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Impact of a multi-hospital intervention utilising screening, hand hygiene education and pulsed xenon ultraviolet (PX-UV) on the rate of hospital associated meticillin resistant *Staphylococcus aureus* infection

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Abstract

Standard approaches to meticillin 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, NC, USA. An MRSA screening programme 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%, and for the entire healthcare system by 56% ($p=0.001$). The two smaller hospitals saw reductions of 51% and 66%, but the results were not statistically significant ($p=0.1047$ and $p=0.2263$). Implementing a PX-UV device in conjunction with active screening and hand hygiene was associated with a decrease in HA-MRSA rates. Studies on the individual effect of PX-UV on HA-MRSA rates are warranted.

Background

Meticillin resistant *Staphylococcus aureus* (MRSA) is a well-known pathogen within healthcare facilities, and its impact on patient outcomes is well documented (Muto et al, 2003; Siegel et al, 2007). Current methods of controlling MRSA transmission have focused on active surveillance and hand hygiene. Active surveillance programmes are used to rapidly identify patients who are colonised with MRSA on admission to the facility, and hand hygiene interventions are designed to prevent the horizontal spread of disease among patients. Although studies indicate that active surveillance for MRSA is effective (Jernigan et al, 1995; West et al, 2006), recent analysis has shown that the effect of screening on reducing MRSA transmission may be overestimated (Gurieva et al, 2012). Similarly, there is evidence that educating staff on hand hygiene has an impact on infection rates, but these decreases may not be sustained or apply to all infection types (Pittet et al, 2000; Gordon et al, 2005). In contrast to the success documented in these studies, there are multi-year studies that indicate there is no association between increasing hand hygiene rates or the use of alcohol-based hand rubs and infection rates (Eckmanns et al, 2006; Backmann et al, 2007). New methods of preventing the spread of infection may be required.

The role of the environment in transmitting infection is addressed as a risk factor in guidelines published by both the Society for Healthcare Epidemiology of America (SHEA) and the Hospital Infection Control Practices Advisory Committee (HICPAC) (Muto et al, 2003; Siegel, 2007). Seventy three per cent of hospital rooms that contained a patient with an MRSA infection will be contaminated after discharge (Boyce et al, 1997). It has been shown that patients in a room where the previous occupant had an MRSA infection are 1.4 times more likely to develop an MRSA infection than those in a room where the previous occupant did not have MRSA (Huang et al, 2006).

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Table 1. Facility characteristics.

Facility	No. of beds	ORs	No. of PX-UV devices
Cumulative	777	38	5
Facility 1	536	20	3
Facility 2	175	14	1
Facility3	66	4	1

ORs: Operating rooms.

Table 2. HA-MRSA rates per 1,000 patient days before and after the intervention.

Facility	Arm	Total HA-MRSA	Min	Mean	Median	Max	IQR	% rate reduction	z	p
Cumulative	Pre	102	0.12	0.42	0.45	0.89	0.34	57%	3.278	0.001
	Post	51	0	0.18	0.14	0.5	0.15			
Facility 1	Pre	76	0.1	0.45	0.49	0.93	0.43	56%	3.246	0.001
	Post	35	0	0.18	0.11	0.54	0.12			
Facility 2	Pre	21	0	0.18	0.27	1.03	0.6	51%	1.622	0.104
	Post	14	0	0.19	0.22	0.81	0.28			
Facility 3	Pre	5	0	0.26	0	1.65	0.42	66%	1.21	0.226
	Post	2	0	0.08	0	0.9	0			

Ultraviolet light has been shown to be an effective method of enhanced environmental disinfection (Stibich, 2010). Disinfection with ultraviolet light is achieved by the creation of thymine dimers in the DNA of organisms in the environment. The presence of thymine dimers inhibits DNA replication and deactivates the organism. Pulsed xenon ultraviolet (PX-UV) is a disinfection method that emits high levels of germicidal UV-C light (Stibich, 2010). PX-UV differs from mercury vapour UV technology in that it is more intense and uses a broader UV range to achieve more effective decontamination. PX-UV has been used previously in healthcare settings to reduce environmental contamination levels and infection rates (Levin et al, 2011; Stibich et al, 2011). Testing of PX-UV disinfection systems has demonstrated the ability to achieve a 5-log reduction in MRSA within five minutes in a laboratory environment (Stibich et al, 2011).

