A Vascular Access Team’s Journey to Central Venous Catheter and Arterial Line Placement

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Abstract

Background: The frequency with which vascular access specialists (VASs) are placing peripherally inserted central catheters (PICCS) has allowed for the improvement and expansion of the skill set by using advanced insertion techniques such as the modified Seldinger technique and ultrasound for real-time imaging. The use of real-time imaging has decreased complications such as arterial puncture and has improved success rates. Due to this positive influence on patient outcomes, many VASs are moving to the placement of central venous catheters (CVC).

Method: We describe the service improvement process of expanding a vascular access team (VAT) practice to include the placement of CVCs and arterial lines in a large community hospital in Illinois. We also outline the history of vascular access and the journey of a VAT.

Results: By following a methodic approach toward implementation of practice expansion, our VAT has gone from solely placing PICCS to the placement of CVCs in the internal jugular, axillary/subclavian, and femoral veins and to the placement of arterial lines.

Conclusions: VASs have the capacity to positively influence patient safety and outcomes even further by placing CVCs, rather than simply staying with the current scope of practice by placing intravenous lines, midlines, and PICCs. Patient outcomes will improve as VASs move to the placement of CVCs, and the costs associated with potential complications will improve also. Moving to the placement of CVCs is vital to the specialty of vascular access and will continue the breadth and depth of service provided by VASs.

Introduction

Infusion therapy and vascular access have seen tremendous growth during the past few centuries. It was in 1654 when “the first animal to animal transfusion using a silver tube inserted into the artery of the donor and a cannula of bone inserted into the vein of the recipient was done.” It was not until 1832 when Latta was credited with saving the lives of 8 out of 25 patients with cholera, whom he treated with intravenous (IV) saline using a small silver tube attached to a syringe containing a hypotonic solution of sodium, chloride, and bicarbonate. In 1960, central venous catheters (CVCs) began being inserted peripherally in the upper and lower extremity veins for central venous pressure monitoring in critically ill patients.

Vascular access specialists (VASs) have been placing peripherally inserted central catheters (PICCs) for more than 30 years. During the initial stages of this new procedure, PICCs were placed in the antecubital fossa using the peel-away or breakaway method. Goodwin described the method of modified Seldinger technique (MST) placement in 1989. The nurses who placed these devices at the bedside, using the MST technique and ultrasound guidance for real-time imaging, began to demonstrate better patient outcomes.
and success rates. In 2004, the US Food and Drug Administration approved the first power injectable, computed tomography-rated PICC. The evolution of products and techniques has vastly decreased complications associated with the placement of PICCs and has improved patient outcomes and satisfaction.

VASs who have embraced the technology and recommended techniques to improve outcomes for the placement of PICCs have shown great success. Now, in the past 5 years, VASs have begun to implement these same strategies to begin to expand the scope of practice to the placement of arterial lines in the radial artery and CVCs in the internal jugular, axillary/subclavian, and femoral veins. This movement can be seen as a natural progression for the specialty of vascular access. There was a time when physicians placed peripheral IVs as well as PICCs. These procedures have been successfully delegated to nurses for more than 30 years, as should the placement of CVCs. Vascular access thought leaders were faced with criticism for their vision that included the placement of PICCs and peripheral IVs. That criticism may continue today regarding the placement of CVCs and arterial lines by VASs. VASs who demonstrate good clinical judgment, a high success rate, and low malposition rate (compared with national averages), should strongly consider moving their practice to the placement of CVCs. The use of MST and real-time imaging 100% of the time for CVC and arterial line placement will help expand the breadth of the specialty and improve patient outcomes compared with current practice. Many times patients are provided a CVC with a blind stick and landmark technique, which subjects them to unnecessary pain, additional needle sticks, increased complications, and a great deal of frustration with their health care provider. The value of VASs will be realized by these patients who need vascular access and this will further solidify the value of VASs, as the movement to the placement of PICCs at the bedside did for the specialty.

