ULTRASOUND GUIDED PERIPHERAL VENOUS ACCESS

by

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A research report submitted in partial fulfillment of the

requirements for the degree of

DOCTOR OF NURSING PRACTICE

2022

Oakland University
Rochester, Michigan

Acknowledgements & Dedication

First and foremost, we would like to express our sincerest thanks to Dr. Laura Rodgers of Oakland University's Graduate Program of Nurse Anesthesia. Her dedication to this project, as well as her encouragement through every step of our graduate education has made an impact greater than she will ever know. We would also like to thank the Michigan Association of Nurse Anesthetists for their involvement in the implementation of this project. Without their enthusiasm and cooperation, it would not have been feasible.

Rachel Sonego

I would like to thank Dr. Andrea Bittinger, both a mentor and a friend, for showing me the world of Nurse Anesthesia many years ago. It is a pleasure and an honor to follow in her footsteps, and I have had so much fun fulfilling my dream of being a student of hers.

I am extremely grateful for my co-author, my anesthesia study buddy, and my great friend Jenna Renault. While we barely knew one another when we decided to take on this part of our educational journey together, I know now that it was the right decision. She has made every step of this process enjoyable, and she inspires me to be better every day. I must also recognize the love and encouragement of my partner, Justin, throughout this entire process. There is nobody who understands all that has gone into the past few years quite like he does, and I cannot imagine having done it without him by my side.

My father has always made me believe that I can do anything – and the pursuit of a doctoral degree is no exception. I am so lucky that he is mine, and that he's been the foundation of my belief in my dreams for as long as I can remember. Finally, I'd like to place on record that which I have no words for – the love and guidance of my mother. She has supported me in every

way possible throughout my years of study and the writing of this thesis. This accomplishment, along with all the rest, would not be possible without her. Thank you.

Jenna Renault

I would like to acknowledge Rachel Sonego for inviting me to work on this project with her. Originally, while this project was still an idea, Rachel had planned to complete this project solo. Luckily for me, she extended the invite to join her and I think we've made a pretty great team throughout the process. A doctoral project is no easy feat, yet Rachel made a very daunting workload seem achievable, always positive and encouraging - the best doctoral partner and friend I could have ever asked for.

I would also like to acknowledge my husband, Ryan Renault. Ryan has shown me so much love and encouragement throughout anesthesia school in its entirety, I will never be able to thank him enough for his endless optimism.

Lastly, I would like to thank my family including my parents and sisters. They have always been there and provided gentle reminders of encouragement throughout this process. They always know how to make me laugh despite the high amounts of stress associated with a doctoral project and we all know laughter is the key to happiness.

Ultrasound Guided Peripheral Venous Access

Abstract

Certified Registered Nurse Anesthetists (CRNAs) currently practice in all settings where anesthesia is delivered. Establishing intravenous (IV) access is one of the first steps to providing a safe and effective anesthetic, thus the ability to do this quickly and efficiently is a crucial skill for CRNAs. IV access can be difficult to obtain, especially in patients with unpalpable vasculature or a history of difficult venous access. One alternative to standard IV insertion methods is the utilization of ultrasonography for peripheral IV placement. Currently, many healthcare institutions lack structured ultrasound (U/S) training programs for CRNAs.

A multi-modal education program for the use of U/S for peripheral IV placement was designed and implemented at the Fall 2021 Michigan Association of Nurse Anesthetists (MANA) conference. The course included a didactic education component, as well as a hands-on component using task trainers. Twenty-one CRNAs participated, with each one completing both a pre-education and post-education knowledge assessment, in addition to a hands-on skill check-off to demonstrate competency. Scores improved by an average of 1.61 (SD = 1.16) after education thus demonstrating a significant improvement, $t(20) = 6.39$, $p < .001$. Additionally, 100% of CRNAs were able to demonstrate competence in peripheral IV placement with ultrasound on a task trainer following education and practice. Therefore, multi-modal education in the use of ultrasound for peripheral IV placement is effective in increasing CRNAs' knowledge and competence in this skill.

Making U/S available to all practicing CRNAs is both feasible and beneficial. By implementing U/S education, CRNAs can become proficient in techniques necessary to obtain intravascular access quickly and safely, thereby improving care for their patients.

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Ultrasound Guided Peripheral Venous Access

Background and Significance

Certified Registered Nurse Anesthetists (CRNAs) currently practice in all settings where anesthesia is delivered, including but not limited to, traditional hospitals and surgical suites, critical access hospitals, ambulatory care centers, and within the United States military (AANA, 2019). One of the most common and crucial skills that CRNAs perform is obtaining vascular access (Bortman, 2019). In the traditional setting, this may include insertion of a peripheral venous catheter (PVC) in a non-urgent environment such as the preoperative area, or more critical situations such as the immediate need for additional access intraoperatively. As CRNAs continue to expand their practice environment throughout rural and underserved areas, they are frequently utilized as the go-to providers for emergent airway and vascular access (University of Kansas Medical Center, 2018). Intravenous (IV) access can be difficult to obtain. The use of ultrasonography offers an alternative to standard insertion methods (McCarthy, et al., 2016). Currently, many healthcare institutions lack structured ultrasound (U/S) training programs for CRNAs. As with any educational programs, training CRNAs to place IVs via U/S requires both financial and human resources. This contributes to the hesitation of institutions to include ultrasonography as a standard of practice in the profession.

In current practice, ultrasonography is an important and advantageous skill for anesthesia providers. U/S guided IV placement can improve access in patients with difficult vasculature, reduce procedural time, decrease central line use, and may lead to improved patient outcomes (Partovi-Deilami et al., 2016). By implementing U/S education, CRNAs can become proficient in techniques necessary to obtain intravascular access quickly and safely, thereby improving care for their patients.

As practicing Student Registered Nurse Anesthetists (SRNAs) in multiple healthcare institutions across the state, we have experienced the gap in patient care created by a lack of competency in U/S use for IV access. Additionally, CRNAs in several clinical settings have expressed interest and motivation to learn this skill for the benefit of patients. With these experiences in mind, our intent was to provide education and hands-on training in U/S guided IV placement for interested CRNAs at the Michigan Association of Nurse Anesthetists (MANA) Annual Conference in the Fall of 2021. MANA is the professional organization for CRNAs in the state of Michigan, consisting of a total of 2,604 active members from five statewide districts (MANA, 2020). With education and hands-on training at the conference, both knowledge and confidence in U/S guided IV placement was improved.

