Anesthesia Providers' Perceptions of Ultrasound-Guided Arterial Line Placements: A DNP Project

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Abstract

Current evidence shows the use of ultrasound guidance is advantageous for arterial line placements in reducing complications and increasing efficiency. Despite this evidence, no formal guidelines have been established regarding ultrasound-guided arterial line placements, leaving anesthesia providers to use their clinical judgment and personal preferences when placing these invasive lines. At this time, there is a lack of understanding regarding anesthesia provider preference for utilization of ultrasound technology for perioperative arterial catheterization. The purpose of this DNP quality improvement project was to develop, implement, and evaluate the perceived adequacy of an educational resource designed specifically for anesthesia providers to improve awareness and utilization of ultrasound for arterial line placement. This project took place at the main operating suite of a large medical facility in eastern North Carolina. CRNAs at this site were provided information on the basics of ultrasound use, troubleshooting tips, and the current research regarding ultrasound-guided arterial line placements. The results showed that confidence level and likelihood of using ultrasound-guidance for arterial line placements increased followg the implementation period. Participants also identified a lack of equipment as a barrier to using ultrasound in their practice. Future projects should focus on increasing access to ultrasound equipment and the addition of a hands-on ultrasound workshop to further increase confidence and skill.

Keywords: arterial line, ultrasound guidance, educational tool, operating room, anesthesia

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Section I. Introduction

Background

Arterial lines are devices commonly used in acute, critical care, and operating room (OR) settings to accurately and continuously measure blood and mean arterial pressures (Wang et al., 2020). This is particularly beneficial in patients who are hemodynamically unstable and require vasopressor support during surgery. Arterial lines can also be indicated for patients requiring frequent blood gas or other lab sampling to decrease multiple punctures. Arterial cannulation is performed by accessing the artery with a needle, advancing a guide wire, and then inserting the catheter over the wire and into the vessel. The most common site for cannulation is the radial artery due to its convenience of access; as such, landmark guided palpation (LMGP) has been the standard of care for inserting radial catheters (Gibbons et al., 2020). However, the use of anatomic landmarks can be difficult due to physiological factors, including obesity, edema, and hypotension, which can be observed in approximately 30% of patients.

To combat these issues, ultrasound can be utilized by anesthesia providers to place arterial lines accurately and efficiently. Ultrasound machines are used to detect blood vessels as these fluid-filled structures do not reflect the ultrasound beam and appear black on the monitor (Oliver et al., 2019). Ultrasound guidance (USG) also allows providers to differentiate between pulsatile arteries and veins which can be seen collapsing with limited pressure from the probe (Wang et al., 2020). Additionally, color doppler can be used to determine flow patterns to identify vascular structures in reference to probe positioning with flow away from the probe visualized as blue and flow towards the probe as red in color. This is particularly beneficial in preventing improper cannulation in patients with vascular abnormalities. When providers need multiple attempts to place arterial lines, it can increase patient discomfort and the potential for

complications. USG is associated with increased first-attempt success and decreased procedure time. In addition, a review by Fatima et al. (2021) evaluated the impact a newly implemented USG quality improvement project had on reducing surgical delays, described as 15 minutes or more. They discovered that surgical delays due to difficulty placing arterial lines decreased when USG was used.

Despite the current evidence supporting the use of USG for arterial line placement, USG use is often only used as a rescue intervention when multiple attempts using LMGP technique have failed. A survey conducted by Chui et al. (2019) found that almost 70% of anesthesiologists wanted to use USG more frequently in their perioperative care, and 72% would like to receive training to increase their comfort in using USG in their practice. Additionally, the American Association of Nurse Anesthesiology (AANA) reports barriers to implementing a standard of care for USG in practice include a lack of training opportunities, a lack of universal training standards, and an inability to obtain and maintain competencies (Pitman et al., 2023).

Organizational Needs Statement

The partnering facility for this quality improvement project is a large, 1700 bed level I trauma center located in the southeastern part of the United States. There are currently no policies at this facility for the use of ultrasound guidance for arterial line catheterizations by anesthesia providers. This is due, in part, to a lack of formal guidelines or recommendations from professional organizations, such as the AANA. Many certified registered nurse anesthetists and anesthesiologists continue to rely on the traditional LMGP technique until this method fails and multiple attempts at arterial line placement have already been required. By offering additional training resources for anesthesia providers on the use and benefits of ultrasound guided techniques, as recommended by the AANA, there may be the potential for increased utilization

of this technology and the subsequent improvement of the quality and safety of arterial cannulation.

Problem Statement

Despite multiple studies supporting the advantages of ultrasound guidance, no formal processes are consistently followed, leaving anesthesia providers at this institution to use clinical judgment and personal preferences when selecting methods for arterial line placement. Currently, there is a lack of understanding regarding anesthesia provider preference for utilization of ultrasound technology for perioperative arterial catheterization.

Purpose Statement

The purpose of this DNP quality improvement project was to develop, implement, and evaluate the perceived adequacy of an educational resource designed specifically for anesthesia providers to improve awareness and utilization of ultrasound for arterial line placement.

Section II. Evidence

Description of Search Strategies

The purpose of this literature review was to examine the current evidence and recommendations regarding ultrasound guidance for arterial line placement, as well as what interventions influence the use of ultrasound guidance in the perioperative period. The PICOT question used to drive this search was: What interventions influence anesthesia providers' use of ultrasound guidance for perioperative placement of arterial lines?

Searches were conducted using the databases Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, and ProQuest Search as well as the search engine Google Scholar. The Boolean operators AND and OR were utilized to combine necessary keywords and concepts, as well as MeSH terms in PubMed and subject headings in CINAHL. Keywords included anesthesia providers, Certified Registered Nurse Anesthetists (CRNAs), ultrasound, ultrasonography, arterial catheters, and arterial line placement. The specific search strategy used to query PubMed was (nurse anesthetists OR anesthesia) AND ultrasonography AND arterial line placement. This search strategy pulled in the MeSH terms nurse anesthetists, anesthesia, ultrasonography, and vascular access devices. All searches were limited to publication within the past five years (2018-2023). See Appendix A for a complete list of the keywords, MeSH terms, and subject terms utilized for the searches. Publications identified through these searches were reviewed for certain inclusion criteria, such as an emphasis on the benefits of ultrasound-guidance for arterial line placement, as well as quality improvement projects aimed at identifying the effects of educational tools on ultrasound compliance. See Appendix B for the search strategies and number of articles found and kept.

The literature search identified multiple articles applicable to the use of ultrasound-guidance for arterial line placement. Based on Melnyk and Fineout-Overholt's (2019) levels of evidence hierarchy, the evidence identified included one Level I (systematic review of randomized controlled trials), two Level II (randomized controlled trials), two Level V (literature reviews), and two Level VI (qualitative studies) sources. See Appendix C for literature matrix.

Selected Literature Synthesis

Most articles selected for inclusion in this review focused on the use of ultrasound guided techniques for arterial line placement in the adult patient. Oliver et al. (2019) provided detailed information in their literature review on the basics of ultrasonography, the transverse versus longitudinal technique, and guidelines for selecting an artery for cannulation. In an additional literature review, Wang et al. (2019) discussed the current research on the indications for and benefits of ultrasound guided arterial line placement. Traditionally, LGMP techniques have been used due to the ability to "easily" palpate an arterial pulse. In certain patients, however, increased subcutaneous fat or peripheral edema impacts the ability to feel the arterial pulsations. Low blood pressure, which is often an indication for arterial line placement in the first place, can also make it difficult for a provider to palpate the artery.

When multiple attempts are required to place arterial lines, there is the chance for increased patient discomfort and unintentional complications. USG is associated with increased first-attempt success as well as decreased time required and number of attempts needed (Wang et al., 2020). This is further supported by Gibbons et al. (2020) and Wilson et al. (2020). A randomized controlled trial (RCT) conducted was by Gibbons et al. (2020) to compare USG and LMGP exclusively for radial arterial lines performed by novice Emergency Medicine interns. In this RCT, twenty patients were included in each group and the data showed USG had a first-pass

success of 75% versus 0% for LMGP. Overall, 100% of interns were successful when using USG versus only 15% for LMGP. The average number of attempts was doubled in the LMGP group and the mean placement time in seconds was 264 for USG versus 524 for LMGP.

A similar study was conducted by Wilson et al. (2020) using Emergency Medicine residents, who generally have more experience placing arterial lines than the novice interns in the previous study. Thirty patients were randomized into each group and an arterial line was successfully placed in 96% of the USG group versus 47% for the LMGP group. An average of 1.3 attempts was required in the USG group versus 2 attempts in the LMGP group. In the case of the 53% failed LMGP patients (greater than 3 attempts), the providers were then asked to implement the use of USG resulting in 100% success rate. Interestingly, they found there was no significant difference in the amount of time needed to place the arterial lines between the two groups. This contrasts with the previous study by Gibbons et al. (2020) as well as a systematic review by Fatima et al. (2021) that evaluated the impact a newly implemented USG quality improvement project had on surgical delays. They discovered that surgical delays, defined as greater than fifteen minutes, due to difficult line placement decreased from 12% to 4% when USG was used.

