Assessing Anesthesia Providers' Perceptions of Ultrasound-Guided Arterial Catheterizations: A DNP Project

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Abstract

CRNAs frequently perform perioperative arterial catheterizations. Despite multiple studies supporting the advantages of ultrasound guidance, no formal processes are consistently followed, leaving CRNAs to use clinical judgment and personal preferences when selecting methods for arterial catheterization procedures. Currently, there is a lack of understanding regarding CRNA knowledge of and 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 CRNAs for improving awareness of and preference for utilization of ultrasound for arterial catheterization. The project was implemented at a large academic hospital in the southeastern United States. Educational materials, including a PowerPoint presentation and handout, were provided to participating CRNAs to utilize in their clinical practice. Review of pre- and post-implementation surveys demonstrated increased awareness of the advantages of ultrasound and improved confidence in ultrasound utilization. The perceived barrier to ultrasound utilization in arterial catheterizations was reported by 100% of respondents as the lack of available ultrasound machinery. Data analysis was limited by the small sample size, partial CRNA participation, and uneven number of respondents to the pre- and post-implementation surveys. Future projects should incorporate a larger sample size, a hands-on ultrasound training and skills workshop, and a thorough assessment of cost-related factors that impact perioperative arterial catheterizations including procedure duration, material costs, surgical delays, and ultrasound equipment.

Keywords: arterial catheterizations, ultrasound-guided, anesthesia, CRNA

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Section I. Introduction

Background

Anesthesia providers uniquely contribute to the careful monitoring of patients in the perioperative period through effective incorporation of specialized medical devices. Arterial catheterization remains frequently used for invasive blood pressure monitoring, blood gas sampling, and analysis of therapy effectiveness for hospitalized patients (Bhattacharjee et al., 2018). The basic catheterization procedure involves arterial puncture, guide-wire passage and catheter insertion, needle removal, and arterial intubation with the selected catheter (Flumignan et al., 2021). Providers commonly perform arterial catheterizations for critically ill patients in the intensive care unit, emergency department, or operating room, as well as for patients requiring diagnostic and therapeutic interventions. Unsuccessful arterial catheterization attempts contribute to complications including infection, swelling, bleeding, nerve damage, tendon injury, vasospasm, thromboses, and hematoma formation (Bhattacharjee et al., 2018). Despite the prevalence of use and potential complications, arterial catheterization technique by anesthesia providers remains variable in practice.

Traditionally, anesthesia providers place arterial catheters using digital palpation and landmark identification to guide arterial puncture and cannulation (Bhattacharjee et al., 2018). Development of ultrasound-guided (USG) techniques for arterial catheterization have demonstrated several advancements, including superior first-pass success rates and comparable total completion time. The American Association of Nurse Anesthesiology (AANA, 2015) guidelines support the incorporation of ultrasound technology for invasive vascular procedures to decrease infection risks, enhance visualization of anatomical structures, and improve patient satisfaction. Practice parameters published by the American Institute of Ultrasound Medicine

(2019), in collaboration with the AANA, advocate for the use of ultrasound by qualified providers when performing arterial cannulations. These recommendations ultimately align with the Triple Aim Framework to enhance patient care experiences and implement cost-saving measures (Berwick et al., 2008).

Integrating ultrasound technology into arterial catheterization procedures contributes significantly to procedural success (Bhattacharjee et al., 2018). However, practice variation across health institutions and clinician-specific experience influence provider preference for utilization of ultrasound equipment. This project aimed to gain understanding of anesthesia provider preference for inclusion of ultrasound in arterial catheterization procedures after participation in an ultrasound technology education program.

Organizational Needs Statement

The utilization of ultrasound for arterial catheterizations by anesthesia providers presents an important opportunity for the partnering organization, a large 974 licensed bed academic medical center in eastern United States. The partnering organization maintains status as a level I trauma center with several intensive care units, operating rooms, and procedural suites, which are the primary areas where arterial catheterizations are performed daily. There are approximately 70 certified registered nurse anesthetists (CRNAs) as well as other anesthesia providers at this facility. Incorporation of USG arterial cannulations has the potential to impact the diverse patient population and overall health system operations. Specifically, implementation of the USG procedure addresses important tenets of the Triple Aim Framework, including patient satisfaction and cost-saving measures (Berwick et al., 2008). Reducing the potential for adverse patient outcomes and cost-reduction measures remain a priority of interest for this institution. Therefore, understanding anesthesia providers' awareness of utilizing USG techniques for arterial

catheterizations and their perceptions of its use highlight important organizational needs for this facility. Anesthesia providers' preference for USG arterial catheterization at the partnering organization may be influenced by gaining knowledge on the recommendations for vascular access published by the AANA (2015) and the American Institute of Ultrasound Medicine (2019).

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 catheterization. Currently, there is a lack of understanding regarding anesthesia provider knowledge of and 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 for improving awareness of and preference for utilization of ultrasound for arterial catheterization.

Section II. Evidence

Description of Search Strategies

The literature review examined current evidence and recommendations addressing anesthesia providers' awareness of and preference for USG arterial catheterizations. The PICOT question used to guide the literature search was: What interventions impact the use of ultrasound technology by anesthesia providers for arterial line placement in the perioperative period? The databases and search engine used to conduct the literature search included PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and Google Scholar. Keywords and concepts were combined using Boolean operators to optimize findings. The search strategy for PubMed included (arterial catheter OR artery catheter OR arterial line placement OR artery cannulation OR arterial cannulation OR arterial access OR artery access) AND (ultrasound OR sonography OR ultrasonics) AND (nurse anesthesia OR crna OR anesthesiology OR anesthesiologist OR anesthetist). The resulting PubMed MeSH terms from this search were arteries, catheters, vascular access devices, catheterization, ultrasonography, ultrasonics, anesthesiology, anesthesiologists, and anesthetists. Limits applied were articles published within five years (2018-2023) and the English language. The search strategy for CINAHL used several keywords, including arterial catheterization, ultrasound, anesthesia, and anesthetist, to identify subject headings. Limits applied were articles published within ten years (2013-2023) and the English language. The Google Scholar search was performed using the same keywords as PubMed. See Appendix A for the entire list of keywords, MeSH terms, and subject headings used for literature searches. See Appendix B for search strategies and results. Additional material and evidence were found through review of publication references and related literature, as well as anesthesia and medical organizations' resources and professional recommendations.

Articles identified by these search strategies were selected based on specificity to arterial catheterizations, ultrasound guidance for catheterization, and interventions for inclusion of ultrasound technology by anesthesia providers. Over 84 articles were reviewed, with nine articles selected for full-text review based on their satisfaction of criteria. Using Melnyk and Fineout-Overholt's (2019) levels of evidence categories, the articles designated for review included two systematic reviews (Level I), one meta-analysis (Level I), three randomized controlled trials (Level II), two quality improvement projects (Level IV), and one prospective cross-sectional study (Level V). See Appendix C for the literature matrix of articles reviewed.

Selected Literature Synthesis

This review and synthesis of current evidence was performed to identify and develop an effective project intervention. Several high level of evidence source types were found that support USG arterial catheterizations for improved outcomes (Abtahi & Saeedi, 2023; Bhattacharjee et al., 2018; Flumignan et al., 2021; Raphael et al., 2023; Yeap et al., 2019; Yu et al., 2019). Authors of the lower level of evidence sources examine USG arterial catheterization training specific to anesthesia providers (Fatima et al., 2021; Pitman et al., 2023; Sharkey et al., 2022).

