenon ultraviolet (PX-UV) disinfection has been used to disinfect surfaces in hospital settings. This study examined the impact of PX-UV disinfection on an Ebola surrogate virus on glass carriers and PPE material to examine the potential benefits of using PX-UV to decontaminate PPE while worn, thereby reducing the pathogen load prior to doffing. Ultraviolet (UV) safety and coverage tests were also conducted. PX-UV exposure resulted in a significant reduction in viral load on glass carriers and PPE materials. Occupational Safety and Health Administration-defined UV exposure limits were

> THE RESEARCHERS SAY THAT PX-UV DISINFECTION SHOULD NOT BE CONSIDERED STERILIZATION

not exceeded during PPE disinfection. Pre-doffing disinfection with PX-UV has potential as an additive measure to the doffing practice guidelines. The researchers say that PX-UV disinfection should not be considered sterilization; all PPE should still be considered contaminated and doffed and disposed of according to established protocols.

■ ■ ■

Whereas pulsed xenon-based ultraviolet light no-touch disinfection systems are being increasingly used for room disinfection after patient discharge with manual cleaning, their effectiveness in the absence of manual disinfection has not been previously evaluated. Jinadatha, et al. (2015) sampled 38 hospital rooms for aerobic bacteria on surfaces and utilized pulsed xenon UV light (PX-UV) as a disinfectant tool without any manual cleaning. The researchers collected aerobic bacteria samples before and after PX-UV disinfection and found a significant decrease in aerobic bacteria counts after PX-UV usage. The researchers say their study indicates that pulsed xenon-based ultraviolet light systems effectively reduce aerobic bacteria in the absence of manual disinfection. These data are important for hospitals planning to adopt this technology as adjunct to routine manual disinfection.

THE RESEARCHERS SAY THEIR STUDY INDICATES THAT PULSED XENON-BASED ULTRAVIOLET LIGHT SYSTEMS EFFECTIVELY REDUCE AEROBIC BACTERIA IN THE ABSENCE OF MANUAL DISINFECTION.

■ ■ ■

The standard for Clostridium difficile surface decontamination is bleach solution at a concentration of 10 percent of sodium hypochlorite. Pulsed xenon UV light (PX-UV) is a means of quickly producing germicidal UV that has been shown to be effective in reducing environmental contamination by C. difficile spores. The purpose of this study by Ghantoji, et al. (2015) was to investigate whether PX-UV was equivalent to bleach for decontamination of surfaces in C. difficile infection isolation rooms. High-touch surfaces in rooms previously occupied by C. difficile infected patients were sampled after discharge but before and after cleaning using either bleach or non-bleach cleaning followed by 15 min of PX-UV treatment. A total of 298 samples were collected by using a moistened wipe specifically designed for the removal of spores. Prior to disinfection, the mean contamination level was 2.39 c.f.u. for bleach rooms and 22.97 for UV rooms. After disinfection, the mean level of contamination for bleach was 0.71 cfu (P=0.1380), and 1.19 c.f.u. (P=0.0017) for PX-UV disinfected rooms. The difference in final contamination levels between the two cleaning protocols was not significantly different (P=0.9838). PX-UV disinfection appears to be at least equivalent to bleach in the ability to decrease environmental contamination with C. difficile spores. The researchers say that larger studies are needed to validate this conclusion.

PULSED XENON UV LIGHT (PX-UV) IS A MEANS OF QUICKLY PRODUCING GERMICIDAL UV THAT HAS BEEN SHOWN TO BE EFFECTIVE IN REDUCING ENVIRONMENTAL CONTAMINATION BY C. DIFFICILE SPORES.