Researchers in each of these studies also sought to address the rate of complications associated with arterial cannulations. Although complications are rare, they become more prevalent with increased attempts and include hematoma formation, ischemia, thrombosis, and infection (Fatima et al., 2021). In the RCT conducted by Gibbons et al. (2020), the LMGP group had one complication (hematoma) and the USG group had none. Complications including lacerations, arterial occlusion, and hematoma were also recorded in the study by Wilson et al. (2020). Only six patients in the USG group experienced a complication, whereas 11 patients in

the LMGP group experienced complications. The most common complication noted was hematoma, with rates of 16.7% and 30%, respectively.

The last two articles selected for inclusion in this review were level VI qualitative studies (Chui et al, 2019; Pitman et al., 2023). Authors of these studies looked at the potential impact of education and training on compliance and success rates associated with the use of ultrasound for vascular access. Anesthesiologist responses to a survey conducted by Chui et al. (2019) found that only 30% frequently or always use ultrasound for arterial cannulation. Similarly, 29% claimed the use of ultrasound is not common practice at their institution for arterial line placement. However, the majority (70%) of respondents stated they would like to receive additional ultrasound training, they would benefit from online learning modules, and they wanted to use ultrasound guidance more frequently as part of their perioperative care.

The implementation of a hybrid training program consisting of equal portions of didactic and hands-on instruction by Pitman et al. (2023), found that confidence and knowledge scores among CRNAs improved significantly following implementation of the program. Additionally, there was no significant decline in hands-on competency from post education to the 90-day follow up evaluation.

This literature review highlighted the many benefits of ultrasound guidance, including increased first pass attempts, decreased complications, and decreased arterial line procedure time. Researchers also discussed concerns that inadequate education and training could be a key barrier to the utilization of ultrasound technology for perioperative arterial cannulation.

Project Framework

The model used for executing this project was the Institute for Healthcare Improvement's (IHI, 2022) model for improvement using the plan-do-study-act (PDSA) cycle. The *plan* phase

consisted of a literature review surrounding ultrasound guided arterial line placement which noted inconsistencies in the utilization of this technique in the perioperative period and the potential benefit of an educational resource. Such an educational resource, as well as pre- and post-assessment surveys, were developed as part of this quality improvement project. Emails were then sent out to participants during the *do* phase with instructions on completing the pre-assessment survey, reviewing the educational resource, and following up with the post-assessment survey in approximately two weeks. During the *study* phase, the submitted assessment surveys were analyzed to determine the participants' perceptions of the educational resource. The *act* phase then included dissemination of the project's results to members of the organization with additional suggestions for changes to be incorporated in additional PDSA cycles.

Ethical Considerations and Protection of Human Subjects

There were no identified ethical considerations or protection of human subjects concerns for this project. The proposed intervention was expected to benefit all CRNA participants equitably with no potential for harm greater than normally encountered in the work environment. Ethical training regarding research involving human subjects was accomplished through completion of the Collaborative Institutional Training Initiative (CITI) modules (https://www.about.citiprogram.org) prior to the project start. Additionally, this project underwent an initial screening process through the East Carolina University (ECU) College of Nursing (CON) and the University and Medical Center Institutional Review Board (UMCIRB). The project was deemed to be a quality improvement project. It was, therefore, exempt from full IRB review. Furthermore, the collection of data was approved by a representative from the

partnering facility and approval was obtained through the organization's review protocol. Approval documents can be in Appendix D.

Section III. Project Design

Project Setting

The setting of this project was the main operating suite of a large, 1700-bed medical facility in eastern North Carolina. This medical facility houses twenty-six main operating rooms in addition to its seven cardiac operating rooms, allowing for a significant number of surgical procedures to be performed daily. This facility is also the only level one trauma center in the region, so there is an increased likelihood that the patients being cared for by the anesthesia providers will require an arterial line for accurate blood pressure management due to the acuity of the patient population. This may provide many opportunities for the anesthesia providers included in the study to apply the information supplied in the intervention. Potential barriers include limited equipment availability and the fast-paced environment of the operating room creating a sense of urgency that could limit the opportunities for utilization of the intervention.

Project Population

The project population included CRNAs practicing in the main operating suite, all of whom are qualified to place arterial lines. A wide range of providers, from new graduate to seasoned, were included to increase the diversity of the study's population. Potential barriers included preconceived notions of the use of ultrasound guidance for arterial line placement as a rescue maneuver only, provider preference for their current insertion techniques, and procedural time constraints. Arterial lines are often inserted during the initial phase of anesthesia, in which providers have many tasks to complete within a short time window. This could deter some providers from incorporating the intervention in their practice.

Project Team

The project team consisted of the team lead Student Registered Nurse Anesthetist (SRNA), three SRNA student colleagues, the project chair, the site contact person, the clinical contact person, and the course director. A collaborative effort was made between the team lead and the other three student colleagues to develop the project topic, educational intervention tool, and pre- and post-intervention surveys to assess the adequacy of the intervention. Implementation and data analysis were then performed solely by the team lead. The project chair, who was also the CRNA program director and clinical site contact, provided guidance and clinical expertise to assist with the project development, participant recruitment, and project implementation. The course director provided direction for the initial literature review, and step-by-step guidance and feedback throughout the duration of the project.

Methods and Measurement

The purpose of this quality improvement project was to evaluate the perceptions of anesthesia providers regarding an educational resource developed to improve the awareness and utilization of ultrasound for arterial line placement. The project was developed and performed using a single PDSA cycle.

During the planning period, a multitude of team meetings were held with the project chair and fellow colleagues to discuss the problem and purpose driving this project, the proposed intervention, processes, and evaluation tools. The project's population was identified, and the participating providers were contacted by the project chair and clinical contact person via email. A narrated PowerPoint and corresponding handout were developed to review ultrasound techniques and current literature regarding ultrasound guidance for arterial line placement (see Appendix E). Pre- and post-intervention survey questionnaires using Qualtrics software were

created to assess the anesthesia providers' perceptions about the effectiveness of the educational resource (see Appendix F). Additionally, the approval of the ECU CON and UMCIRB discussed earlier was obtained during this phase.

In the "do" period, an email was sent out to participants with instructions on completing the attached pre-intervention Qualtrics survey, reviewing the educational resource provided, and implementing these concepts into their practice over a two-week period (see Appendix G). Following the two-week implementation, the anesthesia providers were asked to complete the post-intervention Qualtrics survey to obtain information on the number of times ultrasound guidance was used to perform arterial line placements and perceptions regarding the usefulness of the provided resource.

Data collected from these surveys included nominal, ordinal, ratio, and free response data that was then compiled and analyzed in Excel for the "study" period. All participant information remained confidential. In the "act" phase, recommendations were made for future PDSA cycles and quality improvement projects. No changes to the methods and measurements were needed throughout the duration of the project.

Section IV. Results and Findings

Results

The purpose of this DNP quality improvement project was to evaluate the perceived adequacy of an educational tool to improve awareness and utilization of ultrasound for arterial line placement. The educational tool included a voice-over PowerPoint and complementary handout targeted towards CRNAs in the project site's main operating room. The surveys were designed to compare perceptions of ultrasound use prior to and after the two-week implementation period. Surveys were distributed to a total of 10 CRNA participants via their employee email. Each participant was sent an individual link to the surveys to ensure completion of both pre- and post-surveys by the same participant. All survey responses were kept confidential. Six responses were collected via Qualtrics for the pre-intervention survey and five for the post-intervention survey. The data was then analyzed using Excel.

