



How to Establish an Effective Midline Program: A Case Study of 2 Hospitals

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Abstract

Introduction: Establishing an effective midline program involves more than simply learning an insertion technique for a new product. Midline catheters provide a reliable vascular access option for those patients with difficult venous access who would otherwise require multiple venipunctures or the use of higher-risk central lines to maintain access. An effective midline program establishes a protocol for device selection and includes standing orders to facilitate speed to placement.

Methods: Our retrospective descriptive review evaluated the successful integration of midline programs into existing vascular access bedside insertion programs in 2 acute care hospitals. The investigator reviewed a convenience sample of hospital patients. Participants in the study included vascular access team managers and team members from the sample sites.

Results: The results of this 2-hospital study demonstrate successful integration of a midline program into a bedside insertion program with 0 midline-related infections since initiation. Documentation of overall central line-associated bloodstream infection rates for hospital 1 changed from 1.7/1000 catheter-days to 0.2/1000 catheter-days, reflecting a 78% reduction in infections and a projected cost avoidance of \$531,570 annually. Both hospitals demonstrated reduced rates of infection following implementation of a midline program.

Conclusions: Midlines have a history of lower risk for both infection and thrombosis compared with central venous devices. Although more research is needed on the more recently developed midline catheters, available evidence suggests that midlines provide a safe and reliable form of vascular access, reducing costs and the risk of infection associated with central venous catheters, especially those placed solely for patients with difficult venous access.

Keywords: infusion, intravenous, catheter, indwelling, catheterization, peripheral/method

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Introduction

Selecting the best vascular access device for a patient involves having a clear understanding of what options are available for either low-risk peripheral access or central access when infusions require central administration. With the vast majority of acute-care patients requiring intravenous medication and venous access, the need continues for expanded options for reliable extended access devices that can be inserted by nurses. Short peripheral catheters may not always serve the needs of patients, especially those with difficult-to-access veins. The slightly longer midline catheter works well with intermediate needs of a few days to a month or more. This continued need for reliable, extended vascular

access has caused a resurgence of interest in midlines for both acute care and home care applications.

Peripherally inserted central catheters (PICCs) have continually gained in popularity in the United States during the past 25 years. Now there are approximately 2.5 million inserted per year, the majority of which are placed by nurses.¹ There are currently concerns with PICCs and all central venous access devices (CVADs) regarding the development of central line-associated bloodstream infections (CLABSIs) and the reimbursement penalties associated with these infections. Midlines provide a viable alternative to central lines when the primary need is for reliable access of 5 days or more and central placement is not indicated. The use of midlines is consistent with the Centers for Disease Control and Prevention (CDC) recommendations for safe strategies to reduce CLABSIs.² Midlines have a history of lower risk for both infection and thrombosis than CVADs and should be considered as a beneficial option for patients.³⁻⁸ Evaluating patients on an individual basis for the most appropriate device (eg, peripheral short catheter, ultrasound-guided longer catheter, midline, PICC, internal jugular, subclavian, or other long-term device) follows the goal of vessel health and preservation.^{9,10} Enabling specialty teams to choose devices and insert catheters based on patient need increases efficiency in treatment delivery, hospital through-put, and patient satisfaction.¹¹⁻²⁰ Creation of a policy and referral process that includes midlines should be a part of an overall hospital strategy to reduce infections while effectively delivering treatment plans.^{3-5,7,21-25} The aim of our study was to provide a descriptive review of 2 acute care hospital midline catheter programs.

Methods

This was a 2-site, retrospective descriptive review to evaluate midline programs successfully integrated into existing vascular access programs. Inclusion criteria were for a 2-cohort sample of acute care hospitals with operating midline programs consisting of bedside insertions, policies, and outcomes of >2 years. Excluded were hospitals without functional midline protocols and hospitals in excess of 2. This project was designed as a case study; aggregated facility public outcomes were based on data collected from prior years of hospital use and surveillance for CLABSI using National Health Safety Network definitions. No patient medical information or medical records were reviewed in conjunction with this case study. Management, institutional review board, and ethics chairs approved this case study under waiver without full submission in accordance with federal policy and found it exempt because it used public or privately held records or interview procedures without access to patient health information.

A midline catheter, as defined by the Infusion Nurses Society, is a venous catheter access device measuring 3-8 in (6-20 cm) with the distal tip in the basilic, brachial, or cephalic veins at or below the axillary fold, distal to the shoulder.²⁶ Difficult intravenous access (DIVA) was defined by Keyes in 1999²⁷ as 2 unsuccessful attempts, by Costantino in 2005 as the inability to obtain intravenous access after at least 3 attempts in a group of patients with known difficult access,²⁸ and by Weiner in 2012²⁹ as those patients with 2 or more failed attempts or with known history of difficult intravenous

placement. A literature review of midline use from 1985-2015 was performed with results integrated into the study discussion.