Methods

A combination of hand hygiene education, active surveillance, and PX-UV disinfection was implemented at a tertiary care hospital system. For this study, active surveillance was conducted by sampling the nares of patients and detecting the presence of MRSA using a polymerase chain reaction (PCR) test. For patients who were identified as being MRSA colonised, a decolonisation protocol of antimicrobial nasal ointment and chlorhexidine bathing was implemented for five days. Targeted active surveillance was implemented on two units in July 2010, and was instituted for all admissions in January 2011. In addition to admission surveillance, active screening was instituted prior to selected surgeries in February 2011, and the majority of inpatient and outpatient surgeries in June 2011.

Computer-based learning for hand hygiene was assigned to all hospital staff in January 2011, with a mandatory completion date of February 2011. All current staff completed the hand hygiene education module, as well as staff hired after the mandatory completion date. Hand hygiene was monitored by direct observation on a monthly basis by the infection prevention department. Prior to the computer-based learning, hand hygiene compliance rates ranged from 70–80%. After the education was provided, rates increased to approximately 90%, and this rate was sustained throughout the intervention period.

PX-UV was implemented in February 2011 for terminal cleaning of rooms that housed a patient with an MRSA infection. Patients who were identified as colonised via active surveillance were not included in the PX-UV disinfection group owing to staffing limitations. The PX-UV device has been described elsewhere (Stibich et al, 2011). In this case, the device was used for three positions of five minutes each per patient room. These changes were implemented across all three facilities in the system on the same timeline.

Three facilities participated in the intervention: a 536-bed acute care hospital, a 175-bed community hospital, and a 66-bed community hospital.

The rate of hospital associated MRSA infection (HA-MRSA) was compared before and after the implementation of the combined interventions of active surveillance, hand hygiene education, and PX-UV disinfection. Infection rates were available from October 2009 to January 2011 for baseline data, and from February 2011 to August 2012 for the intervention period. MRSA infection status was determined with clinical cultures using the definitions provided by the Centers for Disease Control and Prevention (CDC, 2013). For the purposes of analysis, the intervention was considered to be fully implemented in February 2011. The rates are compared using Wilcoxon rank sum analysis. Analyses were done on the combined data and the facility-specific data.

Results

Table 1 shows the facility descriptions. Table 2 shows the cumulative and facility-specific HA-MRSA rates before and after the bundled intervention. The cumulative analysis shows a 57% reduction in the

HA-MRSA rate. For the 536-bed facility, the reduction was 56%; for the 175-bed facility, the reduction was 51%; and for the 66-bed facility, the reduction was 66%. Overall, it is estimated that 68 HA-MRSA infections were prevented.

Both the cumulative and the 536-bed facility reductions were statistically significant (p=0.001 and p=0.0012, respectively). For the 175-bed facility and the 66-bed facility, the change in rate was not statistically significant (p=0.1047 and p=0.2263, respectively).

Discussion

The analysis showed a statistically significant reduction in HA-MRSA cumulatively and in the 536-bed facility. HA-MRSA cases were relatively rare at the 175-bed and 66-bed facilities, which may have contributed to the lack of statistical significance.

The implantation of this combination of interventions was associated with a reduction in HA-MRSA; however, it is difficult to discern the effects of individual components. The potential impact of hand hygiene and MRSA screening combined on HA-MRSA rates is controversial. It is likely that the addition of the PX-UV environmental disinfection was a critical contributor to the result. The impact of the PX-UV environmental disinfection system alone, however, was not studied in this project.

This study indicates that the use of PX-UV technology, as part of a multiple intervention approach, is an effective method of reducing the rate of hospital associated MRSA infections. Studies assessing the effectiveness of PX-UV as a stand-alone intervention are needed.