Literature Review

Three databases were utilized including Cumulative Index of Allied Health Literature (CINAHL), PubMed, and Cochrane Database of Systematic Reviews. The following keywords were used to limit results: “IV guided ultrasound and peripheral venous catheter,” “intravenous guided-ultrasound and peripheral venous catheter,” “ultrasound-guided intravenous placement,” and “ultrasound-guided peripheral intravenous line.” Inclusion criteria consisted of articles published within the last five years (2015-2020), written in the English language, and included both pediatric and adult sample populations. Articles chosen included the following dependent variables: rate of success, procedure time, patient satisfaction, and central line use. Those that did not contain any of these dependent variables were excluded. Bibliographies were hand searched and abstracts screened, resulting in 17 articles for extensive review, of which 13 were selected for use in the literature review. By source, PubMed produced 110 results, with 4 chosen after application of exclusion criteria. CINAHL produced 32 results, from which 9 articles were

chosen. None of the results were chosen from the Cochrane Database of Systemic Reviews. The levels of evidence listed in Appendix A were determined by Melnyk & Fineout-Overholt's (2015) "Hierarchy of Evidence for Intervention Studies". After selection, each article was extensively and critically appraised by Fineout-Overholt's (2015) "Rapid Critical Appraisal Checklists." The critical appraisal checklist served as a tool to determine each study's overall strength, quality, and reliability.

Opportunity for Use

Obtaining IV access is a crucial skill for anesthesia providers before any surgical procedure and is vital in emergencies. Blind technique in IV placement can be time-consuming and challenging (Bortman, 2019). IV insertion via U/S guidance is an alternative to standard methods (McCarthy, et al., 2016). Ultrasonography is more readily available now than before, as the equipment is now both portable and affordable (Bortman, 2019).

Number of Attempts

Several studies demonstrated that the utilization of ultrasound decreases the number of attempts required for providers to achieve successful vein cannulation. In a systematic review and meta-analysis, when comparing 2 IV insertion groups, success rates in the group that used ultrasound were 81% while success rates using traditional palpation technique were only 70%. Additionally, total attempts at IV placement were reduced with the use of ultrasonography with a mean difference of 0.92 (95% CI- 0.10 to 1.94, P=0.08, I^2=92) (Van Loon et al., 2018). Ultrasound was also found to be remarkably valuable when utilized after multiple failed attempts were made. U/S guidance has demonstrated success when applied after multiple failed attempts via traditional technique, the odds ratio for success increased to 3.23 (95% CI 1.35-7.72, P=0.008, I^2= 67%) from 1.82 (95% CI, 0.68-4.9, P=0.23, I^2= 69%) compared to when ultrasound

was used upon first attempt (Van Loon et al., 2018). When comparing standard palpation technique versus U/S guided technique for IV cannulation, out of 136 attempts, 107 were successful with U/S guidance while only 84 out of 136 attempts were successful with standard palpation technique (Egan et al., 2013).

Patients are considered to have "difficult access" when healthcare providers classify them as such according to "visible or palpable veins" and provider perception of difficulty with standard landmark approach (McCarthy et al., 2016). U/S guidance is especially beneficial for difficult access patients, as it increases the first attempt success rate for them more so than for patients classified as easy vascular access (McCarthy et al., 2016). Overall, U/S guidance was found to increase the likelihood of successful IV cannulation.

Central Line Insertions

When traditional peripheral IV placement is unsuccessful, patients may undergo central catheterization (termed "central line placement") into larger vessels for reliable vascular access. These procedures are invasive and carry greater risks including the risk of bleeding, air embolism, and infection (Galen et al., 2020). With the increased use of U/S guidance for peripheral IV placement, the necessity of central line placement was decreased in the inpatient setting from a mean of 4.8 central line catheters per month to a mean of 2.5 per month (Galen et al., 2020).

Patient Satisfaction

With the reduction in attempts and increased success rates, U/S guidance for IV placement can enhance the patient experience (Bortman, 2019). When compared to standard landmark technique, U/S use increased patient satisfaction (Van Loon et al., 2018) with a mean difference of 33% (85% CI 22-43, $P < 0.001$) I^2 0%, $t^2 < 0.001$).

CRNA Multimodal Education

CRNAs are considered frontline anesthesia providers and establishing IV access is one of the most common procedures they perform (Bortman, 2019). In a study published by the American Association of Nurse Anesthetists (AANA), a multimodal U/S education program was designed and implemented for a group of 25 CRNAs at a U.S. hospital. Both a pre-education and post-education assessments were performed. Each participant demonstrated competence of the skill using a standardized skill check-off list and task trainers, indicating that multimodal education is effective in teaching CRNAs to place IVs under U/S guidance.

Task trainers have historically been used to teach a wide range of procedural and technical skills including peripheral IV insertion (Swannick, Forrest, Obrien, 2019, p. 166). Task trainers allow participants to develop psychomotor skills and timing of procedures. The use of task trainers has shown improvement in lumbar puncture skills with simulation-based training (Akaishi et al., 2020). The success rate of residents performing lumbar punctures improved with task trainer use from a mean of 46.3% to 95.7%; the performance of traditionally trained residents was significantly lower (mean 65.4%, $p<0.001$) (Barsuk et. al., 2012). Additionally, Zhang, Ong, & Toh (2021) designed a task-trainer based program to perform cricothyroidotomy and were able to significantly increase the confidence of their participants from pre-education mean confidence of 2.5 out of 5 (CI 95%, 2.6-3.2) to post-education mean confidence of 4.0 out of 5 (CI 95%, 3.8-4.1). Task trainers are more effective in the education of procedural skills than didactic education. According to a study published by the AANA, using task trainers to teach CRNAs how to perform peripherally-inserted central catheter (PICC) insertions, the didactic components were found to be helpful to a self-reported “moderate degree”, while task trainers

were found to be the “most effective” at improving the CRNA’s confidence in the actual placement of PICC lines (Ostrowski, Morrison, & O’Donnell, 2019, p.16).