Measurable outcomes for the comparison of USG arterial catheterization to other methods include first attempt success rates, overall success rates, and decreased procedure duration. Bhattacharjee et al. (2018) found in their meta-analysis of 10 randomized controlled trials statistically significant findings ($p < .001$) supporting higher first attempt success rates for USG arterial catheterizations over traditional digital palpation techniques. A systematic review was conducted to examine 48 studies of USG arterial catheterizations in adult patients presented low- to moderate-certainty evidence for improved radial artery catheterization first attempt

success rates (RR 1.44, 95% confidence interval [CI], 1.29 to 1.61) and decreased mean placement times, 1.9 minutes versus 2.3 minutes, when compared to palpation and doppler techniques (Flumignan et al., 2021). Raphael et al. (2023) conducted a systematic review of nine randomized controlled trials for USG arterial catheterizations in pediatric patients found moderate evidence supporting improved first attempt success rates (RR 2.01, 95% CI, 1.64 to 2.46), overall success rates (RR 1.32, 95% CI, 1.10 to 1.59), and reduced mean procedure duration by 98.8 seconds compared to other methods. Yeap et al. (2019) conducted a randomized controlled trial and found that USG arterial catheterization technique increased overall success rates and significantly decreased procedure lengths from a mean of 243.6 seconds to 171.1 seconds.

Authors from two randomized controlled trials found first attempt success rates improved at least 20% for USG arterial catheterizations compared to other methods including palpation and landmark identification (Abtahi & Saeedi, 2023; Yu et al., 2019). Abtahi & Saeedi (2023) additionally demonstrated decreased total catheterization time in the USG group. Further, Fatima et al. (2021) conducted a quality improvement study that utilized USG arterial catheterizations after implementation of an educational course. The team observed an overall 8% decrease in surgical delays due to difficult line placements. Overall, this review of current high level of evidence sources, along with statistically significant findings, is supportive evidence that improvements in first attempt success rates, overall success rates, and decreased procedure time can be obtained when using USG. Further evidence is needed to determine the impact of USG arterial catheterizations on reducing surgical delays.

Several authors explored USG arterial catheterizations based on specialty including anesthesia providers, anesthesiology residents or CRNAs, or by providers on the perioperative

care team. Three randomized controlled trials were conducted that specifically examined anesthesiology residents in different years of study. Authors found that USG arterial catheterizations improved first attempt or overall success rates (Abtahi & Saeedi, 2023; Yeap et al., 2019; Yu et al., 2019). Work by Sharkey et al. (2022) shared the guidelines for anesthesiology resident training, including a minimum of 20 USG arterial catheterizations. A lower level of evidence, the authors gathered expert opinion for the development of learning requirements for anesthesiology residents regarding ultrasound fundamentals, perioperative ultrasound exams, and USG vascular access. A quality improvement project by Pitman et al. (2023) focused on CRNA knowledge and competence with USG vascular access. Training was implemented to address gaps in CRNA comprehension of ultrasound utilization. Authors noted a significantly improved mean user confidence scores (p = .009) pre- and post-education. Fatima et al. (2021) presented quality improvement work focused on difficult perioperative USG arterial catheterizations, total surgical delays, and the impact of an educational program offered to all qualified providers including residents, attending physicians, nurse practitioners, and CRNAs. Surgical delays due to difficult catheterizations decreased from 12% to 4%, supporting the effectiveness of provider training programs. The evidence for anesthesiology residents remains strong for USG arterial catheterization, however, further review is needed for CRNAs and other advanced practice nurses on the perioperative care team.

Ultrasound training programs and educational resources were predicted to impact outcomes in several of the evidence sources. Authors of one randomized controlled trial found participants improved USG arterial catheterization success rates after implementation of training videos, oral lectures, and visual demonstrations (Abtahi & Saeedi, 2023). Pitman et al. (2023) developed a program on USG vascular access including an evidence-based didactic online

lecture course, a structured workshop, and a resource handout. Through pre- and post-intervention surveys, confidence scores reported by CRNAs improved, from 50% to 80% within a 90-day period. Fatima et al. (2021) created an USG arterial catheterization educational course, with an interactive online component and a hands-on workshop, that ultimately contributed to reduced surgical delays at the facility. Finally, Sharkey et al. (2022) surveyed anesthesia residency program directors. Based on the results of the survey, minimum performance requirements were created for the incorporation of ultrasound education into anesthesia resident training, including 20 USG arterial catheterizations, 20 USG central line placements, 20 lung ultrasounds, and 50 transthoracic and transesophageal echocardiography scans. Authors from the identified sources demonstrated a variety of ultrasound training techniques and the impact of educational interventions on successful outcomes, provider competence, and provider perceptions. The low level of evidence of these sources, however, prompts necessity for future studies on anesthesia providers' understandings and views on USG arterial catheterizations.

Ultimately, comprehensive review of the evidence sources supports USG arterial catheterizations for improved first-attempt success rates, overall success rates, and decreased procedure duration. Education on USG arterial catheterization, regardless of format or targeted user, can significantly impact anesthesia providers' confidence using ultrasound and perioperative outcomes. The incorporation of effective ultrasound training for anesthesia providers remains a priority to ensure best clinical practice and improved user perceptions.

Project Framework

This project utilized the Institute for Healthcare Improvement (2023) model of improvement through implementation of a plan-do-study-act (PDSA) cycle for quality improvement. During the "plan" phase and review of the literature, the variable use of ultrasound

guidance for arterial line placement highlighted the need to explore anesthesia providers' awareness and perceptions of this intervention. An educational intervention was designed with a pre- and post-intervention survey to guide the quality improvement project. The "do" phase implemented the pre-intervention survey, the educational intervention and resource, and a post-intervention survey, all to be completed by participating anesthesia providers. The "study" phase involved analysis and synthesis of results from the pre- and post-intervention surveys to determine the awareness and perceptions of information provided by the resource. The "act" phase included presentation of the project findings to members of the organization and planning modifications for future PDSA cycles. This framework highlights the quality improvement process and supports the promotion of best clinical practice.

Ethical Considerations and Protection of Human Subjects

The intervention benefits offered by this quality improvement project were equitably applied to the anesthesia providers performing arterial catheterizations at the partnering organization. The project required no specific ethical considerations or protections required for human subjects. The intervention had no potential risks or harms for participants. Before project implementation, the author completed ethical training modules through the Collaborative Institutional Training Initiative (CITI; https://www.about.citiprogram.org).

This project was designated quality improvement through the shared organizational approval process of the College of Nursing and the East Carolina University (ECU) University Medical Center Institutional Review Board (UMCIRB). The quality improvement assignment allows exemption from the full IRB approval process. In a collaborative approval process, the partnering organization and the UMCIRB authorized implementation of the quality improvement project and the data collection procedures through signature endorsement (Appendix D).

Section III. Project Design

Project Setting

The project site was a large 974 licensed bed academic hospital and level I trauma center in the southeastern United States. The hospital maintains over 50 operating rooms and procedural suites that service a variety of surgical specialties, such as pediatrics, obstetrics, and cardiovascular sciences. Factors serving as facilitators to project implementation included the frequency of arterial catheterizations performed due to the treatment of high acuity patients and specific surgical specialty requirements. Additionally, the perioperative staff familiarity with basic procedural set up and catheterization workflow served project implementation. Barriers to project implementation included a limited supply of operational and calibrated ultrasound machines and adjunct supplies such as ultrasound probe covers and ultrasound gel. Additional potential barriers included time spent gathering supplies and waiting on machine availability.

Project Population

The project population consisted of CRNAs practicing at the project site. Established relationships between the university and anesthesia providers at the hospital facilitated project implementation. Previous involvement of anesthesia providers in previous university quality improvement projects as students facilitating the projects or as participants increased familiarity with the participation process. The CRNAs familiarity with the arterial catheterization procedure served as a facilitator to project implementation. Barriers specific to anesthesia providers include differences in the educational requirements and training backgrounds, underlining variable baseline knowledge of each practitioner. Timing of previous ultrasound technology education, such as ultrasound training using outdated technology or methods, provides additional learning curves for anesthesia providers and serves a barrier for project implementation.

