Reduction of Methicillin-Resistant *Staphylococcus aureus* Surface Microbial Burden and related Healthcare Associated Infections with the Implementation of an Advanced Photocatalytic Oxidation Technology in a Medical-Surgical Intensive Care Unit

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Introduction

Methicillin-Resistant *Staphylococcus aureus* (MRSA) bacteria have long been established as a major cause of infections in the community and hospital. When MRSA infections occur in blood or other sterile sites, it is associated with poorer health outcomes and an increased risk of mortality[1]. This risk is increased when the MRSA infection is acquired in the healthcare setting. Hospital-onset MRSA (HO-MRSA) infections, for the purposes of this study, were defined as any positive MRSA culture that was collected on or after the 3rd hospital day. Despite numerous national initiatives to reduce invasive HO-MRSA infections, progress stalled in the late 2010s, with approximately 120,000 bloodstream infections and 20,000 associated deaths reported in the United States[2]. The ongoing COVID-19 pandemic has not only stymied reduction efforts but has precipitated increases in invasive hospital-onset MRSA infections, with researchers reporting increases of 12-34% in the national MRSA standardized infection ratios in 2020 compared to 2019[3]. The facility had seen similar increases in HO-MRSA infections, despite no change in clinical or cleaning and disinfection practices.

Methods

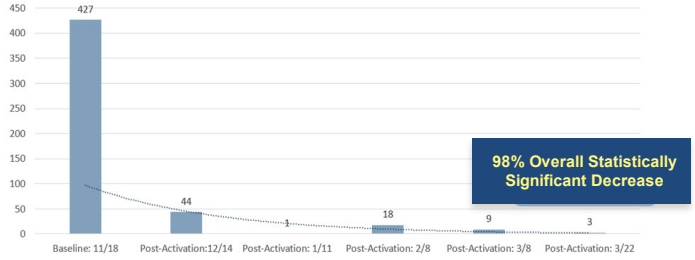
A prospective study was conducted in a 22-bed Medical-Surgical Intensive Care Unit in a 180-bed suburban hospital near New Orleans, Louisiana, from November 2021 to June 2022. Using sterile, pre-moistened sponges, 50 environmental surface samples were collected and plated onto chromagar for MRSA differentiation and enumeration. Samples were collected from frequently touched surfaces throughout the unit, including two nurses' stations, the physician charting area, and five areas in seven patient rooms. Then, the advanced photocatalytic oxidation (aPCO) equipment was installed into the HVAC ductwork throughout the ICU and activated. Environmental surface sampling of the same 50 surfaces was repeated every four weeks for the first five months of the study period. The facility's normal cleaning and disinfection protocols were unchanged and followed during the entire study period. HO-MRSA infections attributed to the unit were also tracked during the study period. Changes in MRSA surface burden were calculated using a repeated methods ANOVA with post hoc analyses as appropriate. Rates of HO-MRSA infections per 1,000 patient days were compared using the chi-square test. The data was communicated to the unit staff monthly.

Results

There was an overall 98% statistically significant decrease in MRSA environmental surface burden from the baseline to the final post-activation test (F= 69.359, p <.001). The average colony forming unit count (CFU) declined from 427 CFU/100cm^2 to 3 CFU/100cm^2 during the same period (Figure 1). Post hoc analyses with Bonferroni adjustment showed that the overall MRSA burden had a statistically significant decrease from baseline to every subsequent environmental test(Z=- 3.597, p <0.001; Z= -4.860, p <0.001; Z= -4.507, p <0.001; Z= -4.719, p <0.001).

Additionally, there were statistically significant decreases seen between post-activation tests, including between post activation tests one and two (Z= -3.818, p <0.001), post activation tests one and three (Z= -2.391, p =0.017), post activation tests one and four (Z= -2.769, p=0.006), post activation tests two and three (Z= -2.046, p=0.041), and post-activation tests two and four (Z= -2.120, p= 0.034). Healthcare-onset MRSA infections also had a statistically significant 100% decrease during the study period compared to the same time frame a year prior (χ^2= 8.29, p=0.004). There was also a statistically significant 100% decrease in HO-MRSA infections in the study period compared to the immediate six months prior to the study (χ^2= 8.365, p=0.003).

Figure 1



Conclusions

The advanced photocatalytic oxidation technology reduced MRSA on frequently touched surfaces in a high-traffic intensive care unit. Corresponding decreases in healthcare-onset MRSA cases were also seen. This study highlights a novel aPCO technology and its efficacy in reducing the microbial burden and healthcare-onset MRSA infections through the continued COVID-19 pandemic, despite no change in clinical or cleaning practices.

Figure 2 Baseline MRSA Burden

Legend: >500 CFU/100cm^2 · 1-99 CFU/100cm^2 · COVID-19 Patient · 100-499 CFU/100cm^2 · Not Detected · MRSA Patient

Figure 3 Final MRSA Burden

References

1. Boucher, H. W., & Corey, G. R. (2008). Epidemiology of Methicillin-Resistant *Staphylococcus aureus*. *Clinical Infectious Diseases*, *46*(S5), S344–S349. https://doi.org/10.1086/533590

2. Kourtis, A. P., Hatfield, K., Baggs, J., Mu, Y., See, I., Epson, E., Nadle, J., Kainer, M. A., Dumyati, G., Petit, S., Ray, S. M., Ham, D., Capers, C., Ewing, H., Coffin, N., McDonald, L. C., Jernigan, J., & Cardo, D. (2019). Vital Signs: Epidemiology and Recent Trends in Methicillin-Resistant and in Methicillin-Susceptible Staphylococcus aureus Bloodstream Infections — United States. *MMWR. Morbidity and Mortality Weekly Report*, *68*(9), 214–219. https://doi.org/10.15585/mmwr.mm6809e1

3. Weiner-Lastinger, L. M., Pattabiraman, V., Konnor, R. Y., Patel, P. R., Wong, E., Xu, S. Y., Smith, B., Edwards, J. R., & Dudeck, M. A. (2022). The impact of coronavirus disease 2019 (COVID-19) on healthcare-associated infections in 2020: A summary of data reported to the National Healthcare Safety Network. *Infection Control & Hospital Epidemiology*, *43*(1), 12–25. https://doi.org/10.1017/ice.2021.362