Theoretical Framework

Donabedian’s theory of quality assurance was the guide for the framework of this quality improvement project. Donabedian’s theory assesses the quality of healthcare which parallels the project’s goal to implement an education program to improve the quality of care (Rich & Butts, 2018). The literature review demonstrates an assessment of the current quality of care. Both the literature review and the project implementation took place in the form of multimodal educational workshops thereby aligning with this theory. Donabedian’s theory utilizes three components including structure, process, and outcome (Rich & Butts, 2018, p. 462). Structure refers to care as it is delivered, including the setting, qualifications of health care professionals, and the administrative systems utilized (Rich & Butts, 2018, p. 462). The setting for the educational workshops developed for this project was the Fall 2021 MANA Conference held in Grand Rapids, Michigan on October 1-3, 2021. The participants were CRNAs attending the conference who registered for the workshop. Administrative systems utilized refer to accreditations (Butts & Rich, 2018, p. 462). The Oakland University Institutional Review Board (IRB) reviewed and approved the project as a quality improvement project before implementation. Process refers to “what is being done and how the implementation will take place” (Butts & Rich, 2018, p. 462). Project methodology defined the implementation process. Outcome assesses desirable or undesirable change that occurs due to the quality improvement (Butts & Rich, 2018, p. 462) The outcomes of the quality improvement process were assessed via pre and post-education assessments, and the subsequent analysis of the data was performed and discussed in the results section. The goal outcome was for improved understanding and

competency in U/S use for peripheral IV placement by the CRNAs attending the educational workshops.

Materials, Methods, and Procedures

Study Design

The DNP Project was designed as a quality improvement project. A multimodal U/S education program for CRNAs was created that included basic ultrasonography education as well as a standardized hands-on training workshop using task trainers to provide active learning and engagement. This method is supported by literature published by the AANA (Bortman, 2019). In this study, a standardized pre-education assessment, post-education assessment, and skill check-off list was created to evaluate education effectiveness. The study method used by the AANA (Bortman, 2019) helped develop the methods of this quality improvement project.

Setting & Population Recruitment

Implementation of this project took place at the Fall 2021 MANA conference in Grand Rapids, Michigan on October 1-3, 2021. MANA members received a conference registration email from the MANA organization, which included the option to register for the educational U/S workshop. The conference email was sent out by the official MANA email address to all members of the organization and included both a brief description and the objectives of the U/S workshop (Appendix B). Interested members had the opportunity to sign up for the workshop upon the completion of conference registration. Each registered participant selected one of the four available 60-minute education workshops to attend, with room for up to ten participants in each workshop. Registered participants received an information sheet regarding the study (Appendix C). Registered participants for the educational workshop provided consent to participate in this quality improvement project.

Key Personnel & Stakeholders

Stakeholders included MANA administrators responsible for scheduling educational workshops at the conference. Key personnel of the project included two Oakland University-Beaumont Graduate Program of Nurse Anesthesia (OUBGPNA) doctoral nursing students responsible for project implementation and their Faculty of Record team member. The task trainers, IV catheters, ultrasound machines, and gel for hands-on practice and competence testing were acquired through Oakland University in Rochester Hills, Michigan.

Approvals for Implementation

Prior to project implementation, the project was granted approval from the Institutional Review Board (IRB) through Oakland University Graduate Program of Nurse Anesthesia (Appendix D). Additionally, the project received a permission letter from the Fall MANA Program Chair, Dr. Linda McDonald, to be compliant with COVID-19 conference policies (Appendix E).

Project Implementation

After both online and on-site registration opportunities, twenty-five CRNA attendees of the Fall 2021 MANA conference participated in the educational workshop. The participants were divided among four 60-minute time slots based on their preferences. Immediately upon beginning each workshop session, a pre-education assessment was distributed and completed by each participant to determine baseline knowledge (Appendix F). The participants were allotted a maximum of ten minutes to complete the assessment. The pre-education assessment also included three demographic questions regarding whether the participant had received past formal U/S training and how often the participant currently utilizes U/S in their practice. Each

participant was instructed to select and remember a four-digit participant number for both the pre-education and post-education assessments to ensure anonymity. Once all assessments were collected, education began. The didactic education was presented via Microsoft PowerPoint presentation (Appendix G) over 15 minutes by the authors. The material included: U/S basics such as echogenicity, knobology, probe orientation and manipulation, the use of doppler mode, imaging for vessel cannulation, and needle visualization. Additional topics crucial for insertion of peripheral IVs via U/S were also covered: anatomy for IV access, step-by-step insertion methods, and common problems including troubleshooting steps. Up to five minutes were designated at the end of didactic education to allow for questions before proceeding with hands-on learning.

After completing the didactic education, participants were divided into two groups of approximately equal size. Each group had one IV task trainer and one U/S machine, as well as standardized materials to place peripheral IVs. The hands-on education was given over 25 minutes and began with a demonstration by the authors of short-axis view, long-axis view, out-of-plane technique, and in-plane technique. The changing of depth and gain, as well as probe manipulation to identify a goal image, was demonstrated. Lastly, the stepwise insertion of a peripheral IV into the simulator vessel using U/S was demonstrated. Each participant had the opportunity to practice scanning with the U/S probe as well as needle insertion. After practicing, each participant had the chance to demonstrate competence in simulated IV placement while being proctored by their respective author instructor using the standardized check-off list (Appendix H). After each participant demonstrated competence in peripheral IV placement via ultrasound, the post-education assessment was distributed (Appendix I). The post-education assessment contained identical questions to the pre-education assessment, excluding the

demographic questions to avoid repetition. An additional question was added to the post-education assessment regarding the effectiveness of the didactic education course.

Ethical Considerations and Risks

Oakland University's IRB approval was obtained before initiating the DNP project. Ethical considerations include the protection of participant information. All CRNAs who chose to participate were de-identified via the creation of self-chosen participant numbers on the pre-education and post-education assessments, as well as their skill check-off form. This served to protect anonymity in the dissemination of results. The project avoided ethical dilemmas as participation was voluntary and did not involve direct patient care. All training was accomplished on simulation task trainers as opposed to living participants. No notable risks to patient safety were identified.

Data Collection and Analysis

Results

In the four education sessions, there was a total of 25 participants. Four participants were omitted from data analysis due to failure to complete the pre or post-education assessment due to the assessments being double-sided. As a result, there were 21 total participants included in data analysis.

As seen in Table 1, of the 21 total participants in the sample, only four participants reported previous formal training in U/S guided peripheral IV placement. While 81% of participants reported not having any formal training in placing peripheral IVs via U/S, 62% of participants reported needing more than two attempts to successfully place a peripheral IV at least weekly; and 43% of participants reported being called at least weekly to assist when other providers have failed. This demonstrates that sampled providers are frequently encountering

difficult access patients in their practice but are untrained in the use of U/S; a skill that could potentially narrow this gap and improve quality of care for difficult access patients.

