# Use of specialized UV-C disinfection operators to reduce multi-drug resistant hospital-acquired infections.

Providence Holy Cross Medical Center, Mission Hills CA

## BACKGROUND

Hospital-acquired infections (HAIs) are a significant contributor to excess patient length of stay, morbidity, and mortality in acute care hospitals.[1] Contaminated patient environments play a key role in the transmission of numerous HAI-causing multi-drug resistant organisms (MDROs) and a recent CDC sponsored study confirmed a "contaminated hospital environment is a modifiable risk factor." [2]

UV-C disinfection and other automated technologies are increasingly common as an adjunct hospital disinfectant due to their germicidal efficacy and consistency at the point-of-use.[3] With one exception, all previous peer-reviewed patient outcome studies on UV-C disinfection have employed environmental services (EVS) staff to operate UV-C devices.[4] However, unspecialized EVS staff may not be ideal UV-C operators given they have numerous responsibilities, are typically unit or floor based, may have contractual labor restrictions, and often have high turnover.

In an effort to expand utilization and improve program reliability, we employed specialized UV-C operators to disinfect terminal discharges in all inpatient units at a large community hospital and measured program utilization, impact on key MDRO-HAIs, and associated cost savings.

## METHODS

***Settings***

The 12-month pre and post designed study was completed at Providence Holy Cross Medical Center in Mission Hills, CA, a 377 bed community hospital, from April 2015 – March 2017. We compared facility-wide hospital-acquired infections caused by key multi-drug resistant organisms before and after a UV-C disinfection intervention implemented by specialized operators.

***Intervention***

UV-C disinfections were completed as an adjunct step after standard terminal disinfection protocols in all acute care inpatient units from April 2016 – March 2017. All UV-C disinfections were performed by specialized operators contracted from Clean Sweep Group, Inc. (CSGI) using Skytron IPT™ UV-C devices.

Priority for UV-C disinfections were as follows: 1) Intensive Care Unit, 2) Isolation discharge, 3) All other discharges. Adherence to protocol was the responsibility of the specialized UV-C operators.

During the study period, no changes were made to EVS' standard terminal disinfection protocols. Additionally, there were no changes in the transmission precautions or disease surveillance protocols.

***Intervention Measures***

Descriptive statistics of the UV-C intervention are provided, including disinfection count and duration.

## METHODS (cont.)

***Clinical Measures***

The clinical incidence rate of five key multi-drug resistant organisms are reported facility-wide, including: Methicillin-resistant Staphylococcus aureus (MRSA), Vancomycin-resistant Enterococcus (VRE), Klebsiella pneumoniae (KP), Acinetobacter baumannii (AB), and Pseudomonas aeruginosa (PA). Clostridium difficile was excluded from the analysis due to variation in the microbiologic test during the study period.

Hospital-acquired infections were determined from clinical cultures taken 3 calendar days or later after hospital admission. Non-index clinical cultures per culture site and organism for each patient were excluded. The aggregate and per organism HAI incidence per 1,000 patient days before and after the UV-C disinfection intervention are compared with a t-test.

***Cost Savings***

Cost savings (cost avoidance) is calculated by comparing expected versus observed number of patient stays with one or more target MDRO-HAIs multiplied by the average excess cost an MDRO-HAI patient stay. Expected number of MDRO-HAI patients is calculated by multiplying the baseline incidence rate by observed patient days during the intervention and dividing by the average number of infections per patient in the baseline. Hospital-specific data on excess length of stay and cost per day are used in MDRO-HAI estimates and intervention costs are not subtracted from reported cost savings.

## RESULTS

***Intervention Measures***

8,449 UV-C disinfections were completed in the intervention period, averaging 23.15 per day. The average room disinfection duration for the measured organisms was 10.12 minutes. UV-C disinfections were completed every day of the intervention with no major interruption in operation.

***Clinical Measures***

The facility-wide incidence rates of all target organisms was 19.18% lower in the intervention period compared to the baseline (4.87 vs. 3.94 per 1,000 patient days; *p = .006*). The unweighted average reduction per organism was 24.7% and ranged from a 53.1% reduction of Acinetobacter baummani to a 7.5% increase in Klebsiella pneumoniae.

*Figure 1*. Facility-wide aggregate hospital-acquired infection rate per 1,000 patient days from target multi-drug resistant organisms.

| Period | MDRO-HAIs | Patient days | MDRO-HAI Rate |
|---|---|---|---|
| **Baseline** | 313 | 64,262 | 4.87 |
| **Intervention** | 245 | 62,242 | 3.94 |
| | **% Change (*P Value*)** | | **- 19.18% (*.006*)** |

## RESULTS (cont.)

*Figure 2*. Facility-wide hospital-acquired infection rate per 1,000 patient days per target multi-drug resistant organisms.

| MDRO | Baseline Rate | Intervention Rate | *P Value* | % Change |
|---|---|---|---|---|
| **AB** | 0.34 | 0.16 | *.031* | **- 53.07%** |
| **KP** | 1.16 | 1.22 | *.359* | **+ 7.49%** |
| **MRSA** | 1.42 | 0.98 | *.015* | **- 30.79%** |
| **PA** | 1.29 | 1.16 | *.219* | **- 12.93%** |
| **VRE** | 0.68 | 0.45 | *.051* | **- 34.30%** |

***Cost Savings***

233 MDRO-HAI patient stays were expected in the intervention and 185 were observed, generating an estimated cost savings of $662,904.00 over 12 months.

*Figure 3.* Cost savings: Expected versus observed MDRO-HAI patient stays multiplied by facility-specific average cost (8.37 days excess LOS * $1,650 per day = $13,810.50 per MDRO-HAI patient stay).

| | MDRO-HAI Pts | Estimated Cost |
|---|---|---|
| **Expected MDRO-HAI Patient Stays during Intervention** | 233 | $3,217,846.50 |
| **Observed MDRO-HAI Patient Stays during Intervention** | 185 | $2,554,942.50 |
| **Reduction** | **48** | **$662,904.00** |

## CONCLUSIONS

The UV-C disinfection intervention was associated with a significant reduction of hospital-acquired infections from epidemiologically important multi-drug resistant organisms. The reduction of hospital-acquired infections generated a large cost savings and positive return on intervention investment.

Additionally, the use of specialized operators expanded utilization and improved reliability of the UV-C intervention. The use of specialized operators improved many human factors associated with complex interventions, e.g. protocol consistency and product expertise. Conversely, it minimized many of the negative human factors generally associated with EVS implementation of UV-C, e.g. high turnover and too many responsibilities to focus solely on UV-C disinfection.

The use of specialized UV-C operators provided a reliable and consistent means of implementing a proven disinfectant, resulting in a large cost savings for the hospital and a significant improvement to patient safety.

*Citations*: 1) CDC. https://www.cdc.gov/winnablebattles/report/hais.html
2) D. Anderson et al. (2017) https://doi.org/10.1016/s0140-6736(16)31588-4
3) M. Spender et al. (2017) http://dx.doi.org/10.1016/j.ajic.2016.11.016
4) N. Naplitano et al. (2015) https://dx.doi.org/10.1016/j.ajic.2015.07.006

*Authors*: 1) Kenneth Archulet, RN, CIC. Infection Prevention Manager, PHCMC.
2) Robert Raggi, MD, JD. Chief Medical Officer, PHCMC.
3) Cody Haag, BA. VP of R&D, CSGI.

*Disclosure*: This study was funded by Providence Holy Cross Medical Center. CH is an employee and stakeholder of CSGI.