Data Presentation

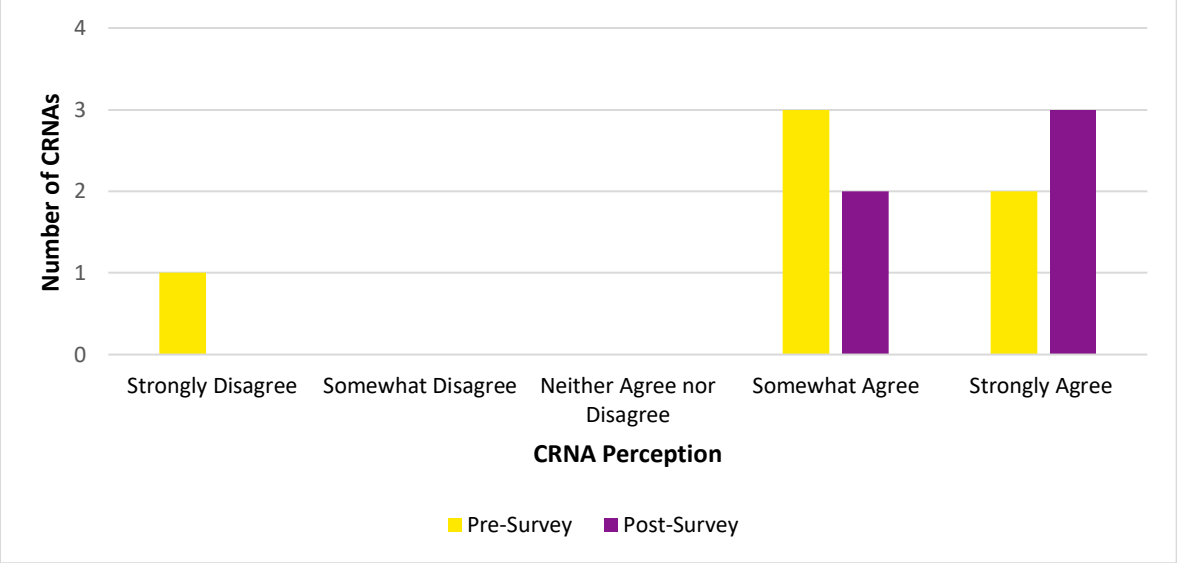
In the pre-intervention survey, participants were asked to supply information regarding their length of time in anesthesia, number of arterial line placements, current ultrasound use, prior training on ultrasound and any perceived barriers to the use of ultrasound in their current practice. For provider background, the initial pre-survey question asked how long the participant has worked in anesthesia. Two out of the six respondents reported they have worked in anesthesia for more than five years, and both responded "no" when asked if they had ever received training on using ultrasound-guidance for arterial line placement. Participants were then asked to report how many arterial lines and ultrasound-guided arterial lines they had placed in the last two weeks. The purpose of this question was to gauge how much exposure the participants had placing arterial lines and how often they use ultrasound for placement in their

current practice. Five respondents stated they placed between 4-6 arterial lines in the past two weeks. Four of the respondents only used ultrasound for 1-3 of those cases and the other respondent did not use ultrasound at all.

Following the pre-intervention survey, participants were provided an educational voice-over PowerPoint on the research regarding ultrasound use for arterial line placement, the basics of ultrasound use, and troubleshooting tips. They were also supplied a complementary handout for daily use at their discretion. Laminated copies of the educational handout were also attached to the ultrasound machines for convenience. Following the two-week implementation period, post-surveys were sent out to all participants and completed by five. Most questions in the post-survey mirrored the pre-survey to allow for comparison and to determine the efficacy of the educational tool. Figure 1 displays data gathered from pre- and post-surveys regarding CRNA confidence level on the ability to use ultrasound-guidance for arterial line placements.

Figure 1

CRNA Confidence Level on Ability to Use Ultrasound-Guidance for Arterial Line Placement

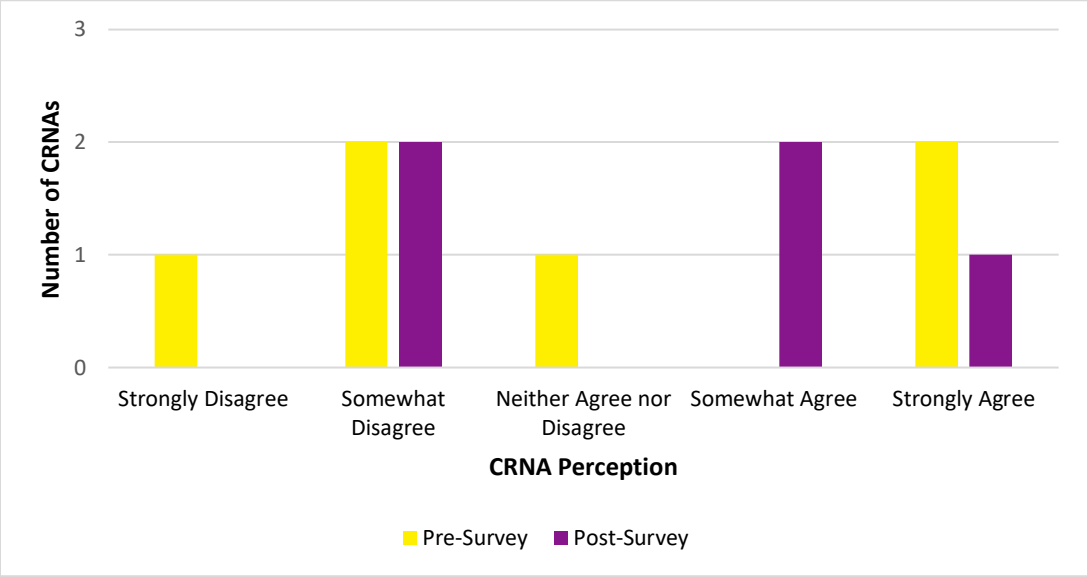


Note. Pre-Survey n=6. Post-Survey n=5

The likelihood of using ultrasound-guidance for arterial line placement was also compared in the pre- and post-surveys (see Figure 2).

Figure 2

CRNA Likelihood of Using Ultrasound-Guidance for Arterial Line Placement

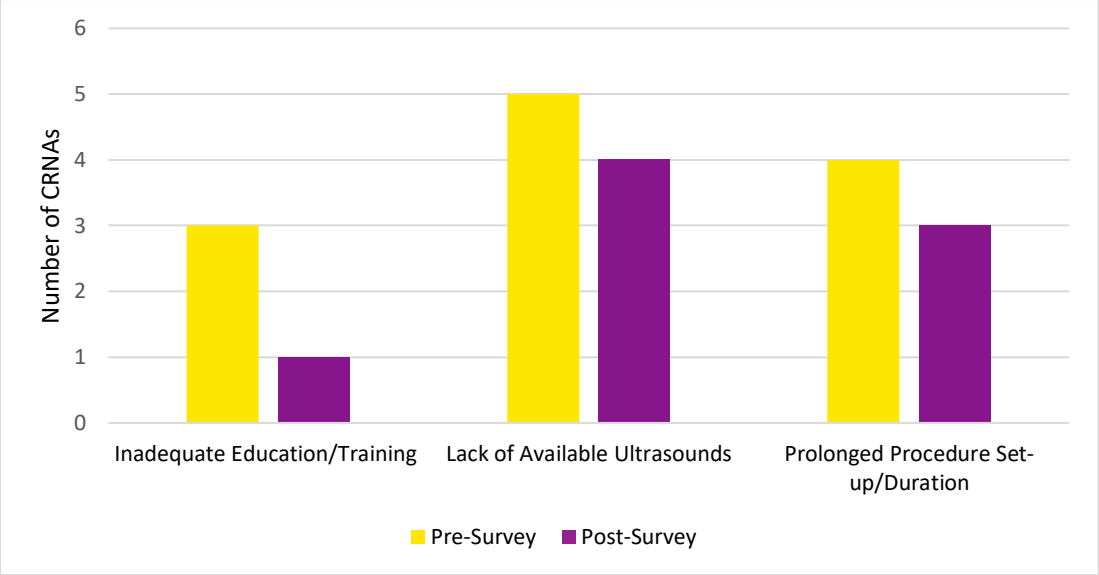


Note. Pre-Survey n=6. Post-Survey n=5

The participants were also asked what they perceive as barriers to ultrasound use in both the pre- and post-surveys. This question was designed to determine if these barriers (i.e. a lack of ultrasound availability) impacted their ability to implement the intervention during the two-week time frame and if these barriers would continue to prevent ultrasound use in their future practice. Participants were allowed to select more than one answer, and responses to this question are compared in Figure 3.

Figure 3

Perceived Barriers to Ultrasound-Guided Arterial Line Placement



Note. Pre-Survey n=6. Post-Survey n=5. Participants could select more than one answer.

When asked whether they believe that the use of ultrasound guidance is superior to traditional palpation techniques, one responded, "strongly disagree," two responded, "neither agree nor disagree," and two responded, "somewhat agree" in the pre-survey. When asked the same question in the post-survey, one responded, "somewhat disagree," and the remaining four responded, "somewhat agree." In addition, participants were asked to report whether their awareness of ultrasound-guidance for arterial line placements decreased, increased, or remained unchanged following the intervention. Three responded that their awareness "increased" and two responded that it remained "unchanged."

