American Journal of Infection Control xxx (2015) 1-4

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major article

Is the pulsed xenon ultraviolet light no-touch disinfection system effective on methicillin-resistant *Staphylococcus aureus* in the absence of manual cleaning?

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Key Words:
Hospital-acquired infections
Supplemental terminal cleaning
Environmental contamination
High touch surfaces

Background: Methicillin-resistant *Staphylococcus aureus* (MRSA) has been shown to survive on ambient surfaces for extended periods of time. Leftover MRSA environmental contamination in a hospital room places future patients at risk. Manual disinfection supplemented by pulsed xenon ultraviolet (PX-UV) light disinfection has been shown to greatly decrease the MRSA bioburden in hospital rooms. However, the effect of PX-UV in the absence of manual disinfection has not been evaluated.

Methods: Rooms that were previously occupied by a MRSA-positive patient (current colonization or infection) were selected for the study immediately postdischarge. Five high-touch surfaces were sampled, before and after PX-UV disinfection, in each hospital room. The effectiveness of the PX-UV device on the concentration of MRSA was assessed employing a Wilcoxon signed-rank test for all 70 samples with MRSA in 14 rooms, as well as by surface location.

Results: The final analysis included 14 rooms. Before PX-UV disinfection there were a total of 393 MRSA colonies isolated from the 5 high-touch surfaces. There were 100 MRSA colonies after disinfection by the PX-UV device and the overall reduction was statistically significant ($P < .01$).

Conclusions: Our study results suggest that PX-UV light effectively reduces MRSA colony counts in the absence of manual disinfection. These findings are important for hospital and environmental services supervisors who plan to adapt new technologies as an adjunct to routine manual disinfection.

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This work was supported by a Merit Review grant from the Department of Veterans Affairs to JZ (IIR 12-347) and the study's laboratory activity was funded 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 jointly sponsored Center for Applied Health Research (Temple, Tex). MIR is partially supported by award No. K23HL096054 from the National Heart, Lung, and Blood Institute. 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 or the official views of the National Heart, Lung, and Blood Institute or the National Institutes of Health. Xenex Healthcare Service did not participate in the study design or in the collection, analysis, and interpretation of data, the writing of the report, or in the decision to submit the manuscript for publication. The device used in this study is owned by Central Texas Veterans Health Care System.

CJ and NGM developed the methodology and protocol and performed data collection and manuscript preparation. MR, FV, IL, JZ, LC, and ES participated in study design, statistical analysis, and contributed to the manuscript. All authors read and approved the final manuscript. Part of this manuscript was presented as a poster at IDWeek 2014, Philadelphia, Pa.

Conflicts of interest: None to report.

http://dx.doi.org/10.1016/j.ajic.2015.04.005

Methicillin-resistant *Staphylococcus aureus* (MRSA) infections in the United States have accounted for $9.7 billion in additional costs to health care systems.[1-3] Surfaces in a patient room play an important role in the transmission of infectious diseases, including MRSA and vancomycin-resistant enterococci.[4,5] MRSA survives on surfaces for several months, possibly contributing to hospital-acquired infections (HAIs).[6] The current recommended cleaning process involves manual disinfection of surfaces using chemical disinfectants. Several studies have shown that a manual disinfection process is inadequate, leaving residual contamination.[7,8] Residual contamination on surfaces can place a future occupant at a 2- to 3-fold increased risk of acquiring an infection from the previous occupant.[9] No-touch disinfection (NTD) systems that produce germicidal spectrum ultraviolet (UV) light from mercury or pulsed xenon (PX)-based sources have been shown to be effective in conjunction with manual disinfection leading to superior terminal cleaning, especially for MRSA.[10,11] Certain mercury-based NTD systems have been shown to be effective even in the presence of organic material and absence of manual disinfection before use of the device.[12] There is currently a dearth of similar evidence for devices that use PX technology. In an attempt to address this deficiency, we devised a study to evaluate the effectiveness of a PX-UV light NTD device against MRSA in the absence of manual cleaning.

METHODS

This quasiexperimental study was conducted at a tertiary care hospital from March-June 2014 in the Central Texas Veterans Health Care System, Temple, Tex. By policy, polymerase chain reaction or cultures for MRSA are performed on nasal swabs collected on all patients at admission, transfer, and discharge. Hence the MRSA status (colonization, infection, or neither) of a patient is known from the outset. Patients with MRSA infection, either community-acquired or hospital-acquired, MRSA colonization, or with prior-year positive polymerase chain reaction/culture are placed on contact isolation for MRSA during their entire hospitalization. Rooms that were previously occupied and designated as contact isolation by a MRSA-positive patient were selected for the study immediately postdischarge. Patients who did not have MRSA on nasal screening or clinical cultures but were prior colonizers or had prior infection were excluded from the study. Furthermore, these rooms had to meet the following criteria to be included in our study:

1. Room had been occupied for at least 48 hours.
2. Room was single-bed occupancy with a private bathroom.
3. Study team was available to collect samples pre- and post-irradiation (typically between 8 am and 5 pm, Monday through Friday) immediately following discharge of the patient.