Table 1

Frequencies of sample background

	n	*%*
Previous formal U/S training		
Yes	4	19
No	17	81
Patients require >2 attempts		
Daily	3	14.3
Weekly	10	47.6
Monthly	7	33.3
Yearly	1	4.8
Assist after other providers have failed		
Daily	1	4.8
Weekly	8	38.1
Monthly	9	42.9
Yearly	2	9.5
Never	1	4.8

To explore how often providers with and without U/S training experience these specific IV events, Mann-Whitney U tests (with asymptotic significance corrected for ties) was used due to the small sample size of those with formal training and the ordinal nature of the frequency variables. Specifically, providers who reported no formal training were more likely than those with formal training to report they encounter patients who require more than two attempts to successfully place a peripheral IV, although the result was not statistically significant, $U = 14.5$, $Z = -1.89$, $p = .059$. As shown in Table 3, there was no difference between those with and without formal training in terms of how frequently they assist in the placement of peripheral IVs after other providers have failed, $U = 25.0$, $Z = -.87$, $p = .387$.

The primary aim of this project was to evaluate if scores on the pre-education assessment improved after the educational intervention. As shown in Table 2, mean and median scores were higher on post-education assessments compared to pre-education assessments, and while only one participant got a perfect score on the pre-education assessment more than half of participants got perfect scores of nine after the education session.

Table 2

Descriptives of assessment test scores

	M	*SD*	*Median*	*Min-Max*
Assessment				
Pre-education	6.76	1.22	7	4-9
Post-education	8.38	0.80	9	6-9

A paired samples t-test was performed to assess the difference between pre-education and post-education assessment scores. Scores improved by an average of 1.61 ($SD = 1.16$) after education, a significant improvement, $t(20) = 6.39$, $p < .001$. The difference scores were not quite normally distributed, and the sample size was small, thus not fully meeting assumptions for the paired samples t-test; however, a non-parametric Wilcoxon signed-rank test also demonstrated a significant improvement, thereby leading to the same conceptual conclusion. In fact, 19 participants improved on the post-education assessment and only two participants scored the same on both their pre-education and post-education tests.

In regard to the hands-on component, 100% of participants were able to successfully achieve vessel cannulation using the ultrasound and therefore were able to complete their skill competence check-off.

As an exploratory follow up, the assessment scores of the participants who had formal U/S training were compared to the participants who reported no formal U/S training using Mann-

Whitney U tests (with asymptotic significance corrected for ties) due to the small sample size of those with formal training ($n = 4$). Those who reported having formal ultrasound training scored significantly higher than those without prior formal training on the pre-education assessment, $U = 9.00, Z = -2.31, p = .021$. However, these two groups did not differ significantly in their post-education assessment scores, $U = 23.5, Z = -1.05, p = .294$.

Discussion

Barriers to Implementation

One barrier to implementation was the short amount of time (ten minutes) between conference sessions. This caused several participants to show up late to their respective sessions, thereby missing the pre-education assessment and part of the didactic education. The consequence of this barrier was a decrease in sample size as compared to total participants. Unfortunately, showing up late and missing any part of the didactic education was an exclusion criterion for data analysis. Since the authors excluded these participants from data analysis, they did not impact results.

An additional barrier to implementation was the enthusiasm of SRNAs (student registered nurse anesthetists) conference attendees. When the original email registration was released to MANA members, the educational sessions quickly filled up with SRNAs, which was unexpected. Since the authors intended to only include practicing CRNAs in data analysis, students were notified that their registration had been canceled and that they could only participate if seats were available the day of the event. Students' seats were then opened up giving CRNAs another opportunity to register online. On the day of the event, several participants reported that there was collective uncertainty regarding seat availability in the

workshops related to confusion with registration. This may have contributed to the small sample size as well.

Analysis of Findings

Based on demographic data analysis, 71% of CRNAs that participated in this quality improvement project reported that in their current practice, they encounter patients requiring more than 2 attempts at peripheral IV insertion daily or weekly. Despite an overall small sample size, this result aligns with current literature stating that CRNAs often need to acquire vascular access for patients with challenging vasculature (Bortman, 2019). In contrast, less than 20% of participants reported having prior U/S training – emphasizing a knowledge gap. The fact that providers who reported having no formal U/S training were somewhat *more* likely to encounter patients requiring multiple peripheral IV insertion attempts further highlights the potential for improved patient care that lies in implementing U/S training as a standard of care.

Statistical analysis demonstrated that standardized, multi-modal education including didactic and hands-on components was effective in improving the knowledge and competence of CRNAs for this skill. This was demonstrated by significant improvement on post-education assessment scores over pre-education scores, as well as 100% competency in the skill check-off among participants. Results support previously published literature by the AANA stating that this format of education can effectively help close the aforementioned knowledge gap (Bortman, 2019). Even more striking is that while the pre-education scores varied significantly among participants with prior U/S training versus those without it, the post-education scores did not differ between these two groups. This outcome demonstrates that as far as foundational knowledge, a brief but impactful education session allowed those without previous formal U/S training to “catch up” to those with previous U/S formal training. All of the CRNA participants

were able to achieve successful vein cannulation which supports the usefulness and effectiveness of task trainers for teaching U/S guided peripheral IV insertion (Swannick, Forrest, Obrien, 2019, p. 166). Anecdotally, many participants also verbally expressedtheir appreciation for the hands-on component of the workshop that utilized task trainers.

Limitations and Recommendations

Limitations

A limiting factor in this project was the small sample size, made even smaller by having to exclude participants who came late to the education sessions based on conference logistics. If the opportunity arose, the authors would conduct this project at a healthcare facility or similar setting where participants could arrive in a timely fashion and stay for as long as they felt necessary to master the material. Another significant limitation was that provider competence in this skill was not able to be demonstrated on live patients due to ethical concerns, risk, and logistical limitations. While task trainers are tools for learning and building confidence, the authors cannot theorize how competence on the task trainers translates to competence in the workplace.

Lastly, a limitation exists in independent provider use of the skill and consequent effects on confidence and competency. While several providers reported that they have the opportunity to place IVs with ultrasound with relative frequency in their practice, many others reported having minimal opportunity to do so. As such, there may be a gap in knowledge and competency for providers who learn to use ultrasound at an educational workshop, but do not use it in their practice with any level of regularity.