There are more than 5 million CVCs placed annually in the United States. The number of critically ill patients is increasing each year. The need for CVCs will also increase, and therefore, CVC-related complications could be significant. Data from the American Society of Anesthesiologists Closed Claims database indicate that CVC-related complications are associated with a 47% mortality rate. Multiple studies have shown that the use of ultrasound reduces complications, and the use of ultrasound reduces the number of attempts required to place CVCs. The National Institute of Clinical Excellence has recommended the use of ultrasound for CVC placement. Some physician specialties have had a mixed response to this recommendation, whereas VASs have embraced the use of ultrasound and its benefits fully. VASs have seen the improvements associated with using MST and ultrasound for PICC placement. Also, VASs believe that using MST and ultrasound for CVC and arterial line placement will help reduce mortality rates, delays in treatment, infection rates, malpositions, and the costs associated with repeated attempts and increased length of stay. To keep patient benefits at the forefront of care, VASs can actually train physicians on these techniques to advance their skills, as well. Many health care settings are moving to nurse-led models of CVC and arterial line placement to deliver high-quality health care and reduce health care costs.

**Background**

The journey to expand the scope of practice for the vascular access team (VAT) at 1 community hospital in Illinois is deeply entrenched in the passion and commitment of the VAT members themselves. For example, the vascular access coordinator’s (VAC) first nursing position in the neonatal intensive care unit (NICU) at a leading children’s hospital in Chicago, involved working with neonates—some of the most fragile patients. This NICU experience laid groundwork of assessment, vein preservation, collaboration, education, and surveillance. After leaving the NICU to work on an adult PICC team at a major university hospital in Chicago, the VAC was mentored by a highly skilled preceptor who would personally challenge her to always ask herself 1 simple question: “Based on what?” This question challenged the VAC to consider the evidence and current standards when assessing patients, making decisions, or participating in discussions about vascular access. These early foundational experiences shaped the VAC’s passion to expand the scope of practice and drive her to achieve top of license practice. However, once the VAC moved to a position of team leader at her current large community hospital, the nursing leadership was key in allowing the vision to flourish. Executive leadership cultivated the personal and professional growth that encouraged the VAC and her team to challenge the status quo and become leaders at their medical center. The VAC’s growth included obtaining certificates, advanced education, and expanding the scope of practice at the medical center and in the vascular access field. However, 1 of the most critical elements to the team members evolving as leaders was the support and inspiration they received from executive management, who believe that every nurse at their community hospital is a leader—regardless of title.

Along with leadership support, we believe that the ability to expand the scope of practice to CVC and arterial line placement requires developing strong relationships with the multidisciplinary team and collaboration throughout the organization. Collegial rapport with hospital leadership and physicians takes time to establish. The physicians who supported and valued vascular access as a specialty included many from our institution’s Intensive Care Unit, Interventional Radiology Department, Emergency Department, Nephrology Department, and Infectious Disease Department. It was their confidence in the VATs knowledge and skill level that allowed practice expansion at this community hospital. The foundation of the program was the collaborative relationships and support of the physicians throughout the organization. Collaboration is essential in successfully achieving positive outcomes for current vascular access devices, but collaboration is even more important when looking to expand vascular access practices to the placement of CVCs and arterial lines. As VASs, we possess the knowledge of infusion standards and national recommendations and can weigh risks vs benefits to address the needs of our patient population. Having this knowledge base
ensures that our patients get the right device and achieve the best possible outcomes. Hadaway describes an infusion therapy team as “a group of infusion nursing experts working collaboratively with all members of an infusion alliance to deliver safe, timely, accurate infusion therapy to all patients.” Working collaboratively, as described by Hadaway, helped us establish credibility. For example, if a malposition occurs during the placement of a central vascular access device, the VAT members communicate with the interventional radiology team about the patient’s history and the difficulties that occurred at the bedside. Other actions normally include accompanying the patient to the interventional radiology suite. This simple action demonstrates commitment to the patient and the interventional radiology team. It was not good enough for the VAT to simply refer the patient. It is important to assist physicians with placement of devices when a bedside attempt fails or a failed reposition occurs. By following through in this manner, the intensive care and interventional radiology physicians quickly realized the commitment to the specialty the VAT possesses. It was not long before they began to tell us that we should be placing CVCs and arterial lines.