Study Procedures

The investigator reviewed a convenience sample of hospitals to determine their eligibility for inclusion into the study based on having an existing midline program. The 2 hospitals meeting the inclusion criteria submitted their policies and outlines of their programs, subsequently receiving approval for the study. Participants in the study included vascular access team managers and team members from the sample sites. The results of observations and interviews were used to describe the recommended processes to develop an effective midline program. Processes for acquiring information involved a series of interviews with team managers and team members with a focus on program development, motivation for development, structure of the program, device use, challenges and solutions, midline indications, infection outcomes, and use of staff education for integration of the program.

Participants and Setting

Hospital 1

The first hospital, an urban Midwestern 400-bed Magnet-recognized (American Nurses Credentialing Center's (ANCC) Magnet Recognition Program®) teaching hospital designated as a level-1 trauma center, had been working to reduce CLABSIs since 2006. Infection control professionals identified a plateau in the reduction of bloodstream infections from 2009-2012 and were motivated to make changes. The CLABSI committee, dedicated to reducing CLABSIs, re-emphasized education of the central line bundle (previously implemented) for all CVAD insertions.³⁰ Secondary solutions included an evaluation of patient indications before each CVAD placement with an intended goal of reducing the use of central lines, especially peripherally inserted central catheters (PICCs), and implementation of ultrasound guidance for the placement of peripheral and midline catheters for those patients whose main indication was difficult access, blood draws, computed tomography for those patients requiring only a few days of therapy, and for patients whose medication did not require a CVAD. In 2010, a proposal to create a vascular access team was submitted and accepted for implementation. Originally formed under collaborative practice with the interventional radiology department where PICCs were placed by physicians, the nursing team was organized to begin PICC placement at the bedsides.

The hospital originally approved a local midline policy specific to the diagnostic imaging department. The protocol, which included evaluation of patients, device selection, and insertion of midline catheters, was performed by the vascular access team without requiring a physician's order. As the program expanded, the protocol was eventually submitted to the medical director, risk management, and the entire system for committee review and hospital-wide approval.

The midline program at this hospital was initiated with the release of a new, accelerated Seldinger technique (AST) midline device (Powerglide; Bard Access, Salt Lake City, UT). The AST midline device was chosen due to an integrated

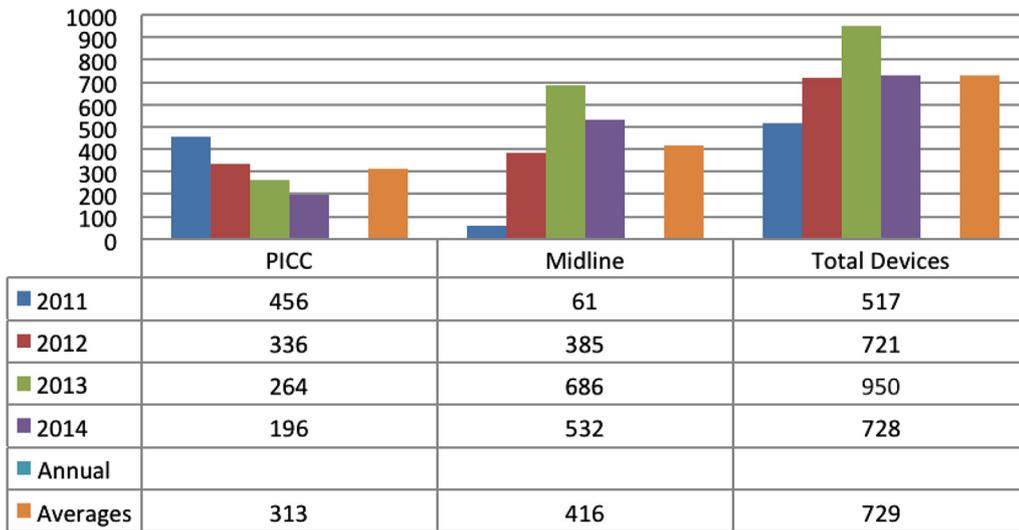


Figure 1. Hospital 1 midline program growth. PICC = Peripherally inserted central catheter.

design that promoted speed and safety in the form of reducing risk of contamination, air and wire embolization. Additional midline products were used intermittently (Bard Poly Midline Catheter, Per-Q-Cath Plus Midline Catheter, and Groshong Midline Catheter, all from Bard Access), employing the more traditional modified Seldinger technique (MST) insertion method. The program was later modified transitioning to another AST midline device (POWERWAND; Access Scientific, San Diego, CA) in an attempt to resolve problems encountered with other devices. Following minor individual adjustments, insertion success increased significantly. For example, 1 clinician found success with insertion of the needle, then inversion of the bevel using ultrasound to guide the entire needle/wire and catheter more deeply into the vessel, anchoring the device in the vein. This “invert and insert” process to shield the cutting point of the needle from damaging the back wall of the vein increased success and ease of insertion.