Analysis

Data gathered from the pre- and post-implementation surveys was analyzed. The educational tool was perceived to be effective in increasing knowledge and use of ultrasound

guidance for arterial line placements by the participants. After initial review of the survey responses, most participants reported an increased use of ultrasound, increased confidence, and increased awareness of the advantages of ultrasound-guidance for arterial line placement during the implementation period.

The initial pre-survey question asked participants to list their years of anesthesia experience. There has generally been an increased focus noted in the literature to use newer technology, including ultrasound guidance. There is a lack of understanding provider preferences for use of newer technology as it relates to time practicing as a CRNA. CRNAs with more experience may be more comfortable using "traditional" methods and may not have the exposure to ultrasound that newer cohorts have and may benefit more from this intervention. For example, one participant in the pre-survey who has been practicing for more than ten years reported they had not utilized ultrasound for arterial line placement in the past two weeks, strongly disagreed that they were confident in their ability to use ultrasound guidance, and perceived inadequate education/training as a barrier to utilizing ultrasound. In contrast, participants who have been practicing for less than five years stated they had utilized ultrasound for arterial line placements at least once in the past two weeks and either somewhat agreed or strongly agreed that they were confident in their ability to utilize ultrasound. This could show that a project population lacking adequate representation of a range anesthesia years of practice could potentially lead to skewed results.

In an attempt to assess whether there was an increase in USG for arterial line placement following the implementation period, participants were asked to report the number of arterial lines placed and the number of arterial lines placed utilizing ultrasound. In the pre-survey, four participants reported they utilized ultrasound approximately 50% of the time, one participant

reported utilization almost 100% of the time, and one participant reported no utilization. In the post-survey, only three of the participants reported the same utilization of ultrasound, one reported an increased use, and one reported a decreased use. From these results, it is difficult to conclude that the intervention impacted utilization of ultrasound guidance for arterial line placements.

When asked about perceived barriers to using ultrasound for arterial line placement, three participants listed "inadequate education/training" as a barrier in the pre-survey, but only one stated this again in the post-survey. This implies that our educational tool was successful in removing a barrier for ultrasound guided arterial line placement. However, five out of six participants on the pre-survey and four out of six on the post-survey listed a "lack of available machinery" as a barrier, which suggests that participants may not have been able to adequately use the intervention and utilize ultrasound for their arterial line placements based solely on a lack of available equipment. This can also affect the future use of ultrasound for arterial line placements for practice at this facility.

Section V. Implications

Financial and Nonfinancial Analysis

As discussed in the literature synthesis, the use of ultrasound guidance for arterial line placement has been shown to improve first-pass success, reduce complications, and decrease surgical delays due to difficult line placement (Fatima et al., 2021; Gibbons et al., 2020). In the randomized controlled trial conducted by Gibbons et al. (2020), an average of 1.30 attempts was needed for USG, compared to 2.95 for LMGP, with each attempt requiring a new arterial catheter. This facility uses ARROW™ radial artery catheters that cost an average of $20 each. Surgical delays can also be costly, as one minute of operating room time costs an average of $36 (Ely, 2018). A 15-minute surgical delay plus two additional radial artery catheters could; therefore, cost the facility an additional $600 per patient.

The costs associated with implementing this quality improvement project on a larger scale utilizing project site staff would include the salary of the employee or employees during the periods of development and implementation. For this project, four individuals created the PowerPoint with voiceover and the intervention handout with each contributing about five hours of time. Based on a quick Google search of the average salaries of clinical educators in North Carolina, this would cost roughly $900. Microsoft PowerPoint was used to create both the educational tools free of charge, and the tools were distributed to participants via email, which also did not incur a cost. Laminating a copy of the educational handout for each ultrasound machine cost $20.

On the other hand, the availability of ultrasound machinery is crucial to the success of this quality improvement project as it was almost unanimously seen as a barrier to our project's participants. The ultrasound machines used at this facility cost upwards of $20,000-$30,000 for a

single machine. The main OR suite at the project site only has access to three of these ultrasound machines, and often one of these machines is designated to stay in the PACU area for regional nerve blocks. Therefore, there are only three circulating ultrasound machines for 27 OR rooms in the main OR area, severely limiting access. In order to implement this quality improvement project on a larger hospital scale, the facility would need to invest in more ultrasound machinery. Although this would be a significant initial expense to the facility, these machines last several years and can be used on countless patients during this time. The increased availability could also lead to increased quality assurance, increased efficiency, and increased patient satisfaction.

Implications of Project

The aim of this DNP project was to evaluate the perceived adequacy of an educational resource designed specifically for anesthesia providers. Following the quality improvement project, the CRNA participants would ideally have an increased appreciation for and utilization of ultrasound for arterial line placement.

Because there are currently no policies at this facility for the use of ultrasound guidance for arterial line catheterizations by anesthesia providers, many CRNAs rely on the traditional LMGP technique until this method fails. There are also no formal recommendations or guidelines from professional organizations, such as the AANA. However, the AANA does recognize the benefits of ultrasound use for arterial line placements and have reported barriers to implementing a standard of care for USG in practice, such as a lack of training opportunities and lack of universal training standards (Pitman et al., 2023). By providing additional training resources for anesthesia providers on the use and benefits of ultrasound guided techniques, this quality improvement project has demonstrated that there is increased knowledge of and confidence in using this technology. In turn, this could correlate to increased utilization in future

practice. As evidenced by the literature, this would lead to increased first-pass attempts, decreased patient complications, and increased efficiency.

Sustainability

If the organization were to use this pilot QI project as a foundation to implement on a larger scale, the costs of the educational tools, personnel, and implementation would be insignificant compared to the amount they could potentially save on decreased supplies and surgical delays. The educational handout could be used for an extended period and be replaced if needed at a relatively low cost. Additionally, the handout was placed on each ultrasound machine and could also be sent electronically to each provider. The other benefit of the handout is that it is simple to follow and user friendly, even for those who may not have participated in the QI project but still use ultrasound at the facility (e.g.. anesthesiologists, contract CRNAs, etc.). Additional QI projects could include a hybrid training program, similar to Pitman et al. (2023), to determine if a hands-on approach could further increase confidence levels and utilization of ultrasound for arterial line placement. Projects in collaboration with CRNAs and anesthesiologists could enhance knowledge and utilization from an interdisciplinary approach. In the current facility, it was observed by the project lead that anesthesiologists were more inclined to use ultrasound in their daily practice. In addition, if professional organizations, including the AANA released standardized protocols for ultrasound guided arterial line placements, there may be more of a push for this type of easily accessible educational tool.

Dissemination Plan

The primary team leader SRNA developed a poster to disseminate the quality improvement project results. The primary team leader also presented the poster to fellow SRNAs within the program and the nurse anesthesia department members, and other community

members through in-person and virtual formats. Project participants were also invited to attend. The final version of this paper and accompanying poster have been posted in The Scholarship, the East Carolina University digital repository. Information regarding project plan, results, and implications for future use will be made available to partnering organization.

Section VI. Conclusion

Limitations

The small sample size of this project (n=6 pre-survey; n=5 post-survey) provides a low statistical power and prevents generalizations of results. As evidenced by the barriers reported by the participants, the lack of available machinery severely limited utilization of the educational tool during the implementation period. Additionally, not every patient requires placement of an arterial line, limiting the number of opportunities for participants to utilize the tool. Another limitation of the project was in the phrasing of particular survey questions. For example, when asked, "How often have you utilized ultrasound for arterial line placement?" there was no specification on whether ultrasound was used from the start or only as a rescue attempt when traditional methods failed. Additionally, when asked about barriers to utilization of ultrasound, there was no clarity on whether these were personal or generalized answers. For example, did the one participant who reported "inadequate education/training" in the post-survey believe *they* had inadequate education/training or that other providers might not utilize ultrasound based on their own lack of education? If the former, it could be inferred that the educational tool itself was not sufficient and needed improvement.

Recommendations for Future Implementation and/or Additional Study

This quality improvement DNP project would provide a strong foundation for future QI projects. The educational PowerPoint and handout provide useful information for any provider who is qualified to use ultrasound for arterial line placements. The use of cost-effective methods such as electronically disseminated interventions and communications, Qualtrics surveys for data collection, and Microsoft Excel for data analysis is recommended.

It may also be beneficial to conduct further research on the impact of patient characteristics on the difficulty of arterial line placements. For example, if the patient has a certain BMI, wrist circumference, and/or systolic blood pressure that could make LMGP challenging, the project participant should be even further prompted to utilize ultrasound for placement. If this project were to be repeated, a larger sample size would be needed for more statistically significant data. Increased access to ultrasound machinery would also be recommended as this was deemed by participants to be a significant barrier to utilization. As mentioned previously, pre- and post-survey questions should also be adjusted for clarity in future studies and the consideration for a hands-on ultrasound workshop is warranted.

