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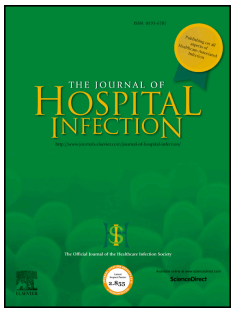

First UK trial of Xenex PX-UV, an automated ultraviolet room decontamination device in a clinical haematology and bone marrow transplantation unit

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First UK trial of Xenex PX-UV, an automated ultraviolet room decontamination device in a clinical haematology and bone marrow transplantation unit[star]

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SUMMARY

Background: There is growing interest in the use of no-touch automated room decontamination devices within healthcare settings. Xenex PX-UV is an automated room disinfection device using pulsed ultraviolet (UV) C radiation with a short cycle time.

Aim: To investigate the microbiological efficacy of this device when deployed for terminal decontamination of isolation rooms within a clinical haematology unit.

Methods: The device was deployed in isolation rooms in a clinical haematology unit. Contact plates were applied to common touch points to determine aerobic total colony counts (TCCs) and samples collected using Polywipe™ sponges for detection of vancomycin-resistant enterococci (VRE).

Results: The device was easy to transport, easy to use, and it disinfected rooms rapidly. There was a 76% reduction in the TCCs following manual cleaning, with an additional 14% reduction following UV disinfection, resulting in an overall reduction of 90% in TCCs. There was a 38% reduction in the number of sites where VRE was detected, from 26 of 80 sites following manual cleaning to 16 of 80 sites with additional UV disinfection.

Conclusions: The Xenex PX-UV device can offer a simple and rapid additional decontamination step for terminal disinfection of patient rooms. However, the microbiological efficacy against VRE was somewhat limited.

Keywords:

Xenex

Ultraviolet (UV)
Decontamination

Introduction

Healthcare-associated infections (HCAIs) remain a significant source of morbidity and mortality for patients despite a number of national infection prevention and control initiatives.[1] These have included guidance on hand hygiene as well as standards on cleanliness within a healthcare environment.[1] Hand hygiene is especially important at reducing the cross-transmission of pathogens, and further improvements can be achieved through reducing the bioburden at touch points.[1] However, several studies have shown that manual cleaning is often suboptimal, and improvements through education and feedback are difficult to maintain.[2–4]

In order to reduce the risks of operator error during cleaning, there is growing interest in no-touch automated room decontamination devices such as hydrogen peroxide and ultra-violet (UV) radiation.[5,6] UV radiation has been shown to be efficacious at killing a number of bacteria including spore-forming organisms through destruction of nucleic acids.[7] A number of these devices are now available on the market and studies have demonstrated efficacy in seeded plate and simulated experiments against meticillin-resistant *Staphylococcus aureus* (MRSA), multi-resistant acinetobacter (MRA) and vancomycin-resistant enterococci (VRE).[8–10] VRE remain important nosocomial pathogens, and infection is associated with increased morbidity, particularly in haematology patients undergoing bone marrow transplantation.[11]

This study investigated the efficacy of the PX-UV device (Xenex disinfection services) as a means of (i) reducing the total aerobic colony counts (TCCs) on surfaces and (ii) removing environmental reservoirs of VRE in an isolation room on a busy haematology and bone marrow transplant unit.

Methods

Clinical setting

This study was performed in single occupancy, isolation, en-suite rooms in clinical haematology wards in a large teaching hospital. Rooms were sampled immediately after the discharge of a patient. The clinical haematology unit performs weekly surveillance stool cultures on inpatients for carriage of VRE. Eight of the 18 rooms in this study were sampled following occupancy by confirmed VRE-positive patients.

PX-UV device use and disinfection

The Xenex PX-UV machine measured 48×40×100 cm in size, with a movable section containing a xenon gas flash bulb. The flash bulb pulsed a broad spectrum of UV light, which is bactericidal.[12] The device contained a number of safety mechanisms to assist and protect

the user, including warning signs and a motion sensor to automatically cease operation if movement is detected. Within each room, the device was deployed at three locations, each for a 5 min disinfection cycle, to ensure that all sites directly received at least once cycle of UV disinfection in the line of sight (Figure 1). On average, 25 min were required to perform the room disinfection.