Nerandzic, et al. (2015) sought to determine the effectiveness of a pulsed xenon ultraviolet (PX-UV) disinfection device for reduction in recovery of healthcare-associated pathogens in two acute-care hospitals. The researchers examined the effectiveness of PX-UV for killing of Clostridium difficile spores, methicillin-resistant Staphylococcus aureus (MRSA), and vancomycin-resistant Enterococcus (VRE) on glass carriers and evaluated the impact of pathogen concentration, distance from the device, organic load, and shading from the direct field of radiation on killing efficacy. The researchers compared the effectiveness of PX-UV and ultraviolet-C (UV-C) irradiation, each delivered for 10 minutes at 4 feet. In hospital rooms, the frequency of native pathogen contamination on high-touch surfaces was assessed before and after 10 minutes of PX-UV irradiation. On carriers, irradiation delivered for 10 minutes at 4 feet from the PX-UV device reduced recovery of C. difficile spores, MRSA, and VRE by 0.55±0.34, 1.85±0.49, and 0.6±0.25 log10 colony-forming units (CFU)/cm2, respectively. Increasing distance from the PX-UV device dramatically reduced killing efficacy, whereas pathogen concentration, organic load, and shading did not. Continuous UV-C achieved significantly greater log10CFU reductions than PX-UV irradiation on glass carriers. On frequently touched surfaces, PX-UV significantly reduced the frequency of positive C. difficile, VRE, and MRSA culture results. The researchers say that the PX-UV device reduced recovery of MRSA, C. difficile and VRE on glass carriers and on frequently touched surfaces in hospital rooms with a 10-minute UV exposure time. PX-UV was not more effective than continuous UV-C in reducing pathogen recovery on glass slides, suggesting that both forms of UV have some effectiveness at relatively short exposure times.

THE RESEARCHERS SAY THAT THE PX-UV DEVICE REDUCED RECOVERY OF MRSA, C. DIFFICILE, AND VRE ON GLASS CARRIERS AND ON FREQUENTLY TOUCHED SURFACES IN HOSPITAL ROOMS WITH A 10-MINUTE UV EXPOSURE TIME.

Nagaraja, et al. (2015) sought to evaluate CDI cases in greater detail to understand the effect of UV disinfection (UVD) after previously reporting a significant decrease in hospital-acquired (HA) Clostridium difficile infection (CDI) coincident with the introduction of pulsed xenon ultraviolet light for room disinfection (UVD). Compared with pre-UVD, during UVD, HA-CDI was 22 percent less ($P = .06$). There was a 70 percent decrease for the adult intensive care units (ICUs) ($P < .001$), where the percentage of room discharges with UVD was greater ($P < .001$). During UVD, CA-CDI increased by 18 percent, and length of stay of all CDI cases was lower because of the greater proportion of CA-CDI. No significant difference was found in days to HA-CDI in rooms with a prior CDI occupant. The researchers conclude that these data suggest that UVD contributed to a reduction in ICU-acquired CDI where UVD was used for a larger proportion of discharges; they add that evaluation of UVD should include data for hospitalized CA-CDI cases because these cases may impact the HA-CDI rate.

THE RESEARCHERS CONCLUDE THAT THESE DATA SUGGEST THAT UVD CONTRIBUTED TO A REDUCTION IN ICU-ACQUIRED CDI WHERE UVD WAS USED FOR A LARGER PROPORTION OF DISCHARGES.

Haas, et al. (2014) conducted a retrospective study of the implementation of ultraviolet environmental disinfection (UVD) following discharge cleaning of contact precautions rooms and other high-risk areas at Westchester Medical Center, a 643-bed tertiary care academic medical center. Incidence rates of hospital-acquired MDROs plus CD before and during the UVD use were evaluated using rate ratios and piecewise regression. The average time per UVD was 51 minutes, and machines were in use 30 percent of available time. UVD was used 11,389 times; 3,833 (34 percent) of uses were for contact precautions discharges. UVD was completed for 76 percent of contact precautions discharges. There was a 20 percent decrease in hospital-acquired MDRO plus CD rates during the 22-month UVD period compared with the 30-month pre-UVD period (2.14 cases/1,000 patient-days vs 2.67 cases per 1,000 patient-days, respectively; rate ratio, 0.80; 95% confidence interval: 0.73-0.88, $P < .001$). The researchers concluded that during the time period UVD was in use, there was a significant decrease in overall hospital-acquired MDRO plus CD in spite of missing 24 percent of opportunities to disinfect contact-precautions rooms.

