Implementing an emergency department vascular access team: A quality review of training, competency, and outcomes

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Abstract
Peripheral intravenous catheters are frequently used devices in emergency departments. Many patients now present with difficult anatomy and are labeled as difficult intravenous access patients. A common technology to address this challenge is ultrasound. While studies have examined the ability to train emergency staff, few have addressed how this should be done and the outcomes associated with such training. No studies were found with dedicated vascular access specialist teams in emergency departments. An emergency department vascular access specialist team was formed at a hospital in Bangor, Maine, United States to train, validate, and proctor clinicians with ultrasound-guided peripheral intravenous devices. A quality review of this process was compiled and determined that appropriate clinicians with dedicated training and guidance can achieve higher levels of procedural success. Furthermore, evidence substantiates that frequent practice is linked to a higher quality of care and that a significant need for such teams is present. This review examines how a team was implemented and its impact both department- and facility-wide. It is possible that hospitals benefit from the services of vascular access specialists to provide higher quality care. Successful implementation of such specialist teams requires foundational knowledge and skills in vascular access with ongoing quality measures to ensure competency and compliance with evidence-based practices.

Keywords
Ultrasound-guided peripheral cannulation, vascular access, emergency department, quality care, system efficiencies, teams

Introduction
The term vascular access specialist team (VAST) often represents a group of personnel specifically affiliated with vascular access device (VAD) insertion and care1 and is now synonymous with numerous team titles in today's health care setting. Vascular access specialists (nurses, doctors, respiratory therapists, radiology technicians, and physician assistants) individually identify as having advanced knowledge and skills when inserting or managing VADs.1 The alternative is a generalist model, where larger non-specialist groups of health care professionals who have fewer skills are tasked with gaining vascular access for patients. The use of a team approach for inserting peripheral intravenous catheters (PIVCs) increases first-time insertion success, and historically is associated with decreased device-related complications.2,3 While VASTs have been widely used in hospitals, most emergency departments (EDs) use a generalist model.

A recent systematic review demonstrated a two- to 64-fold greater risk of catheter-related bloodstream infection (CRBSI) from a central venous catheter (CVC) compared to a PIVC.4 Considering the 330 million PIVCs that are used each year in the United States, excluding approximately one-fourth used in children and the 20% from failed insertion attempts,5 and the 0.18% incidence of

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One community hospital addressed this issue by the implementation of a dedicated nurse-led team to train and validate clinicians for the provision of emergency room vascular access requirements. This work yielded quality clinical data that provided robust feedback to the facility, highlighting outcomes that helped improve vascular access quality for patients across the continuum of ER care. This article will be of interest to any health care professionals seeking to provide better quality vascular access services to their patients.

**Aim**

To examine the process and outcomes of successful implementation of an emergency department vascular access specialist team (EVAST) in a single-center, 90-bed community hospital and provide a summary of the efficiencies, patient impact, and device-related experiences to the facility.

**Method**

This level 3, 18-bed ED is located within the St Joseph Hospital, a 112-bed community primary and specialty health care facility, located in Bangor, Maine, United States. It is a small urban, non-teaching hospital with approximately 20,000 ED patient visits per year. The EVAST was created in April 2016 with five nurses, varying in levels of experience and training for performing ultrasound-guided peripheral intravenous (USGPIV) access. A Plan-Do-Study-Act quality improvement cycle was employed to evaluate and guide the implementation process and to drive clinician education and competency (Figure 1). This study was evaluated by the Director of Compliance and Risk Management and deemed as a quality review process and did not require the hospitals’ Internal Review Board/Ethics approval.

The first stage of the implementation process aimed to develop a data collection process to establish and validate the EVAST team nurses’ competency and compliance, aligning with the facility policy of performing a minimum of six USGPIV procedures per month. Initial data capture was performed using hand-written log sheets; however, it was noted by several clinicians to be time-consuming and onerous to provide clear documentation on the procedural elements and for the use of point of care ultrasound (US). This relatively short-lived non-compliance was addressed and was repeatedly encouraged through regular team discussions. Providing more depth and accuracy of clinical documentation and reporting allowed for improved peer and self-assessment reviews, which in turn provided greater monitoring and evaluation by leadership. This helped establish a greater understanding in the role of local data quality and its importance to support and evaluate current services, and for possible future advancement strategies within the facility. All data were collected, entered, and analyzed in Microsoft Excel for Mac® 2019 (Ver. 16.28; Microsoft Corp., Redmond, WA) using the basic statistics package, from April 2016 to August 2018.