Recommendations

After an extensive literature review and implementation of this quality improvement project, we recommend that all practicing CRNAs have access to formal education in U/S use for IV insertion that includes both didactic and hands-on components. We believe this skill is highly useful for anesthesia providers and can improve patient safety and satisfaction. Further research is needed regarding exactly how to standardize U/S education for CRNAs in current practice. Currently, there is no standard as to the setting that works best for the implementation of this education. As stated previously, education should ideally be distributed in a place where providers are not time-limited as needs may vary among learners. Secondly, there needs to be a better understanding of how task trainer competence in placing peripheral IVs via U/S translates to competence on live patients. Further studies should also focus on how often CRNAs must use this skill in their practice to maintain competence once education has occurred. Finally, the financial impact of the utilization of U/S for peripheral IV placement, specifically in patients with difficult vasculature, would be an interesting topic for research and could potentially serve as a motivator for healthcare institutions to make this education available for their anesthesia providers.

Implications for Practice and Career Development

This quality improvement project has the potential to greatly impact anesthesia practice and CRNA career development. The literature review concluded that CRNAs are frequently being utilized as go-to providers for obtaining difficult vascular access now, more than ever before. The implications of this demonstrate that now is the ideal time to standardize U/S education in anesthesia training (University of Kansas Medical Center, 2018). By making U/S education available to CRNAs in current practice, healthcare institutions can be assured that their

anesthesia providers are able to utilize all available tools to ensure patient safety. Furthermore, CRNAs who seek to improve their practice may seek formal U/S education with the knowledge that other CRNAs with no prior training have been able to achieve competence in this skill. This project along with literature previously published by the AANA (Bortman, 2019) provides a blueprint for how to create effective, multi-modal education to provide CRNAs with the knowledge and competence to utilize U/S for peripheral IV placement.

Project Contribution to DNP Essentials and Personal Goals

Completion of this project has played a significant role in our Doctor of Nursing Practice (DNP) journey as well as personal career goals. The literature review and planning of this project involved extensive clinical scholarship and analytical methods for evidence-based practice as well as quality improvement and systems thinking, therefore fulfilling DNP Essential II. To develop the education provided in the workshops, we studied U/S technology extensively and spent many hours practicing peripheral IV placement under U/S using task trainers to master the skill. Such effort helped develop scientific underpinnings for practice and therefore met DNP Essential I. Implementation of the education at the Fall 2021 MANA conference allowed us to experience interprofessional collaboration for improving patient outcomes. This experience was highly motivating and encouraging for students at a crucial time in their doctoral education. Implementation met DNP Essential VI. Data analysis and investigation of results allowed us to put the pieces together and see how our work has the potential to impact anesthesia practice. Since the focus of the project was implementing patient care technology (U/S), the investigation of results met DNP Essential IV. Personally, we feel that the culmination of the effort required at each phase of the DNP project has demonstrated the true meaning of advanced practice nursing, therefore meeting Essential VIII. The opportunity to develop a deeper understanding of

evidence-based practice, to teach and collaborate with other anesthesia professionals, and to utilize technology to improve patient safety and outcomes has been a privilege. This project has validated the decision to pursue a Doctorate of Nursing Practice, specializing in Nurse Anesthesia.

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Appendix A - Synthesis Table – Level of Evidence

	1	2	3	4	5	6	7	8	9	10	11	12	13
Level I: Systematic Review or Meta-Analysis				X							X		
Level II: Randomized controlled trial		X						X				X	
Level III: Controlled trial without randomization													
Level IV: Case-control study/ Cohort study	X		X		X				X	X			X
Level V: Systematic review of qualitative studies													
Level VI: Descriptive study						X	X						

1 = Bortman et al., 2019 2 = Bridey et al., 2018 3 = Butterfield, 2017, 4 = Egan et al., 2013, 5 = Fabiani et al., 2016, 6 = Galen et al., 2018., 7 = Galen et al., 2020, 8 = McCarthy et al., 2016, 9 = Ng et al., 2017, 10 = Partovi- Deilami et al., 2016, 11 = Van Loon et al., 2018, 12 = Vinograd 2019, 13 = Zitek et al., 2018

Appendix B

Description and Project Objectives for MANA Email

Description:
Ultrasound-guided peripheral intravenous catheter (PIV) placement is an alternative to central venous access in patients with difficult vascular access. This ultrasound-guided PIV placement education workshop will teach CRNAs how to cannulate veins under ultrasound guidance using the in-plane and out-of-plane technique. Hands-on practice will allow CRNA participants to increase their knowledge, comfort and competence with cannulating vessels under direct ultrasound visualization. This course is designed for the CRNA with no previous formal education on PIV placement under guided ultrasound.

Course Objectives: By the end of the education workshop, the CRNA will be able to:

1. Define ultrasound, orient the ultrasound probe and properly use doppler color flow.
2. Determine echogenicity, gain, and the differences between in-plane and out-of-plane techniques.
3. Identify various structures (including arteries and veins) on ultrasound.
4. Place a peripheral intravenous catheter using ultrasound technology.

Appendix C

Information Sheet

Study Title: Ultrasound Guided Peripheral Venous Access

Principal Investigator: Rachel Sonego

Address: 6620 Pineway Dr.,Troy Michigan 48098

Location: Michigan Association of Nurse Anesthetists (MANA) Fall Conference, Grand Rapids, Michigan

Purpose: You are being asked to participate in a study for obtaining baseline information regarding Certified Registered Nurse Anesthetists' knowledge on the use of ultrasonography for establishing venous access. Additionally, this study will assess the use of didactic and simulation education on the use of ultrasonography for obtaining venous access, to improve Certified Registered Nurse Anesthetists' knowledge regarding this skill.

Study Procedures: If you choose to take part in the study, you will be asked to do the following:

- Complete a pre-education assessment on the use of ultrasonography for establishing venous access.
- Agree to attend an educational PowerPoint presentation on the use of ultrasonography for establishing venous access.
- Agree to participate in a hands-on skill training session, using task trainers, to place peripheral venous catheters under ultrasound guidance.
- Complete a post-education assessment on the use of ultrasonography for establishing venous access.
- The time frame necessary for involvement will be approximately 60 minutes.
  The decision to participate is up to you. You may refuse to take part in the study at any time without affecting your participation in the workshop.