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Pitman, J. S., Buscemi, M., Funk, E. M., Weaver, S., Thompson, J. A., & Falyar, C. (2023). Incorporating evidence-based ultrasound-guided vascular access (USGVA) standards into

the nurse anesthetist armamentarium: A quality improvement project. *Journal of Perianesthesia*, *38*(4), 564–571. https://doi.org/10.1016/j.jopan.2022.11.014

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Wilson, C., Rose, D., Kelen, G. D., Billioux, V., & Bright, L. (2020). Comparison of ultrasound-guided vs traditional arterial cannulation by emergency medicine residents. *Western Journal of Emergency Medicine*, *21(*2), 353-358. https://doi.org/10.5811/westjem.2019.12.44583

Appendix A

Literature Search Concepts Table

	Concept 1 Anesthesia providers	Concept 2 Ultrasound guidance	Concept 3 Arterial lines
Keywords	Anesthesia providers Certified Registered Nurse Anesthetists	ultrasound ultrasound guidance	Arterial line A-line Arterial line placement
PubMed MeSH	"Anesthesia," "nurse anesthetists"[MeSH Terms]	"ultrasonography"[MeSH Terms]	"vascular access devices" [MeSH Terms]
CINAHL Subject Headings	(MH "Certified Registered Nurse Anesthetists") OR (MH "Anesthetists")	(MH "Technology, Ultrasound")	(MH "Arterial Catheters") OR (MH "Catheter Placement Determination")
Google Scholar	Anesthesia providers OR certified registered nurse anesthetists	Ultrasound guidance	Arterial line OR A-line placement

Appendix B

Search Strategy

Search date	Database or search engine	Search strategy	Limits applied	Number of citations found/kept	Rationale for inclusion/exclusion of items
09/2023	PubMed	(nurse anesthetists OR anesthesia) AND ultrasonography AND arterial line placement (("nurse anesthetists"[MeSH Terms] OR ("nurse"[All Fields] AND "anesthetists"[All Fields]) OR "nurse anesthetists"[All Fields] OR ("anaesthesia"[All Fields] OR "anesthesia"[MeSH Terms] OR "anesthesia"[All Fields] OR "anaesthesias"[All Fields] OR "anesthesias"[All Fields])) AND ("diagnostic imaging"[MeSH Subheading] OR ("diagnostic"[All Fields] AND "imaging"[All Fields]) OR "diagnostic imaging"[All Fields] OR "ultrasonography"[All Fields] OR "ultrasonography"[MeSH Terms] OR "ultrasonographies"[All Fields]) AND (("vascular access devices"[MeSH Terms] OR ("vascular"[All Fields] AND "access"[All Fields] AND "devices"[All Fields]) OR "vascular access devices"[All Fields] OR ("arterial"[All Fields] AND "line"[All Fields]) OR "arterial line"[All	5 years (actual years 2018-2023)	31/6 kept	Specific for arterial access, risks and benefits discussed

		Fields]) AND ("placement"[All Fields] OR "placements"[All Fields])) AND (2018:2023[pdat])			
09/2023	CINAHL	(MH "Certified Registered Nurse Anesthetists") OR (MH "Anesthetists") AND (MH "Technology, Ultrasound") AND (MH "Arterial Catheters)	5 years (actual years 2018-2023)	367/3 kept	Included arterial access with ultrasound use
09/2023	Google Scholar	(nurse anesthetists OR anesthesia) AND ultrasonography AND arterial line placement	4 years (actual years 2019-2023)	14,600/10 kept (reviewed 10 pages of results)	Specific for arterial access, emphasis on ultrasound training
09/2023	OneSearch	Ultrasound Guided Arterial Line Placement	5 years (actual years 2018-2023)	27/10 kept	Specific for arterial access with emphasis of benefits of ultrasound use

Appendix C

Literature Matrix

Year	Author, Title, Journal	Purpose & Conceptual Framework or Model	Design and Level of Evidence	Setting	Sample	Tool/s and/or Intervention/s	Results
2023	Pitman, J. S., Buscemi, M., Funk, E. M., Weaver, S., Thompson, J. A., & Falyar, C. (2023). Incorporating evidence-based ultrasound-guided vascular access (USGVA) standards into the nurse anesthetist armamentarium: A quality improvement project. *Journal of Perianesthesia Nursing: Official Journal of the American Society of PeriAnesthesia Nurses, 38*(4), 564–571	This was a quality improvement project that developed and implemented a training program for CRNAs to improve knowledge and confidence regarding ultrasound guided vascular access No framework of model noted	Level VI: qualitative study	Hospital	17 volunteer CRNAs	Measured assessments at: (1) baseline, (2) immediately after attending a hybrid training educational program, and (3) 90 days after implementation into clinical practice Number of attempts required for successful placement was also measured	Reviewed peripheral IV, central venous catheter and arterial catheter placement The hybrid training program consists of a 2-hour evidence based didactic course and then a 2-hour hands on workshop Overall percentage of successful vascular access placements increased following the program.
2021	Fatima, H., Chaudhary, O., Krumm, S., Hamza Mufarrih, S., Qaisar Qureshi, N., Oren-Grinberg, A., Bose, R. R., Huang, L, Mahmood, F., & Matyal, R. (2021). Workflow of ultrasound-guided arterial access. *Journal of Cardiothoracic and*	This report outlines the process of ultrasound-guided arterial line cannulation as well as their recommended training program and evaluates the effect	Level I: systematic review	N/A	13 randomized controlled trials	Compare ultrasound guidance vs. palpation guided technique for arterial catheterization	Provides detailed steps for ultrasound set-up and procedure. Discusses the impacts of a hybrid training program (30-minute modules followed by a 90-minute hands-on workshop). Surgical delays following

	Vascular Anesthesia, 35(6), 1611-1617	implementation has on surgical delays No framework or model noted					implementation of this training program dropped from 12% to 4%.
2020	Gibbons, R. C., Zanaboni, A., Saravitz, S. M., & Costantino, T. G. (2020). Ultrasound guidance versus landmark-guided palpation for radial arterial line placement by novice emergency medicine interns: A randomized controlled trial. *Journal of Emergency Medicine, 59*(6), 911-917	Purpose was to compare ultrasound-guided and landmark-guided palpation of radial arterial line cannulation by novice emergency medicine interns in respect to overall success No framework or model noted	Level II: Randomized controlled trial	Urban university hospital	40 adults aged 28-90	Measured percent of first pass success, number of attempts needed, time in seconds to complete cannulation, and number of complications noted	Important limitations: single-center study with selection bias from convenience sampling; no account for vasopressor use before cannulation which can result in vasoconstriction and increased difficulty for LMGP.
2020	Wilson, C., Rose, D., Kelen, G. D., Billioux, V., & Bright, L. (2020). Comparison of ultrasound-guided vs traditional arterial cannulation by emergency medicine residents. *Western Journal of Emergency Medicine, 21*(2), 353-358	Purpose was to determine whether ultrasound-guided arterial line placement was more successful than traditional landmark palpation when performed by emergency medicine residents with standard ultrasound training.	Level II: Prospective, randomized, interventional study	Tertiary care, urban academic emergency department	60 adults via randomized convenience sampling	Measured average number of attempts needed, percentage of overall success, time in seconds to complete cannulation, and number of complications noted	**Note:** focuses on emergency medicine providers and not anesthesia providers; however, provides evidence on the usefulness of ultrasound guided techniques **limitations**: single site study; timekeepers not formally trained which could influence overall time calculations; sampling bias based on type of study conducted

2019	Chui, J., Lavi, R., Hegazy, A. F., Jones, P. M., Arellano, R., Yang, H., & Bainbridge, D. (2019). Identifying barriers to the use of ultrasound in the perioperative period: A survey of southwestern Ontario anesthesiologists. *BMC Health Services Research, 19*(1), 214.	Purpose was to determine how often ultrasound guidance is used, identify barriers of using ultrasound, assess the attitudes toward the use of ultrasound and preferred methods of education among anesthesiologists No framework or model noted	Level VI: Single qualitative study	40 academic or community hospitals at south-western Ontario	266 anesthesiologists with a 25% response rate	Web-based surveys on Qualtrics addressing participant characteristics, institution characteristics, participants' practice, barriers of using ultrasound and training preferences	The largest barrier to the use of ultrasound in practice is inadequate resource allocation **Limitation**: only focused on anesthesiologists and not all anesthesia providers
2019	Oliver, L., Oliver, J., Ohanyan, S., Park, W., Benelyahoo, A, & Vadivelu, N. (2019). Ultrasound for peripheral and arterial access. *Best Practice & Research: Clinical Anaesthesiology, 33*(4), 523-537	Purpose is to provide information on the basics of ultrasound technology and how it can be used to obtain arterial access No framework or model noted	Level V: Literature review	N/A	N/A	Detailed information on the basics of ultrasonography, various arterial line insertion techniques	**Usefulness**: detailed description of the use of ultrasonography for arterial line placement **Limitations**: includes other systematic reviews and studies that contradict the concept of ultrasound guidance as a best practice technique for arterial line placement
2019	Wang, A., Hendin, A., Millington, S. J., Koenig, S., Eisen, L. A., & Shiloh, A. L. (2019). Better with ultrasound: Arterial line placement. *Critical Care: Special Features, 157*(3), 574-579	Purpose of this paper is to present an approach for incorporating ultrasound guidance for arterial line placement into bedside practice	Level V: Literature review	N/A	N/A	Reviewed current research on ultrasound techniques, arterial line complications	Gives detailed descriptions on how to properly assess the anatomy with ultrasound, and steps on how to perform both radial and femoral artery catheterizations

		No framework or model noted					using ultrasound. Describes all applicable complications associated with arterial line insertion and what the literature says about reduction in these rates with ultrasound use. Includes anatomical reasons for why ultrasound is preferable to palpation techniques.

