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Major Article

Infection free midline catheter implementation at a community hospital (2 years)

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Key Words:

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CLABSI**Background:** To reduce excess central line use and provide an option for difficult venous access patients through the introduction of a midline catheter.**Methods:** Design included prospective monitoring of the implementation of a quality improvement project. The setting was a 576 bed, urban, community, nonprofit, Magnet recognized, level 3 trauma center serving primarily adult patients. Midline and peripherally inserted central catheters were inserted by a specialty nursing team; care and maintenance of all devices were provided by front line staff.**Results:** Zero midline catheter infections were observed in the 24 months after implementation of the fixed length, power injectable device. Completion of therapy was 80%, the most frequently encountered complication was device dislodgement.**Conclusions:** Adoption of a vascular access nurse led midline catheter program, coupled with device selection algorithms expanded the ability to select the right device for the patient, while decreasing excess central line usage without additional increased risks to the patient.

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Over the past years, there has been ongoing and increasing awareness of the need to reduce or eliminate central line– associated bloodstream infections (CLABSI). Initial efforts focused heavily on implementation of the central line insertion bundle after the results described by Pronovost et al¹ from their Keystone project demonstrating the possibility of “getting to zero.” Ongoing efforts and data analysis have led to equal emphasis on the care and maintenance phase of the catheters. Beyond that, a critical question of device necessity must be asked. Understanding the clinical need for a central line versus just a need for vascular access is a topic that has not received sufficient attention at the bedside. Guidelines and standards call for a daily review of central line necessity, but fall short of providing a framework for staff identifying whether it is the most appropriate access for the patient and therefore truly necessary.^{2,3} With the publication of the Michigan Appropriateness Guide for Intravenous

Catheters (MAGIC) recommendations, organizations were given a thoughtful framework to help assess current device selection patterns compared with recommendations from an expert panel.⁴ This article (and subsequent related tools) helps describe various clinical situations in which specific catheter types (from short peripheral catheters through tunneled and fully implanted devices) are indicated, preferred, not recommended, or without consensus.

OBJECTIVE

Our organization launched a midline catheter program as part of its CLABSI prevention strategy, with a focus on reducing unnecessary central line days and decreasing CLABSI. Of interest was ensuring that the introduction of a new device type was not a source of any increased risk to our patients in terms of infectious as well as noninfectious complications. Others have reported various implementation strategies with favorable outcomes.^{5–9} Each of the reports started with a clearly defined goal and patient population and quantified the impact of device implementation. Focuses included emergency room difficult access patients, surgical intensive care, as well as broader hospital implementation. Our organization’s vascular access team had identified a need for a midline catheter. There was team

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consensus that leaving peripherally inserted central catheters (PICC) at a midline tip termination created an unacceptable patient safety risk. That concern is due to staff misidentifying the line (assuming it is a central line owing to intended purpose of the manufactured device) and the potential complications with inadvertent infusion of nonperipherally compatible infusates. Infection control supported an opportunity to reduce unnecessary central line days provided that there was not an increase noted in bloodstream infections with the midline catheters. The organization had previously adopted clinical indication policies for short peripheral catheters (PIVs), removing time-based site rotation for these devices.¹⁰ Despite 20% of PIVs now achieving >7 days of dwell time and 35% lasting beyond 5 days, we were falling short with achieving true completion of therapy with these devices when longer courses of therapy were indicated.¹¹ There were remaining opportunities for patients who required longer term vascular access but did not require a central line-based on infusate or other patient considerations.

METHODS

The vascular access team identified 2 fixed length midline catheters to evaluate based on contractual obligations and clinician preference. Both devices were placed using a modified Seldinger technique and employing maximum sterile barrier precautions. Dressings were changed at least every 7 days or sooner if wet, soiled, or loose. Bio-patch and alcohol caps were used on all inpatient vascular access devices. Care and maintenance were provided by bedside staff. Industry representatives provided onsite training and assistance to the team throughout the trial period. After 4 months with unsuccessful implementation of the first option provided (largely owing to difficulty with insertion among members of the team), they began a trial of a second device (an 8 cm, fixed length power injectable catheter) that was ultimately adopted. Shortly after implementing the 8 cm line, a 10 cm version became available and was also introduced. The organization has a significant bariatric population that made the longer, 10 cm version a useful addition to available vascular access options. An alternate (polyurethane, trimmable, nonpower injectable) catheter was also made available as a secondary choice for patients requiring a longer catheter.

An infection prevention and control certified microbiologist on the infection prevention team prospectively reviews all positive blood cultures to identify whether they qualify as laboratory-confirmed bloodstream infections after the current National Healthcare Safety Network (NHSN) surveillance protocol for CLABSI and non-CLABSI.¹² Patients identified as having a primary bloodstream infection are further reviewed to identify which vascular access devices were in place the day of or the day before the infection, and verify that access has been in place for at least 3 calendar days. This methodology has been used in our organization for 16 years, shifting slightly each year as the new NHSN protocols are released.