Once the study rooms were identified, samples were collected from 5 high-touch surfaces (ie, bedrail, toilet seat, bathroom handrail, call button, and tray table) before and after PX-UV exposure. The device used in this study has been previously described by our laboratory.[10] The PX-UV light was placed and run for 5 minutes per location: once on both sides of the bed and once in the bathroom, exposing the above-mentioned high-touch surfaces for a total of 15 minutes of PX-UV exposure per room.[10]

The samples were collected adjacent to 1 another to minimize variability. Microbiologic sampling was performed using Rodac contact plates (Hardy Diagnostics, Santa Monica, Calif). For flat surfaces, the contact plate was firmly pressed for 5 seconds. For nonflat surfaces, we used a roll-plate technique. If visible soiling was observed, the samples for that surface were taken adjacent to the soiling. The plates were then incubated at 35°C-37°C for 48 hours. Suspected MRSA was confirmed as MRSA using standard methods. If the MRSA colony counts were >200, the count was recorded as 200. This was done to limit the effect of a few outliers skewing the data and hence overestimating the potential effect of PX-UV light on MRSA. The effectiveness of the PX-UV light device on the concentration of MRSA was assessed employing a Wilcoxon signed-rank test for all 70 [pre/post] samples in 14 rooms, as well as by surface location. A type I error of $\alpha = 0.05$ was assumed. Data were analyzed using SAS version 9.3 (SAS Institute Inc, Cary, NC) and R version 3.1.1 (R Foundation for Statistical Computing, Vienna, Austria).

Table 1
Surface colony counts in rooms with methicillin-resistant *Staphylococcus aureus*

Location	No. Samples	Before PX-UV light	After PX-UV light	Count reduction	*P* value*
Bathroom handrail	14	4.8 ± 9.2 1 (0, 35; 0-6)	0.4 ± 0.9 0 (0, 3; 0-0)	4.4 ± 9.4 1 (-3, 35; 0-5)	.02
Bedrail	14	1.9 ± 3.1 0.5 (0, 10; 0-3)	0.43 ± 1.2 0 (0, 4; 0-0)	1.5 ± 3.2 0 (-2, 10; 0-1)	.13
Call button	13	3.5 ± 7.5 1 (0, 26; 0-2)	0.2 ± 0.4 0 (0, 1; 0-0)	3.4 ± 7.5 0 (0, 26; 0-2)	.03
Toilet seat	14	14.1 ± 31.4 0 (0, 90; 0-5)	6.0 ± 12.3 0 (0, 38; 0-1)	8.1 ± 22.0 0 (-10, 70; 0-2)	.31
Tray table	14	3.9 ± 7.1 0.5 (0, 23; 0-3)	0.2 ± 0.6 0 (0, 2; 0-0)	3.7 ± 6.7 0.5 (0, 21; 0-3)	.02
Total	69	5.7 ± 15.6 1 (0, 90; 0-4)	1.5 ± 5.9 0 (0, 38; 0-0)	4.3 ± 11.6 0 (-10, 70; 0-3)	<.01

NOTE. Values are presented as mean ± standard deviation and median (minimum, maximum; interquartile range).
PX-UV, pulsed xenon ultraviolet.
*Wilcoxon signed-rank tests were employed, assuming a significance level of $\alpha = 0.05$.

RESULTS

We sampled 40 patient rooms. Of the 40 rooms selected only 14 (35%) contained MRSA on at least 1 high-touch surface before UV light exposure. Only these 14 rooms were included in the final analysis. Before PX-UV light use there were a total of 393 MRSA colonies isolated from the high-touch surfaces in the 14 rooms. Of the 393 MRSA colonies, 67 (17%) were on the bathroom handrail, 27 (7%) were on the bedrail, 46 (12%) were on the call button, 198 (50%) were on the toilet seat, and 55 (14%) were on the tray table. The surfaces with the highest contamination were the toilet seat, bathroom handrail, and tray table with mean colony counts of 14.1, 4.8, and 3.9, respectively. After use of the PX-UV light device there were a total of 100 MRSA colonies. Of the 100 MRSA colonies, there were 5 (5%) on the bathroom handrail, 6 (6%) on the bedrail, 2 (2%) on the call button, 84 (84%) on the toilet seat, and 3 (3%) on the tray table (Table 1). However, there was a significant outlier on the call button surface in 1 of the samples after PX-UV light device use. This outlier was considerably higher than any of the other samples after PX-UV light use, with 116 MRSA colonies. The outlier was attributed to cross-contamination and thus removed from the final analysis.

DISCUSSION

Through this study we demonstrated a reduction in surface MRSA colony counts after PX-UV irradiation. NTD technologies, such as PX-UV light, use high-intensity broad-spectrum UV irradiation to disrupt the molecular bonds in the DNA of microorganisms.[13,14] UV light exposure causes bonding within DNA, creating thymine dimers that inhibit proliferation of the organism.[13] PX-UV along with