Infection Control & Hospital Epidemiology (2020), **41**, 113–115
doi:10.1017/ice.2019.286

Concise Communication

Introducing a nursing maintenance bundle for patients with pulmonary arterial catheters

Michael A. Ben-Aderet MD[1], Matthew J. P. Almario MPH[1], Meghan S. Madhusudhan MPH[1], Carissa Drucker BSN[1], Jeffery Luria BSN[1], Sneha Krishna MS[1], Laila Massie BSN[2], Catherine Bresee MS[3], Alice Chan MSN[2], Jimmy Nguyen MSN[2], Rekha K. Murthy MD[4] and Jonathan D. Grein MD[1]

[1]Department of Hospital Epidemiology, Cedars-Sinai Medical Center, Los Angeles, California, [2]Department of Nursing, Cedars-Sinai Medical Center, Los Angeles, California, [3]Biostatistics and Bioinformatics Research Center, Cedars-Sinai Medical Center, Los Angeles, California and [4]Department of Medical Affairs, Cedars-Sinai Medical Center, Los Angeles, California

Abstract

We undertook a quality improvement project to address challenges with pulmonary artery catheter (PAC) line maintenance in a setting of low-baseline central-line infection rates. We observed a subsequent reduction in *Staphylococcal* PAC line infections and a trend toward a reduction in overall PAC infection rates over 1 year.

(Received 27 June 2019; accepted 15 September 2019; electronically published 21 October 2019)

Central-line–associated bloodstream infections (CLABSIs) increase patient length of stay and hospital costs and contribute to morbidity and mortality.[1] Although sterile insertion bundles reduce CLABSI incidence[2,3] and have been incorporated into prevention guidelines,[2] few data are available concerning maintenance bundles, though limited evidence suggests their effectiveness.[3,4]

Pulmonary artery catheters (PACs) are often used as a part of heart transplant evaluation. Although few data are available regarding CLABSI prevention in PACs, studies suggest that bacterial colonization of the insertion site increases PAC CLABSI risk.[5]

We identified an increase in PAC CLABSIs in 2017 at our institution despite stable overall CLABSI numbers. Feedback from real-time case reviews performed for all PAC CLABSIs in 2017 suggested broader issues maintaining intact dressings in these lines. Subsequently, we implemented a quality improvement project to improve dressing maintenance and to reduce the incidence of PAC CLABSIs.

Methods

This intervention was implemented in an 886-bed tertiary-care academic hospital performing > 100 heart transplants per year. PACs are frequently used in ICU and non-ICU settings. CLABSI prevention includes sterile insertion bundles, universal daily chlorhexidine (CHG) bathing, alcohol-impregnated port protectors, and audits.[2] All CLABSIs are reviewed with clinical staff in real-time case reviews. CLABSI surveillance is performed by CIC-certified infection preventionists using Centers for Disease Control/National Health Safety Network (NHSN) methodology.[1]

This intervention was a multidisciplinary project to introduce new dressing kits specific to PACs and to develop specific education for all nurses caring for patients with PACs. Baseline dressing kits available to nurses included a single transparent bandage, CHG swab, sterile gloves, mask, and tweezers. Kits for PACs were updated with a skin prep (Cavilon, 3M, Maplewood, MN), narrow beard-clipper blades, and a second anchoring bandage. Education was performed in a 1:1 fashion by nurses on the units who were designated "champions" and who had been educated on the proper use of products by company representatives. Using patient mannequins, all nurses on target units (~250 nurses) were educated on the use of skip prep, CHG (including optimal dry times), dressing removal, beard clipping, and techniques emphasizing skin integrity and sterility.

The multidisciplinary bundle was implemented between January 1, 2018, and April 30, 2018. The postintervention period was May 1, 2018, through April 30, 2019. We compared the outcomes from this period with those from our preintervention period (January 1, 2017, through December 31, 2017). There were no changes to CLABSI surveillance during this time. During the first 4 months of the postintervention period, infection preventionists performed weekly audits on an electronically generated list of all patients with PACs, inspecting PAC dressings to ensure integrity.