Benefits: As a participant in this study, the direct benefit for you would be the acquisition of a new skill for intravenous catheter placement under ultrasound guidance.

Risks: There are no foreseeable risks.

Costs: There will be no costs to you for participating in this research study.

Compensation: There will be no compensation for participating in the study.

Confidentiality: All aspects of the study including pre & post-assessment education will be confidential with the use of randomized participant numbers.

Voluntary participation/withdrawal: Taking part in this research study is voluntary. You may withdraw from the study at any time.
Questions: Any questions about this study now or in the future can be answered by Rachel Sonego at rsonego@oakland.edu or by telephone at 248-720-9838 or contact the investigator's faculty, Dr. Laura Rodgers, at larodgers@oakland.edu. If you have questions or concerns about your rights as a participant, please contact the Institutional Review Board at 248-370-4898. The institutional Review Board oversees all human participant research conducted through Oakland University.

Participation: By registering for the IV Ultrasound Guided workshop at the 2021 MANA Fall Conference, you are agreeing to participate in the study.

APPENDIX C cont.

Receipt of Patient Information Sheet

Participant Number:

Study Title: Ultrasound Guided Peripheral Venous Access

I have reviewed the information sheet for this study with the participant number:
The participant has agreed to participate in the study.

Comments, if applicable:

Name of person distributing information sheet:

Signature of person distributing information sheet:

Date:

Appendix D

IRB approval

Date: 2-13-2022

IRB #: IRB-FY2021-178
Title: Venous Access Utilizing Ultrasonography
Creation Date: 11-29-2020
End Date:
Status: Approved
Principal Investigator: Rachel Sonego
Review Board: OU IRB
Sponsor:

Study History

Submission Type	Review Type	Decision
Initial	Exempt	Exempt

Appendix E

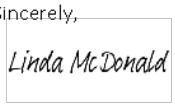
MANA Approval

August 23, 2021

To Whom It May Concern:

Jenna Renault, BSN, RN and Rachel Sonego BSN, RN will be conducting an IV ultrasound workshop at the fall 2021 Michigan Association of Nurse Anesthetist meeting.

Sincerely,



Linda McDonald, DNAP, CRNA
MANA Program Planning Chairperson

Appendix F

Pre-Education Assessment

Ultrasound Guided Peripheral Vascular Access
Pre-Education Assessment
*Participant #*_____

I. Ultrasound Basics

1. Ultrasound beams are a form of _____ energy.
    a) Kinetic
    b) Electric
    c) Mechanical sound
    d) Potential
2. What knob can be adjusted on the ultrasound screen to give an image more or less "contrast"?
    a) Echogenicity
    b) Gain
    c) Color
    d) Translucent
3. What determines whether a structure will appear bright white, grey, or black on the ultrasound screen?
    a) Reflection
    b) Echogenicity
    c) Depth
    d) Echo
4. What is the easiest way to determine ultrasound probe orientation?
    a) Look for the indicator, Touch one side of the probe visualize where your touch shows up on the screen
    b) Orient yourself to the anatomy on the screen
    c) Turn on color doppler
    d) Change the probe long axis orientation

5. If you can see the tip of your needle as a bright white dot, but cannot see the entirety of the needle shaft while placing an IV, what technique are you using?
    a) Out-of-plane technique
    b) In-plane technique

II. IV Placement Technique

6. What will a vein look like on ultrasound?
    a) Compressible
    b) Pulsatile
    c) Straight
    d) Thick

7. T/F: By changing to a long-axis view after entering the vessel, you may be able to visualize the catheter entering the vein?

a) True
b) False

8. T/F: When you turn on 2D Doppler, the red indicates arterial flow, and the blue indicates venous flow.

a) True
b) False

III. Example Scenario

9. Your patient with a BMI of 45 has excess adipose tissue on her arms, and no veins are easily palpable or visible. Upon scanning with a high-frequency linear probe, you are able to visualize a layer of adipose tissue on the screen, but no vessels. What ultrasound property may need to be adjusted to visualize vessels underneath the adipose?

a) Depth
b) Change your probe
c) Scan to a more superficial area of the arm
d) There are no veins in this location

IV. Individual Practice

10. I have previously had formal training in placing peripheral IVs via ultrasound?

a) Yes
b) No

11. In my current or most recent practice, I encounter patients who require >2 attempts to successfully place a peripheral IV.

a) Daily
b) Weekly
c) Monthly
d) Yearly
e) Never

12. In my current or most recent practice, I am called to assist in the placement of peripheral IVs after other providers have failed.

a) Daily
b) Weekly
c) Monthly
d) Yearly
e) Never

13. As of this moment, if I were asked to do so, I would feel comfortable placing a peripheral IV with ultrasound guidance for a patient with difficult access.

a) Not at all comfortable
b) Not comfortable, but I'll give it a shot
c) Pretty comfortable
d) Confident

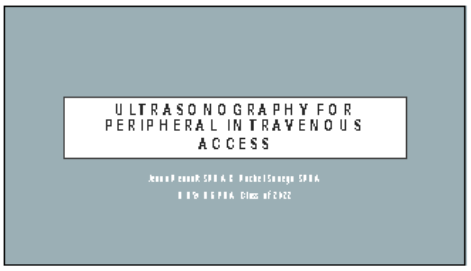
14. As of this moment, I feel I have a general understanding of how the ultrasound machine works and how I can use it to place a peripheral IV.

a) No
b) Minimal understanding
c) Yes

Appendix G

Didactic Education Material - PowerPoint

6/24/21



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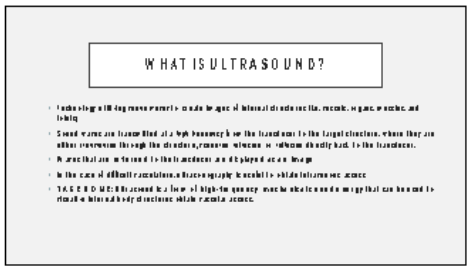

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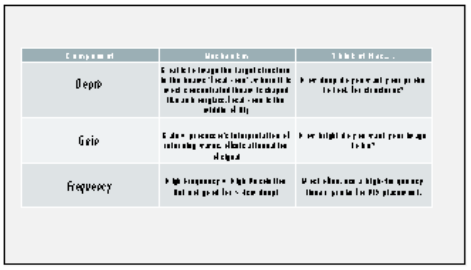