Review of the electronic medical record was completed to determine the inpatient device days (counted using the NHSN methodology with insertion day counting as day 1) for the primary device as well as the removal date and reason. These numbers were used to determine completion of therapy (avoidance of premature removal of the device because of complication) of the device as well as complications rates.

The outcomes were concurrently monitored and reported over the first several months of implementation to understand overall performance characteristics of the chosen device. Data from the initial year were collaboratively abstracted by the senior infection control officer and 1 of the vascular access team nurses. When the first year of analysis was presented internally, the team found it somewhat difficult to interpret the complication rates without context in relation to the other devices they placed. That prompted inclusion of

parallel data on a 605 line review of peripheral catheters (placed almost exclusively by emergency room and bedside staff) and a sample of 4 months (286 lines) of PICC placements by the team. After presentation of that data, prospective monitoring was implemented as an expectation of all members of the vascular access team on all PICCs and midline catheters placed. Monthly analysis was originally conducted and presented by infection control but transitioned to autocalculating templates to allow the teams (infection control as well as vascular access) to more easily understand line performance on demand and further engage the team in understanding the outcomes associated with the devices they choose to insert. Data quality checks were conducted by infection control and data collection spreadsheets continually updated to allow consistency in the data being collected.

Process and outcome surveillance are part of the approved scope of the infection control program at the institution with ongoing review of performance of vascular access devices. This review of outcomes associated with introduction of a new class of device is part of our quality improvement efforts that are regularly reviewed and reported. Institutional review board approval was not required.

RESULTS

Throughout the first 2 years of the midline catheter program discussed in this manuscript, there were zero bloodstream infections associated with the primary midline device (Powerwand, Access Scientific) over 5,430 midline days. As of this writing, it remains the only device within our organization that has never been associated with a bloodstream infection beyond 1 year. A small number of infections (1.07/1,000 midline days in 2016 and 0.8/1,000 midline days in 2017) were identified in both 2016 and 2017 with the alternate device (Bard Access, poly midline catheter, inserted with modified Seldinger technique). PICC placements by the vascular access team decreased 35% after the first year of the midline catheter program introduction.

The data are reflected in the graph depicting the consistent outcomes with Powerwand across both initial years of the midline catheter program (Fig 1). Key complications reviewed included infiltration, device dislodgement, kinking, occlusion, and bloodstream infection. These rates were not significantly different between the 2 years. During a 9 month period the same year, PICC CLABSIs in lines placed by the vascular access team were 1.83/1,000 PICC days. Dislodgement rates were similar between the PICCs (7%) and midline catheters (8%), better than what was seen with the PIVs (14%) in the sample. Infiltration rates, not surprisingly, were markedly lower in the midline catheters (1.4%) than short peripheral catheters (17%).

DISCUSSION

Although bloodstream infections are arguably the most serious complication associated with vascular access, the considerations and complications extend far beyond infections.

Older published work identified the incidence of midline catheter bloodstream infections at 0.2/1,000 midline days.¹³ Midline catheters are longer peripheral devices defined by a tip location at the axilla, below the shoulder generally selected for therapies of 1–4 weeks. Like other peripheral devices, they are not appropriate for infusates that require central administration. They do, however, provide an option for patients requiring more extended infusions of peripherally compatible medications and fluids, thereby providing an option for both difficult access patients and circumstances in which PICCs may have been placed owing to longer anticipated infusion needs than achievable via PIV. Although no vascular access device is recommended to be removed based on length of dwell, expected performance for longer dwell is more favorable with a midline rather than a traditional short peripheral catheter. Differences noted between the

