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Perceived Importance of Ultrasound Vascular Access Education among Residents

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Abstract

Background: Peripheral intravenous catheter (PIVC) failure and difficult intravenous access (DIVA) are pervasive issues causing patient suffering and increased costs. Despite their prevalence, there is a gap in internal medicine and pediatric resident training to manage these challenges effectively.

Objective: This study aimed to assess the value of ultrasound-guided-PIVC (USG-PIVC) education for internal medicine and pediatric residents and the impact of a 1-hour multidisciplinary workshop on their knowledge and confidence.

Methods: A cross-sectional survey study was conducted at an academic medical center in 2022 to assess residents’ perceptions of USG-PIVC education. This was followed by a USG-PIVC simulation-based workshop with limited enrollment (11-slots). Pre- and postworkshop assessments were used to evaluate changes in knowledge and confidence. Data were analyzed using descriptive statistics.

Results: Of the 136 residents surveyed, 68 (50%) responded. Most respondents (78%) reported encountering situations where no one could obtain DIVA. While 71% (n=48) of residents considered USG-PIVC placement a useful skill, only 13% (n=9) had prior experience.

Following the workshop, the 11 participants had improvement in both confidence (mean pre-assessment score of 38.2 ±8.3 increased to 56.6 ±6.4, p

Conclusions: Most internal medicine and pediatric residents at an academic medical center lack experience with USG-PIVC insertion and express interest in acquiring this skill. A one-hour multidisciplinary workshop may be an effective strategy to increase their knowledge and confidence, making it a promising avenue for enhancing residency curricula.

Keywords
Medical Education, Simulation Training, Ultrasound, Catheterization, Difficult Intravenous Access, Multidisciplinary Workshop

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Disclosures: The authors have no conflicts of interest relevant to this article to disclose Funding/Support: Our study utilized the Research Electronic Data Capture (REDCap) software for survey development and data collection, which was obtained through the UNMC Office of the Vice Chancellor for Researchers. Biostatistics services were provided by the College of Public Health at UNMC. The Simulation Laboratory at the Davis Global Center iEXCEL provided space and ultrasound equipment for the successful completion of the workshop. Role of Funders: The authors are solely responsible for the content of this paper, which may not necessarily reflect the official views of the funding organizations. The funding organizations were not involved in the design, preparation, review, or approval of this paper. Contributor Statements: Dr. Lamarche was responsible for the study’s conceptualization and design and conducted data collection, analysis, and interpretation. Dr. Lamarche led the simulation-based workshop,
coordinated the event, developed and presented the content for the didactic session, and supervised participants during the hands-on portion of the workshop. In addition, Dr. Lamarche drafted the initial manuscript and reviewed and revised the manuscript. Dr. Claudy provided oversight for the study's conceptualization and design and supervised data collection, analysis, and interpretation. Additionally, she oversaw the workshop, contributed her knowledge to the didactic session, and supervised the participants during the hands-on session. She critically reviewed and revised the manuscript and ultimately approved the final manuscript for submission. Dr. Marx provided oversight for the study's conceptualization and design. Assisted with content development for the didactic portion of the workshop, provided pre-workshop educational videos, and supervised participants during the hands-on portion of the workshop. He critically reviewed and revised the manuscript and ultimately approved the final manuscript for submission. Ms. Ma contributed to the development of the surveys in this study. She was involved in data analysis and interpretation and assisted with drafting the methods section of the manuscript. She approved the final manuscript for submission. Acknowledgments: The authors would like to express their appreciation to Jeff Whannel, Advanced Simulation Specialist at the Simulation Laboratory Davis Global Center iEXCEL, for his assistance in accommodating sessions to refine the workshop's contents.

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Following the workshop, the 11 participants had improvement in both confidence (mean pre-assessment score of 38.2 ±8.3 increased to 56.6 ±6.4, p<.001) and knowledge (mean pre-test score of 13 improved to 15.6, p=0.009).

Conclusions: Most internal medicine and pediatric residents at an academic medical center lack experience with USG-PIVC insertion and express interest in acquiring this skill. A one-hour multidisciplinary workshop may be an effective strategy to increase their knowledge and confidence, making it a promising avenue for enhancing residency curricula.