The second stage was to establish a standardized education program to enhance the skills for clinicians who wished to learn USGPIV. The educational program incorporated two components: one covering the sciences of anatomy, vascular access and US, and second, an evidence-based review of practices from the Infusion Nurses Society Standards of Practice. The didactic reviews covering US and clinical evidence were 2 h in length and were expected to be completed prior to hands-on training. The self-study module was distributed to candidates via email upon registration to the class. Assessment of this required knowledge base was then conducted using a 25-question multiple-choice tool. After the assessment, a 2-h class was scheduled with a 1:2 teacher-student ratio, where clinicians were provided with an in-depth education to several US machines used within the facility. This class included learning a full US assessment of peripheral venous and arterial systems, including surrounding nerve and musculoskeletal structures, both performed on each other and the instructor(s). The class also allocated time for students to develop the dexterity and skills of successfully guiding a needle through tissue to veins, while continually maintaining visualization of the needle tip and/or needle shaft on an US tissue simulator. These were all deemed essential requirements to improve clinicians’ procedural successes.

The final stage saw all clinicians performing three successful US-guided cannulation procedures on patients with the direct supervision from an EVAST clinician. Candidates were routinely encouraged to seek individual mentoring throughout the training process, and most utilized a mentor for their first 10 device placements. Many of the clinicians articulated that it took 25–50 procedures to become fairly proficient with USGPIV placement, which is consistent with currently published evidence evaluating USGPIV competency. Today’s clinical practice environment requires ongoing training and evaluation, and USGPIV skills are becoming more evident with increasing patient acuities and difficult vascular access issues.

Eight additional clinicians were successfully trained throughout 2016 and subsequently added to the existing team numbers. The first full year of EVAST service (2017) provided early team growth, with three additionally trained clinicians, as well as providing further education and support to those who had recently completed their
training. The number of devices being placed by the EVAST members steadily increased, including the number of first-time device insertions successes, highlighting greater clinician skill and proficiency with US insertions (see Figure 2). There was clear demonstration that the need for US-guided device placement for difficult venous access was much greater than the facility had initially estimated.

Results
A total of 3351 devices were attempted. The most frequently placed device was a 20 Ga (gauge) 1.75” (inch) catheter ($n = 3063, 93\%$). There was similar distribution between the left ($n = 1783, 54.4\%$) and right ($n = 1497, 45.6\%$) extremities. The majority were placed in the forearm ($n = 1456, 44.4\%$) or upper arm ($n = 653, 19.9\%$), away from areas of flexion (wrist, elbow). A moderate number of devices were placed in the antecubital fossa (ACF) ($n = 1161, 35.4\%$), often due to specific treatment requests (e.g. contrast injection), or in the upper arm, often due to lack of lower extremity alternatives. Very few devices were placed both in the hand and the lower extremities ($n = 10, 0.4\%$), which were avoided as frequently as possible.

The majority of the devices were placed in the ED ($n = 2759, 82.3\%$), while a moderate number ($n = 592, 17.7\%$) were also placed outside the department, primarily due to a lack of skilled clinicians available to perform the procedure or with appropriate training. On these occasions, an EVAST member from the ED would provide USGPIV support to the ward areas, most often when workload time permitted throughout the evenings or weekends. The majority ($n = 2973, 88\%$) were placed on the first attempt. All clinicians achieved a first-time success (FTS) of at least 80\% over time, with the most proficient at 90\% or greater. There was a correlation between numbers of attempts and FTS. There were 85 failed attempts to cannulate by trainees. These devices were then successfully placed with FTS by experienced EVAST team members who were supervising the trainee and procedure. Distribution by day was consistent except Saturdays, which were routinely busier.

Many patients ($n = 1898, 56.6\%$) needed an USGPIV on multiple occasions of admission, with a smaller number ($n = 238, 7.1\%$) being seen by a vascular access specialist more than 10 times across the same period. Most weekdays ($n = 592, 67\%$) had between one and five patients who had a required need for an US-placed intravenous (IV) device. Approximately 25\% ($n = 214$) had between 6 and 17 calls for the team, with less than 10\% of days having no placements. Over the course of this review, 17 clinicians were trained in total, with an average of 12–14 clinicians on the team at any given time.
Discussion

It is not immediately apparent that an 18-bed ED in a community hospital requires the need for a dedicated vascular access team (see Figure 3). However, with the increasing rate of patients with difficult intravenous access (DIVA), and the high failure of nurse generalists to gain reliable IV access,11–14 it is probable that every facility, of any size, needs to develop specialist clinicians for the provision of quality vascular access.15 There have been a number of recent publications supporting the use of non-physician practice for vascular access provision and have comparable (or better) outcomes than other reported medical systems.16–22 The initial team members faced several hurdles, as there had been early inconsistencies among clinician training. Some team members originally trained in other healthcare institutions, often to various levels of competency, or had initially been self-trained, highlighting an inconsistent knowledge and skill base. This was addressed through additional supportive education to align the clinicians with current evidence-based recommendations and the expectations of the facility’s program. Second, there was no clear or supporting documentation of previously performed procedures to monitor the compliance and success rates for each clinician. Finally, balancing each team member’s mandatory ED nursing workloads, while providing IV vascular access services, provided a number of logistical challenges.

Although early placements outside of the ED (17.7%) were not deemed that large in numbers, the process began
to demonstrate the teams’ ability to provide timely services for vascular access needs throughout the entire organization. The number of unsuccessfully placed devices demonstrated that some newly trained clinicians were still consolidating their skills and competencies. Where needed, these patients had devices successfully placed by more experienced EVAST members.