In this hospital, the protocol for midline insertion was established for patients with DIVA when requested from the bedside nurse; or when identified through vascular access consult, evaluation, and selection by the team. Consistent with other peripheral devices, no physician’s order was required for placement of a midline device. The daily patient assessment for central and midline catheters was expanded to include assessment for signs and symptoms of insertion site infection, evaluation of maintenance compliance, and daily assessment for continued need of the CVAD. Identification of noncompliance resulted in opportunities for teachable moments with bedside clinical staff. Education of bedside staff was an important component in the integration of midlines. The additional tier of surveillance (ie, in addition to regular bedside registered nurse and medical team assessment) to assess for continued need of the CVAD offered opportunities for early intervention and removal of the CVAD.

Hospital 2

The second study hospital is a 215-bed not-for-profit hospital located near Atlanta, GA. The motivation for development of a midline program came after nursing representatives attended a

conference where a clinician presented a hospital midline study.³¹ The hospital, already questioning the need for so many PICCs, agreed that midlines were an option that could offer additional vascular access choices that may result in reduced CLABSIs and provide added patient safety. A veteran team, based out of the hospital’s cardiac catheterization lab, was placing 60-80 PICCs per month with 99% success rate using ultrasound-guided placement and tip positioning (without navigation). The midline program began in 2011 with 80-100 midline insertions per month using the AST (POWERWAND). Despite a significant learning curve and variable levels of insertion success, the team committed to this new device that consistently demonstrated superior performance in patients. Consistent instruction by the company’s clinical representatives and a hospital clinician resulted in a steady increase in successful insertions. The goals for device selection focused on midlines for patients with DIVA along with avoidance of unnecessary CVADs. The goal was to remove PICCs and other CVADs early and replace them with a midline or peripheral intravenous catheter before the patient was transferred to a routine medical/surgical floor. The team achieved high levels of flow (130-160 ml/min) with the 4 and 5 Fr catheters.

Results

During the 12-month period from August 2011 to August 2012, with the initiation of the Hospital 1 PICC and midline program, a total of 589 insertions were performed by the team averaging a 99.4% success rate. Total PICC insertions for the first 12 months were 456 (see Figure 1 for breakdown of 4 years of insertions). From 2012, when the team was up to full capacity, to 2014 the PICC insertions declined from an average of 38 orders and insertions per month to 16 per month, a 58% reduction in the average number of PICC insertions performed annually. The increased use of midline catheters and subsequent reduction of PICCs was consistent with the goal of CVAD placement only in evidence-based indications. Figure 2 depicts the decline of CVAD use from 0.48/100 device-days to 0.23/100 device-days. Orders received for placement of PICCs for access or blood draws alone were transitioned to midline placement. Midlines reflected a