Keywords
Medical Education, Simulation Training, Ultrasound, Catheterization, Difficult Intravenous Access, Multidisciplinary Workshop

Abbreviations
CVC = central venous catheter
DIVA = difficult intravenous access
USG-PIVC = ultrasound-guided peripheral intravenous catheter
RN= Registered Nurse

Introduction

Difficult intravenous access (DIVA), mostly defined as two or more failed attempts at peripheral intravenous access, and no visible or palpable veins, is a common problem in hospitalized patients that can have adverse effects on patient care, including delays in resuscitation, nonproductive nursing time, increased costs, and patient suffering.1-4 Studies have reported that more than one in three PIVCs fail before completion of inpatient treatment. Additionally, up to 43% of hospitalized patients and up to 59% of highly complex hospitalized patients meet DIVA criteria.5,6 Furthermore, 36.8% of children admitted to a pediatric critical care unit were reported to have DIVA.7 Ultrasound-guided PIVC (USG-PIVC) insertion is a promising approach for patients with DIVA, as it is associated with an increased first attempt and overall placement success rates.4,8-10 In adult and pediatric patients, USG-PIVC placement has been found to increase the longevity of access with fewer complications, improve patient satisfaction, and decrease central venous catheter (CVC) use.1,3,4,8-18 Placement of USG-PIVC in DIVA patients may negate the need for more invasive vascular access, such as CVCs or intraosseous needles, and thus eliminate complications associated with these procedures, including but not limited to infection, pneumothorax, and fracture.3-4 In many academic medical centers, there is limited emphasis on training internal medicine and pediatric residents to perform peripheral intravenous catheter (PIVC) insertion. To our knowledge, no studies have explored the value of USG-PIVC insertion training from the perspective of these residents. Therefore, this study aims to explore the value of USG-PIVC training from the perspective of internal medicine, internal medicine/pediatrics, and pediatric residents. Additionally, we conducted a small (11 slots) multidisciplinary USG-PIVC insertion workshop to assess changes in knowledge and confidence after training.

Methods

This cross-sectional survey study was conducted at an academic medical center. The Office of Regulatory Affairs determined that this project does not constitute human subjects research, and no Institutional Review Board application was required.

All internal medicine (n=77), internal medicine/pediatrics (n=16), and pediatric (n=43) residents were invited to participate in the study by completing an anonymous survey on March 27, 2022, through Research Electronic Data Capture (Copyright, REDCap., Nashville, Tennessee, U.S.), which included nine questions (Supplement 1). Two survey reminders were sent on April 26, 2022, and May 9, 2022, respectively. Participation in the survey was voluntary.

The same residents were also invited to participate in a multidisciplinary simulation-based USG-PIVC placement workshop on April 19, 2022. Enrollment was based on an online signup software and was limited to eleven available slots. Prior to the workshop, participants were asked to review USG-PIVC procedure videos (Supplement 2). The workshop comprised a 30-minute didactic session followed by hands-on practice using chicken-breast vascular access models to simulate percutaneous vascular access (method developed by Rippey et al19,20). All participants completed pre-workshop assessments of confidence (14 items) and
knowledge (18 items) (Supplement 3). Post-workshop assessments were completed four days after the workshop.

Descriptive statistics were used to summarize data, and statistical significance was set at p < .05. The paired t-test was used to evaluate continuous data with normal distributions from pre- and post-workshop knowledge and confidence assessments. For continuous data with non-normal distributions, Mann-Whitney U and Kruskal Wallis tests were used. Finally, categorical data were evaluated using Chi-squared and Fisher exact tests. The SAS software version 9.4 (Copyright, SAS Institute Inc., Cary, North Carolina, USA) was used for all statistical analyses.

Results

Out of 136 residents, 68 (50%) responded to the perception survey. Of these, 14 (21%) were pediatric residents, 39 (57%) were internal medicine residents, and 15 (22%) were internal medicine/pediatrics residents. The latter corresponds to 50.6% of the total internal medicine residents, 94% of the total internal medicine/pediatrics residents, and 32.5% of the total pediatric residency class (Figure 1). Most residents, 71% (n= 48), perceived USG-PIVC placement as a useful skill for them. However, this perception varied by training specialty. All internal medicine/pediatrics residents indicated that USG-PIVC would be useful compared to 60% of pediatric residents and 62% of internal medicine residents (p<0.001).

Additionally, 72% (n=49) of all residents indicated an interest in USG-PIVC training at some point during their careers, but only 13% (n=9) had prior experience with the procedure. Fifty-three (78%) residents reported having been in a situation where a patient needed vascular access, RNs were unsuccessful at landmark-guided PIVC insertion, and the vascular access team was not readily available. Only 61% (n=24) of internal medicine residents encountered this clinical situation, compared to 100% of pediatric and internal medicine/pediatrics residents (p<0.001).

