American Journal of Infection Control 43 (2015) 415-7

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Brief report

Can pulsed xenon ultraviolet light systems disinfect aerobic bacteria in the absence of manual disinfection?

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Key Words:
No-touch disinfection
Enhanced manual cleaning
Aerobic bacteria colony count
Hospital acquired infections

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. Our 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.

Aerobic bacterial colony (ABC) counts on hospital high-touch surfaces indicate the level of microbiologic contamination.[1] ABC counts have been used in studies to assess the effectiveness of mercury-based ultraviolet (Hg-UV) and pulsed xenon-based ultraviolet (PX-UV) no-touch disinfection devices (NTD).[2-4] Although a room could be disinfected manually without using NTD, the reverse is not accepted practice.[2,5] But there may be occasions where surfaces are not thoroughly disinfected due to human error or significant contamination.[6] There is evidence to suggest the effectiveness of Hg-UV disinfection on ABC counts in the absence of any manual cleaning, but, such data is lacking for PX-UV disinfection devices.[2,4] Hence, we devised a study to evaluate the effectiveness of PX-UV disinfection on ABC counts in the absence of any manual disinfection.

MATERIALS AND METHODS

To determine if the PX-UV disinfection system can effectively reduce ABC without prior manual disinfection, a prospective pre–post study design was developed. The study site was a single Veterans Affairs facility located in Temple, Texas. A convenience sample of 38 recently vacated rooms ($n = 38$) that had not yet undergone any manual disinfection and had been occupied for a minimum of 48 hours were identified and before and after PX-UV surface samples were collected. The description of the device and the methodology used for disinfection was similar to those described in Jinadatha et al[5] except there was no manual disinfection before PX-UV use. Five high-touch surfaces within each room were sampled before and after PX-UV disinfection. The surfaces included 3 in the patient room (ie, call button, bedrail, and tray table) and 2 in the bathroom (ie, handrail and toilet). Therefore, a total of 190 samples before and after PX-UV disinfection were obtained across 38 rooms.

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This work was supported by a Merit Review grant from the Department of Veterans Affairs to JZ (IIR 12-347). The study's laboratory activity was supported by a grant from Xenex Healthcare Services, LLC. Further, this work was supported by the Central Texas Veterans Health Care System (Temple, Tex), with additional support from Scott & White Healthcare (Temple, Tex) and the Center for Applied Health Research (Temple, Tex). The views expressed in this article are those of the author(s) and do not necessarily represent the views of the Department of Veterans Affairs. Xenex Healthcare Services did not participate in study design; in the collection, analysis, and interpretation of data; or in the writing of the report or in the decision to submit the work for publication. The device used in this study is owned by Central Texas Veterans Health Care System. All authors made a significant contribution to the project. CJ and NGM developed the methodology, protocol, performed data collection, and manuscript preparation. DB helped with data collection and manuscript preparation. FV, IL, JZ, LC, and ES participated in statistical analysis and contributed to the manuscript. All authors read and approved the final manuscript. Part of this work was presented as a poster at the APIC 2014 41st Annual Educational Conference, Anaheim, Calif, June 7-9, 2014.
Conflicts of interest: None to report.

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http://dx.doi.org/10.1016/j.ajic.2014.12.012

Table 1
Mean aerobic bacterial colony (ABC) counts from high-touch surfaces before and after application of pulsed xenon-based ultraviolet light (PX-UV) disinfection systems in the absence of manual cleaning

Location	No. of samples	ABC before PX-UV	ABC after PX-UV	ABC reduction	*P* value*
Call button	38	88.5 ± 68.7 76 (5, 200) (21-122)	16.1 ± 33.0 4 (0, 161) (1-12)	72.4 ± 64.8 66 (−52, 199) (19-108)	<.01
Bedrail	38	84.0 ± 70.3 42 (7, 200) (32-125)	13.0 ± 17.2 5.5 (0, 70) (2-18)	71.0 ± 66.6 35 (−6, 200) (20-112)	<.01
Tray table	38	54.5 ± 62.9 23 (1, 200) (12-67)	13.3 ± 17.0 7.5 (0, 79) (1-22)	41.2 ± 61.8 15.5 (−24, 200) (8-45)	<.01
Bathroom handrail	38	60.7 ± 56.3 35 (0, 200) (16-95)	16.1 ± 32.9 6.5 (0, 200) (3-16)	44.6 ± 62.1 30.5 (−171, 194) (9-79)	<.01
Toilet seat	38	80.2 ± 81.0 46 (0, 200) (11-200)	40.6 ± 59.3 13 (0, 200) (2-45)	39.6 ± 69.7 14 (−70, 199) (1-61)	<.01
Overall	190	73.6 ± 69.0 47 (0, 200) (19-113)	19.8 ± 36.6 6 (0, 200) (2-20)	53.8 ± 66.1 28.5 (−171, 200) (10-90)	<.01

NOTE. Values are presented as mean ± SD (top values) and median (minimum, maximum; interquartile range) (bottom values).
*Wilcoxon signed-rank tests were employed, assuming a significance level of $\alpha = 0.05$.