Note: CRNA = Certified Registered Nurse Anesthetist; LMGP = landmark guided palpation; Key to Levels of Evidence: I: Systematic review/meta-analysis of randomized controlled trials (RCTs); II: RCTs; III: Nonrandomized controlled trials; IV: Controlled cohort studies; V: Uncontrolled cohort studies; VI: Descriptive or qualitative study, case studies, EBP implementation and QI; VII: Expert opinion from individuals or groups. Adapted from Evidence-based practice in nursing and healthcare: A guide to best practice (4th ed.), by B. M. Melnyk and E. Fineout-Overholt, 2019, p. 131. Copyright 2019 by Wolters Kluwer.

Appendix D

Approval Forms

Click "download PDF" to save a copy of this page for your records.
Note: The IRB Office does not maintain copies of your responses.

Below is a summary of your responses — Download PDF

Quality Improvement/Program Evaluation Self-Certification Tool

Purpose:
Projects that do not meet the federal definition of human research pursuant to 45 CFR 46 do not require IRB review. This tool was developed to assist in the determination of when a project falls outside of the IRB's purview.

Instructions:
Please complete the requested project information, as this document may be used for documentation that IRB review is not required. Select the appropriate answers to each question in the order they appear below. Additional questions may appear based on your answers. If you do not receive a STOP HERE message, the form may be printed as certification that the project is "not research", and does not require IRB review. The IRB will not review your responses as part of the self-certification process. For projects being done at Vidant Health, site support will be required. Please email crg.quality@vidanthealth.com to obtain site support from Vidant Health.

Name of Project Leader:

Laura Pearce

Project Title:

Anesthesia Providers' Perceptions of Ultrasound-Guided Arterial Line Placement: A DNP Project

Brief description of Project/Goals:

The purpose of this quality improvement project is to assess anesthesia providers' perceptions of adequacy of a newly developed resource for ultrasound guided arterial line placement. Process: A quick-reference perioperative ultrasound-guided arterial line placement resource, based upon current literature, will be developed. Anesthesia providers at ECU Health Medical Center will be asked several questions (through Qualtrics) about their perceptions of the adequacy of their current ultrasound utilization for arterial line placement and their current practice. An educational tool about the advantages of ultrasound usage will be made available to them, and they will be asked to use ultrasound assistance for arterial line placement for two weeks. Upon completion of the two-week utilization period, they will be asked to complete a questionnaire about their perceptions of the adequacy of the resource and the use of ultrasound in their current practice. Qualtrics survey software will be used to deliver the intervention link and gather participant perceptions prior to and post implementation of the project. No patient information will be recorded or maintained during this project.

Will the project involve testing an experimental drug, device (including medical software or assays), or biologic?

- ○ Yes
- ● No

Has the project received funding (e.g. federal, industry) to be conducted as a human subject research study?

- ○ Yes
- ● No

Is this a multi-site project (e.g. there is a coordinating or lead center, more than one site participating, and/or a study-wide protocol)?

- ○ Yes
- ● No

Is this a systematic investigation designed with the intent to contribute to generalizable knowledge (e.g. testing a hypothesis; randomization of subjects; comparison of case vs. control; observational research; comparative effectiveness research; or comparable criteria in alternative research paradigms)?

- ○ Yes
- ● No

Will the results of the project be published, presented or disseminated outside of the institution or program conducting it?

- ● Yes
- ○ No

Would the project occur regardless of whether individuals conducting it may benefit professionally from it?

- (●) Yes
- ( ) No

Does the project involve "no more than minimal risk" procedures (meaning the probability and magnitude of harm or discomfort anticipated are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests)?

- (●) Yes
- ( ) No

Is the project intended to improve or evaluate the practice or process within a particular institution or a specific program, and falls under well-accepted care practices/guidelines?

- (●) Yes
- ( ) No

Based on your responses, the project appears to constitute QI and/or Program Evaluation and IRB review is not required because, in accordance with federal regulations, your project does not constitute research as defined under 45 CFR 46.102(d). If the project results are disseminated, they should be characterized as QI and/or Program Evaluation findings. Finally, if the project changes in any way that might affect the intent or design, please complete this self-certification again to ensure that IRB review is still not required. Click the button below to view a printable version of this form to save with your files, as it serves as documentation that IRB review is not required for this project. 11/7/2023

Human Subject Research Determination Form

This form should be completed and submitted for review by the service lines impacted by the work prior to project initiation (including, but not limited to, collection or analysis of baseline data). Projects that are "Not Human Subjects Research" are not required to submit an IRB application in ePirate. To help make that determination, you may utilize the Decision Chart provided by the Office for Human Research Protections along with this worksheet. For any project where there is a question as to whether it qualifies as Quality Improvement or Research, or if certification of "Not Human Subjects Research" is needed for publication, please route to the UMCIRB office via email: umcirb@ecu.edu.

Please check the Office of Clinical Research Website or UMCIRB website to make sure that you have the most recent version of this form.

Project Title	Anesthesia Providers' Perceptions of Ultrasound-Guided Arterial Line Placements
Project Leader	Laura Pearce
Project Leader Contact E-mail	Pearcela13@students.ecu.edu
Department or Unit Affiliation	[redacted]Nurse Anesthesia Program
Project Advisor (if applicable)[1]	Travis Chabo

Additional Faculty, Staff, and Trainees Involved (add more rows if needed):

Name	Department or Unit	Role	Check this box if this team member will access PHI or PII for the purposes of this project.
			☐
			☐
			☐
			☐
			☐
			☐
			☐
			☐
			☐
			☐
			☐
			☐
			☐
			☐

[1] All student, resident, and fellow projects must have a faculty or unit leader designated as the advisor for the project.

Please answer the following questions to the best of your ability. If the answers to these questions change during the course of the project, please resubmit this form for review:

End Goal / Desired Outcome:

[The purpose of this quality improvement project is to assess anesthesia providers'/ICU nurses' perceptions of adequacy of a newly developed ultrasound-guided arterial line placement guide. A quick-reference ultrasound-guided arterial line placement guide, based upon accepted national guidelines, will be developed. Anesthesia providers/ICU nurses a[redacted] will be asked several questions (through Qualtrics) about their perceptions of the adequacy of the/their currently used arterial line placement techniques and preparedness for ultrasound guided techniques

Methodology / Intervention:

[The project will consist of a single Plan, Do, Study, Act cycle using a pre- and post-intervention survey design. CRNA participants will be contacted via email and asked to complete a pre-survey and then utilize an informational tool based on current evidence that aligns with practices currently accepted within the facility to support their practice regarding arterial line placement. After two weeks they will then be asked to complete a post-survey addressing their perceptions of the intervention and their own practice. The primary researcher will be available electronically, by phone, or in person to consult with participants as needed. The intervention for this project will be a newly created informational tool focused on the benefits of ultrasound guidance and how to use it for arterial line placement, which is based on current evidence and falls within current accepted practice standards within the facility.