Patient-level data were abstracted from electronic records and included dates and durations of each catheter. All infections meeting NHSN CLABSI criteria were included in this analysis if there was a PAC in place at the time of infection or within 2 days prior.[1]

CLABSI rates were computed as the number of infections per day of exposure. Differences in catheter-line duration were tested with mixed model regression, and CLABSI rates were tested with

Author for correspondence: Michael A. Ben-Aderet, Email: Michael.Ben-Aderet@cshs.org
Cite this article: Ben-Aderet MA, *et al.* (2020). Introducing a nursing maintenance bundle for patients with pulmonary arterial catheters. *Infection Control & Hospital Epidemiology*, 41: 113–115, https://doi.org/10.1017/ice.2019.286

Table 1. CLABSI Rates and Characteristics Before and After Implementation of a PAC Line Dressing Intervention at an Academic Medical Center

Variable	Pre intervention (Jan–Dec 2017)	Post intervention (May 2018–Apr 2019)	P Value[a]
Patients with PAC, no.	506	481	...
PACs, no.	614	567	...
Average PAC duration, d	7.3 ± 0.41	8.0 ± 0.43	.46
PAC CLABSIs, no.	10	4	...
Non-PAC CLABSIs, no.	36	33	...
Median days to PAC CLABSI	7.5	15.0	.07
PAC line days, no.	4,487	4,516	...
PAC CLABSI	*Staphylococcus epidermidis* (n = 6) *S. aureus* (n = 2) *Enterococcus faecalis* (n = 1) *Escherichia coli* (n = 1)	*S. aureus* (n = 1) *Klebsiella pneumoniae* (n = 1) *Enterobacter cloacae* complex (n = 1) *Candida albicans/E. coli* (n = 1)	...
PAC CLABSI rate[b]	2.23 ± 0.67[c]	0.88 ± 0.43	.11
Non-PAC CLABSI rate[b]	0.62 ± 0.11	0.56 ± 0.09	.69
Staphylococcus spp PAC CLABSI rate[b]	1.78 ± 0.61	0.22 ± 0.03	.04

Note. CLABSI, central-line–associated bloodstream infection; PAC, pulmonary artery catheter;
[a]All *P* values reflect comparison with preintervention rate.
[b]CLABSI/1,000 catheter days.
[c]All intervals shown ± standard error.

Poisson regression. Median time to CLABSI was tested using marginal Cox modeling. Data were statistically significant where $P < .05$. The statistical analysis was performed using SAS version 9.4 software (SAS Institute, Cary, NC).

Results

Key outcomes from the intervention are summarized in Table 1. During the preintervention period, 46 CLABSIs occurred hospital-wide. The overall standardized infection ratio (SIR) was 0.7, reflecting a better-than-expected infection rate according to NHSN models.[7] CLABSI occurred in 10 patients with a PAC, representing 22% of total. We observed that the PAC CLABSI rate was 2.23, whereas the non-PAC CLABSI rate was 0.80 CLABSI per 1,000 central-line days. Of 10 PAC CLABSIs, 6 (60%) were listed for heart transplant and 8 (80%) involved *Staphylococcus* spp. Real-time case reviews identified that nearly all PAC infections (90%) were preceded by frequent dressing changes, driven by difficulties maintaining intact and occlusive line dressings. Contributing factors included beard growth, patient ambulation, inadequate use of dressing material, and the weight/location of the catheters.

Overall, 4 PAC CLABSIs occurred during the postintervention period: all in patients being evaluated for heart transplant, and 1 (25%) with *Staphylococcus*. In 1 patient, (25%) nurses reported challenges maintaining the dressing; further investigation confirmed that the updated kits had not been used in that patient. Weekly line audits demonstrated improvement in proportion of PACs with occlusive dressings, from 53% (19 of 36) in May 2018 to 76% (45 of 59) in August 2018.

Compared to the preintervention period, a lower PAC CLABSI rate was observed in the postintervention phase (61% reduction) and a significant reduction occurred in PAC CLABSIs associated with *Staphylococcus* spp (88% reduction). Average PAC duration and line days were stable across the 2 periods (Table 1).