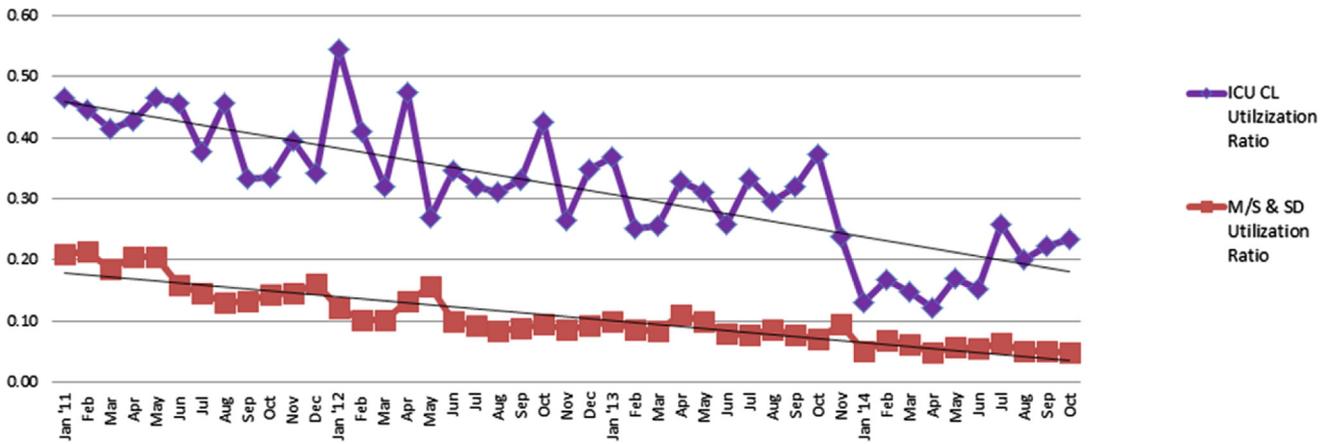


Figure 2. Central line use ratio (device-days/patient-days). ICU = Intensive care unit; M/S = Medical/Surgical; SD = Standard Device; CL = Central Line.

steady rise from 2011-2013. Midline use increased from 2012-2013 by 44% and in 2013-2014 decreased slightly by 22% as shown in Figure 1.

In Hospital 2, midline insertions, which averaged 10-20 per month (200 per year), for 2011-2012 doubled in 2012-2013 to 20-40 per month (400 per year), and in 2013-2014 averaged 80 per month (960 per year). In both hospitals, peripheral catheter policy changed to allow catheters to be placed with ultrasound guidance and under special conditions to dwell longer than 96 hours.

Midline requests with both facilities focused on patients with DIVA with limited veins and the need to replace CVADs with a lower-risk device. Peripheral catheters and midlines were treated as nursing (not physician) options for patient access. An increase in requests for midline placement from the nephrology department was an unexpected result for Hospital 1 in an effort to save subclavian veins for future use.

In both hospitals, an increase in education for bedside nurses, with an emphasis placed on vessel health and preservation, resulted in greater compliance in avoiding antecubital veins for peripheral insertions and placement of the most appropriate device early in hospitalization. Results of enhanced vascular access education and mentoring became

apparent in Hospital 2 because emergency room personnel began changing from an insertion practice of 100% device placement in the antecubital fossa to avoidance of the antecubital fossa for those patient slated for hospital admission.

No midline infections were reported for midlines since the inception of this program for either of these hospitals. Documentation of overall CLABSI rates fell from 1.7-0.2 from 2011 to 2014, reflecting a 78% reduction and a projected cost savings of \$531,570 annually for Hospital 1 (Figure 3). Hospital 2 reported a 2014 facility-wide 0 CLABSI rate and 0 midline infection rate, attributing this success to the work of the team and their use of midlines, early removal of CVADs, replacement of CVADs with midlines, and an improvement in blood culture collections. As a byproduct of better management of vascular access and early insertion of the best device, steady improvement was seen in both facilities in patient and nursing satisfaction. It was noted that patients and nurses alike expressed their appreciation for this additional venous access option.

Because the nurses on the team managing midline and PICC insertions were originally emergency room and cardiac catheter lab/interventional radiology nurses, a thought-process transition was required from short-term/immediate procedure-oriented

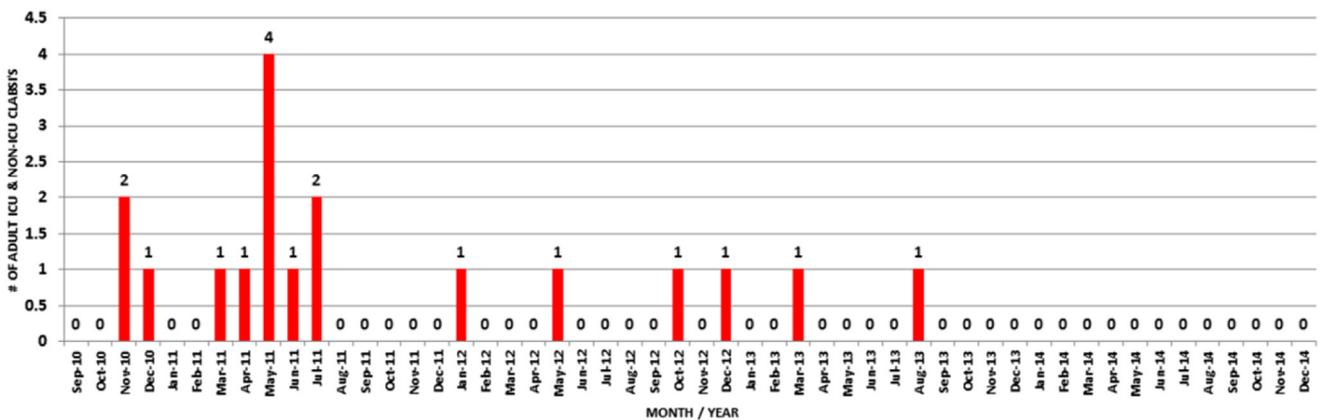


Figure 3. Advocate Illinois Masonic Medical Center central Line-associated bloodstream infection trend.