Ninety-three percent (n = 63) of the surveyed residents held the perception that USG-PIVC placement was less likely to result in severe complications compared to CVC placement. Notably, no significant association was observed between the residents' year of residency and any of the variables included in the perception survey.

Simulation-based Training Results

Of the 136 total residents, 11 (8%) participated in a simulation-based workshop on USG-PIVC placement (Figure 2). Participation was limited by simulation workshop size and enrollment proceeded on a rolling basis. Participants' confidence in this skill significantly improved following the workshop; on a scale of 1-70, mean pre-assessment score of 38.2 ±8.3 increased to 56.6 ±6.4 on post-workshop assessment (p < .001) (Table 2). Participants also demonstrated increased knowledge after the workshop; On a scale of 1-18, average pre-test knowledge scores of 13 improved to 15.6 on the post-workshop test (p= 0.009) (Table 3).

Discussion

Nearly all hospitalized patients undergo PIVC insertion with over 90% of hospitalized adults, and up to 81% of pediatric patients admitted to our free-standing children’s

![Figure 1. Distribution of Perception Survey Respondents Across Residency Programs.](image1)

![Table 1. Perception Survey Responses Reported as Number (%)](image2)

![Figure 2. Workshop Participants by Training Specialty.](image3)
hospital requiring a PIVC. Despite the ubiquity of this procedure, PIVC failure rates and DIVA rates remain unacceptably high.5,6 Consequently, we expected that most residents in our study would experience situations where DIVA could not be obtained. While it is important to consider the frequency of such events, our data suggest that training internal medicine and pediatric residents could lead to improved patient outcomes. This may be particularly relevant for residents planning to care for inpatients or work in rural settings, where vascular access teams may not be available. Our survey showed that most residents found USG-PIVC training to be useful, emphasizing the importance of incorporating this skill into their training. Due to the limited workshop size, this study is underpowered to conduct a subgroup analysis of the perceived value of USG-PIVC training (comparing workshop participants to non-participants).

This study demonstrates that a majority of surveyed residents had never placed a USG-PIVC despite perceiving it as a useful skill. Residents in this study also anticipated a lower success rate for the procedure if a RN had unsuccessfully attempted landmark-guided PIVC insertions. This is consistent with prior research, which suggests that RNs have higher success rates than physicians with landmark-guided PIVC insertion (44% compared to 23%). RNs trained to obtain USG-PIVCs are capable of a greater than 70% success rate after four USG-PIVC attempts in adults22 and nine USG-PIVC attempts in pediatric patients.23 While the learning curve for USG-PIVC use has not been formally evaluated in residents, evidence suggests that experienced physicians have a better first-stick success rate with USG-PIVC insertion compared to RNs and technicians.24 Furthermore, there is evidence that novice medical students perceive USG-PIVC placement as less difficult compared to landmark-guided PIVC insertion.25 Ultimately, more research is needed to evaluate the USG-PIVC learning curve for residents.

Considering the well-established benefits of ultrasound procedural guidance,4 interdisciplinary ultrasound education presents a promising approach to broadening the pool of educators and fostering collaboration among healthcare providers.27 Additionally, using chicken-breast vascular access models may offer a cost-effective alternative to phantom blocks for training purposes.28

### Table 2. Pre- and Post-workshop Confidence Assessment of USG-PIVC Placement Micro-skills. Frequency of “agree and strongly agree” Responses (N=11), Reported as Number (%)

<table>
<thead>
<tr>
<th>Abbreviated Items</th>
<th>Pre-workshop</th>
<th>Post-workshop</th>
<th>P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can choose the best probe to place a USG-PIVC</td>
<td>2 (18)</td>
<td>11 (100)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>I can interpret the images on the US screen in relation to the probe marker</td>
<td>3 (27)</td>
<td>11 (100)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>I can identify the vascular anatomy of the upper extremity</td>
<td>1 (9)</td>
<td>9 (81)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>I can identify veins</td>
<td>6 (54)</td>
<td>11 (100)</td>
<td>0.001</td>
</tr>
<tr>
<td>I can identify arteries</td>
<td>7 (63)</td>
<td>11 (100)</td>
<td>0.01</td>
</tr>
<tr>
<td>I can identify nerves</td>
<td>1 (9)</td>
<td>4 (36)</td>
<td>0.004</td>
</tr>
<tr>
<td>I can optimize depth</td>
<td>1 (9)</td>
<td>10 (91)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>I can adjust the gain to better visualize my target vessel</td>
<td>1 (9)</td>
<td>10 (91)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>I can identify the distance to the target vein</td>
<td>1 (9)</td>
<td>8 (72)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>I can select the right catheter size and length</td>
<td>0</td>
<td>5 (45)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>I can navigate the needle tip inside the vessel using US</td>
<td>2 (18)</td>
<td>10 (91)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>I can verify that I placed the catheter correctly using US</td>
<td>2 (18)</td>
<td>10 (91)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>I can properly disinfect the probes and US machine</td>
<td>6 (54)</td>
<td>11 (100)</td>
<td>0.004</td>
</tr>
<tr>
<td>I can obtain a USG-PIVC</td>
<td>0</td>
<td>9 (81)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*Paired t-test was used to evaluate the difference between pre-post confidence levels.