THE RESEARCHERS CONCLUDED THAT DURING THE TIME PERIOD UVD WAS IN USE, THERE WAS A SIGNIFICANT DECREASE IN OVERALL HOSPITAL-ACQUIRED MDRO PLUS CD IN SPITE OF MISSING 24 PERCENT OF OPPORTUNITIES TO DISINFECT CONTACT PRECAUTIONS ROOMS.

Simmons, et al. (2013) say that standard approaches to methicillin-resistant Staphylococcus aureus (MRSA) prevention have included hand hygiene and active surveillance. These approaches have shown mixed results. The addition of pulsed xenon ultraviolet (PX-UV) room disinfection for MRSA prevention is a novel approach. This new MRSA prevention method was implemented at an acute-care hospital system in Greensboro, N.C. A MRSA screening program was implemented over a six-month period from July 2011 to January 2012 to include all high-risk patients and the majority of surgical patients. A two-week hand hygiene education initiative was implemented in February 2011. The use of PX-UV for terminal cleaning of MRSA patient rooms was also implemented in February 2011. The rates of hospital associated MRSA (HA-MRSA) infections were monitored before and after implementation of all prevention efforts. The HA-MRSA rate decreased at the largest facility in the system by 57 percent, and for the entire healthcare system by 56 percent ($p=0.001$). The two smaller hospitals saw reductions of 51 percent and 66 percent, but the results were not statistically significant ($p=0.1047$ and $p=0.2263$). The researchers state that implementing a PX-UV device in conjunction with active screening and hand hygiene was associated with a decrease in HA-MRSA rates, and that studies on the individual effect of PX-UV on HA-MRSA rates are warranted.

THE RESEARCHER STATE THAT IMPLEMENTING A PX-UV DEVICE IN CONJUNCTION WITH ACTIVE SCREENING AND HAND HYGIENE WAS ASSOCIATED WITH A DECREASE IN HA-MRSA RATES, AND THAT STUDIES ON THE INDIVIDUAL EFFECT OF PX-UV ON HA-MRSA RATES ARE WARRANTED.

Levin, et al. (2013) say there is evidence that contamination of patient rooms from previous occupants is associated with hospital-associated Clostridium difficile infection (HA-CDI). During January 2011, the use of two portable pulsed xenon ultraviolet light devices (PPX-UV) to disinfect patient rooms was added to routine hospital discharge cleaning in a community hospital. In 2010, the HA-CDI rate was 9.46 per 10,000 patient-days; in 2011, the HA-CDI rates was 4.45 per 10,000 patient-days (53 percent reduction, P = .01). The number of deaths and colectomies attributable to hospital-associated C difficile infection also declined dramatically.

THE NUMBER OF DEATHS AND COLECTOMIES ATTRIBUTABLE TO HOSPITAL-ASSOCIATED C DIFFICILE INFECTION ALSO DECLINED DRAMATICALLY.

Bruno-Murtha, et al. say there is evidence that environmental contamination and insufficient surface disinfection contribute to the transmission of pathogens associated with healthcare-acquired infections (HAIs). Germicidal irradiation produced by the pulsed xenon ultraviolet (PX-UV) portable device produces energy in the 200-320 nm range which is cidal for microorganisms. The researchers evaluated the effects of (PX-UVD) by comparing bacterial contamination on surfaces and in the air of operating rooms (ORs) after standard cleaning (SC) and a quick clean (QC), defined as cleaning the bed and visible soiled areas, followed by PX-UVD. Twelve surfaces in two ORs, including the anesthesia keyboard, anesthesia cart, anesthesia controls, intravenous infusion pole, overhead lamp, bed control, Bair hugger control, floor, nurse's mouse, cautery power control, inside door surface and Mayo stand, were sampled before and after between-case SC. Contact agar plates (Remel) were used and colony counts determined after incubation at 35°C for 48 h. 60 before and 60 after SC cultures were obtained followed by 72 cultures after a QC and PX-UVD. Four 5-minute PX-UV treatment cycles were performed at standardized locations in the OR, based upon mapping conducted by Xenex personnel utilizing a UV-C radiometer to determine the optimal treatment time. Two devices were utilized simultaneously to reduce total room treatment time to 10 minutes. Airborne contamination was measured by placing 5-9cm blood agar (TSA II) settle plates near the operative field for eight hours during cases and for eight hours following the terminal clean on two separate days. Air sampling was repeated after a QC plus PX-UVD between cases and following the terminal clean plus PX-UVD. Negative binomial regression, sign-rank test and two sample Wilcoxon-Mann-Whitney analyses were performed using Stata. In comparing the two ORs, there was no significant difference in the frequency of positive pre-cleaning cultures (62.5% vs. 58.3%, p=0.37). However, there was a significant difference in positive cultures following routine cleaning (29.2% vs. 47.2, p=0.045). After QC and PX-UV, the frequency of positive cultures was similar (19.4% vs. 16.7%, p=0.745). The researchers concluded that SC did not significantly decrease surface contamination or bioburden in our OR. However, a QC and PX-UVD resulted in a significant