solutions to longer-term analysis with assessment, device selection, and a focus on improving device-related patient outcomes. Attendance at Association for Vascular Access national and local network meetings provided insights that contributed to overall understanding and the development of better selection processes for PICCs and midlines. Even when access was challenging, the team made sure each patient had the safest feasible form of access. The team committed to becoming more knowledgeable and certified in vascular access and, to date, all but the most recently hired clinician have achieved this designation (that clinician is scheduled to take the examination).

As the team transitioned to being a vascular access specialty team, respect grew among physicians for the efficiency of the midline program and the quality of team services provided to patients. Critical care intensivists proactively began ordering the high-flow midline for replacement of PICCs and other CVADs as patient conditions improved. The protocol and standing orders established for this midline program did not require a physician's order; this facilitated bedside nurses in gaining fast assistance from the vascular access team when patient access became challenging.

Regular education and mentoring offered by the team members regarding vascular access selection and safe practices was an essential ingredient to promoting understanding by the bedside nurses and ordering physicians. One component of education practiced by this team was good mentoring of bedside nurses. Team members found the majority of nurses wanted to listen and learn about device care, dressings, aseptic access principles, and CLABSI reduction practices. Working 1-on-1 with the nursing staff, team members provided daily education through individual mentoring, procedure demonstration, and by offering a leadership example. Using this approach, nurses in the emergency room learned ultrasound-guided peripheral catheter insertions. Four to 6 hours of consistent education was also provided to residents and new orientees on the topic of vascular access safe practices.

Successful insertion of midlines became the norm as this team applied a 2-person assisted midline placement for every patient, similar to recommended PICC practice. Greater success was achieved when performing insertions with an "invert and insert" technique, where the needle bevel is rotated once inside the vessel, reducing vein wall contact. A focus on inserting midlines in the cephalic vein using a lower angle created the best results. This team recognized that although no significant evidence existed to support the 2-person insertion technique, the central line insertion bundle requires an observer to complete the checklist and assist as needed. According to the American Society of Anesthesiologists guidelines, "The consultants and ASA members agree that a trained assistant should be used during the placement of a central venous catheter."³² This insertion team experienced increased success and efficiency with 2 team members working together to complete insertions and manage patients. The nurses made the fifth vital sign a priority, assessing for pain and providing ample anesthetic agents during insertion. The hospital noted a steady rise in patient satisfaction with vascular access insertion and care; this became a source of pride for the vascular access team.

When not inserting devices, team members performed consistent rounding on all devices each day, assessing device function,

dressings, and looking for opportunities to teach. With greater success, orders for placement continued to grow and new team members were needed. The team searched for new hires who were assertive, willing to work, had good skills, and displayed a positive attitude. With the team now up to 4 members working 10-hour staggered schedules Monday through Friday, the hospital receives coverage for 137 midline or PICC insertions per month and 40 additional procedures such as dressing changes per week. Bedside nurses are empowered to request midlines for difficult-access veins under the accepted protocol. To create a cohesive team, this group and hospital leadership committed to a transformational leadership approach that focuses on transparency, honesty, and a willingness to consider what is best for everyone, including hospital and patient.

When considering differences between hospitals, few variations were noted. Hospital 1 represented a more centralized team structure with the management and team leadership collection of outcomes. The team at Hospital 2 shared many responsibilities with a more transitional leadership style and a more relaxed approach to statistical analysis. Despite the difference in leadership styles, the implementation of a midline program within a functional nursing-based bedside PICC program provided similar results.