Tryptic soy agar supplemented with lecithin and polysorbate 80 Rodac contact plates (Hardy Diagnostics, Santa Maria, Calif) were used for sampling of surfaces. If gross visible soiling was observed, such as food particles or spilt condiments, the area adjacent was sampled by press plate technique. Roll plate method was used for nonflat surfaces such as bedrails and handrails. Once the baseline samples were taken the PX-UV was used to disinfect the room and then post-PX-UV samples were collected in areas adjacent to the samples taken before disinfection.

The plates were then incubated for 48 hours at 37°C. After incubation the colonies were counted and recorded. The mean and the median aerobic bacteria CFU/25 cm^2 and 95% confidence intervals (CIs) were calculated for each surface type. An upper limit of 200 CFU was used for ABC counts exceeding this value. The effectiveness of PX-UV on the concentration of aerobic bacteria was assessed employing a Wilcoxon signed-rank test for all 190 pre−post samples in 38 rooms, as well as by surface location. A type 1 error of $\alpha = 0.05$ was assumed. Data were analyzed using SAS version 9.2 (SAS Institute Inc, Cary, NC).

RESULTS

The overall mean ABC count across all 190 samples before PX-UV disinfection was 73.6 (95% CI, 63.8-83.4) (Table 1). The surface with greatest ABC count was the call button, with a mean of 88.5 (95% CI, 66.7-110.3), followed by the bedrail, with a mean 84.0 (95% CI, 61.6-106.4). The tray table had the lowest mean ABC count before PX-UV disinfection, with 54.5 (95% CI, 34.5-74.5). After disinfection, the call button had the greatest mean ABC count reduction of 72.4 (median reduction of 66.0; $P < .01$). All high-touch surfaces experienced a significant reduction in ABC count. Overall, before PX-UV disinfection, 187 (98.4%) of the surfaces were contaminated with aerobic bacteria; this was reduced to 169 (88.9%) surfaces after disinfection, leading to 18 (9.6%) contaminated surfaces now becoming free of aerobic bacteria after PX-UV disinfection. Levels of ABC were reduced from 74 ± 10 to no more than 20 ± 3 colonies overall, with the highest residual counts on bathroom surfaces. When the results from Table 1 were compared with ABC count reduction after standard manual disinfection without use of PX-UV disinfection, the results were similar (data not shown).

DISCUSSION

Surface contamination has been shown to play a significant role in the acquisition of hospital-acquired infections.[7,8] In fact, Huang et al[8] showed a 40% increased odds of transmission for methicillin-resistant *Staphylococcus aureus* and vancomycin-resistant enterococci if the room's previous occupant was positive for either antibiotic-resistant bacteria. The current standard for disinfection in most hospitals is manual cleaning by Environmental Management Services staff with disinfectants.[9] These methods are inconsistent and often inadequate in decreasing environmental bioburden.[5,10] Newer NTD technologies have the potential to supplement manual disinfection to provide enhanced disinfection.[2-5] Anderson et al[2] showed that Hg-UV is effective at decreasing the ABC counts in hospital settings even in the absence of manual disinfection. However, until now research has been lacking for PX-UV disinfection systems. Our study results indicate that PX-UV disinfection reduces aerobic bacteria in the absence of manual disinfection. Our results were similar to the reduction of ABC counts seen in other studies that used a mercury-based no-touch UV disinfection device.[2,4] In our previous study, we evaluated a properly truncated aesthetic cleaning protocol supplemented by PX-UV disinfection in vacated hospital rooms.[5] But we were not able to delineate if PX-UV was effective on surfaces where Environmental Management Services personnel did not apply a chemical disinfectant, which is part of standard cleaning protocol. It is highly unlikely that the UV light devices are going to be used alone without manual precleaning, for aesthetic reasons. Although our study is not intended to advocate abandoning manual disinfection practices altogether, it provides insight into what happens if a surface is missed by Environmental Management Services personnel during manual disinfection when PX-UV is subsequently deployed. Our study had several limitations, including no evaluation of organism-specific reduction. This study was conducted in a Veterans Affairs hospital setting and may not be generalizable to community hospitals. Although the sample size was small, it represents a larger cohort than other previously reported studies.[3,5]

CONCLUSIONS

Our study suggests that PX-UV effectively reduces ABC counts in the absence of manual disinfection. These data are important for hospitals that plan to adapt this technology as adjunct to routine manual disinfection and alleviate any fears that adapting this technology may actually harm patients because Environmental Management Services personnel may miss surfaces.

Acknowledgments

The authors thank Kimberly Sikes, Robin Keene, and Deana Hamson for collecting samples; Elicia Greene and the entire

Infection Prevention and Control Department; Allen Lassiter and the Environmental Management Services team; and the nursing service personnel for their help in coordinating study activities.

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