


## Concise Communication

# A quality improvement project to decrease utilization of multilumen peripherally inserted central catheters

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### Abstract

We performed a quality improvement project to decrease utilization of multilumen peripherally inserted central catheters (PICCs) in favor of single-lumen PICCs and midline catheters. Through optimization of electronic orders, education and decision support, we decreased utilization of multilumen PICCs, changed provider ordering patterns, and showed a downward trend in CLABSIs.

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Peripherally inserted central catheters (PICCs) are increasingly used for vascular access. At our institution, >4,000 PICCs are placed each year by highly trained vascular access nurses. Although PICCs are generally considered safe and effective,<sup>1</sup> they do carry risk of infection and thrombosis.<sup>2–5</sup> This risk increases with an increasing number of lumens.<sup>4,6</sup> PICC-associated complications negatively impact patient outcomes, healthcare costs, and central-line-associated bloodstream infection (CLABSI) rates. As PICC utilization rates have increased, PICCs now contribute to a significant number of CLABSIs each year. We reviewed PICC usage at our institution and designed interventions to improve utilization.

### Methods

On review of our PICC data, we found that multilumen PICCs were used in the majority of inpatients. Audits identified that frequently more lumens were placed than were clinically required and that midline catheters were relatively underutilized.

A multidisciplinary team composed of infectious disease experts, hospital-based clinicians, and PICC nurses was formed to address overutilization of multilumen PICCs. The team used six-sigma methodology and followed the define, measure, analyze, implement, control (DMAIC) framework to guide analysis and interventions.

Process mapping, semistructured interviews with key stakeholders, electronic surveys, and audits were conducted to identify

gaps and guided interventions. Three key gaps emerged: poorly designed electronic orders, knowledge deficits, and a culture of overutilization. First, the electronic orders did not help providers choose the correct line and did not prompt them to convey key clinical information to the PICC team. Consequently, the PICC nurses expended a significant amount of time verifying the order's appropriateness before PICC placement. Second, surveys revealed that providers had knowledge gaps regarding appropriate line selection and utilization of midline catheters. Lastly, our analysis identified a pervasive misconception that "more is better" regarding the number of PICC lumens, related to lack of knowledge of the associated risks and a culture of convenience. Moreover, due to their perception of the medical hierarchy, PICC nurses frequently deferred to the provider's request for more lumens, even if the request was misguided.

On the basis of the information gathered, the quality improvement team designed a multipronged intervention to decrease the overall utilization of PICCs, to decrease number of lumens and to increase midline catheter use when appropriate.

### Intervention

The intervention included 3 components to address the key gaps identified: changes to the electronic ordering system, educational interventions, and clinical decision support.

First, modifications to the electronic order for a PICC required clinicians to include the indication for the line and to document the patient's renal function and anticipated duration of use. The number of lumens was defaulted to a single lumen unless otherwise specified. The additional information in the order allowed PICC nurses to better assess line appropriateness.

To address knowledge gaps, an informational screen was added to the order to help providers select the most appropriate line and to identify situations in which a midline catheter would be appropriate. Educational presentations emphasizing use of the Michigan Appropriateness Guide for Intravenous Catheters (MAGIC) were

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**PREVIOUS PRESENTATION.** Portions of this quality improvement work were presented at a poster session at the annual meeting of the Society of Hospital Medicine on March 25, 2019, in National Harbor, Maryland, and at the Institute for Healthcare Improvement National Forum on December 11, 2018, in Orlando, Florida. The abstract was accepted for poster presentation at the SHEA/CDC Decennial Meeting, ultimately, however, it was not presented due to the cancellation of the meeting.

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**Table 1.** Utilization of PICCs and Midline Catheters and PICC-Related CLABSIs Before and After the Intervention

Variable	Before the Intervention (12 mo)	After the Intervention (24 mo)	P Value <sup>a</sup>
<b>PICCs</b>			
Lumens, no. (%)			
Single	1,327 (28.5)	3,121 (41.9)	<.0001 <sup>a</sup>
Double	1,806 (38.8)	2,670 (35.8)	.0009 <sup>a</sup>
Triple	1,485 (31.9)	1,666 (22.3)	<.0001 <sup>a</sup>
Monthly utilization rates <sup>b</sup>			
Single lumen	110.6	130.0	.0074 <sup>a</sup>
Double lumen	150.5	111.3	<.0001 <sup>a</sup>
Triple lumen	123.8	69.4	<.0001 <sup>a</sup>
Total PICCs	387.9	310.7	<.0001 <sup>a</sup>
<b>Midline catheters</b>			
Proportion of total lines, no. (%)	434 (8.5)	929 (11.1)	<.001 <sup>a</sup>
Monthly utilization rate <sup>b</sup>	36.2	38.7	.546
<b>CLABSIs</b>			
PICC-related CLABSI events	31	51	.90

Note. PICC, peripherally inserted central catheter; CLABSI, central-line-associated bloodstream infection.

<sup>a</sup>Global P value comparing the number of single, double, and triple lumen catheters and midline catheters placed before versus after the intervention,  $P < .001$ .