Project Team

The team consisted of the author as team lead and three student members, all student registered nurse anesthetists (SRNAs). The student team collaborated on initial project development, but project implementation was performed separately respective to clinical setting. The project lead implemented this project in the cardiovascular surgery suite and was responsible for data collection and analysis. The nurse anesthesia program director acted as the supervising project chair and the clinical contact liaison. The partnering organization's clinical coordinator operated as the site contact person and signed the letter of acknowledgement for the data collection process. The course director, a college of nursing faculty member, offered direction and guidance throughout project development and implementation.

Methods and Measurement

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 for improving awareness of and preference for utilization of ultrasound for arterial catheterization. The devised intervention was evidence-based and consisted of an educational resource handout and a dictated instructional PowerPoint presentation (Appendix E). Pre- and post-intervention surveys were created using Qualtrics surveys (Appendix F). The intervention material and survey links were emailed to participants (Appendix G). Once participants completed the pre-intervention survey, the educational resources were emailed, and the educational handout was also printed and provided as a hard copy. Pre-intervention surveys were completed by four participants, whereas post-intervention surveys were completed by three participants, allowing three measurable outcomes for data analysis.

The Institute for Healthcare Improvement (2023) PDSA model guided the development and implementation of this quality improvement project. An educational intervention was designed with a pre- and post-intervention Qualtrics survey to guide the quality improvement project. The "plan" phase consisted of initial project development through the collaborative efforts of the SRNAs, the project chair, and the program director. Current evidence was analyzed for best practice guidelines and the project chair offered clinical expertise and guidance to develop the project purpose, goals, and intervention. The intervention was created and revised several times by SRNA project members, the project chair, and course director to ensure efficiency and comprehension by participants. Approval for project implementation was granted after submitting applications through the university and partnering organization. Finally, project participant recruitment was initiated by the site contact person via emailing staff and generating a list of interested participants. Nine eligible project participants were recruited by the collaborative decisions of the site contact person and clinical contact liaison.

The "do" phase began by emailing the pre-intervention survey to the nine eligible participants one week prior to the intervention implementation. The pre-intervention survey assigned each participant a numerical identification upon survey completion, to be used for the post-intervention survey phase. The intervention materials were emailed to the nine participants and a handout of the educational resource was given to or placed in the workplace mailbox of participating individuals. Two weeks after the intervention email was sent, the post-intervention survey was emailed to the nine participants and remained open for one week to allow survey completion. The eight-item pre-intervention survey and the seven-item post-intervention survey measured nominal, interval, and free response data. All participants' survey responses were kept confidential.

The "study" phase included data analysis by the project lead comparing pre- and post-intervention survey responses. The pre-intervention survey was completed by four of the nine eligible project participants. The post-intervention survey was completed by three of the four participants that completed the pre-intervention survey. The post-intervention survey could only be completed by those that completed the pre-intervention survey, due to the requirement of retyping their numerical identification. Data analysis included the comparison of pre- and post-intervention survey responses and participant response rates.

Lastly, the "act" phase included presentation of the measurable outcomes to members of the organization and planning modifications for future PDSA cycles. The author developed a PowerPoint poster and presentation to display results of the project and propose recommendations for future quality improvement initiatives. The presentation was given to an audience including SRNAs of the university, the program director and project chair, the course director, the site contact person, and the chief CRNA of the partnering organization.

Section IV. Results and Findings

Results

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 for improving awareness of and preference for utilization of ultrasound for arterial catheterization (Appendix E). Pre- and post-implementation surveys were used to assess project participants' perceptions. The surveys were distributed via email to nine CRNAs in the cardiovascular surgery setting at the partnering facility. Responses were collected over an 18-day period in which the participants could utilize the educational resources. Participant responses were confidentially collected using a Qualtrics survey via an embedded link in the email distributions. Excel software was used to analyze responses received and create figures from the data collected. Four CRNAs completed the pre-implementation survey and three completed the post-implementation survey.

Data Presentation

The pre-implementation survey included eight questions and the post-implementation survery included 7 questions that assessed CRNAs experience and perceptions of USG arterial catheterizations. In the pre-implementation survey, one survey respondent reported "2 to 5 years" of CRNA experience and three survey respondents reported ">10 years" of CRNA experience. Regarding previous education on USG arterial catheterizations, one survey respondent reported "yes" to previous education and three respondents reported "no" to previous education.

In the pre-implementation survey, arterial line placement frequency before the implementation included two responses of "4 to 6 cases" and two responses of "> 10 cases" within the previous two weeks. Arterial line placement frequency using USG before the

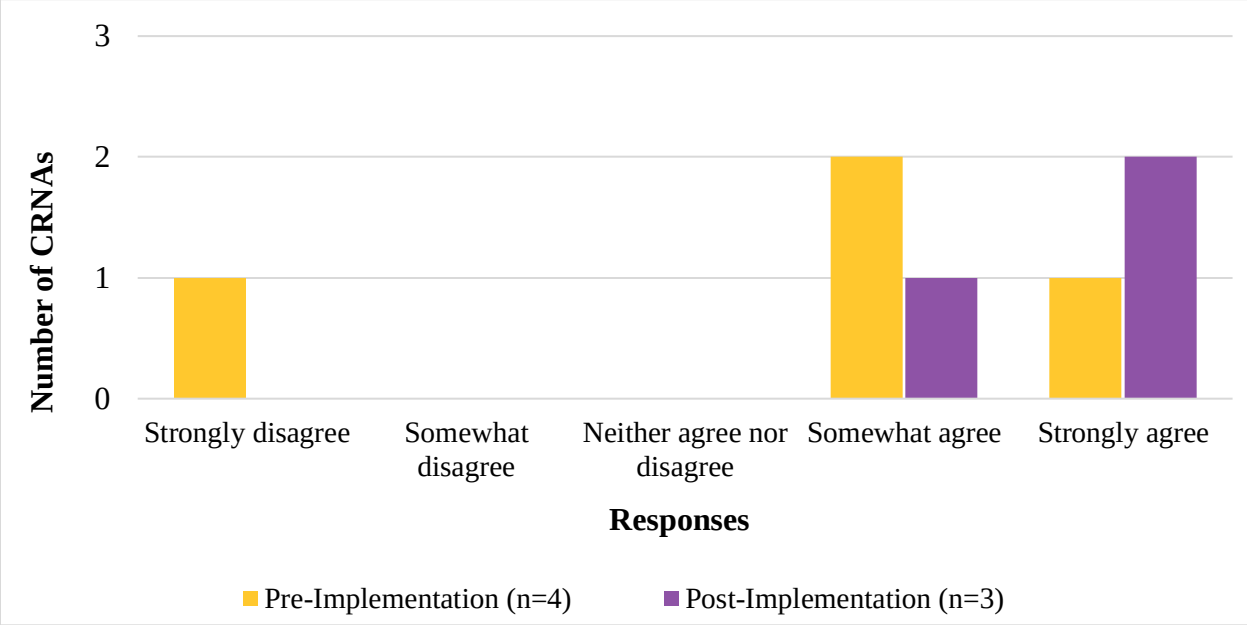
implementation included two responses of "4 to 6 cases" and two responses of "1 to 3 cases" within the previous two weeks. In the post-implementation survey, arterial line placement frequency after the implementation included two responses of "1 to 3 cases" and one response of "7 to 10" within the previous two weeks. Arterial line placement frequency using USG after the implementation included two responses of "1 to 3 cases" and one response of "none" within the previous two weeks.