THE RESEARCHERS SAY THAT THE IMPACT OF PX-UVD MAY EVEN BE GREATER IN A BUSY OR SINCE THEY OBSERVED A SIGNIFICANT DECREASE IN BIOBURDEN AFTER QC AND PX-UVD AS COMPARED TO SC AFTER THE THIRD CASE.

reduction (55 percent) in positive surface cultures and bioburden (81 percent) compared to SC. PX-UVD also significantly decreased air contamination during cases (46 percent) and after the terminal clean (100 percent). The researchers say that the impact of PX-UVD may even be greater in a busy OR since they observed a significant decrease in bioburden after QC and PX-UVD as compared to SC after the third case. The researchers add that this finding warrants further investigation and that they plan to identify whether the cultured organisms are typical pathogens associated with infections.

■ ■ ■

Wiltshire, et al. say that the role of the environment in infection transmission in long-term care facilities may be greater than in acute care settings. Patient-to patient contact and extended length of stay add increased colonization pressure of common hospital associated pathogens, such as Clostridium difficile (C. difficile). Because patient rooms can be inhabited for weeks to months at a time, thorough disinfection remains a challenge for environmental services. With the goal of preventing hospital-acquired (HA) C. difficile infection and recurrence, a skilled nursing facility implemented pulsed xenon ultraviolet disinfection (PX-UV) in order to enhance environmental disinfection practices. Incident and recurrent C. difficile infection was defined using NHSN definitions. Three prevention programs were implemented: staff retraining on hand hygiene practices was conducted in June/July of 2014, followed by the implementation of sodium hypochlorite cleaning in August. No immediate change in infection rates were identified with these two interventions, so ultraviolet disinfection using a pulsed-xenon disinfection robot was added at the start of September 2014. PX-UV was performed in all isolation rooms on a daily basis, as well as in common areas. Bleach cleaning continued in isolation rooms daily, and at patient discharge. In the eight-month period prior to PX-UV implementation, the number of HA-C. difficile cases was 30, with 22 of these being recurrences. Following the implementation of PX-UV, the number of HA-C. difficile cases was eight, with five being recurrences. This represents a statistically significant reduction of 76.8 percent (p=0.03). The researchers showed that only four HA-C. difficile infections (two recurrent) occurred within the final seven intervention months. The researchers say the success of this intervention could be a result of high environmental disinfection compliance, driven by the ease of integration of the PX-UV system and hypochlorite wipes by patients and staff into daily hospital operations within the long term care setting.

BECAUSE PATIENT ROOMS CAN BE INHABITED FOR WEEKS TO MONTHS AT A TIME, THOROUGH DISINFECTION REMAINS A CHALLENGE FOR ENVIRONMENTAL SERVICES.