Environmental samples

Environmental sampling was performed in 10 rooms at three time-points: (1) immediately following patient discharge, (2) following a manual clean performed by cleaning services staff using a general purpose detergent in warm water as per national standards, and (3) immediately after completion of three PX-UV disinfection cycles.[13] In each room, 10 standard sampling points were identified that included areas at risk of direct faecal contamination, which included a variety of touch points (e.g. bed controls, chair arm, patient table) and areas that may be difficult to access for cleaning (e.g. floor in corner) (Table I). TCCs were assessed using Tryptone Soya Agar contact plates (E&O Laboratories, Bonnybridge, UK). The plates were incubated at 37°C for 48 h and the total colony-forming units (cfu) enumerated.

In another eight rooms, 10 sampling points were swabbed with a Polywipe™ sponge (Medical Wire and Equipment, Corsham, UK) at time-point (2), following a manual clean using a general purpose detergent in warm water as per national standards, and at time-point (3), immediately after PX-UV surface disinfection.[13] In each of the sampling sites, adjacent areas were selected at each time-point to mitigate against the effects of additional cleaning through sampling. The sponges were immersed in 30 mL of brain–heart infusion broth (Oxoid, Basingstoke, UK) and incubated at 37°C for 12–18 h. Ten microlitres of the broth were subcultured on to VRE-selective agar (Oxoid) which was incubated at 37°C for 48 h. Blue or purple colonies indicating probable VRE were confirmed using Gram staining, Bile-aesculin positivity and vancomycin sensitivity testing. VRE sampling was performed in different rooms and at separate time-points from TCCs.

Data analysis

Quantitative data (TCCs) were summarized using box–whisker plots and a chi-squared test was performed to compare the percentage of VRE-positive samples before and after PX-UV disinfection. $P < 0.05$ was considered statistically significant.

Results

Total aerobic colony counts

Overall, a median of 35.5 cfu per contact plate [interquartile range (IQR): 17.25–111.5] was detected prior to cleaning from a total of 100 sampling points. This was

reduced to a median of 4 cfu per contact plate (IQR: 1–4) following manual cleaning and to 2 cfu/contact plate (IQR: 0–4) following deployment of PX-UV (Figure 2). Following UV decontamination, floor areas in front of the toilet in two separate rooms remained heavily contaminated despite being in an easily accessible location to clean manually and in the direct line of UV exposure (Table II).

VRE detection

In all, 160 Polywipe sponge samples were obtained from eight patient rooms. VRE was detected from 26/80 (32.5%) samples post cleaning and from 16/80 (20%) samples post Xenex PX-UV ($P = 0.072$, chi-squared test) (Table III). There appeared to be no poorly performing sampling sites from which VRE was consistently detected, because the positive results were spread across all the 10 sites in the eight different rooms.

Discussion

This small study of the Xenex PX-UV device has demonstrated effectiveness at reducing the overall bioburden at critical touch-points in the clinical environment. The device also showed an additional reduction in the detection of VRE following manual cleaning, but this was not statistically significant.

There are several limitations to this study. It was performed in one institution and sampling was performed in a small number of rooms. A limited number of touch-points were sampled in the rooms and this may not accurately reflect the true level of contamination. Ideally the sampling should have been performed in triplicate, at each location in each room, to achieve a mean value. We did not assess efficacy of Xenex PX-UV against *Clostridium difficile* and MRSA because the incidence of these two organisms in our haematology and bone marrow transplant unit is currently very low.

The main advantages of this device were that it was easy to use and had rapid cycle times for disinfection, which meant that there was improved uptake from the cleaning services team. However, the short cycle times may have reduced efficacy against key pathogens. In addition, Xenex PX-UV does not contain mercury bulbs, unlike some continuous UV decontamination devices, hence there are no safety hazards associated with mercury disposal.

Sampling of touch points using contact plates showed a large reduction in bacterial bioburden following manual cleaning (76%) and a further reduction (14%) in TCCs following UV disinfection. The highest TCCs were recovered from floors in the room and toilet, as well as the toilet bin lid.

Following manual cleaning, VRE was cultured from a number of sites and UV disinfection led to small a reduction in the number of locations where VRE remained detectable. Our methodology was optimized for maximum sensitivity for VRE detection using

broth enrichment, hence it was not possible to quantify the degree of environmental VRE contamination in terms of cfu. From our results, we conclude that the three 5 min cycles of UV disinfection do not ensure total eradication of VRE. However, longer periods of UV emission might increase the effectiveness of this device against VRE.

A recent study using seeded surfaces in a simulated environment has shown that short-pulsed UV devices are somewhat less effective than continuous UV radiation.[12]

In summary, pulsed UV is an emerging decontamination technology that is effective at reducing bacterial contamination in the clinical environment to some degree, but further studies are required to elucidate whether this technology should be relied upon for terminal disinfection of rooms of patients with VRE and other important HCAI pathogens.