Survey respondents' pre-implementation assessment of the superiority of USG arterial line placements versus traditional palpation techniques reported one response of "somewhat disagree," two responses of "somewhat agree," and one response of "strongly agree." Post-implementation assessment of the superiority of USG arterial line placements versus traditional palpation techniques found one response of "neither agree nor disagree," one response of "somewhat agree," and one response of "strongly agree." Post-implementation assessment of participants' awareness of the advantages of USG arterial catheterizations, one survey respondent reported "unchanged" to awareness of advantages and two respondents reported "increased" to awareness of advantages.

Survey respondents’ pre-implementation confidence in USG arterial catheterization ability included one response for "strongly disagree," two responses for "somewhat agree," and one response for "strongly agree." Post-implementation confidence in ultrasound guided arterial catheterization ability included one response for "somewhat agree," and two responses for "strongly agree." Data for pre- and post-implementation user confidence in USG arterial catheterization is demonstrated in Figure 1.

Figure 1

CRNA Confidence in Ability for Ultrasound-Guided Arterial Line Placement

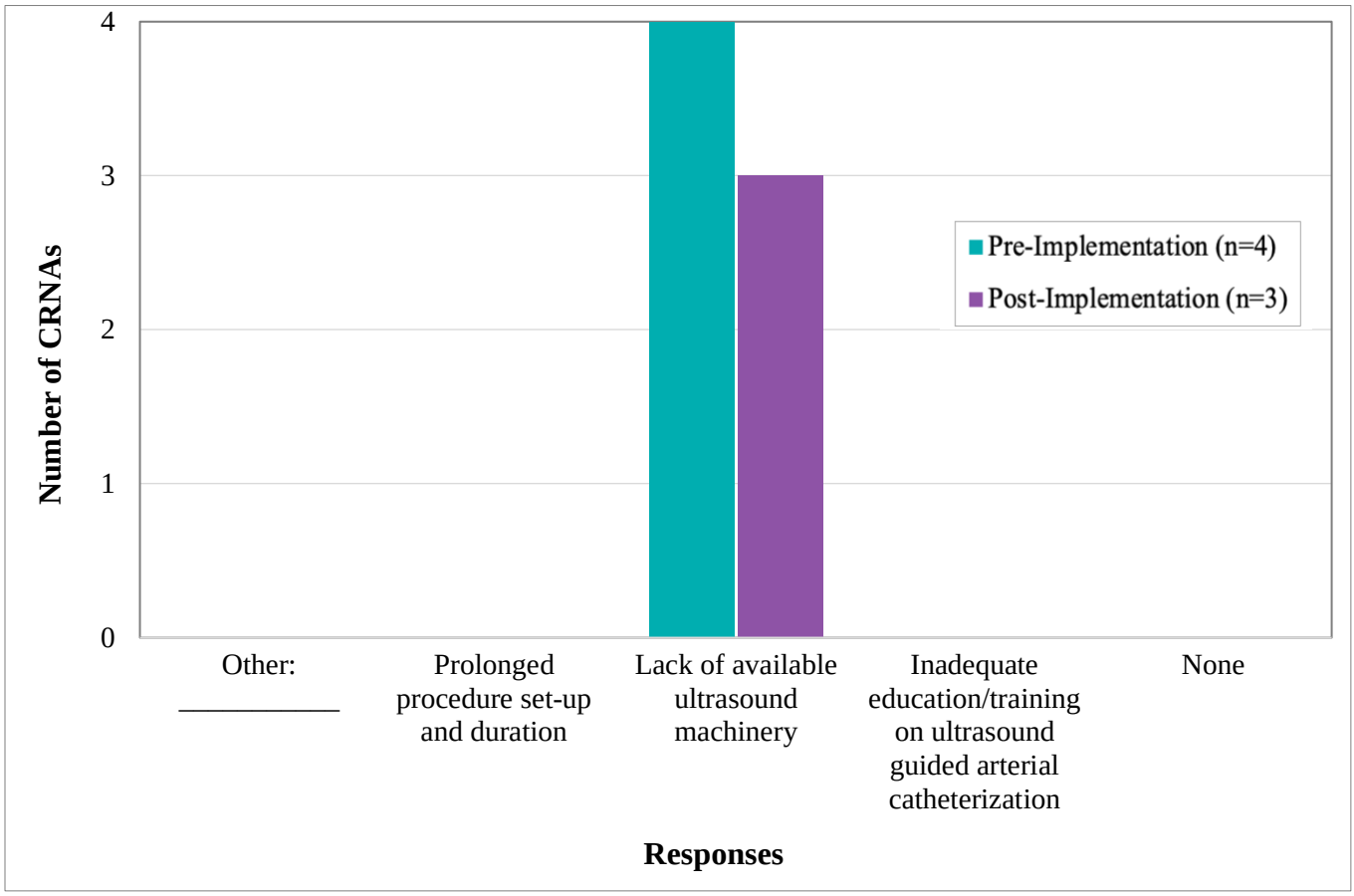


Next, pre-implementation assessment of survey respondents' likeliness to use ultrasound for arterial line placement found one response for "somewhat disagree" and three responses for "somewhat agree." Post-implementation assessment of survey respondents' likeliness to use ultrasound for arterial line placement found two responses for "somewhat agree" and one response for "strongly agree."

Lastly, both the pre-implementation and post-implementation assessment of perceived barriers to ultrasound guided arterial catheterizations included 100% of respondents selecting "lack of available ultrasound machinery," and none of the other options. The responses for the perceived barriers are seen in Figure 2.

Figure 2

Perceived Barriers to Utilizing Ultrasound for Arterial Line Placement



Analysis

Overall participation from the nine selected CRNAs included four responses for the pre-implementation survey and three responses for the post-implementation survey. The eight-item pre-intervention survey and the seven-item post-intervention survey measured nominal, interval, and free response data. Confidential collection of responses allowed data comparison of pre- and post-implementation results for the completed surveys.

The respondents to the pre-implementation survey were primarily (3/4) CRNAs with more than ten years of experience in anesthesia. The CRNAs with more years of experience likely have had more exposure to arterial catheterizations, USG arterial catheterizations, and opportunities for education. However, the survey did not quantify experience years or hour equivalents, including CRNAs working full-time, part-time, or in a per diem capacity. Additionally, there was no distinction between those with greater than ten years of experience, allowing a large range of experience years to be defined by this answer choice.

Responses for arterial line placements over a two-week period, whether by USG or other method, varied among respondents. The average number of cases in which arterial lines were placed decreased from pre- to post-implementation survey responses. The average number of cases in which USG arterial lines were placed decreased from pre- to post-implementation survey responses as well. The decrease in arterial lines placed could reflect a variety of contributing influences, such as patient indicators, CRNA respondent factors, surgeon or surgical indicators, or facility specific factors. Further assessment into the decrease in arterial line placements is needed for accurate data analysis.

Responses to the advantages and superiority of USG techniques changed slightly from pre- to post-implementation survey. The majority of respondents reported awareness "increased" to the advantages of USG arterial catheterization in the post-implementation survey. Responses regarding the superiority of USG arterial catheterization improved in the post-implementation survey to include answers from "neither agree nor disagree" to "strongly agree." Overall, the reported responses demonstrate slight alterations to the CRNAs' perceptions of the advantages or superiority of USG arterial catheterizations.