Discussion

The results of this study provide a limited view of an effective midline program, including insertion, establishing indications for midlines and CVADs, and reducing CLABSI. There is a growing need to reduce unnecessary central lines and focus on evidence-based indications for the insertion of PICCs and other CVADs. Finding other evidence-based alternatives to CVADs, especially those placed for access only, or worse, with no clear indication, provides much of the motivation behind the re-emergence of midline catheters. Chopra et al³³ and others have published findings pointing to an increased risk of infection and thrombosis associated with central venous catheters and specifically PICCs, highlighting the need for selection of these devices only when medically indicated by the nature of infusates, number of necessary access lumens, and the need for rapid large volume infusion. Evidence points to midline catheters as the safest option for vascular access treatment lasting 48 hours or more when no clear indication exists for central venous catheter insertion.^{3,6,31,34-37} Although all midline catheter devices are not the same, reported complication rates for most midlines are low.³⁸ As stated by Maki³⁹ in his review of midline catheters, "CVADs are 20-300 times more expensive and are associated with as much as a 20-fold higher rate of CLABSI" than peripheral catheters. With the average peripheral intravenous catheter lasting only 44 hours or 1.9 days, patients requiring continued treatment benefit from a peripherally placed midline device that can remain in place for the duration of treatment.^{37,40-44} According to the CDC, "Midline catheters appear to be associated with lower rates of phlebitis than are short peripheral catheters and lower rates of infection than CVADs."² Bacterial concentration on the arm is the lowest on the body, approximately 10 CFU/cm², making peripheral access a preferred insertion location from the standpoint of infection.^{45,46} Infection rates associated with midline catheters appear to make this device one of the

safest in terms of infection with a range of 0-0.8/1000 catheter-days with a mean of 0.2/1000 catheter-days in comparison to central venous catheter infections 2.1/1000 catheter-days and short peripheral catheters with projected infection rates of 0.5/1000 catheter-days.^{2-4,6,7,38,45,47,48}

Hospitals are moving to reduce central catheter-days in an effort to reduce infections. Midline catheters may be considered a good choice for certain patients requiring reliable venous access and may also reduce the total number of central catheter-days.⁴⁹ Longer dwell times of CVADs are associated with an increased risk of bloodstream infection.^{2,50} Central venous catheters are commonly inserted during patient stays in intensive care units and later left in place simply as a means of vascular access, despite reduced need for central access. Millstone and associates⁵⁰ point to the need for routine replacement of central catheters with peripheral access devices when central devices are no longer needed. Midlines may serve this purpose, providing an option for reliable, high-flow access.

Midline catheters fill a gap for patients requiring treatment longer than 48 hours and consistently demonstrate safety through lower thrombosis rates (<2.0%), phlebitis rates (<11%), and longer dwell times (7.69-16.4 days) with completion of therapy 79%-89% of the time in comparison with both peripheral and central venous catheters.^{4,6,7,23-25,31,38,47,51,52} According to Maki,³⁹ one of the few randomized controlled trials with short peripheral catheters, 27%-70% of peripheral catheters become phlebitic; Strumpfer⁵³ reports 50% of peripheral catheters become phlebitic within 72 hours and Anderson demonstrated that a typical patient with pneumonia will have at least 3 cannulations over a 5.6-day stay, representing the economic break-even point for peripheral vs midline catheters.

Indications leading to the selection of a midline device:

1. Patients with DIVA,
2. Requirement for intravenous medications more than a few days (ie, 4-5 days),
3. Computed tomography short-term needs,
4. Frequent blood draws with poor access,
5. Renal failure and pre-renal patients, and
6. CVAD no longer indicated with continuing vascular access needs.

Patients with the following conditions are candidates for midline catheters:

- Cellulitis
- Diabetes
- Pneumonia
- Congestive heart failure
- Abscess
- Bronchitis/asthma
- Pyelonephritis
- Osteomyelitis
- Chronic renal failure (with approval of nephrology)
- Major surgery
- Burns
- Obesity
- Malnutrition
- Dehydration
- Stroke/transient ischemic attack

- Contractures
- Multiple tattoos
- Poor vasculature
- Advanced age
- Chronic conditions

Treatment indications include:

- Continuous infusions, hydrating;
- Isotonic, lower osmolarity infusion (<600 mOsm);
- Antibiotic agents appropriate for peripheral infusion;
- Heparin, steroid, antacids, sedation, and analgesia/pain medication infusions;
- Treatments requiring extended dwell without need of central venous access; and
- Therapies that extend longer than 6 days or require reliable access.

Contraindication for midline catheter insertion include:

- Mastectomy or circulatory impairment in peripheral circulation,
- Peripheral neuropathy,
- Venous thrombosis affecting peripheral circulation,
- Lymph node dissection or limitations to specific arm due to surgery,
- Fistula (nephrology approval for patients experiencing renal failure), and
- Skin conditions affecting the insertion area.

Midline program implementation can be challenging, as reflected in the description of these 2 hospitals. Newer midline designs have an integrated needle, wire, and catheter and use an insertion process known as AST that requires a learning curve to achieve greatest success. AST incorporates a change in technique that may initially be challenging to some clinicians, just as ultrasound and MST often are to beginners. However, as with any skill, improvement comes with practice and may include small adjustments such as those described in the Hospital 1 and 2 details.