Many clinicians historically place an IV device in the ACF likely for the ease of finding a large, and relatively superficial vessel.23 This location however is sub-optimal, primarily due to an area of high flexion, with higher reported rates of infiltration, phlebitis, dislodgment, and extravasation, and less comfort for the patient.23–29 This review shows an overall improvement to patient care with an FTS rate of device placement over 85% for the team in training, with the most competent specialists around 92%–94%. This may be due to a detailed assessment of more appropriate site locations. Using feedback from the team’s collected data, and providing a strengthening of assessment on site selection, we drastically reduced the number of devices placed in the ACF. EVAST team members access the ACF region only when required (35.4%), and this was most often requested by the imaging department primarily for power injection of contrast media (see Table 1). The EVAST additionally provides care to the pediatric population, often with difficult venous access issues themselves, without excessive trauma or stress to both patient and parent, while utilizing using ultrasound-guided (USG) technologies.

### Team availabilities

The EVAST service provides 24-h patient care and support throughout the organization, and this is quite evident with increased utilization outside ED both after-hours and on weekends (see Figure 4). Providing after-hours cover has been a constant challenge, often due to clinicians frequently changing rosters when permanent day shifts become available. The EVAST have continued to work on training selected night staff to assist in this coverage both for the ED and for the facility.

The increased benefits and improved device and patient outcomes reported by dedicated vascular access specialists’ teams have shown that there is an escalating requirement for these specialist clinician services.13,15,16 There were only 8.6% (63/730) episodes reported over 2 years where no USGPIV catheter placements were requested, and this number has continued to reduce over time. The first quarter of 2018 show only 6.7% (6/89) with no placements. There were several months in which 11–17 devices were placed within a 24-h period, including weekends. On average, approximately 5–10 USGPIVs are placed within

### Table 1. Anatomic location, laterality, and catheter size.

<table>
<thead>
<tr>
<th>Location</th>
<th>n</th>
<th>Left side</th>
<th>Right side</th>
<th>%</th>
<th>14 Ga</th>
<th>16 Ga</th>
<th>18 Ga</th>
<th>20 Ga</th>
<th>22 Ga</th>
<th>24 Ga</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antecubital</td>
<td>512</td>
<td>284</td>
<td>228</td>
<td>34.1</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>472</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Forearm</td>
<td>659</td>
<td>386</td>
<td>273</td>
<td>43.9</td>
<td>0</td>
<td>0</td>
<td>26</td>
<td>616</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>Hand</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>0.2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leg</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Upper arm</td>
<td>327</td>
<td>179</td>
<td>148</td>
<td>21.8</td>
<td>1</td>
<td>0</td>
<td>27</td>
<td>292</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>1502</td>
<td>850</td>
<td>652</td>
<td>100.0</td>
<td>1</td>
<td>0</td>
<td>78</td>
<td>1383</td>
<td>34</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 4. 24-h service utilization for emergency department (ED) and inpatient (IP) services.
the ER. Most of these devices are placed under emergent conditions, quite often for the sickest patients, with an immediate need for vascular access. Emergency colleagues within the facility have expressed a high level of appreciation and satisfaction for the timely quality of work provided, with patients ready for urgent treatments and therapies without delays.

Training and validating

Studies have shown that training vascular access specialists increases FTS and decreases costs and delays.30–33 This review demonstrates the importance of having a clear policy regarding frequent use of advanced IV skills.34–37 The EVAST found there was a 78% correlation between the number of attempts performed and FTS of the EVAST members when compared to members who only maintained the minimum required USG cannulations (6) established by the facilities policy. The EVAST team members have achieved >95% FTS when inserting more than 10 devices per month (see Figure 2).

This collaborative training program has been successfully implemented with the engagement of all clinical team members, including the ED staff and hospital leadership. Clinicians who complete the training class components were encouraged to begin utilizing the new skills upon returning to the ED. All team members are alerted to newly trained clinicians and encouraged to provide mentorship, coaching, and feedback. In addition, individual reports enable EVAST team leaders, and the clinicians themselves, to monitor professional development and growth. This feedback is provided using reports generated for each team member from the collective data pool. The reports demonstrate an example of good data management and collation to improve clinical practices based upon outcomes-driven data. Once data metrics are decided and the spreadsheet is created, very little effort is required to enter, update, produce, and distribute the individual reports, and all clinicians on the team find it extremely valuable to see their numbers and outcomes and know how they are performing on key metrics.

DIVA scoring tool

In February 2017, the ED implemented the Comprehensive–Difficult IV Access (C-DIVA) scoring tool (Figure 5). The tool was modeled on the A-DIVA tool which was developed and validated in Europe38 with reference to other similar tools which are population-specific (i.e. pediatric, oncology, etc.).39–43 This tool allows generalist
can successfully place USGPIVs and improve vascular access outcomes across various patient populations. Further investigation is required to understand the clinical and financial impact of dedicated vascular access teams on larger health care facilities.

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