CRNA confidence for USG arterial line placements improved between pre- and post-implementation surveys. Participants' perception of confidence in their ability improved between surveys, reflecting a possible impact of the educational resource and project implementation. The participants' increased confidence in this skill provide support for the utilization of educational tools to improve provider awareness and job performance. Additionally, the lack of educational resources reported by providers and then subsequent increased confidence in the USG arterial catheterization skill supports the use of educational resources to improve CRNA performance. Data interpretation to support the project's education impact on CRNA confidence however remains impaired due to the low response rates from the participants, sample size, and lack of distinct tracking of the number of times the CRNA used the educational resource.

Finally, the consistency of responses of "lack of available machinery" as a barrier to USG arterial catheterization remains a contributing barrier for CRNAs at this facility. This barrier can be applied to previous responses, and may help explain the decreased use of ultrasound guidance for arterial catheterizations during the implementation phase of the project. Further, the lack of equipment and opportunity for its use could impair CRNAs' level of comfort and confidence with the technology, as opposed to previous education on its use. It would be helpful to distinguish whether the CRNAs' confidence and utilization of ultrasound are related solely to the lack of availability of ultrasound machinery or if the previously identified lack of educational resources has a greater impact.

Section V. Implications

Financial and Nonfinancial Analysis

The incorporation of USG arterial catheterizations can significantly impact anesthesia providers' workflow, organizational goals, and patient outcomes. USG techniques improve first-attempt success rates for arterial catheterizations and decrease procedure duration, both of which decrease total anesthesia preparation time in the operating room (Flumignan et al., 2021). The decrease in anesthesia preparation time can significantly impact patient costs and operating room schedules. Additionally, the increased first-attempt success rate reduces the number of materials used, such as additional catheters, and provides a cost-effective strategy for organizations (Yeap et al., 2019).

Costs of ultrasound equipment can range from $4,000 to $80,000 (Soliman & Osman, 2018). Although initial equipment costs are large, cost-saving measures such as decreased placement time and infiltration rates afforded savings of greater than $90,000 for one hospital implementing ultrasound for peripheral intravenous catheter placements. Additionally, training CRNAs on USG arterial catheterization techniques requires ongoing competencies and maintenance of knowledge for skill proficiency. Paradis et al. (2022) demonstrated the cost-effective strategy of a training device totaling about $160 to improve provider skills in USG utilization. An in-person training session, along with the electronically created educational resource from the project, would provide cost-effective strategies for anesthesia provider education on USG arterial catheterization techniques.

Overall, the organization would benefit from investing in increasing CRNA ultrasound usage for arterial line placement. Initial organization costs could cover the purchase of additional ultrasound machines, ultrasound training devices, and laminated printed materials for

dissemination. Over time, increased ultrasound utilization will ultimately be reflected by reduced arterial line complications, decreased anesthesia preparation time, reduced surgical delays, more efficient operating room scheduling, decreased material usage, and improved first attempt success rates. These advantages strongly support the cost-benefit implications of increased USG arterial catheterizations.

Implications of Project

The USG arterial catheterization technique presents an opportunity for the partnering organization. The partnering organization provides regular perioperative care for many critically ill patients that require arterial catheterizations. Incorporation of ultrasound technology for arterial cannulations may impact the diverse patient population and overall health system operations. Specifically, implementation of the USG procedure addresses important tenets of the triple aim framework, including patient satisfaction and cost-saving measures (Berwick et al., 2008). Reducing the potential for adverse patient outcomes and cost-reduction measures remain a priority of interest for this institution. Therefore, understanding anesthesia providers' awareness of USG arterial catheterizations and their perceptions of its use highlight important organizational needs for this facility. Anesthesia providers' preference for USG arterial catheterization at the partnering organization may be influenced by gaining knowledge on the recommendations for vascular access published by the AANA (2015) and the American Institute of Ultrasound Medicine (2019).

The many advantages of USG arterial catheterizations, including cost-saving measures, reduced complications, and improved success rates, were acknowledged by the CRNA participants during project implementation. Several CRNAs' responses reflected improved understanding of the benefit of USG arterial catheterizations and likeliness to incorporate

ultrasound technology in their practice. However, the lack of available ultrasound equipment remains a priority barrier to its incorporation in anesthesia practice. This barrier possibly explains its decreased utilization in cases where arterial lines were placed. The recognition of the benefits of ultrasound by these highly experienced CRNAs and the increased confidence in its usage after project implementation supports the organizational interest in purchasing additional ultrasound machinery and investing in further ultrasound training and education for anesthesia providers.

Improvements in the process of arterial catheterizations demonstrates benefits to many parties involved in the organization. Increased first-attempt success rates and decreased procedure duration reduces anesthesia preparation time and optimizes surgical time in the operating room. This benefits the anesthesia team workflow, in which time can be more efficiently spent completing other necessary perioperative tasks. This benefits the surgical team and organization by decreasing time spent in the operating room and increasing efficiency of surgery scheduling. Lastly, this benefits the patients by decreasing complications or discomfort related to prolonged arterial catheterization procedures, multiple attempts, and increased operating room billing times.

Sustainability

The partnering organization could benefit from expanding the quality improvement project to analyze the impact of USG arterial catheterizations in all facility operating room areas. The organization could further assess all anesthesia providers' perceptions of USG arterial catheterizations and analyze the data collected to guide future projects and studies. The organization would not incur additional costs by expanding the project implementation to all anesthesia providers because the previously created materials can be sent and disseminated

electronically. Additionally, the organization could develop a quality improvement initiative that assess the CRNA's perceptions of an in-person USG arterial catheterization training. A hands-on training may demonstrate increased improvements in provider confidence and likelihood to utilize ultrasound for arterial catheterization. Overall, this organization would benefit from assessing the impact of USG arterial catheterizations on total costs and the cost-benefit ratio of investing in more available ultrasound machinery for the anesthesia department.

Dissemination Plan

The findings of the quality improvement project were displayed on an electronic poster and disseminated via a presentation to the nurse anesthesia department members, project participants, and nurse anesthesia faculty and students. The final version of this DNP project paper and poster were published in The Scholarship, the East Carolina University digital repository.

Section VI. Conclusion

Limitations

Multiple limitations were identified throughout the implementation and evaluation of this project. The small sample size, partial CRNA participation, and uneven number of respondents to the pre- and post-implementation surveys limited data analysis. Increasing the number of initial participants by surveying the entire anesthesia department could have increased respondent numbers and provided more data for interpretation. The brief implementation period may have limited anesthesia providers' abilities to access and utilize the educational resource. Participants may also have not responded due to lack of perceived value of the project. Lastly, participants' identification of insufficient ultrasound machines may have hindered their ability to utilize ultrasound technology for arterial line placements during the implementation period.

Recommendations for Future Implementation

There are multiple recommendations for future study and project implementation specific to this facility. The organization would benefit from assessing factors related to perioperative arterial catheterizations, including procedure duration, material costs, surgical delays, and utilization of ultrasound technology. This assessment may determine baseline organizational needs and measurements for project outcomes. Implementation strategies could build on the educational resource by including a hands-on ultrasound training and skills workshop available to all anesthesia providers at this facility. The larger sample size and advanced education may improve data findings on the utilization of USG for arterial catheterization. Additionally, this organization may benefit from investigation on USG arterial catheterizations performed in the preoperative area compared to the operating room as a surgical delay reduction and cost-saving measure.