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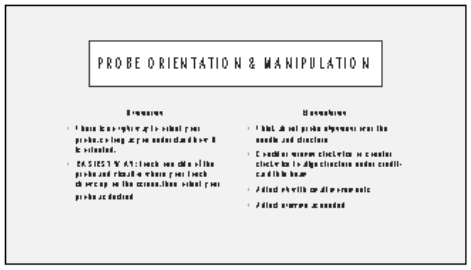

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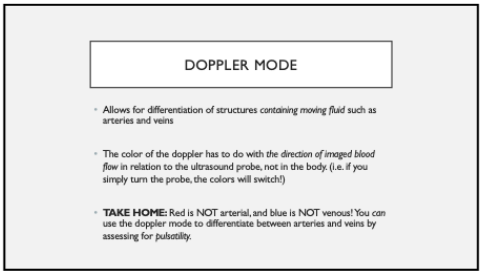
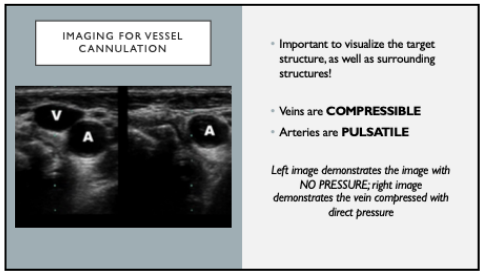
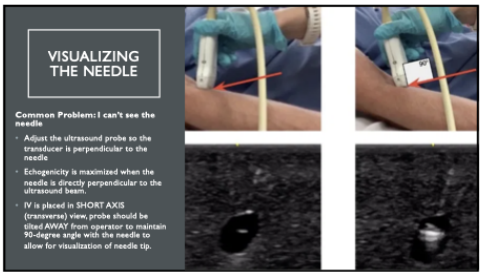

DOPPLER MODE
Allows for differentiation of structures containing moving fluid such as arteries and veins
The color of the doppler has to do with the direction of imaged blood flow in relation to the ultrasound probe, not in the body. (i.e. if you simply turn the probe, the colors will switch!)
TAKE HOME: Red is NOT arterial, and blue is NOT venous! You can use the doppler mode to differentiate between arteries and veins by assessing for pulsatility.

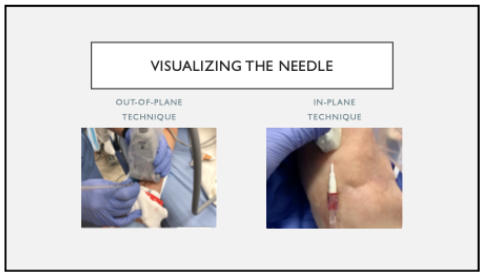
7


IMAGING FOR VESSEL CANNULATION
V
A
A
Important to visualize the target structure, as well as surrounding structures!
Veins are COMPRESSIBLE
Arteries are PULSATILE
Left image demonstrates the image with NO PRESSURE; right image demonstrates the vein compressed with direct pressure

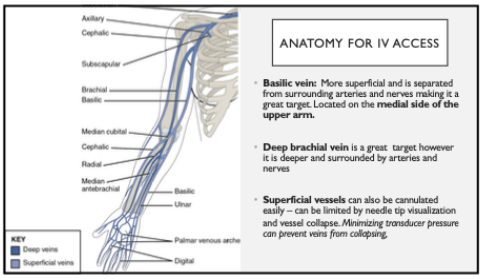
8


VISUALIZING THE NEEDLE
Common Problem: I can't see the needle
Adjust the ultrasound probe so the transducer is perpendicular to the needle
Echogenicity is maximized when the needle is directly perpendicular to the ultrasound beam.
IV is placed in SHORT AXIS (transverse) view, probe should be tilted AWAY from operator to maintain 90-degree angle with the needle to allow for visualization of needle tip.

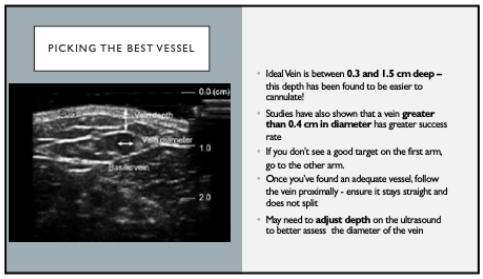
9


VISUALIZING THE NEEDLE
OUT-OF-PLANE TECHNIQUE
IN-PLANE TECHNIQUE

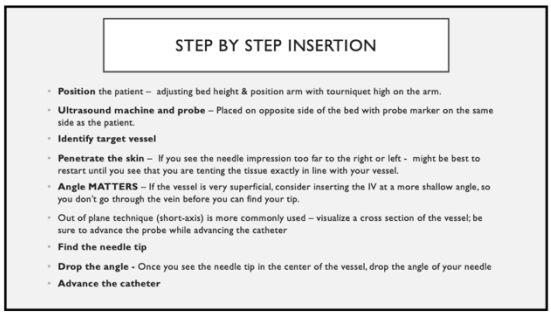
10


Axillary
Cephalic
Subscapular
Brachial
Basilic
Median cubital
Cephalic
Radial
Median antebrachial
Basilic
Ulnar
Palmar venous arche
Digital
KEY
Deep veins
Superficial veins
ANATOMY FOR IV ACCESS
Basilic vein: More superficial and is separated from surrounding arteries and nerves making it a great target. Located on the medial side of the upper arm.
Deep brachial vein is a great target however it is deeper and surrounded by arteries and nerves
Superficial vessels can also be cannulated easily – can be limited by needle tip visualization and vessel collapse. Minimizing transducer pressure can prevent veins from collapsing.