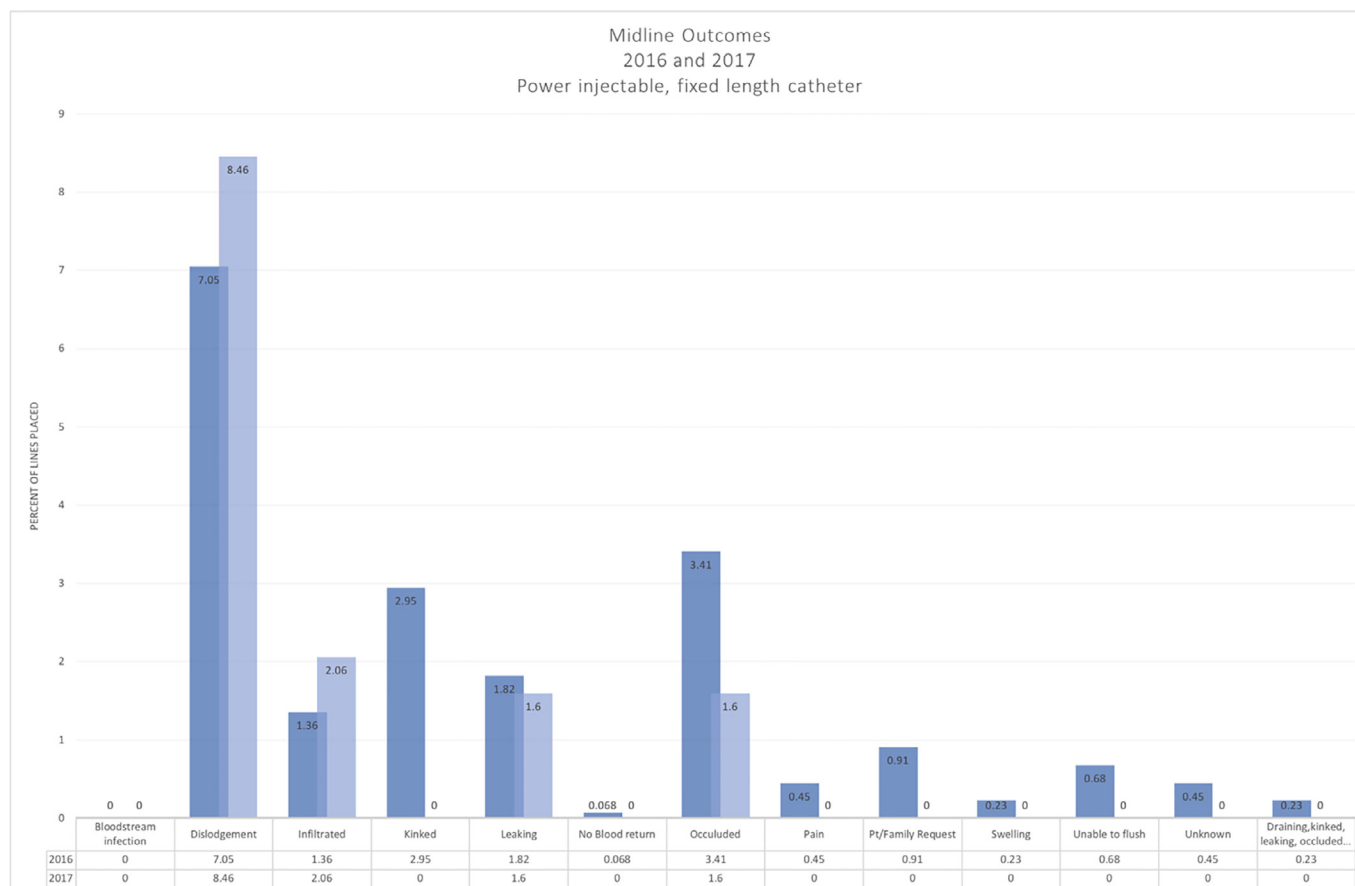


Fig 1. Review of outcomes with power injectable, fixed length (8 and 10 cm) midline during the first 2 years of implementation.

2 midline catheters during this review, although not yet statistically significant, is a key differentiator within our facility when identifying the most appropriate line. The finding of zero Powerwand infections has been reported by other organizations as well.^{5,8,14} Recent laboratory studies have demonstrated that the material this catheter is made of appears to resist bacterial adhesion and biofilm formation when compared to a standard polyurethane catheter.¹⁵ This may, in part, explain the differences observed in our organization.

Appreciating the difference in outcomes among the spectrum of devices available for the vascular access team to insert allows them to be patient advocates. Although PICCs were noted to have a higher completion of therapy (92% vs 80%), the overall CLABSI rate for PICCs placed by the team was 1.83/1,000 PICC days during the period of this review, making careful assessment of a true indication for a central line crucial to ensuring patients are not unnecessarily exposed to an increased infectious risk. We define completion of therapy as the device remaining functional throughout its intended indication. Prior to the introduction of the midline catheter program, the 5,430 Powerwand days reported in this article would most likely have become PICC days based on the previous insertion decisions made by the team. Extrapolating that to the PICC CLABSI rate noted during that time, this may have been associated with 10 (9.77) additional CLABSIs, and at least 1 avoided death using a conservative 15% mortality estimate for CLABSI. Understanding the relationships of these devices helps inform responsible device selection recommendations for our vascular access team and a source of valuable information to use when educating providers.