References

Abtahi, D., & Saeedi, N. (2023). Increasing the success rate of first-year anesthesia residents using ultrasound for radial artery catheterization compared to the palpation method in adult surgical patients. *Novelty in Biomedicine, 11*(2), 68-76. https://doi.org/10.22037/nbm.v11i3.40314

American Association of Nurse Anesthesiology. (2015, February). *Infection prevention and control guidelines for anesthesia care.* https://issuu.com/aanapublishing/docs/4_-infection_prevention_and_control_guidelines_for?fr=sOTEzMjU2NDAxMjU

American Institute of Ultrasound Medicine. (2019). AIUM practice parameter for the use of ultrasound to guide vascular access procedures. *Journal of Ultrasound in Medicine, 38*(3), E4-E18. https://doi.org/10.1002/jum.14954

Berwick, D. M., Nolan, T. W., & Whittington, J. (2008). The triple aim: Care, health, and cost. *Health Affairs (Project Hope), 27*(3), 759-769. https://doi.org/10.1377/hlthaff.27.3.759

Bhattacharjee, S., Maitra, S., & Baidya, D. K. (2018). Comparison between ultrasound guided technique and digital palpation technique for radial artery cannulation in adult patients: An updated meta-analysis of randomized controlled trials. *Journal of Clinical Anesthesia, 47*, 54-59. https://doi.org/10.1016/j.jclinane.2018.03.019

Fatima, H., Chaudhary, O., Krumm, S., Mufarrih, S. H., Qureshi, N. Q., Oren-Grinberg, A., Bose, R. R., Huang, L., Mahmood, F., & Matyal, R. (2021). Workflow of ultrasound-guided arterial access. *Journal of Cardiothoracic and Vascular Anesthesia, 35*(6), 1611-1617. https://doi.org/10.1053/j.jvca.2020.12.018

Flumignan, R. L., Trevisani, V. F., Lopes, R. D., Baptista-Silva, J. C., Flumignan, C. D., &

Nakano, L. C. (2021). Ultrasound guidance for arterial (other than femoral) catheterisation in adults. *Cochrane Database of Systematic Reviews, 10*(10), CD013585. https://doi.org/10.1002/14651858.CD013585.pub2

Institute for Healthcare Improvement. (2023). *Science of improvement: Testing changes.* https://www.ihi.org/resources/Pages/HowtoImprove/ScienceofImprovementTestingChanges.aspx

Melnyk, B. M. & Fineout-Overholt, E. (2019) *Evidence-based practice in nursing and healthcare: A guide to best practice.* (4th ed.). Wolters Kluwer.

Paradis, O., Bitterman, L., Park, K. H., Ernest, S., Russell, A., Bengiamin, D. I., & Young, T. P. (2022). Arterial line placement pitfalls can be demonstrated and visualized with an inexpensive, wearable trainer. *The Journal of Emergency Medicine, 62*(2), 210-215. https://doi.org/10.1016/j.jemermed.2021.10.017

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*, *38*(4), 564-571. https://doi.org/10.1016/j.jopan.2022.11.014

Raphael, C. K., El Hage Chehade, Nour A, Khabsa, J., Akl, E. A., Aouad-Maroun, M., & Kaddoum, R. (2023). Ultrasound-guided arterial cannulation in the paediatric population. *Cochrane Database of Systematic Reviews, 3*(3), CD011364-CD011364. https://doi.org/10.1002/14651858.CD011364.pub3

Sharkey, A., Mitchell, J. D., Fatima, H., Bose, R. R., Quraishi, I., Neves, S. E., Isaak, R., Wong, V. T., Mahmood, F., & Matyal, R. (2022). National Delphi survey on anesthesiology

resident training in perioperative ultrasound. *Journal of Cardiothoracic and Vascular Anesthesia, 36*(11), 4022-4031. https://doi.org/10.1059/j.jvca.2022.07.019

Soliman, A. H., & Osman, A. M. (2018). Cost-effectiveness of ultrasound-guided surgical clips placement for breast cancer localization prior to neoadjuvant chemotherapy. *Egyptian Journal of Radiology and Nuclear Medicine, 49*(4), 1163-1168. https://doi.org/10.1016/j.ejrnm.2018.06.010

Yeap, Y. L., Wolfe, J. W., Stewart, J., & Backfish, K. M. (2019). Prospective comparison of ultrasound-guided versus palpation techniques for arterial line placement by residents in a teaching institution. *Journal of Graduate Medical Education, 11*(2), 177-181. https://doi.org/10.4300/JGME-D-18-00592.1

Yu, Y., Lu, X., Fang, W., Liu, X., & Lu, Y. (2019). Ultrasound-guided artery cannulation technique versus palpation technique in adult patients in pre-anesthesia room: A randomized controlled trial. *Medical Science Monitor, 25*, 7306-7311. https://doi.org/10.12659/MSM.916252

Appendix A
Literature Search Concept Table

	Concept 1 Arterial catheterization	**Concept 2** Ultrasound guided	**Concept 3** Anesthesia provider
Keywords	Arterial catheter OR artery catheter OR arterial line placement OR artery cannulation OR arterial cannulation OR arterial access OR artery access	Ultrasound OR sonography	"Nurse anesthetist" OR anesthesiologist OR CRNA
PubMed [MeSH Terms]	“arteries” "catheterization" "catheters" "vascular access devices"	"ultrasonography" "ultrasonics"	"anesthesia" "anesthesiologists" "nurse anesthetists"
CINAHL Subject Headings	(MH "Arterial Catheters") OR (MH "Catheterization") OR "arterial catheterization"	(MH "Technology, Ultrasound") OR "ultrasound" OR (MH "Ultrasonography, Doppler, Duplex") OR (MH "Ultrasonography, Doppler, Pulsed") OR (MH "Ultrasonography, Doppler, Color") OR (MH "Ultrasonography, Doppler")	(MH "Anesthesia") OR "anesthesia" OR (MH "Education, Nurse Anesthesia") OR (MH "Anesthesia, Conduction") OR (MH "Anesthesia, General") OR (MH "Certified Registered Nurse Anesthetists") OR (MH "Anesthetists") OR "anesthetist" OR (MH "Anesthesiologists")
Google Scholar	Arterial catheter OR artery catheter OR arterial line placement OR artery cannulation OR arterial cannulation OR arterial access OR artery access	Ultrasound OR sonography	"Nurse anesthetist" OR anesthesiologist OR CRNA

Appendix B
Literature Search Log

Search date	Database or search engine	Search strategy	Limits applied	Number of citations found/kept	Rationale for inclusion/exclusion of items
09/24/2023	PubMed	(arterial catheter OR artery catheter OR arterial line placement OR artery cannulation OR arterial cannulation OR arterial access OR artery access) AND (ultrasound OR sonography OR ultrasonics) AND (nurse anesthesia OR crna OR anesthesiology OR anesthesiologist OR anesthetist) MeSH Terms "arteries," "catheters", "vascular access devices," "catheterization," "ultrasonography," "ultrasonics," "anesthesiology," "anesthesiologists," and "anesthetists"	5 years (2018-2023) English	506 found/ 34 kept	Included items about peripheral arterial access, anesthesia or perioperative placement, ultrasound technology used Excluded items about venous or general vascular access, pulmonary artery catheters, arterial access for non-catheter line placement, critical care providers, and non-ultrasound catheter placement
09/24/2023	CINAHL	((MH "Arterial Catheters") OR (MH "Catheterization") OR "arterial catheterization") AND ((MH "Technology, Ultrasound") OR "ultrasound" OR (MH "Ultrasonography, Doppler, Duplex") OR (MH "Ultrasonography, Doppler, Pulsed") OR (MH "Ultrasonography, Doppler, Color") OR (MH "Ultrasonography, Doppler")) AND ((MH "Anesthesia") OR "anesthesia" OR (MH "Education, Nurse Anesthesia") OR (MH "Anesthesia,	10 years (2013-2023) English	106 found/14 kept	Included items about arterial catheters, arterial line placements, perioperative or surgery, anesthesia providers, providers in the operating room Excluded items about venous catheters or cannulations, major artery access