<sup>b</sup>Average number of devices placed per month.

given, and an electronic tool kit of resources was created, including simple algorithms and posters.<sup>7</sup>

Lastly, a team of physician vascular access subject matter experts (SMEs) was created to provide decision support to the PICC team and to ordering providers. These physicians serve as a resource for the PICC team when concerns arise about appropriateness of a vascular access request. When called by the PICC team, they review the case and speak with the ordering provider to offer guidance on appropriate line selection.

### Measures and definitions

All PICCs and midline catheters inserted by the PICC RN team in adult inpatients from July 1, 2016, through June 30, 2019, were included in the analysis. PICCs inserted by interventional radiology staff or in the outpatient setting were excluded. CLABSI data were obtained from the hospital's infection control database.

### Outcomes

The primary outcome of interest was the change in the proportion of triple-lumen PICCs inserted. Secondary outcomes were the changes in proportion of single-lumen PICCs, proportion of midline catheters, overall volumes of PICCs inserted, and CLABSIs in patients with PICC lines.

### Statistical analysis

The  $\chi^2$  test was used to compare the differences in proportion of single-, double-, triple-lumen PICCs and midline catheters inserted before and after the intervention. The Student *t* test was used to compare average monthly insertion rate changes between the pre- and postintervention groups.

### Results

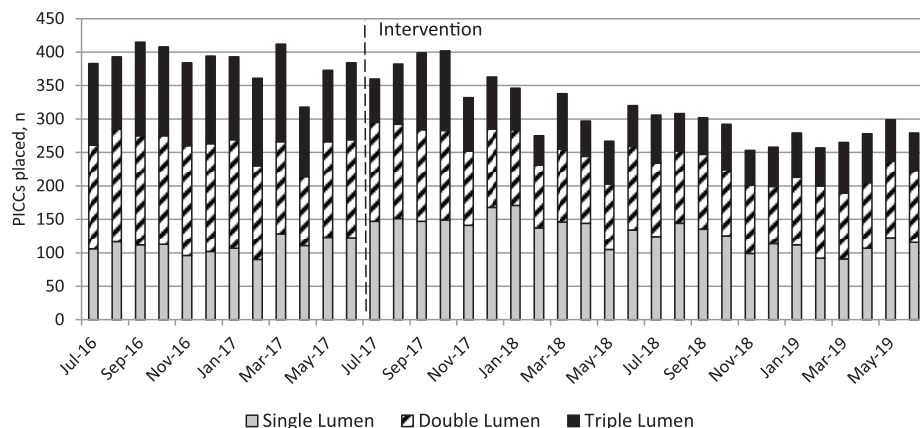
In total, 12,112 PICCs and 1,363 midline catheters placed between July 1, 2016, and June 30, 2019, were included in the analysis. Of these, 4,655 PICCs and 434 midline catheters were placed during the 12-month preintervention period, and 7,457 PICCs and 929 midline catheters were placed during the 24 months following our intervention. The results of our intervention are presented in Table 1. Following implementation of the intervention, the monthly volumes and proportion of triple-lumen PICCs decreased with a concurrent increase in the proportion and volume of single-lumen PICCs (Fig. 1). Overall PICC line utilization also decreased.

Midline catheter monthly insertion volumes remained steady between the pre- and postintervention periods; however, they comprised a higher proportion of total lines placed (PICCs and midline catheters) in the postintervention period. Similarly, there was a sharp decline in the number of multilumen PICCs (ie, combined double- and triple-lumen PICCs) and an increase in the number of single-lumen devices (ie, single-lumen PICCs and midline catheters).

We detected a downward trend in PICC-related CLABSI events in the postintervention period, with 31 events in the 12 months preintervention compared with 51 events in the 24 months postintervention; however this decrease did not meet statistical significance.

### Discussion

We successfully reduced utilization of triple-lumen PICCs and increased relative utilization of single-lumen PICCs and midline catheters at our institution. We also observed a significant decline in overall PICC utilization, which was the first decline in yearly PICC volumes since the PICC team was started. We observed a downward trend in PICC-related CLABSIs in hospitalized patients, and we expect that the improved utilization will



**Fig. 1.** Monthly volumes of single-, double-, and triple-lumen peripherally inserted central catheters (PICCs) before and after the implementation of the interventions.

have numerous additional downstream benefits in decreasing complications.

Our study demonstrates that optimizing the electronic order system, in conjunction with targeted education and decision support, can have a sustained impact on provider ordering behavior and can shift the culture of utilization, even in a large academic medical center with frequent turnover of trainees.

This study has several limitations. As our intervention was multimodal, so we were unable to determine which component of the intervention was most effective. Although we did observe a downward in PICC-related CLABSIs, this was not statistically significant in the study period. We did not have accurate data on PICC line days to determine a change in this metric. Additionally, we did not have data on direct cost or thrombosis rates, though we expect improvement based on the results of previous studies.<sup>8,9</sup>

In conclusion, our intervention led to a significant and sustained decrease in the utilization of multilumen PICCs and a relative increase in utilization of single-lumen PICCs, with an associated downward trend in PICC-related CLABSI events. Future studies should be done across multiple sites to validate these findings with the statistical power needed to show expected improvements in clinical outcomes, particularly in infection and thrombosis and cost-effectiveness.

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

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