■ ■ ■

Vianna, et al. report the impact of a pulsed-xenon ultraviolet (PX-UV) no-touch disinfection system as an adjunct to traditional cleaning methods on infection rates of multidrug-resistant organisms in the ICU and non-ICU areas of a tertiary-care facility. From November 2012 until August 2014, a PX-UV device was utilized in ICU and non-ICU areas at South Seminole Hospital. In the ICU, all discharge rooms were disinfected with PX-UV, while non-ICU areas

were only disinfected with PX-UV after being vacated by a patient infected with Clostridium difficile. In non-ICU areas, a significant reduction was found for C. difficile, as well as a non-significant decrease in VRE. In the ICU, all infections were reduced, but only VRE was significant. Overall, there were 39 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. This study demonstrated a 29 percent facility-wide decrease in MDROs; a 41 percent facility-wide decrease in C. difficile (30 fewer infections); a 50 percent facility-wide decrease in VRE (15 fewer infections); a 61 percent decrease in ICU MDROs (16 fewer infections) and an 87 percent decrease in ICU VRE (six fewer infections).

OVERALL, THERE WERE 39 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.

References:

Bruno-Murtha L, Fridman A, Osgood R, Mcallister J and Atwell K. Poster: Decreasing Operating Room Contamination of Surfaces and Air with Pulsed Xenon Ultraviolet Disinfection (PX-UVD).

Ghantoji SS, Stibich M, Stachowiak J, Cantu S, Adachi JA, Raad II and Chemaly R. Non-inferiority of pulsed xenon ultraviolet light versus bleach versus for reducing environmental Clostridium difficile contamination on high-touch surfaces in Clostridium difficile isolation rooms. J Med Microbiol. Jan 13, 2015, Epub ahead of print.

Haas J, Menz J, Dusza S, Montecalvo MA. Implementation and impact of ultraviolet environmental disinfection in an acute care setting. American Journal of Infection Control 2014, 42:586-90.

Jinadatha C, Simmons S, Dale C, Ganachari-Mallappa N, Villamaria FC, Goulding N, Tanner B, Stachowiak J and Stibich M. Disinfecting personal protective equipment with pulsed xenon ultraviolet as a risk mitigation strategy for health care workers. Am J Infect Control. Volume 43, Issue 4, Pages 412-414. April 1, 2015.

Jinadatha C, Villamaria FC, Ganachari-Mallappa N, Brown DS, Liao IC, Stock EM, Copeland LA, Zeber JE. Can pulsed xenon ultraviolet light systems disinfect aerobic bacteria in the absence of manual disinfection? Am J Infect Control. Volume 43, Issue 4, Pages 415–417. April 1, 2015.

Levin J, Riley LS, Parrish C, English D, Ahn S. The effect of portable pulsed xenon ultraviolet light after terminal cleaning on hospital-associated Clostridium difficile infection in a community hospital. American Journal Infection Control 2013, 41:746-748.

Nagaraja A, Visintainer P, Haas JP, Menz J, Wormser GP, Montecalvo MA. Clostridium difficile infections before and during use of ultraviolet disinfection. Am J Infect Control. 2015 Jul 6. pii: S0196-6553(15)00514-3.

Nerandzic MM, Thota P, Sankar CT, Jencson A, Cadnum JL, Ray AJ, Salata RA, Watkins RR and Donskey CJ. Evaluation of a pulsed xenon ultraviolet disinfection system for reduction of healthcare-associated pathogens in hospital rooms. Infection Control & Hospital Epidemiology, 2015,36:192-197.

Simmons S, Morgan M, Hopkins T, Helsabeck K, Stachowiak J, Stibich M. Impact of a multi-hospital intervention utilising screening, hand hygiene education and pulsed pxenon ultraviolet (PX-UV) on the rate of hospital associated methicillin-resistant Staphylococcus aureus infection. Journal of Infection Prevention 2013, 14:172-174.

Vianna PG, Dale CR Jr., Simmons S, Stibich M and Licitra CM. Poster: The Impact of Pulsed-Xenon Ultraviolet Light on Hospital Acquired Infection Rates in a Tertiary Care Community Hospital.

Wiltshire M, Simmons S, Dale C, Stibich M, Stachowiak J, MIA. Poster: The Effect of Pulsed Xenon Ultraviolet Disinfection and Enhanced Chemical Disinfection of Surfaces on Incidence and Recurrence of Clostridium difficile Cases within a Skilled Nursing Facility