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Conflict of interest statement

None declared.

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Table I

Sites sampled using contact plates for total colony counts (A–J) and using Polywipe™ sponges for vancomycin-resistant enterococci (1–10)

Number	Sampling sites
A/1	Top of patient table
B/2	Floor in corner of the room
C/3	Bed controls
D/4	Floor in front of toilet
E/5	Top of service rail
6	Nurse call buzzer
7	Door handle – bathroom
8	Bed safety rail
9	Tap on sink
10	Toilet flush handle
F	Top of fridge
G	Toilet bin lid
H	Chair arm (left)
I	Chair arm (right)
J	Telephone on top of locker

Table II

Total aerobic colony counts from the 10 sampled sites in 10 rooms before cleaning, after manual cleaning, and after ultraviolet disinfection

Site	Before cleaning	After manual cleaning	After ultraviolet disinfection
Top of patient table	17 (0–39)	2 (0–5)	0 (0–2)
Floor in corner of the room	132 (29–278)	5 (0–171)	2 (1–54)
Bed controls	19 (2–148)	2 (0–23)	1 (0–7)
Floor in front of toilet	56 (1–220)	3 (0–121)	2 (0–167)
Top of service rail	62 (6–136)	3 (0–37)	2 (0–12)
Top of fridge	35 (3–131)	3 (0–92)	1 (0–18)
Toilet bin lid	103 (10–259)	32 (2–171)	1 (0–32)
Chair arm (left)	22 (7–333)	12 (0–126)	4 (0–27)
Chair arm (right)	23 (5–267)	10 (0–102)	2 (0–5)
Telephone on top of locker	34 (15–187)	13 (0–26)	1 (0–18)

Values are median (range).

Table III

Number of vancomycin-resistant enterococci (VRE)-positive sites[a] after manual cleaning and additional ultraviolet (UV) disinfection

Area	No. of VRE-positive sites after manual cleaning	No. of VRE-positive sites after additional UV disinfection
Room 1	3/10	1/10
Room 2	6/10	4/10
Room 3	0/10	0/10
Room 4	2/10	1/10
Room 5	2/10	1/10
Room 6	4/10	4/10
Room 7	8/10	5/10
Room 8	1/10	0/10
Total	26/80	16/80

[a]VRE was detected using broth enrichment, hence quantification of bacterial load at sampling sites was not possible.

