UV-C Light as an Adjunct to Infection Control in a Pediatric Burn Hospital

Shriners Hospitals for Children® — Cincinnati

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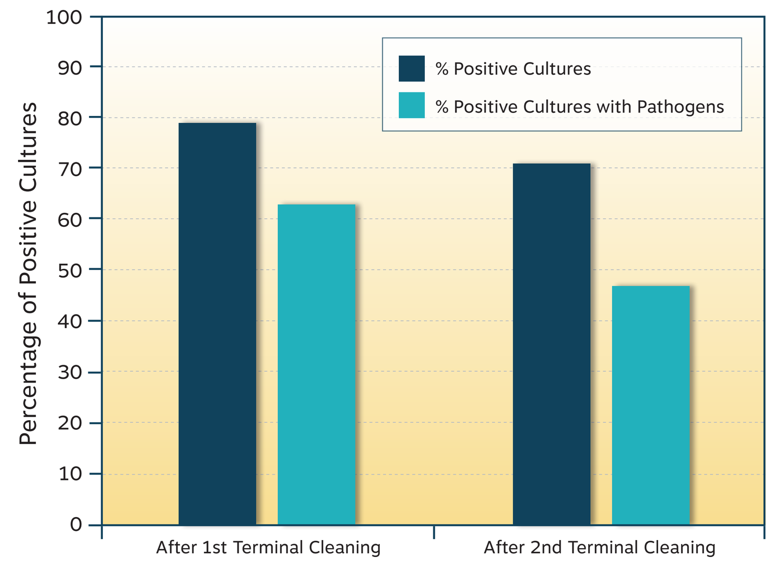
Introduction

Maintaining a clean environment is integral to preventing the transfer of pathogens that may cause hospital-acquired infection (HAI). Patient rooms are cleaned daily and upon patient discharge with the approved hospital disinfectant, a quaternary-based cleaner disinfectant, requiring a ten minute dwell time. Intensive Care Unit (ICU) rooms are cleaned twice daily and upon discharge. Following the transfer of a multidrug-resistant organism (MDRO), the efficacy of our environmental services (EVS) terminal cleaning process was questioned.

Cultures were obtained from high-touch items after terminal cleaning of a patient room known to be heavily colonized with bacterial organisms. Culture results revealed potentially pathogenic organisms present on many of the room surfaces. These organisms included Methicillin-resistant *Staphylococcus aureus* (MRSA), *Klebsiella pneumoniae*, *Enterococcus faecalis*, Coagulase-negative staphylococci, and *Bacillus* species. The room was terminally cleaned a second time and cultures were repeated. Pathogenic organisms, while reduced, remained present on room surfaces *(Figure 1)*. Organisms recovered included, *Staphylococcus aureus* (MRSA), *Enterococcus faecalis*, Coagulase-negative staphylococci, and *Bacillus* species.

Figure 1. *Percentage of Positive Cultures AFTER Terminal Cleaning*



Results from this initial room were the catalyst for exploring UV-C as an adjunct to our cleaning process.

To ensure there was not an efficacy problem with the disinfectant; the microbiology laboratory performed an EPA-approved disinfectant assay on a randomly-selected isolate of each organism type found in the patient room. The disinfectant cleaner proved to be bactericidal in all disinfectant assays performed.

We recognize that although our disinfectant is capable of eradicating bacterial organisms in the laboratory testing, the actual cleaning process is not always a fail-safe method to ensure adequate patient room disinfection. The purpose of this study was to determine if use of an ultraviolet disinfection system (UV-C) would improve bacterial eradication. The Surfacide® Helios® Ultraviolet Light Disinfection System *(Figure 2)* was brought in for a one month product evaluation.

Figure 2. *Surfacide® Helios® Ultraviolet Light Disinfection System*

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Methods

Patient Rooms

Bacterial cultures were taken from twenty-six high-touch surfaces in 3 patient rooms before and after EVS cleaning, and after a system calculated UV-C disinfection cycle *(Figure 3)*. Cultures were obtained using the BBL Brand Culture-Swab Collection & Transport System (Becton Dickinson). Culturettes were pre-moistened with culture media from within the collection tube, then used to swab the high-touch surfaces. This process of culturing before and after EVS cleaning and after UV-C disinfection was performed in three patient rooms.