Discussion

We implemented a project utilizing nursing feedback to improve PAC dressing integrity and reinforce PAC-specific education, which was associated with improvement in dressing occlusion and 61% reduction in PAC infection rates. Although small numbers of events limited our ability to demonstrate statistical significance, this trend is clinically relevant and is linked to a significant reduction in PAC infections associated with *Staphylococcus* spp. Although existing maintenance bundles emphasize the role of maintaining sterile and intact catheter dressings,[2–4] our project focused on the role of bedside nursing technique in achieving these aims.

Staphylococcus are skin flora and predominant organisms associated with catheter infections.[8] Coagulase-negative *Staphylococcus* and *S. aureus* represented 16.4% and 13.2% of overall CLABSIs, respectively. *Staphylococcus* spp likely comprise an even higher proportion of CLABSI in PACs.[5,6] We hypothesized that our intervention led to a greater reduction in these CLABSIs by improving the sterility of line dressings and by keeping them occlusive longer, thus limiting skin flora contamination.

This study has several strengths. It was multidisciplinary, involving nursing, cardiology, materials management, and epidemiology. Surveillance was consistent and CLABSI definition was standardized using NHSN criteria. Sustainment includes permanent changes in nursing education, dressing kits, and ongoing monitoring by infection preventionists. The limitations of this study included risk of observation bias. The project was an unblinded quality improvement project, and we were unable to collect dressing integrity data before the intervention for comparison to postintervention findings. Also, athough PAC CLABSI reduction was sustained over 1 year, it is too early to assess long-term impacts.

In summary, we observed reductions in PAC CLABSIs following a nursing-centered intervention to improve dressing care, reinforcing that maintaining an aseptic insertion site by improving dressing integrity can prevent CLABSIs, even in a setting with pre-existing low rates. Additionally, these findings highlight the critical role of nurses in CLABSI prevention after line insertion.

Acknowledgements. The authors thank the following staff for assistance with project implementation: Jillian Felice MSN, Carol Noseworthy, Zachary Krom MSN, Jose Chavez MSN, Emily Gaddam BSN, and Charito Olay BSN.

Financial support. No financial support was provided relevant to this article.

Conflicts of interest. All authors report no conflicts of interest relevant to this article.

References

1. Bloodstream infection event (central line-associated bloodstream infection and non–central-line-associated bloodstream infection). Centers for Disease Control and Prevention website. https://www.cdc.gov/nhsn/pdfs/pscmanual/4psc_clabscurrent.pdf. Updated January 2019. Accessed September 30, 2019.
2. O'Grady, NP, Alexander, M, Burns, LA, *et al.* Guidelines for the prevention of intravascular catheter-related infections. *Clin Infect Dis* 2011;52(9):e162–e193.

https://doi.org/10.1017/ice.2019.286 Published online by Cambridge University Press

3. Marschall, J, Mermel, LA, Fakih, M, *et al*. Strategies to prevent central line-associated bloodstream infections in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol* 2014;35:753–771.
4. Preventing central line–associated bloodstream infections: useful tools, an international perspective. The Joint Commission website. http://www.jointcommission.org/CLABSIToolkit, Published 2013. Accessed September 30, 2019.
5. Kac G, Durain E, Amrein C, Herisson E, Fiemeyer A, Buu-Hoi A. Colonization and infection of pulmonary artery catheter in cardiac surgery patients: epidemiology and multivariate analysis of risk factors. *Crit Care Med* 2001;29:971–975.
6. Yetmar Z, Lahr B, O'Horo J, Behfar A, Sampathkumar P, Beam E. Pulmonary artery catheter epidemiology of risk in pre–heart-transplant recipients. *Infect Control Hosp Epidemiol* 2019;40:632–638.
7. National Healthcare Safety Network. The NHSN standardized infection ratio (SIR). Centers for Disease Control and Prevention website. https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/nhsn-sir-guide.pdf. Updated March 2019. Accessed September 30, 2019.
8. Weiner, LM, Webb, AK, Limbago, B, *et al*. Antimicrobial-resistant pathogens associated with healthcare-associated infections: summary of data reported to the National Healthcare Safety Network at the Centers for Disease Control and Prevention, 2011–2014. *Infect Control Hosp Epidemiol* 2016;37:1288–1301.

https://doi.org/10.1017/ice.2019.286 Published online by Cambridge University Press