Data to be collected:

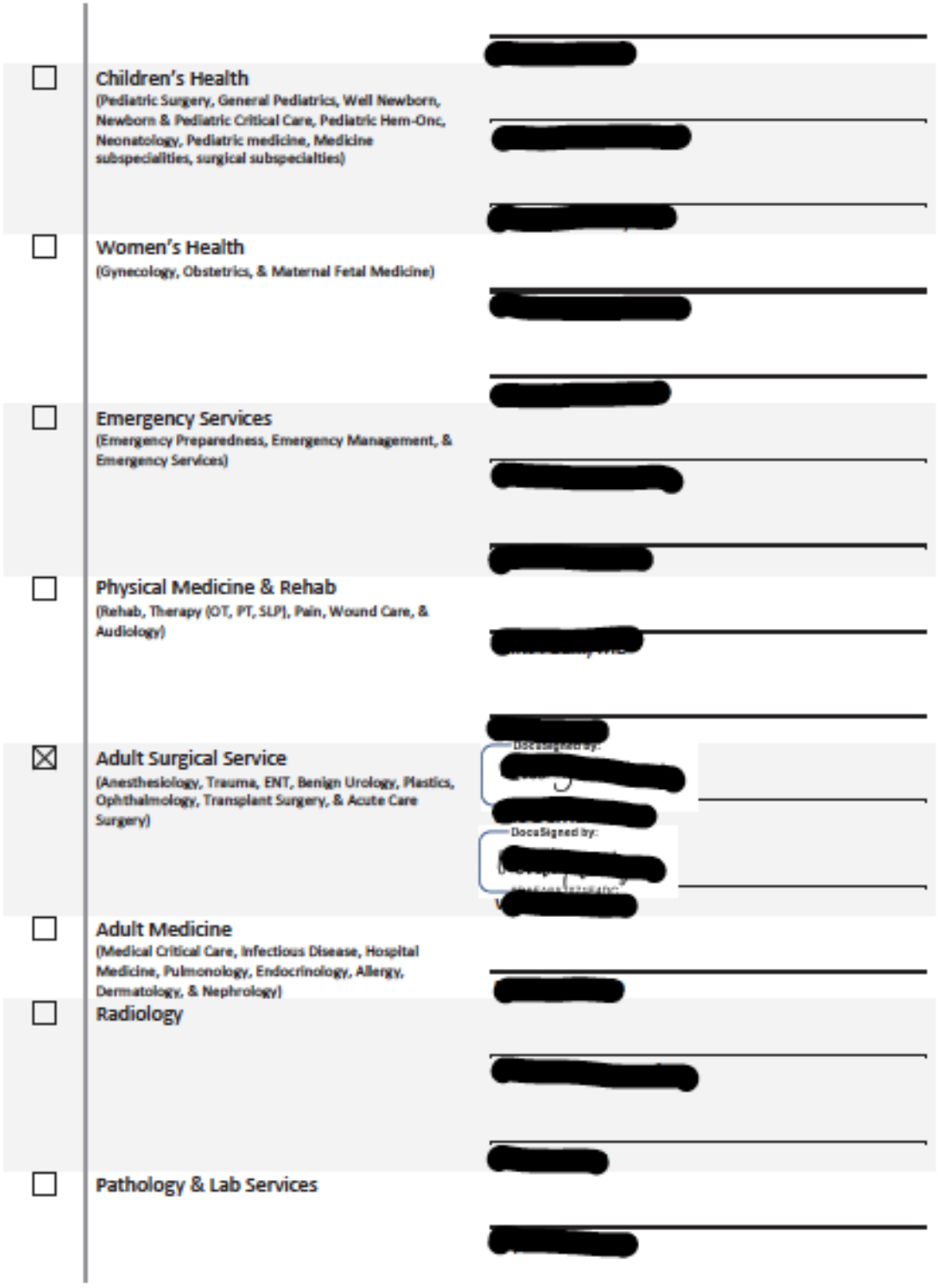
[Data will be gathered directly from participants through completion of Qualtrics pre- and post-surveys delivered and completed electronically. Aside from participant emails, no identifiable data will be gathered. Data of interest is participant opinions and perceptions of practice and the newly developed informational tool. All data will be gathered using Qualtrics survey software then transferred to Excel for analysis. The only identifying information will be email addresses. Qualtrics survey software is accessed throug[redacted]and involves multifactorial password protection. Data in Excel will be on a password protected personal laptop. Email addresses will be deleted from Excel files after both surveys are completed and analysis of results begins.

Complete the following questions to guide leadership's determination of this project's status:

	True	False
The PRIMARY purpose of the proposed activity or project is limited to: - implementing a standard practice to improve the quality of patient care and to collect data regarding that implementation for clinical, practical, or administrative purposes, and/or - delivering healthcare and measuring and reporting provider performance data for clinical, practical, or administrative uses.	☒	☐
The activity or project would be carried out even if there was no possibility of publication in a journal or presentation at an academic meeting.	☒	☐
The activity or project falls under well-accepted care practices/guidelines and are designed to bring about immediate improvements in health delivery or quality of care. If "true" and the project is related to clinical activity, please provide a citation below as evidence that project activities fall within standards of care. Projects not directly related to clinical activity, such as medical education, do not need to provide a citation. Chui, J., Lavi, R., Hegazy, A. F., Jones, P. M., Arellano, R., Yang, H., & Bainbridge, D. (2019). Identifying barriers to the use of ultrasound in the perioperative period: A survey of southwestern Ontario anesthesiologists. *BMC Health Services Research*, *19*(1), 214. https://doi.org/10.1186/s12913-019-4040-2	☒	☐
The activity or project involves "no more than minimal risk" procedures. (i.e., the probability and magnitude of harm or discomfort anticipated are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests).	☒	☐

Please submit this form to your supervisor (or designee) for review and approval. Signature on this form certifies that that the below individual is in support of this project taking place and agrees with the project leader's answers to the above questions:

Supervisor's Name	[redacted]
Signature	DocuSigned by: [redacted] 0704FC0E5DCA423...



☐ **Children's Health**
(Pediatric Surgery, General Pediatrics, Well Newborn, Newborn & Pediatric Critical Care, Pediatric Hem-Onc, Neonatology, Pediatric medicine, Medicine subspecialities, surgical subspecialties)

☐ **Women's Health**
(Gynecology, Obstetrics, & Maternal Fetal Medicine)

☐ **Emergency Services**
(Emergency Preparedness, Emergency Management, & Emergency Services)

☐ **Physical Medicine & Rehab**
(Rehab, Therapy (OT, PT, SLP), Pain, Wound Care, & Audiology)

☒ **Adult Surgical Service**
(Anesthesiology, Trauma, ENT, Benign Urology, Plastics, Ophthalmology, Transplant Surgery, & Acute Care Surgery)

☐ **Adult Medicine**
(Medical Critical Care, Infectious Disease, Hospital Medicine, Pulmonology, Endocrinology, Allergy, Dermatology, & Nephrology)

☐ **Radiology**

☐ **Pathology & Lab Services**

[redacted]

Optional Determination:
For any project where there is a question as to whether it qualifies as Quality Improvement or Research, or if certification of "Not Human Subjects Research" is needed for publication, please route to the UMCIRB office via email: umcirb@ecu.edu.

☒ **Not Human Subjects Research:** The UMCIRB office has determined that based on the description of the project, approval by the IRB is not necessary. Any changes or modifications to this project may be discussed with the UMCIRB office at that time to ensure those changes do not elevate the project to human research that would need IRB approval.

☐ **Human Subjects Research:** This project requires review by the IRB prior to initiation. An application in the electronic IRB submission system should be submitted.

UMCIRB Office Staff Signature: [redacted] **Date:** 3/14/2024

The UMCIRB office will contact you if any further information is needed to make this determination. Please note that if the UMCIRB office determines the activity is not human subjects research, then any presentation, publication, etc. should not refer to the activity as such.

Appendix E

Intervention Handout

Ultrasound for Arterial Line Placement

ECU COLLEGE OF NURSING NURSE ANESTHESIA PROGRAM

Current Recommendations

AANA endorses ultrasound-guided vascular access to reduce infection and improve patient satisfaction

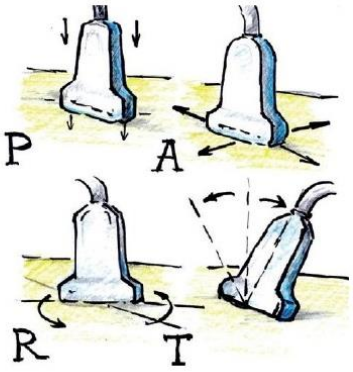
AIUM supports USG arterial cannulations

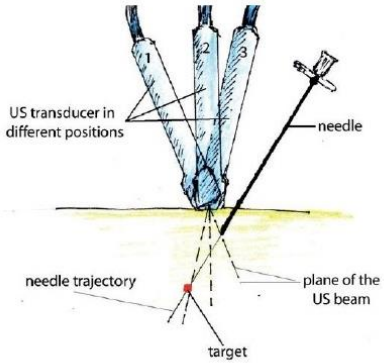
Advantages of Ultrasound

- ★ **Improved first pass success**
  - 32% lower risk of first-attempt failure
- ★ **Decreased complication risk**
  - Radial artery hematoma formation decreased by 61%
- ★ **Improved total success rates**
  - Overall success increased from 47% to 96%
- ★ **Decreased procedure time**
  - Surgical delays due to line placement decreased from 12% to 4%