Figure 3. *Surfacide® System Set-up in Patient Room*

UV-C Only Room

Additionally, the efficacy of the UV-C was tested in a controlled environment. In an unoccupied patient room, thirty-two high touch surfaces were identified by nursing staff. Wax rings were drawn on each surface to ensure exact location of organism inoculation and subsequent culture. Ten organisms, including 5 MDROs, were randomly selected for this controlled study. The organisms were grown on BBL Trypticase Soy Agar II with 5% Sheep Blood (Becton Dickinson) for 24 hours in a 5% CO_2 incubator at 37°C. A $1x10^8$ inoculum was prepared in Pleuronics Water for each test isolate. Colony count plates were also prepared to determine inoculum density of each test isolate.

A sterile cotton-tipped applicator was used to inoculate the area within the wax ring with the test organism. The organism was allowed to dry for approximately 15 minutes. A positive organism control (protected from UV light exposure) was included in each test run. The room was then UV disinfected using the Surfacide® Helios® system. Upon completion of the UV disinfection cycle, cultures were obtained by swabbing the areas within the wax rings. After cultures were collected, the areas inside the wax rings were cleaned with the hospital disinfectant and allowed to dry. Subsequently, the wax ring areas were saturated with sterile water and allowed to dry before proceeding with the inoculation of the next isolate.

House-prepared Letheen Broth was used as the culture medium for all cultures. The inoculated Letheen Broth tubes were incubated for up to five days in a non-CO_2 incubator at 37°C before being reported as negative. All positive-growth cultures were subcultured to TSA II with 5% Sheep Blood and identified to ensure that the organism was consistent with the test organism. Data were collected as percentage of bacteria eradicated.

Results

A total of 234 cultures were obtained from 3 patient rooms under-going terminal clean and UV-C treatment *(Table 1)*. There was a 37% organism reduction between terminal cleaning and UV-C, and total elimination of pathogens *(Figure 4)*.

In the controlled UV-C only study, a total of 330 cultures were obtained (320 organism inoculums and 10 positive controls). The Surfacide system demonstrated a 97.5% organism reduction *(Table 2)*. Eight of the 320 surfaces tested positive after UV-C disinfection, four were recovered from a drawer handle which contained an adhesive label. We concluded that the organism was able to leach behind the label, and was thus protected from the UV-C. Two items, a dressing cart and a patient monitor remote box were positive for *Vancomycin-resistant enterococcus* (VRE). An MDR-*Pseudomonas aeruginosa* was recovered from a desktop calculator, and *Klebsiella pneumoniae* (ESBL+) was found on the handle of the medication scanner. No unintended organisms were recovered from any culture *(Figure 5)*.

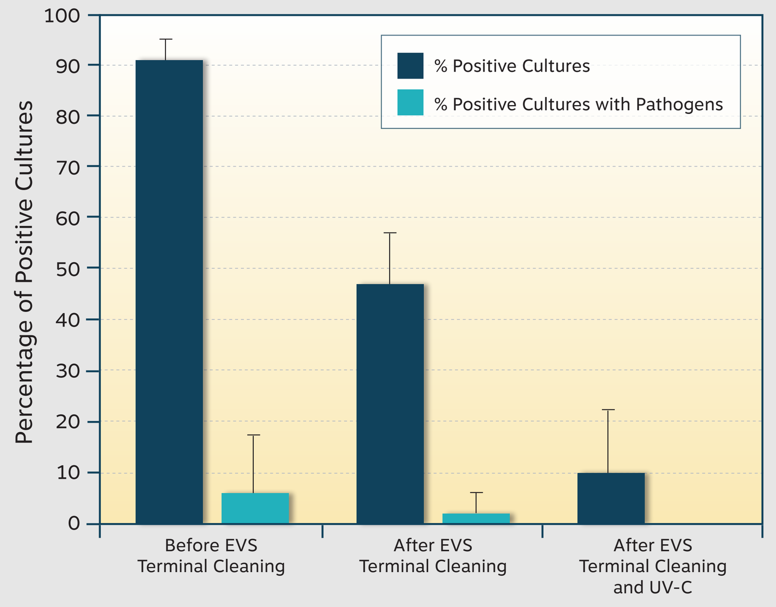
Table 1. *Profile of Cultures from 3 Patient Rooms*