### Table 3. Pre- and Post-Workshop Knowledge Quiz Correct Response Frequency (N=11), Reported as Number (%)

<table>
<thead>
<tr>
<th>Abbreviated Questions</th>
<th>Pre-Workshop</th>
<th>Post-Workshop</th>
<th>P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population in which USG-PIVC can be used</td>
<td>10 (91)</td>
<td>11 (100)</td>
<td>0.34</td>
</tr>
<tr>
<td>Ideal probe for USG-PIVC</td>
<td>10 (91)</td>
<td>10 (91)</td>
<td></td>
</tr>
<tr>
<td>CVCs versus PIVCs for volume resuscitation</td>
<td>11 (100)</td>
<td>11 (100)</td>
<td></td>
</tr>
<tr>
<td>Best USG-PIVC vessel for beginners</td>
<td>4 (36)</td>
<td>8 (73)</td>
<td>0.1</td>
</tr>
<tr>
<td>Ideal USG-PIVC vessel characteristics</td>
<td>6 (54)</td>
<td>9 (82)</td>
<td>0.08</td>
</tr>
<tr>
<td>Artery identification</td>
<td>10 (91)</td>
<td>10 (91)</td>
<td></td>
</tr>
<tr>
<td>Vein identification</td>
<td>5 (45)</td>
<td>8 (73)</td>
<td>0.19</td>
</tr>
<tr>
<td>Optimal Angle of insonation</td>
<td>9 (82)</td>
<td>9 (82)</td>
<td></td>
</tr>
<tr>
<td>How to hold the US probe</td>
<td>10 (91)</td>
<td>7 (64)</td>
<td>0.08</td>
</tr>
<tr>
<td>Selecting the appropriate catheter length</td>
<td>1 (9)</td>
<td>5 (45)</td>
<td>0.03</td>
</tr>
<tr>
<td>Gain adjustment</td>
<td>11 (100)</td>
<td>11 (100)</td>
<td></td>
</tr>
<tr>
<td>Depth adjustment</td>
<td>9 (82)</td>
<td>11 (100)</td>
<td>0.16</td>
</tr>
<tr>
<td>US machine positioning</td>
<td>9 (82)</td>
<td>10 (91)</td>
<td>0.58</td>
</tr>
<tr>
<td>Short axis technique</td>
<td>11 (100)</td>
<td>9 (82)</td>
<td>0.16</td>
</tr>
<tr>
<td>Long axis technique</td>
<td>9 (82)</td>
<td>10 (91)</td>
<td>0.58</td>
</tr>
<tr>
<td>USG-PIVC complications</td>
<td>11 (100)</td>
<td>11 (100)</td>
<td></td>
</tr>
<tr>
<td>Process of navigating the needle tip</td>
<td>4 (36)</td>
<td>9 (82)</td>
<td>0.05</td>
</tr>
<tr>
<td>Next step after achieving catheter “blood-flash”</td>
<td>4 (36)</td>
<td>11 (100)</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Abbreviations: USG-PIVC, ultrasound-guided peripheral intravenous catheter; CVC, central venous catheter; US, ultrasound.

*Paired t-test was used to evaluate the difference between pre-post confidence levels.
The authors have no conflicts of interest relevant to this article to disclose Funding/Support: Our study utilized the Research Electronic Data Capture (REDCap) software for survey development and data collection, which was obtained through the UNMC Office of the Vice Chancellor for Researchers. Biostatistics services were provided by the College of Public Health at UNMC. The Simulation Laboratory at the Davis Global Center iEXCEL provided space and ultrasound equipment for the successful completion of the workshop. Role of Funders: The authors are solely responsible for the content of this paper, which may not necessarily reflect the official views of the funding organizations. The funding organizations were not involved in the design, preparation, review, or approval of this paper.

Authors Contribution
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References

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