Collecting comprehensive, national-level comparative data similar to what physicians collect for benchmarking their outcomes was the pivotal part of the journey. The VAC used an Excel (Microsoft Corp, Redmond, WA) worksheet to collect data points for line placement for many past years. The chief nursing officer of this community hospital appreciated the Excel data collection tool because it demonstrated productivity at the community hospital. However, in July 2010, the organization was offered an opportunity to become a beta site for the PICC Registry. Collecting data in the registry allows individual data and hospital data to be compared with national vascular access outcomes data. VASs know that collecting individual data in a hidden silo of an Excel spreadsheet does not show that performance is good or bad when it is not compared with national-level data or used to create benchmarks. The first 12 months of PICC placement and outcomes data were compared with national-level comparison data and was presented to our chief nursing officer. The community hospital success rates and outcomes confirmed physician observations that the VAT was performing above national benchmarks. After nationally benchmarking the local data, the process of expanding the scope of practice began to move quickly forward. Using the PICC Registry allowed the authors to demonstrate that first attempt success rates were well above the national success rate and that malposition rates were well below the national average. These data points were presented at multiple internal medical committees to provide the evidence to support moving to the placement of CVCs and arterial lines.

**Inquiry Phase**

The journey to CVC and arterial line placement included understanding the Illinois State Practice Acts and the scope of practice. After presenting the national-level PICC data and other supporting literature and evidence to the hospital chief nursing officer, a teleconference was scheduled with the Illinois State Board of Nursing representative. The Board representative explained that Illinois is a delegation state. This means that when a physician delegates a task (like the placement of peripheral IVs, PICCs, or CVCs), the hospital must agree that the delegation is appropriate. Once the delegation is approved by hospital administration, the clinician must obtain appropriate training and complete yearly competencies. The process is similar to what clinicians went through to begin the placement of peripheral IVs and PICCs. Many states did not change the language to specify placement by using MST for PICCs, but instead ruled that it was within the current scope of practice. Currently vascular access nurses place CVCs in 36 states (see the Figure).

**Design Phase**

After the discussion with the Board representative, physician supporters were identified to serve as mentors for the expanded nurse role to place CVCs. The interventional radiology physicians did not see the value in nurse-initiated subclavian placement and the intensive care unit physicians did not see the value in nurse-initiated jugular vein placement. The VAS knew that learning only 1 CVC insertion site would not meet the needs of all patients; therefore, both interventional radiology and intensive care unit physicians were identified as mentors. Once the mentors were identified, the next step was to participate in a CVC placement education course. The VAC attended her first CVC education course (sponsored by Teleflex, Morrisville, NC) in 2012.

Attending the CVC course provided an opportunity to meet other nurses who shared the same vision for the specialty of vascular access. The course was filled with representatives of various health care disciplines (eg, physicians, physician assistants, advanced practice nurses, registered nurses, and respiratory therapists) wanting to advance their practice or perfect their current technique. The education program was divided into multiple stations to assist in learning and understanding practice guidelines and recommendations. The curriculum provided attendees the chance to gain fundamental knowledge and participate in a hands-on high-fidelity simulation lab. It included the basics of sterile gloving and gowning as well as more advanced applications such as ultrasound techniques and vessel identification, along with the identification of the sliding lung. It showcased demonstrations and hands-on practice with live models; an insertion technique station with complete kits; and a blue phantom to mock an insertion, including a high-fidelity complication station where a physician drilled down potential complications and interventions. This was essential in learning how to manage potential complications.