	Before EVS Terminal Cleaning (n=78)	After EVS Terminal Cleaning Only (n = 78)	After EVS Terminal Cleaning and UV-C (n=78)
Positive Growth Cultures % (n)	91% (71)	47% (37)	10.3% (8)
Positive Growth Cultures With Pathogens Present% (n)	7% (5)	2.7% (1)	0% (0)

Table 2. *Cultures After UV-C Only*

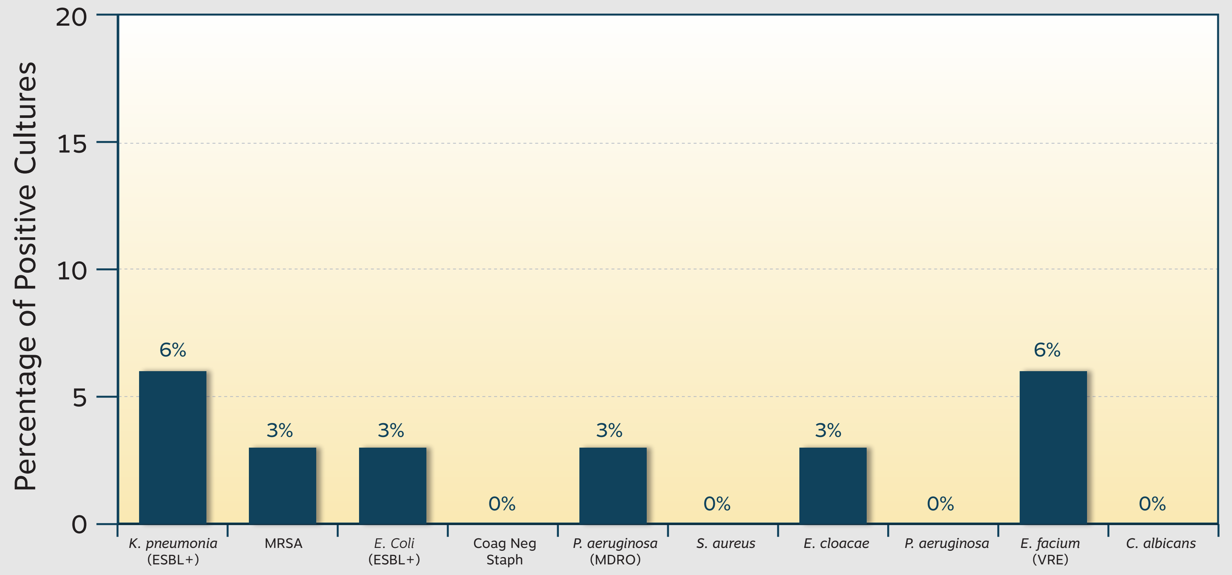
Number of Cultures (n)	Positive Cultures After UV-C Treatment Only (n)	Overall Kill Rate of UV-C Treatment Only
320	8	97.5%

Figure 4. *Percentage of Positive Cultures from Patient Rooms*



Average number of positive cultures from patient rooms for each step of the cleaning process

Figure 5. *Percentage of Positive Cultures by Organism AFTER Treatment with UV-C Only*



n-32, each organism considered separately

Conclusions

Culture results from patient rooms after both cleaning and UV-C disinfection demonstrate that UV-C is an effective and integral component in the reduction of bacterial pathogens not eradicated by the cleaning process alone.

Applicability to Practice

EVS disinfection of the patient room does not guarantee eradication of potential HAI causing organisms. Implementation of touch-free disinfection systems, such as the Surfacide UV-C Helios provide an additional level of security in reducing the risk of HAIs.