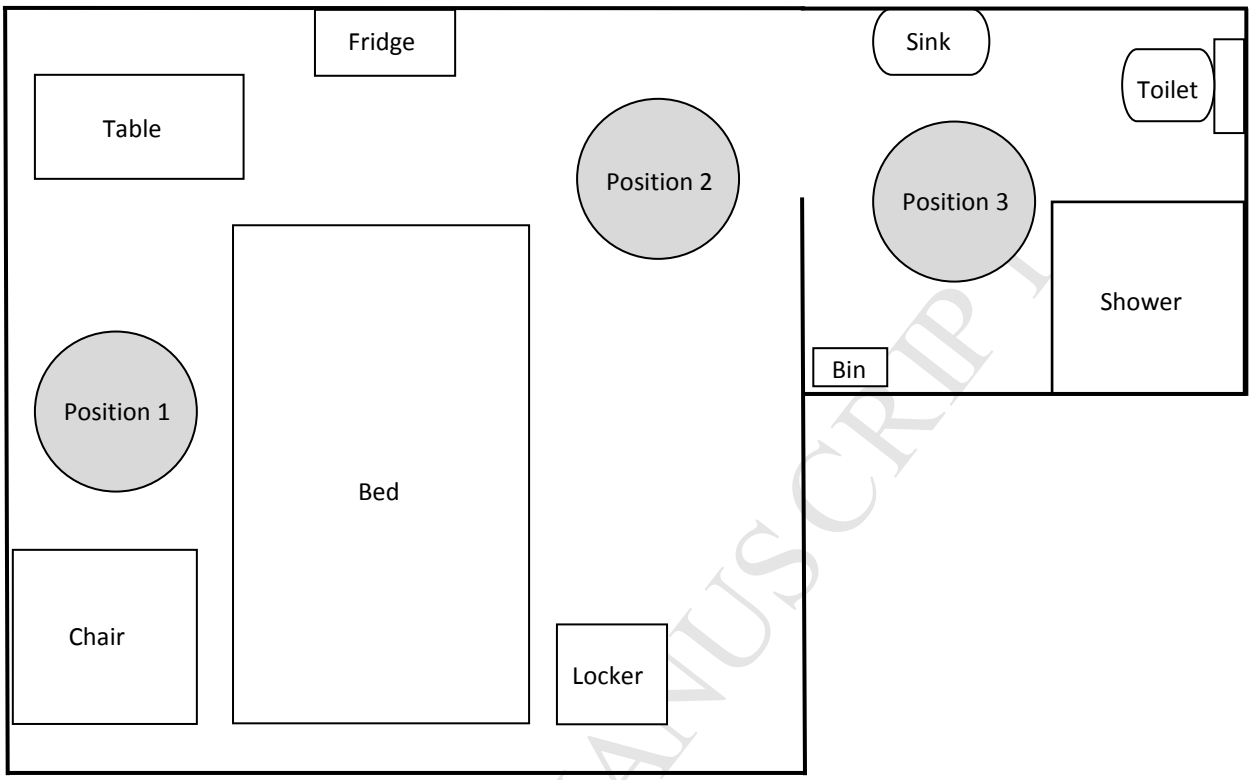

Figure 1. Three positions of deployment of the Xenex PX-UV device, for 5 min at each location.

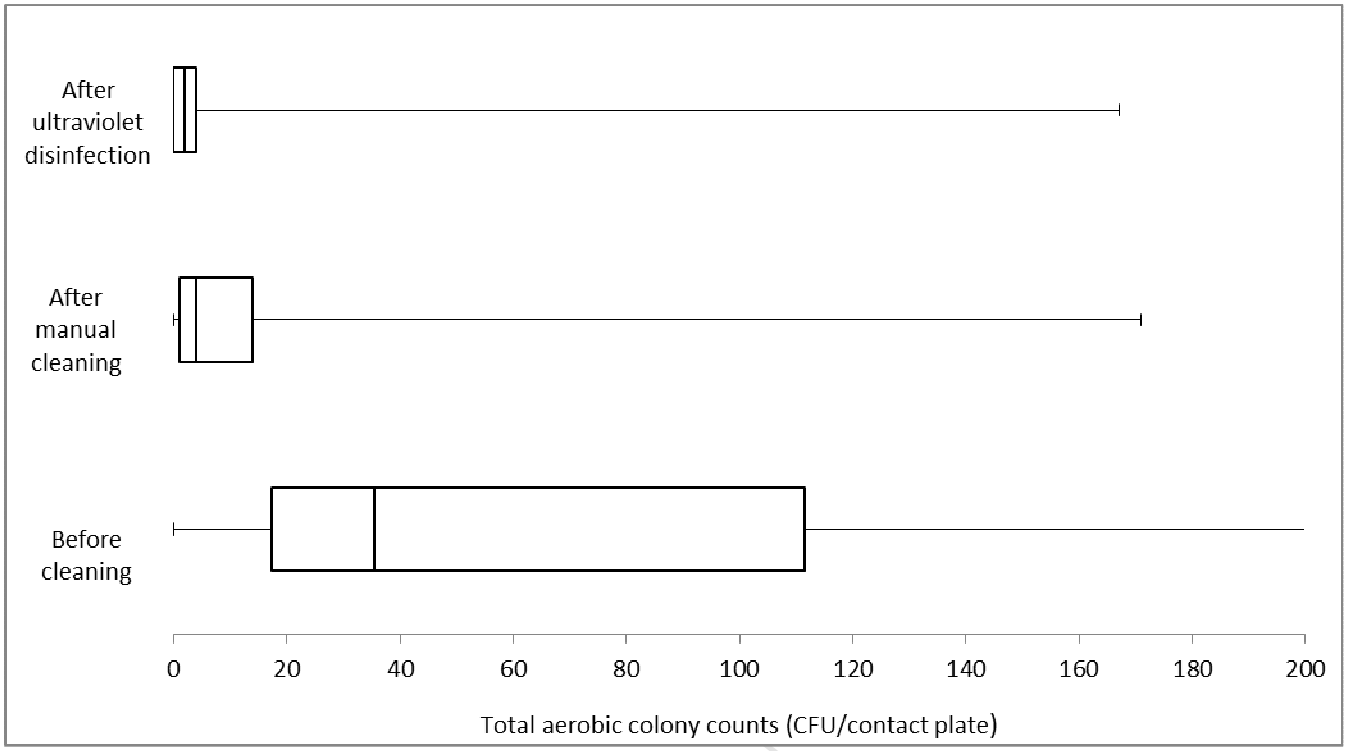

Figure 2. Box-plot demonstrating total aerobic colony counts from contact plates before cleaning, after manual cleaning, and after ultraviolet disinfection.