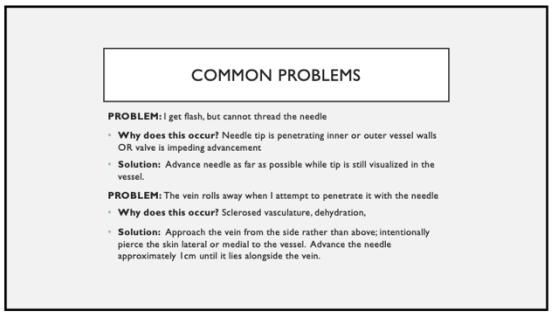
11


PICKING THE BEST VESSEL
0.0 (cm)
1.0
2.0
Ideal Vein is between 0.3 and 1.5 cm deep – this depth has been found to be easier to cannulate!
Studies have also shown that a vein greater than 0.4 cm in diameter has greater success rate
If you don't see a good target on the first arm, go to the other arm.
Once you've found an adequate vessel, follow the vein proximally - ensure it stays straight and does not split
May need to adjust depth on the ultrasound to better assess the diameter of the vein

12


STEP BY STEP INSERTION
Position the patient – adjusting bed height & position arm with tourniquet high on the arm.
Ultrasound machine and probe – Placed on opposite side of the bed with probe marker on the same side as the patient.
Identify target vessel
Penetrate the skin – If you see the needle impression too far to the right or left - might be best to restart until you see that you are tenting the tissue exactly in line with your vessel.
Angle MATTERS – If the vessel is very superficial, consider inserting the IV at a more shallow angle, so you don't go through the vein before you can find your tip.
Out of plane technique (short-axis) is more commonly used – visualize a cross section of the vessel; be sure to advance the probe while advancing the catheter
Find the needle tip
Drop the angle - Once you see the needle tip in the center of the vessel, drop the angle of your needle
Advance the catheter

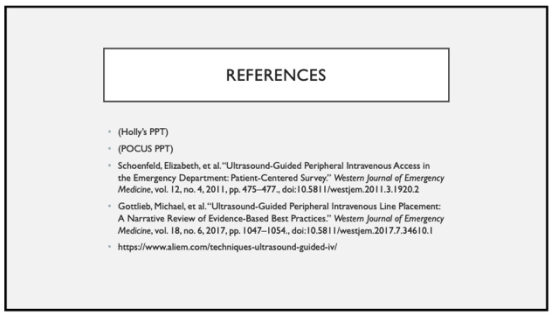
13


COMMON PROBLEMS
PROBLEM: I get flash, but cannot thread the needle
Why does this occur? Needle tip is penetrating inner or outer vessel walls OR valve is impeding advancement
Solution: Advance needle as far as possible while tip is still visualized in the vessel.
PROBLEM: The vein rolls away when I attempt to penetrate it with the needle
Why does this occur? Sclerosed vasculature, dehydration,
Solution: Approach the vein from the side rather than above; intentionally pierce the skin lateral or medial to the vessel. Advance the needle approximately 1cm until it lies alongside the vein.

14


QUESTIONS?
Jenna Renault Email: jennacoon@oakland.edu
Rachel Sonego Email: rsonego@oakland.edu

15


REFERENCES
(Holly's PPT)
(POCUS PPT)
Schoenfeld, Elizabeth, et al. "Ultrasound-Guided Peripheral Intravenous Access in the Emergency Department: Patient-Centered Survey." Western Journal of Emergency Medicine, vol. 12, no. 4, 2011, pp. 475–477., doi:10.5811/westjem.2011.3.1920.2
Gottlieb, Michael, et al. "Ultrasound-Guided Peripheral Intravenous Line Placement: A Narrative Review of Evidence-Based Best Practices." Western Journal of Emergency Medicine, vol. 18, no. 6, 2017, pp. 1047–1054., doi:10.5811/westjem.2017.7.34610.1
https://www.aliem.com/techniques-ultrasound-guided-iv/

16

Appendix H

Ultrasound Guided IV Insertion Check Off

Participant will be asked to demonstrate the following skills to one of the student educators. (Educator: Circle pass or fail)

1. Place ultrasound probe on the simulator and demonstrate how to orient the probe.

    - Pass Fail

2. Demonstrate adjustment of depth and gain to optimize the image.

    - Pass Fail

3. Obtain goal image via alignment, rotation, tilt, and pressure adjustments.

    - Pass Fail

4.Verbalize plan for needle insertion and where needle should be seen on the screen.

    - Pass Fail

5. Cannulate vessel with peripheral venous catheter under ultrasound guidance.

    - Pass Fail

Appendix I

Post-Education Assessment

Ultrasound Guided Peripheral Vascular Access
Post-Education Assessment
*Participant #*_____

I. Ultrasound Basics

1. Ultrasound beams are a form of _____ energy.
    a) Kinetic
    b) Electric
    c) Mechanical sound
    d) Potential
2. What knob can be adjusted on the ultrasound screen to give an image more or less "contrast"?
    a) Echogenicity
    b) Gain
    c) Color
    d) Translucent
3. What determines whether a structure will appear bright white, grey, or black on the ultrasound screen?
    a) Reflection
    b) Echogenicity
    c) Depth
    d) Echo
4. What is the easiest way to determine ultrasound probe orientation?
    a) Look for the indicator, Touch one side of the probe visualize where your touch shows up on the screen
    b) Orient yourself to the anatomy on the screen
    c) Turn on color doppler
    d) Change the probe long axis orientation

5. If you can see the tip of your needle as a bright white dot, but cannot see the entirety of the needle shaft while placing an IV, what technique are you using?
    a) Out-of-plane technique
    b) In-plane technique

II. IV Placement Technique

6. What will a vein look like on ultrasound?
    a) Compressible
    b) Pulsatile
    c) Straight
    d) Thick

7. T/F: By changing to a long-axis view after entering the vessel, you may be able to visualize the catheter entering the vein?

a) True
b) False

8. T/F: When you turn on 2D Doppler, the red indicates arterial flow, and the blue indicates venous flow.

a) True
b) False

III. Example Scenario

9. Your patient with a BMI of 45 has excess adipose tissue on her arms, and no veins are easily palpable or visible. Upon scanning with a high-frequency linear probe, you are able to visualize a layer of adipose tissue on the screen, but no vessels. What ultrasound property may need to be adjusted to visualize vessels underneath the adipose?

a) Depth
b) Change your probe
c) Scan to a more superficial area of the arm
d) There are no veins in this location

IV. Individual Practice

10. As of this moment, if I were asked to do so, I would feel comfortable placing a peripheral IV with ultrasound guidance for a patient with difficult access.

a) Not at all comfortable
b) Not comfortable, but I'll give it a shot
c) Pretty comfortable
d) Confident

11. As of this moment, I feel I have a general understanding of how the ultrasound machine works and how I can use it to place a peripheral IV.

a) No
b) Minimal understanding
c) Yes

12. How effective was the ultrasounds education at giving an understanding of the use of ultrasound for peripheral IV placement?

a) effective
b) not effective
c) somewhat effective