Complications associated with midline catheters were reported in research by Caparas and Hu,³⁴ including leakage, dislodgment, and infiltration; no infections were reported. Thrombosis and phlebitis rates were 0 for the midline group. No vascular access device is devoid of complications, but as the Caparas study described, a midline program with team management resulted in complications equal to that of PICCs with no statistical difference. The rate of complications was 19.9% (leakage [n = 1], dislodgement [n = 2], and infiltrations [n = 3]) with midlines and 17.9% (bloodstream infection [n = 1] and dislodgement [n = 4]) with PICCs. Issues of vessel health and preservation direct clinicians to weigh midline vs CVAD risk-to-benefit ratios, comparing the potential complications with the benefits of reliable access.

The economic incentive of “value-based purchasing” coupled with patient satisfaction act as a driving force for hospitals to consider processes and devices that are reliable and safe, thus increasing quality. Issues related to CLABSIs and the lack of reimbursement for prolonged hospitalization and treatment undergird the need to choose intravenous devices wisely. Devices such as midline catheters and the increased use of ultrasound to insert peripheral intravenous catheters both provide options to remove CVADs when they are no

longer necessary, reducing the risk of CLABSI.⁵⁴ Additional economic gains associated with the use of midline catheters include the elimination of costs associated with tip confirmation, which is not needed for midlines; the elimination of thrombolytic agents for the treatment of occlusions; lower insertion device costs; and the potential for reduced length of stay.^{4,55,56} Caparas and Hu³⁴ reported a cost savings of \$90 with each midline insertion compared with dual-lumen PICCs.

In a recent review by Gorski et al,⁵⁷ using pH levels as a sole indicator for central venous catheter placement was refuted. The conclusions stated medications such as vancomycin could be safely administered through the deeper veins of the upper arm using a midline; this result was supported by Caparas and Hu.³⁴ Dilution and consideration for a vancomycin concentration 5 mg/mL or less were discussed and references detailed in the review by Gorski et al.⁵⁷ In light of these findings, and with a lack of evidence to the contrary, the decision to place a CVAD based solely on the pH of the intended therapy, vancomycin in particular, is not supported by the evidence.³⁶ Clinicians, physicians, pharmacists, and administration have long debated the issue of administering vancomycin via peripheral access. As represented in the review by Gorski et al,⁵⁷ pH is a factor primarily for parenteral nutrition and not antibiotic agent infusions. This paradigm shift from concerns over pH <5 or >9 requiring central venous access reflects a notable change in practice and points to the need for careful consideration of the characteristics of each medication, the potential for irritation, optimal concentration, and the ability to safely administer the medication through a peripheral or midline catheter. More evidence exists specific to phlebitis, infiltration, and other complications, anecdotally reported as associated with vancomycin, but those outcomes may more likely be associated with factors such as microparticles in solution (as suggested by Maki³⁹), individual patient risk factors such as infection, inflammatory disease, cancer, and cardiovascular disease or hypercoagulable states.^{41,58} Despite the reduced concern over the pH of medication infusions, caution is still needed in the infusion of vesicant or irritant medications because they increase the risk of thrombosis with peripheral administration.⁵⁸

In comparison with short peripheral catheters <4 cm, longer midline catheters, 6-20 cm, placed using ultrasound guidance have greater success and longer dwell times.⁵⁹⁻⁶³ Placement of these catheters in the veins of the upper arm (ie, basilic or cephalic) allows for increased blood flow, greater dilution of medications, and reduced risk of phlebitis and infiltration.⁴ The blood flow from the lower arm to the upper arm has a 5-fold difference from 20-40 mL/min to 100-150 mL/min.⁴ Dilution of medications reduces the risk of phlebitis, specifically with vancomycin and other highly concentrated solutions. Where a catheter is placed has a major influence on the ultimate risk of complications. Midline catheters are positioned in a secure, stable location in the mid-upper arm with a terminal tip positioned below the shoulder, short of the axillary vein. This protected point of entry allows flat positioning, facilitating the use of manufactured securement devices that reduce

complications. Positioning the catheter below the axillary fold of the arm—not entering the chest—aids in the prevention of thrombosis for midlines.⁶⁴