Ultrasound Basics

Probe manipulation "PART" - Pressure, Align, Rotate, Tilt





Probe selection: **Straight linear array transducer** (a high frequency probe)

Depth: **Low** (< 2.0 cm) for superficial vasculature

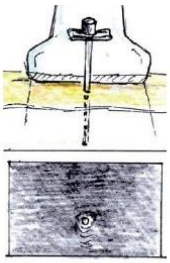
Gain: Adjust to **brighten/darken** image

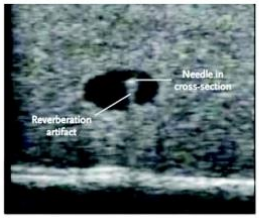
Doppler/Color: Depicts blood vessel flow relative to probe
"BART" - Blue Away, Red Towards

Ultrasound Techniques

Short-axis out-of-plane view

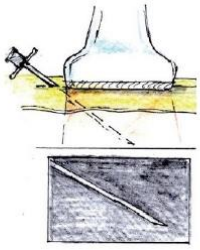
- Transducer placed **perpendicular** to artery
- Artery will appear as a pulsatile anechoic circle
- Insert needle 30-45° to the skin
- Needle will appear as a **hyperechoic dot**

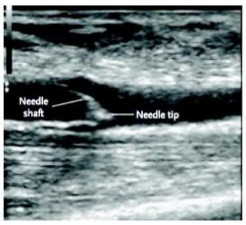




Long-axis in-plane view

- Identify artery in short-axis view
- Rotate transducer 90° while keeping the artery at the center of the screen
- The transducer should be **parallel** to the artery
- Artery will appear as a pulsatile anechoic tube
- Insert needle 30-45° to the skin
- Needle will appear as a **hyperechoic double line**





Scan QR code for video overview of ultrasound guided radial artery catheterization

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Wilson, C., Rose, D., Kelen, G. D., Billioux, V., & Bright, L. (2020). Comparison of ultrasound-guided vs traditional arterial cannulation by emergency medicine residents. *The Western Journal of Emergency Medicine, 21*(2), 353-358. https://doi.org/10.5811/westjem.2019.12.44583

Appendix F

Emails to Participants

Initial Pre-Survey and Video Email to Participants (1)

Dear [redacted]CRNA,

Thank you for considering participation in a quality improvement project titled "**Anesthesia Providers' Perceptions of Ultrasound-Guided Arterial Line Placements: A DNP Project**." The purpose of this project is to develop, implement, and evaluate the perceived adequacy of an educational resource designed specifically for anesthesia providers at [redacted] Center to improve awareness and utilization of ultrasound for arterial line placement.

Participation is voluntary and will involve completing a short pre-intervention survey, viewing a brief educational PowerPoint, utilizing ultrasound for arterial line placements in your CRNA practice for two weeks (at your discretion), and completing a short post-intervention survey when the two-week implementation period is over.

Each survey and the educational PowerPoint should take less than 10 minutes to complete. The surveys were created and are completed using Qualtrics® survey software. The use of ultrasound guidance for arterial line placement falls within currently accepted practice in your work area. Your participation is voluntary and confidential. We will share the results of this QI study with you upon completion.

First, complete the pre-intervention survey
https://ecu.az1.qualtrics.com/jfe/form/SV_5vE2VL1lZG7b6zI

Following completion of the survey, view the educational PowerPoint and complementary handout available as a downloadable attachment to this email. A laminated copy of the handout will also be attached to the ultrasound machines at this facility for quick access.

Again, thank you for your participation in our quality improvement project. I will be at ECU Health from March 25th until April 8th if you have any questions. You may also reach out to me or Dr. Chabo by email at any time.

Sincerely,

Laura Pearce, BSN, SRNA[redacted]
Travis Chabo, PhD, CRNA[redacted]

Pre-Survey and Video Reminder Email to Participants (2)

Hello [redacted] CRNAs,

I just wanted to send a quick reminder about the ongoing DNP Project on ultrasound guided arterial line placement (original email below). If you've already filled out the pre-survey and viewed educational PowerPoint, thank you. If you haven't had a chance to do so yet, it's not too late and would be very helpful and much appreciated. The PowerPoint presentation and complementary handout are attached to this email for review at your earliest convenience. You may use these at your discretion. After the end of next week, I will begin sending out the post-surveys.

Pre-Survey link:
https://ecu.az1.qualtrics.com/jfe/form/SV_5vE2VL1lZG7b6zI

Please let me know if you have any questions and thank you again for your participation.

Sincerely,
Laura Pearce, BSN, SRNA
ECU Nurse Anesthesia Program
Class of 2025

Post-Survey Email to Participants (3)

Dear [redacted] CRNAs,

Thank you to everyone who has already completed the pre-survey and viewed the educational PowerPoint. It's now time to complete the brief post-survey.

If you have not filled out a pre-survey, I would really and truly appreciate your participation (it's just surveys and an educational PowerPoint!). The link to the pre-survey is https://ecu.az1.qualtrics.com/jfe/form/SV_5vE2VL1lZG7b6zI, and you can follow it up by watching the educational PPT and utilizing the complementary handout available for day-to-day use if you would like them, but their use is not mandatory for participation in this project.

If you've already completed the first survey, please complete the post-survey at https://ecu.az1.qualtrics.com/jfe/form/SV_1NvtSLtRunly8Zg. It should take less than 2 minutes.

If anyone has questions or issues with any of these links, please let me know. Again, thank you to everyone for your help and for being excellent preceptors.

Sincerely,
Laura Pearce, BSN, SRNA
ECU Nurse Anesthesia Program
Class of 2025

Final Thank You Email to Participants (4)

Dear [redacted] CRNAs,

I just wanted to say thank you so much to everyone for helping me out with my DNP Project! I have collected all of the data I need to proceed with data analysis and will then be finishing my paper. Once it's complete you all will be able to read it if you'd like.

Thank you again! I hope to work with you more in the future.

Take care,
Laura Pearce, BSN, SRNA
ECU Nurse Anesthesia Program
Class of 2025

Appendix G

Qualtrics Pre- and Post-Surveys

Ultrasound-Guided Arterial Line Placement: Pre-Intervention Survey

ECU

How long have you worked in anesthesia?

- ○ < 2 years
- ○ 2 to 5 years
- ○ 6 to 10 years
- ○ > 10 years

In the past two weeks, how often have you placed arterial lines in the perioperative setting?

- ○ None
- ○ 1-3 cases
- ○ 4-6 cases
- ○ 7-10 cases
- ○ > 10 cases

In the past two weeks, how often have you utilized ultrasound for arterial line placement in the perioperative setting?

- ○ None
- ○ 1-3 cases
- ○ 4-6 cases
- ○ 7-10 cases
- ○ > 10 cases

I am confident in my ability to use ultrasound guidance for arterial line placement.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly agree

I am likely to use ultrasound-guidance for arterial line placement.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly agree

Have you ever received education on ultrasound-guided arterial line placement?

- ○ Yes
- ○ No
- ○ Unsure

The use of ultrasound guidance for arterial line placement is superior to traditional palpation techniques.

- ○ strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly agree

What do you perceive as barriers to utilizing ultrasound for arterial line placement?

- ☐ None
- ☐ Inadequate education/training on ultrasound guided arterial catheterization
- ☐ Lack of available ultrasound machinery
- ☐ Prolonged procedure set-up and duration
- ☐ Other

Ultrasound-Guided Arterial Line Placement: Post-Intervention Survey

ECU

Think about the impact of the educational tool on your practice or potential impact on your practice when answering the following questions.

How often have you placed arterial lines in the perioperative setting over the last two weeks?

- ○ None
- ○ 1-3 cases
- ○ 4-6 cases
- ○ 7-10 cases
- ○ >10 cases

How often have you utilized ultrasound for arterial line placement in the perioperative setting over the last two weeks?

- ○ None
- ○ 1-3 cases
- ○ 4-6 cases
- ○ 7-10 cases
- ○ > 10 cases

My awareness of the advantages of ultrasound-guided arterial line placement has...

- ○ Decreased
- ○ Unchanged
- ○ Increased

I am confident in my ability to use ultrasound for arterial line placement.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly agree

I am likely to use ultrasound-guidance for arterial line placement.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly agree

I believe that the use of ultrasound guidance for arterial line placement is superior to traditional palpation techniques.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly agree

What do you perceive as barriers to using ultrasound for arterial line placement? (select all that apply)

- ☐ None
- ☐ Inadequate education/training on ultrasound-guided arterial catheterization
- ☐ Lack of available ultrasound machinery
- ☐ Prolonged procedure set-up and duration
- ☐ Other