Attending the CVC education course created increased excitement around moving the specialty forward. More importantly, it rekindled the VAT’s original objective of ensuring that patients receive the right device to deliver their prescribed therapy. It also reinforced best practices in central vascular access insertion. There is nothing worse for a VAS than walking away from a patient because he or she was not a PICC candidate or watching a patient get stuck multiple times to insert a CVC using the outdated landmark technique.
A formal business plan and executive summary was then written and presented to the hospital chief nursing officer. The plan was then presented by the chief nursing officer to the system leadership—which consists of chief nursing officers from 12 hospitals—who approved the plan. It was then presented to the hospital’s Intensive Care Unit Committee, adding an outline of the training that was completed and would be put into practice. The committee approved the idea only after the training plan was finalized. The final plan included attending a training course and hiring an additional VAS, who showed equal dedication and passion for vascular access. The focus was to be on nonemergent CVC placement for patients who were not PICC candidates, such as patients with end-stage renal disease or inappropriate PICC orders in the intensive care unit. Initially, all CVC placements had to be done under direct supervision of a physician mentor. The target number of supervised CVC placements was 10 in each insertion site. The number could be more or less depending on the judgment of the mentor and/or the VAS’s comfort. Once this goal was achieved, it was decided that the VAS would only be placing a CVC when an intensive care unit physician was on the unit. This was to be reevaluated at 6 months and then 1 year.

The executive summary was then presented to the Medical Committee. Some physicians were concerned about nurses performing a procedure traditionally performed by physicians. A supportive interventional radiology physician, who was a member of this committee, gave a testimonial regarding the skill level and low malposition rate of the VAS. He confidently assured the other physicians that patient safety would not be compromised, after which they approved the proposal.

Opposition from the Surgical Committee created the most revision to the plan. The concern was complication management, specifically what a nurse would do if a pneumothorax or a cardiac tamponade occurred. VASs are not trained to manage these types of complications because they are not typically associated with PICC placements. Surgeons wanted a detailed, step-by-step plan on how these complications would be managed if they occurred. Therefore, the revised plan included steps that were already in place when a patient decompensates, such as a rapid response or a code blue. Again, the surgeons were not supportive and requested more revisions. They indicated they were not prepared to approve the plan unless the Medical Executive Committee approved the proposal. Therefore, the VAT had 1 more hurdle to overcome: the Medical Executive Committee. At this point it was clear that the support of a key opinion leader needed to be obtained. Jack LeDonne, MD, a vascular access surgeon and 1 of the CVC course instructors reviewed the plan. He also reminded the VAC that the course was built around evidenced-based strategies designed to reduce the very risks the Surgical Committee was concerned about.

Now that the vision to expand the scope of practice was becoming a reality, an additional 0.4 full-time employee was hired. This VAT demonstrated a high success rate, low malposition rate, good clinical judgment, and a vision to expand the scope of practice. The revised business plan and executive summary were sent to our institution’s Medical Executive Committee. A formal presentation was made that included the PICC program history. The PICC data history included a 96% first attempt success rate and a 3% malposition rate. Both of these were well above the national-level data as documented in the PICC Registry. To date, the VAC had placed more than 10,000 PICCs and the newest VAT member had placed 5,000. The presentation also reviewed the details of the CVC course and identified the other committees that were presented to and had approved the business plan and executive summary. It also
included a step-by-step plan of action in the event a complica-
tion occurred, including pneumothorax and cardiac tam-
ponade. The VAC also reassured the committee members that 
ultrasound for real-time imaging would be used 100% of the 
time. After robust discussion about moving to 
tunneled CVCs, future training, and the future plans of the 
VAT, the Medical Executive Committee approved the busi-
ness plan and executive summary to expand the scope of 
practice to CVC and arterial line placement by the VAT. 
With that approval, the vision was on its way to being 
realized.

Implementation Phase
The process of writing and rewriting the proposal and get-
ting it approved by our institution’s Medical, Surgical, and 
Medical Executive Committees took almost a year. A year 
had also passed since the VAC completed the initial CVC 
course, so both VAT members decided to attend a CVC course in 
2013 to prepare for CVC and arterial line placement. After 
CVC course completion, and with administration and Medical 
Committee approvals, the team of 2 was ready to begin placing 
CVCs. The team placed its first CVC in August 2013 on the 
Monday after attending the CVC course.