Dwell time for midline catheters exceeds that of peripheral and even PICCs. Average dwell time for a peripheral catheter is 44 hours, for a PICC is 283.2 hours, for a midline is 393.6 hours, and midline maximum dwell up to 296 days based on available evidence.^{4,6,8,40,52,65-68} Current Infusion Nurses Society standards indicate midline dwell for 1-4 weeks and manufacturer's guidance typically specifies 29 days. The move to clinically indicated dwell and removal based on complications or end of therapy rather than a specified dwell time may allow these midline devices to be used in a variety of clinical settings for longer periods of time.⁶⁹ The CDC states, "Midline catheters were in place a median of 7 days, but as long as 49 days."² Although the findings of this study suggest that midline catheters can be changed only when there is a specific indication, there are no prospective, randomized studies associated with midline catheter extended dwell vs routine replacement.⁷⁰ In Australian studies,^{2,71,72} randomized trials have established clinically indicated removal based on short peripheral catheters and although more studies are needed, this finding may be cautiously applied to midline catheters in the same peripheral group. The CDC established a category II recommendation for replacement of midline catheters only when there is a specific clinical indication.

Patient satisfaction is the final measure for device use. As was reported by the hospitals in this study, implementation of a midline program increased patient satisfaction and improved the overall patient experience while establishing the potential for each hospital to receive the Medicare bonus payment under the "value-based purchasing" hospital comparison performance measures. Longer dwell times, lower infection rates, low thrombosis incidence, and low complication rates all add up to economic savings, better quality indicators, and greater patient satisfaction—all key components of the Patient Protection and Affordable Care Act of 2010 and Press Ganey Scores for hospitals in the United States.^{4,35,52,73,74}

Limitations of the study include the small sample size, lack of demographic information, and narrow outcome reporting. A 2-hospital study is not representative of a standard program, but is offered as a sample of an effective process for implementation of midline catheter insertion integration into a current vascular access program.

Conclusions

We found 2 hospitals that effectively established midline insertion processes within a hospital nursing team program initially for PICCs. Midline catheters are a reasonable alternative to PICCs or short peripheral catheters as a means to providing reliable vascular access for the majority of patients with DIVA, preventing multiple venipunctures and invasive central line insertions. The aim of this study was to evaluate the bedside midline programs in 2 hospitals, review the infection outcomes, and describe the processes used in the facilities. The results demonstrate the low infection rates of midline catheters at these facilities, effectively reducing bloodstream infection rates at their institutions by reducing total PICCs and

central line catheter-days. Establishing an effective midline program is more than simply learning an insertion technique for a new product. Although gaining success with catheter placement is important, working within the entire landscape of vascular access to select the best device, apply evidence-based indications for central venous catheter insertions, and develop a strategy for placement of peripheral short and midline catheters are also keys to creating a high quality program that results in the best outcomes with highest patient and nursing satisfaction. Creating a process for device selection with standing orders or a protocol for midlines facilitates speed to placement. Although more research is needed on the more recently developed midline devices, evidence suggests midline catheters provide a safe and reliable form of vascular access that reduces costs and infections associated with central venous catheters, especially those CVADs placed solely for patients with difficult venous access.

Based on our findings we offer the following process for establishing a midline program.

1. Evaluate current CVAD use and CLABSI rates, including economic influence on cost for insertion and cost of infections.
2. Calculate potential cost avoidance with midline program.
3. Consider reimbursement or charges per unit for specialty team placement with ultrasound guidance. Determine cost of midlines and ultrasound-guided peripheral catheter insertions and potential savings.
4. Gain champions among physicians, administration, and infection prevention specialists. Establish buy-in for the midline program.
5. Consider midline products, because 1 device may not fit all needs. A trial may include 2 similar devices or a third with a different design.
6. Create a proposal and develop protocol for orders and policies and procedures.
7. Gain approval for implementation of the protocol through administration and medical staff review.
8. Create a plan for education and implement team training, then expand throughout the hospital. Provide education on risks/benefits of various devices, indications, contraindications, maintenance, and aseptic technique for access. Create patient education materials.
9. Locate clinicians with excellent venous access insertion skills, preferably with ultrasound. Educate inserters; provide instruction on indications, care, and maintenance for bedside staff; teach indications and use of midlines to medical staff. Apply an algorithm or decision tree for patients with difficult access.⁷⁵
10. Develop a Likert-type scale for device evaluation, then begin a midline device trial.
11. Use a Likert-type scale to evaluate clinician feedback on every insertion. Maintain documentation of any problems identified during daily rounding and assessment.
12. Define a strategy and individuals responsible for collection of statistics on success and outcomes with inserters and devices. Keep statistics on number of devices placed, attempts per device, vessel selected, arm, dwell

time, complications/infections, and special patient-related considerations, such as dialysis.

13. Modify policies and procedures as needed.
14. Work toward gaining success knowing that the process of gaining skills with AST improves over time, similar to MST and ultrasound use (3-8 months).

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