		Conduction") OR (MH "Anesthesia, General") OR (MH "Certified Registered Nurse Anesthetists") OR (MH "Anesthetists") OR "anesthetist" OR (MH "Anesthesiologists"))			
09/24/2023	Google Scholar	(arterial catheter OR artery catheter OR arterial line placement OR artery cannulation OR arterial cannulation OR arterial access OR artery access) AND (ultrasound OR sonography OR ultrasonics) AND (nurse anesthesia OR crna OR anesthesiology OR anesthesiologist OR anesthetist)	3 years (2021-2024)	5540 found/36 kept (reviewed 10 pages of results)	Included items about arterial catheters, arterial line, anesthesia or perioperative placement, ultrasound or doppler technology Excluded items about venous or vascular access, critical care providers, and non-ultrasound catheter placement

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	Abtahi, D., & Saeedi, N. (2023). Increasing the success rate of first-year anesthesia residents using ultrasound for radial artery catheterization compared to the palpation method in adult surgical patients. *Novelty in Biomedicine, 11*(2), 68-76.	Assess effect of early ultrasound training for first-year anesthesia residents in radial artery catheterization No conceptual framework or model noted	Randomized controlled trial (Level II)	Academic hospital, Iran	20 first-year residents *N* = 640, total arterial catheters placed in 2 phases (320 per phase)	Training program via video, oral lectures, and visual demonstration, implemented before phase 1 and phase 2 Phase 1 and phase 2 measurements taken comparing ultrasound- to palpation-guided arterial line placement to determine effectiveness of resident training SPSS version 17	Ultrasound-guidance improved first attempt rates (71.3% versus 52.5%), $p<.001$ (statistical significance $p<.05$), and decreased total catheterization time (median 132 seconds versus 149.5 seconds) with significance of $p<.001$

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, 38*(4), 564-571.	Assess knowledge of ultrasound-guided vascular access before and after implementation of training program No conceptual framework or model noted	QI (Level IV) utilizing the revised standards for quality improvement reporting excellence (SQUIRE 2.0)	Hospital, United States southeast region	*N* = 17 (certified registered nurse anesthetists) 14 in training course 12 in post-intervention knowledge test 11 in post-intervention survey and assessment	Intervention included a 2-hour evidence-based didactic online lecture course, a 2-hour structured workshop, and a resource handout Measured pre- and post-training competency with survey, knowledge test, and skills assessment Also recorded number of attempts for success of vascular catheters	Statistical significance observed in confidence scores of certified registered nurse anesthetists and successful vascular placements improved 50% to 80%
2023	Raphael, C. K., El Hage Chehade, N. A., Khabsa, J., Akl, E. A., Aouad-Maroun, M., & Kaddoum, R. (2023). Ultrasound-	Compared ultrasound-guided arterial cannulation to pulse palpation and Doppler	Systematic Review (Level I)	Several international hospitals, perioperative and critical care units	9 randomized controlled trials examined Pediatric participants,	Primary measurements include first attempt success rate and complications	Moderate evidence for ultrasound guidance to improve first attempt success rate

	guided arterial cannulation in the paediatric population. *The Cochrane Database of Systematic Reviews*, *3*(3), CD011364.	auditory assistance No conceptual framework or model noted			aged 1 month to 18 years old Total of 748 arterial cannulations performed, including ultrasound-assisted, palpation-assisted, and Doppler-assisted	Secondary measurements include cannulation success, number of attempts, and procedure duration	and overall success rate Moderate evidence to support reduced risk of complications and procedure duration
2022	Sharkey, A., Mitchell, J. D., Fatima, H., Bose, R. R., Quraishi, I., Neves, S. E., Isaak, R., Wong, V. T., Mahmood, F., & Matyal, R. (2022). National Delphi survey on anesthesiology resident training in perioperative ultrasound. *Journal of Cardiothoracic and Vascular Anesthesia*, *36*(11), 4022-4031.	Assess expert opinion to guide development of education standards for ultrasound training for anesthesiology residents No conceptual framework or model noted	Prospective cross-sectional study (Level V) utilizing Delphi survey methodology	Multi-institutional academic medical centers, United States	*N* = 120 Anesthesiology residency program directors, experts in perioperative ultrasound 75 participated in first Delphi round, 40 in second round	Recommend-ations based on items rated 4 or 5 on 5-point Likert scale with 70% or more participant support	Guidelines developed for anesthesia resident training on basic ultrasound usage and ultrasound guided vascular access, 20 minimum recommended

2021	Fatima, H., Chaudhary, O., Krumm, S., Mufarrih, S. H., Qureshi, N. Q., Oren-Grinberg, A., Bose, R. R., Huang, L., Mahmood, F., & Matyal, R. (2021). Workflow of ultrasound-guided arterial access. *Journal of Cardiothoracic and Vascular Anesthesia, 35*(6), 1611-1617.	To provide training on the workflow of ultrasound-guided arterial line placement and to evaluate effect of on surgical delays due to difficult line placement No conceptual framework or model noted	QI (Level IV)	Academic hospital, United States northeast region	Analyzed pre- and post-intervention surgical delays of greater than 15 minutes during a 6-month period Delays due to difficult line placement selected through Perioperative Information Management System (PIMS)	Educational course included online interactive course and hands-on ultrasound-guided arterial line placement workshop, targeting individuals with all levels of training including residents, attending physicians, and midlevel providers	Surgical delays due to difficult line placements decreased from 12% to 4% post-intervention, reflecting possible advantages of ultrasound-guidance training for arterial line placement
2021	Flumignan, R. L., Trevisani, V. F., Lopes, R. D., Baptista-Silva, J. C., Flumignan, C. D., & Nakano, L. C. (2021). Ultrasound guidance for arterial (other than femoral) catheterisation in adults. *Cochrane Database of Systematic*	Assess effects of ultrasound guidance for arterial (excluding femoral) catheterization in adults No conceptual framework or model noted	Systematic review (Level I)	Several international hospitals	*N* = 7997 48 studies selected from RCTs including cross-over trials and cluster RCT's, comparing ultrasound guidance versus palpation or landmark	Assessed landmark and palpation, Doppler auditory ultrasound assistance, ultrasound direct guidance, modified ultrasound techniques	Results specific to ultrasound technique and arterial site, with radial artery cannulation demonstrating low-certainty evidence for improved first pass rates over

	Reviews, 10(10), CD013585-CD013585.				technique for arterial (excluding femoral) catheterization Participants mean age 41-73 years old	First attempt success rate, total success rate, procedural time, complication rates	palpation, overall success rates, and decreased time for placement Moderate-certainty evidence reported for only ultrasound over doppler-assisted for improving first attempt success rates
2019	Yeap, Y. L., Wolfe, J. W., Stewart, J., & Backfish, K. M. (2019). Prospective comparison of ultrasound-guided versus palpation techniques for arterial line placement by residents in a teaching institution. *Journal of Graduate Medical*	Compares ultrasound-guidance technique to traditional blind palpation for radial artery line placement by residents No conceptual framework or model noted	Prospective randomized controlled trial (Level II)	Large academic medical center, United States, midwest region	*N* = 412, total radial artery catheterizations 85 total operators, (postgraduate year 3 and year 4 anesthesiology residents, similar experience levels)	Participating residents received prior training during intern year, including minimum of 5 ultrasound-guided and 5 palpation-guided arterial line placements Measurements included time to cannulation,	Ultrasound guided technique had decreased procedure length (mean 243.6 seconds versus 171.1 seconds, p=.012), fewer insertion attempts (mean 1.78 versus 2.48, p<.001), fewer catheters used (mean