The first obstacle encountered was that of insertion tech-
nique. The physician mentors placed CVCs using MST. The 
triple lumen MST CVC was not yet available. The second 
obstacle encountered was that of vessel identification. The 
physician mentors wanted the VAC to use landmark technique 
for CVC placement. The team used this as an opportunity to 
teach the physician mentors about ultrasound and the benefit 
of using real-time imaging to reduce complications. The third 
obstacle to expanding practice was that of securement. The 
physician mentors wanted the VAC to suture all CVCs 
because that was their standard. Although the VAC cited 
evidence-based literature that supported not using sutures, to 
maintain a collegial relationship with the physician mentors 
both VASs learned to suture until the MST CVC kit with a 
sutureless securement device was available.

Results and Discussion
After 1 year of placing CVCs, the VAT has successfully 
expanded the practice to CVC and arterial line placement. 
Internal jugular and axillary-subclavian veins are easily accessed with 
no placement-related complications. With the MST CVC kit, 
which includes sutureless securement, patients are being assessed for 
best securement before placement. The intensive care unit 
physician mentors are amazed at how fast insertions are 
completed, whereas the intensive care unit nurses are surprised 
that a blood return is aspirated on first needle insertion attempt.

There were additional unexpected, positive outcomes. During 
physician CVC placements, historically the environment was 
not easy to control. Many nurses were expected to be present to assist the physician or stand by for complications. 
Conversely, with a VAT CVC placement only the inserter and the primary nurse are present. This aids in a calm, 
controlled environment and is believed to improve success. Af-
fter the mentoring phase, tip confirmation technology was 
added to the CVC placement protocol to ensure the CVC tip is precisely in the cavoatrial junction. A new goal was to elim-
inate chest radiographs after VAT CVC placement when tip 
confirmation is achieved and no complication-related symp-
toms are present. This goal was achieved in January 2015.

Lastly, with the VAT CVC placement success, physicians do 
not need to be present at the bedside or on the unit for CVC 
placement. The physician mentors also empowered the VAT 
to place CVCs when a PICC is inappropriately ordered, 
ensuring the proper device for each patient.

Unfortunately, there was 1 unexpected negative outcome. 
Our VAT expected a large volume of CVC insertions after 
completing training with the physician mentors. Over the past 2 years total PICC order volume has decreased, however, 
possibly causing CVC placement opportunities to be low. This 
could in part be due to lower overall census and/or physicians 
not ordering CVCs in an unfounded effort to reduce catheter-
related bloodstream infections. To fully accept any practice 
change a cultural shift within the hospital is required, as dis-
cussed by Alexandrou et al.\textsuperscript{13} Totals of VAT-initiated place-
ments as of January 2015 are: internal jugular: 35, axillary-
subclavian: 15, and femoral: 0.

Implication for Practice
The purpose of describing this journey was to detail the 
practice expansion method that was used to help other VATs 
complete their own journey to CVC placement. This challenge 
was not initially supported at the local level. The motivation 
was that it would positively affect patient outcomes by expand-
ing the scope of practice of vascular accesses nurses to the 
placement of CVCs and arterial lines. Obstacles such as gain-
ing support, writing executive summaries, meeting with 
various physician committees, learning MST for insertion, 
and suturing were all unforeseen hurdles that were overcome. 
A high skill level, interdisciplinary relationships, communica-
tion, and national-level comparison data were the foundation of the program (see the Table).

It was also important to have VAS leaders as resources. These 
leaders were resources for policies, procedures, and the encour-
agement to help overcome the difficulties on this journey. In 

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<td><strong>Foundation</strong></td>
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<td>High success rate</td>
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<td>Comparative data</td>
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<td>Vision to expand scope of practice</td>
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<td>Understanding of state practice act</td>
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hindsight, the obstacles and challenges were all worth the effort to be able to provide the appropriate access for patients instead of walking away from bedsides with no CVAD in place simply because the patient was not a PICC candidate.

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References