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Declaration of conflicting interests

Sarah Simmons is an employee of Xenex Healthcare Services. Mark Stibich and Julie Stachowiak are employees and shareholders in Xenex Healthcare Services.

References

Backman C, Zoutman D, Marck P. (2007) An integrative review of the current evidence on the relationship between hand hygiene interventions and the incidence of health care-associated infections. *American Journal of Infection Control* **36**(**5**): 333–48.

Boyce J, Potter-Bynoe G, Chenevert C, King T. (1997) Environmental contamination due to methicillin-resistant Staphylococcus aureus: possible infection control implications. *Infection Control and Hospital Epidemiology* **18**(**9**): 622–7.

Centers for Disease Control and Prevention. (2013) MDRO and CDI Module. Multidrug-resistant organism & *Clostridium difficile* infection (MDRO/CDI) module. http://www.cdc.gov/nhsn/PDFs/pscManual/12pscMDRO_CDADcurrent.pdf (accessed 17 April 2013).

Eckmanns T, Schwab F, Bessert J, Wettstein R, Behnke M, Grundmann H, Rüden H, Gastmeier P. (2006) Hand rub consumption and hand hygiene compliance are not indicators of pathogen transmission in intensive care units. *Journal of Hospital Infection* **63**(**4**): 406–11.

Gordon F, Schultz M, Huber R, Gill J. (2005) Reduction in nosocomial transmission of drug-resistant bacteria after an introduction of an alcohol based hand rub. *Infection Control and Hospital Epidemiology* **26**(**7**): 650–3.

Gurieva T, Bootsma M, Bonten M. (2012) Successful veterans affairs initiative to prevent methicillin-resistant Staphylococcus aureus infections revisited. *Clinincal Infectious Diseases* **54**(**11**): 1618–20.

Huang S, Datta R, Platt R. (2006) Risk of acquiring antibiotic-resistant bacteria from prior room occupants. *Archives of Internal Medicine* **166**(**18**): 1945–51.

Jernigan J, Clemence M, Stott G, Titus M, Alexander C, Palumbo C, Farr B. (1995) Control of methicillin-resistant Staphylococcus aureus at a university hospital: one decade later. *Infection Control and Hospital Epidemiology* **16**(**12**): 686–96.

Levin J, Riley L, Parrish C, English D. (2011) The use of portable pulsed xenon ultraviolet light (PPX-UV) after terminal cleaning was associated with a dramatic decrease in the hospital-associated *Clostridium difficile* infection (HA-CDI) rate in a community hospital. Poster presented at Infectious Diseases Society of America National Conference, 2011.

Muto C, Jernigan J, Ostrowski B, Richet H, Jarvis W, Boyce J, Farr B. (2003) SHEA guideline for preventing nosocomial transmission of multidrug-resistant strains of Staphylococcus aureus and enterococcus. *Infection Control and Hospital Epidemiology* **24**(**5**): 362–86.

Pittet D, Hugonnet S, Harbarth S, Mourouga P, Sauvan V, Touveneau S, Perneger T. (2000) Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. *Lancet* **356**: 1307–12.

Siegel J, Rhinehart E, Jackson M, Chiarello L. (2007) *2007 Guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings*. Centers for Disease Control and Prevention: Atlanta.

Stibich M. (2010) Use of pulse xenon ultraviolet to deactivate Clostridium difficile, methicillin-resistant Staphylococcus aureus and vancomycin-resistant Enterococci. SHEA Fifth Decennial Conference, 18-22 March, 2010, Atlanta, GA.

Stibich M, Stachowiak J, Tanner B, Berkheiser M, Moore L, Raad I, Chemaly R. (2011) Evaluation of a pulsed-xenon ultraviolet room disinfection device for impact on hospital operations and microbial reduction. *Infection Control and Hospital Epidemiology* **32**(**3**): 286–8.

West T, Guerry C, Hiott M, Morrow N, Ward K, Salgado C. (2006) Effect of targeted surveillance for control of methicillin-resistant Staphylococcus aureus in a community hospital system. *Infection Control and Hospital Epidemiology* **27**(**3**): 233–8.

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