There has been a shift to midline catheters and other peripheral devices in some organizations with the somewhat misguided philosophy that no central lines equal no CLABSI (and its associated

penalties). The problem with that approach is it does not take into consideration that there are very clear indications for central lines, and from a patient safety perspective it is inappropriate to use a short peripheral catheter or midline catheter in those circumstances. In our organization, the decision to place a midline catheter is at the discretion of the vascular access nurse with consultation with the ordering provider if indicated. In late 2017, order sets were added to include MAGIC criteria for assisting providers with ordering the appropriate devices and daily review of line necessity flowsheets were expanded to include appropriate indications for a central line; additionally, best practice alerts were created to flag review of central line necessity by providers every 48 hours to help drive decisions to remove central lines that no longer have a clear indication. Vascular access policies are drafted to mirror these recommendations and all bedside nurses received education (via webinar) on appropriate line indications based on the MAGIC criteria.

CONCLUSIONS

Vascular access choices require a clear understanding of patient needs, vessel health, and preservation concepts and length and nature of prescribed therapy. Guidelines, standards, and published literature offer an excellent starting point to determine appropriate device selection, but equally important is understanding the performance of those devices once placed within an organization by that facility's available inserters and the staff who are providing care and maintenance. Using that information to continuously inform the inserters (and providers) can help ensure device selections remain evidence-based and with a clear understanding of patient safety implication. In our large, urban community hospital, infection

prevention and vascular access teams were able to successfully launch a carefully controlled midline catheter program without any reported infections (with the primary device), maintaining an 80% completion of therapy, while at the same time helping decrease excess central line placements and their associated CLABSI risk.

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References

1. Pronovost P, Needham D, Berenholtz S, Sinopoli D, Chu H, Cosgrove S, et al. An intervention to decrease catheter-related bloodstream infections in the ICU. *N Engl J Med* 2006;355:2725–32.
2. O'Grady NP, Alexander M, Burns LA, Dellinger EP, Garland J, Heard SO, et al. Guidelines for the prevention of intravascular catheter-related infections. *Clin Infect Dis* 2011;52:e162–93.
3. Gorski L, Hadaway L, Hagle ME, McGoldrick M, Orr M, Doellman D. Infusion therapy standards of practice. *J Infus Nurs* 2016;39(suppl 1):S1–S159.
4. Chopra V, Flanders SA, Saint S, Woller SC, O'Grady NP, Safdar N, et al. The Michigan Appropriateness Guide for Intravenous Catheters (MAGIC): results from a multispecialty panel using the RAND/UCLA appropriateness method. *Ann Intern Med* 2015;163(6 Suppl):1–40.
5. Moureau N, Sigl G, Hill M. How to establish an effective midline program: a case study of 2 hospitals. *J Vasc Access* 2015;20:179–88.
6. Scoppettuolo G, Pittiruti M, Pitoni S, Dolcetti L, Emoli A, Mitidieri A, et al. Ultrasound-guided “short” midline catheters for difficult venous access in the emergency department: a retrospective analysis. *Int J Emerg Med* 2016;9:3.
7. Adams DZ, Little A, Vinsant C, Khandelwal S. The midline catheter: a clinical review. *J Emerg Med* 2016;51:252–8.
8. Pathak R, Gangina S, Jairam F, Hinton K. A vascular access and midlines program can decrease hospital-acquired central line-associated bloodstream infections and cost to a community-based hospital. *Ther Clin Risk Manag* 2018;14:1453–6.
9. Deutsch GB, Sathyanarayana SA, Singh N, Nicastro J. Ultrasound-guided placement of midline catheters in the surgical intensive care unit: a cost-effective proposal for timely central line removal. *J Surg Res* 2014;191:1–5.
10. DeVries M, Valentine M, Mancos P. Protected clinical indication of peripheral intravenous lines: successful implementation. *J Vasc Access* 2016;21:89–92.
11. DeVries M, Strimbu K. Short peripheral catheter performance following adoption of clinical indication removal. *J Infus Nurs* 2019;42:81–90.
12. Centers for Disease Control (CDC). Bloodstream Infection Event (Central Line-Associated Bloodstream Infection and non-central line-associated Bloodstream Infection). Published January 2019. https://www.cdc.gov/nhsn/pdfs/pscmanual/4psc_clabscurrent.pdf. Accessed April 17, 2019.
13. Maki DG, Kluger DM, Crnich CJ. The risk of bloodstream infection in adults with different intravascular devices: a systematic review of 200 published prospective studies. *Mayo Clin Proc* 2006;81:1159–71.
14. Caparas JV, Hu JP. Safe administration of vancomycin through a novel midline catheter: a randomized, prospective clinical trial. *J Vasc Access* 2014;15:251–6.
15. Pathak R, Bierman S, d'Arnaud P. Inhibition of bacterial attachment and biofilm formation by a novel intravenous catheter material using an in vitro percutaneous catheter insertion model. *Med Devices (Auckl)* 2018;11:427–32.