	Education, 11(2), 177-181.					success rate, number of attempts, site and catheter used, number of operators used SPSS version 23.0 Statistical analysis used 1-way analysis of variance (ANOVA), p<.05 considered significant	1.39 versus 1.59, p=.035), and increased success rates (96% versus 90%, p=.012)
2019	Yu, Y., Lu, X., Fang, W., Liu, X., & Lu, Y. (2019). Ultrasound-guided artery cannulation technique versus palpation technique in adult patients in pre-anesthesia room: A randomized controlled trial. *Medical Science*	Compares the ultrasound-guided technique versus traditional palpation arterial cannulation in the pre-anesthesia unit	Randomized controlled trial (Level II)	University affiliated hospital, China	*N* = 60 Patients (18 to 90 years old), elective surgery	Measurements included first attempt success and total success rates, cannulation duration and total procedure duration, and complications related to cannulation	Ultrasound guided techniques had higher first attempt success rates (96.6%), compared to palpation (73.3%), with statistical significance of p=.03 (p<.05

	Monitor, 25, 7306-7311.	No conceptual framework or model noted				SPSS version 25.0 Statistical analyses performed using Kolmogorov-Smirnov test and *t*-test, and Pearson x^2 test	considered significant)
2018	Bhattacharjee, S., Maitra, S., & Baidya, D. K. (2018). Comparison between ultrasound guided technique and digital palpation technique for radial artery cannulation in adult patients: An updated meta-analysis of randomized controlled trials. *Journal of Clinical Anesthesia, 47*, 54-59.	Compares ultrasound guided radial artery cannulation to digital palpation method No conceptual framework or model noted	Meta-analysis (Level I)	Multiple hospitals	*N* = 1895 10 studies selected from published RCTs	Measurements include cannulation success rate, first attempt success rate, time to cannulation, and mean number of attempts to successful cannulation	Ultrasound guided technique had higher first attempt success rate with odds ratio (95% CI) of 2.76 and statistical significance of p <.001 (p<.05 considered significant) No difference in time to place arterial line amongst groups. No difference in number of

							attempts found. No difference in overall success rate

Note: QI = quality improvement; N = total population ; p = statistical measure of probability of observing a value of test statistic if the null hypothesis is true ; SPSS = Statistical Package for the Social Sciences; 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
Project 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:

Paige Mackenzie Chase

Project Title:

Assessing Anesthesia Providers' Perceptions of Ultrasound-Guided Arterial Catheterizations: 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 [redacted] 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. 11/12/2023

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	Assessing Anesthesia Providers' Perceptions of Ultrasound-Guided Arterial Catheterizations: A DNP Project
Project Leader	Paige Chase
Project Leader Contact E-mail	chasep12@students.ecu.edu
Department or Unit Affiliation	Anesthesia
Project Advisor (if applicable)[1]	Dr. 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' perceptions of adequacy of a newly developed quick-reference guide addressing ultrasound-guided arterial catheterization. The quick-reference guide addressing ultrasound-guided arterial catheterizations, will be developed based upon accepted national guidelines. Anesthesia providers at [redacted] will be administered a pre-survey asking about their familiarity with the/their current practice with ultrasound use for arterial catheterizations including perceptions of adequacy and frequency of use. Then, a quick-reference guide addressing ultrasound usage for arterial catheterizations will be made available to them, and they will be asked to use the guide for two weeks. Upon completion of the two-week utilization period, they will be asked to complete a post-survey about their perceptions of the adequacy of the guide. Qualtrics survey software will be used to gather data. No patient information will be recorded or maintained during this project.

Methodology / Intervention:

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

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 through ECU and involves multifactorial password protection. Data in Excel will be on a password protected spreadsheet and laptop. Email addresses will be deleted from Excel files after both surveys are completed and analysis of results begins. No PHI will be collected for this project. Data will be stored in Qualtrics and in Excel files (de-identified) until student graduation, anticipated to be spring of 2025. The deidentified data will be analyzed with results shared via a poster presentation to the ECU Nurse Anesthesia Program students and faculty, with participants invited to view the presentation remotely. If requested, a presentation of results to the participating department will be provided. Additionally, analysis of results will be addressed in a DNP Project Paper, completion of which is required for program graduation. This paper will be posted in the ECU digital repository, The Scholarship.

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. 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, 38*(4), 564-571. https://doi.org/10.1016/j.jopan.2022.11.014	☒	☐
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	Dewayne Byrd
Signature	DocuSigned by: [redacted]
Date	2/28/2024 | 11:44 PM EST

For Project Leaders: From the list below, please check the boxes for each service line where interventions may take place or where data may be collected. For each selected area, please route for signature for both the physician leader and administrator (preferably via DocuSign). Send a completed copy of the form to qualityimprovement@ecu.edu.

For Service Line Leaders: Signature on this form certifies that you are in support of this project taking place and agree with the answers to the above questions. If you are not in support of the proposed project, please discuss with the project leader, supervisor, and UMCIRB as needed.

	SERVICE LINE	SIGNATORY
☐	Heart & Vascular (Interventional Cardiology, Electrophysiology, Cardiac Surgery, Advanced Heart Failure, Cardiac Critical Care, Vascular Surgery, Cardio pulmonary rehab, Structural heart, & Thoracic Surgery)	Mark D. Iannettoni, MD Brian Floyd
☐	Cancer (Breast cancer, Lung cancer, Gynecologic cancer, hematology, GI cancer, Urologic cancer, and Head & Neck cancer)	Emmanuel Zervos, MD Todd Hickey
☐	Neuro Sciences (Neurology, Neurosurgery, Neuro Degenerative Disease, Neuro Critical Care, Stroke, Neuro Radiology, & Spine)	Stuart Lee, MD Jay Briley
☐	Orthopedics (Joints, Orthopedic Surgery, Rheumatology, Sports medicine, Orthopedic medicine, & Orthopedic Trauma)	Deanna Boyette, MD Van Smith
☐	Behavioral Health (Child / Adolescent Psychiatry, Behavioral medicine, & Adult Psychiatry)	Michael Lang, MD Todd Hickey
☐	Primary Care (Family medicine, Med-Peds, General Internal Medicine, Palliative Care, Geriatrics, & Sleep Medicine)	Jonathon Firnhaber, MD Dan Drake, PhD

☐	**Children's Health** (Pediatric Surgery, General Pediatrics, Well Newborn, Newborn & Pediatric Critical Care, Pediatric Hem-Onc, Neonatology, Pediatric medicine, Medicine subspecialities, surgical subspecialties)	Matthew Ledoux, MD Kim Crickmore, PhD
☐	**Women's Health** (Gynecology, Obstetrics, & Maternal Fetal Medicine)	James Whiteside, MD Kim Crickmore, PhD
☐	**Emergency Services** (Emergency Preparedness, Emergency Management, & Emergency Services)	Leigh Patterson, MD Debra Hernandez
☐	**Physical Medicine & Rehab** (Rehab, Therapy (OT, PT, SLP), Pain, Wound Care, & Audiology)	Clint Faulk, MD Dave Harlow
X☐	**Adult Surgical Service** (Anesthesiology, Trauma, ENT, Benign Urology, Plastics, Ophthalmology, Transplant Surgery, & Acute Care Surgery)	DocuSigned by: [redacted] 1D073CC8771647B... Eric DeMaria, MD DocuSigned by: [redacted] 6DAFA6A7071E4DC... Wendy Leutgen
☐	**Adult Medicine** (Medical Critical Care, Infectious Disease, Hospital Medicine, Pulmonology, Endocrinology, Allergy, Dermatology, & Nephrology)	Paul Bolin, MD
☐	**Radiology**	Eric Martin, MD, PhD Dave Harlow
☐	**Pathology & Lab Services**	Jay Fallon, MD Dave Harlow

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.

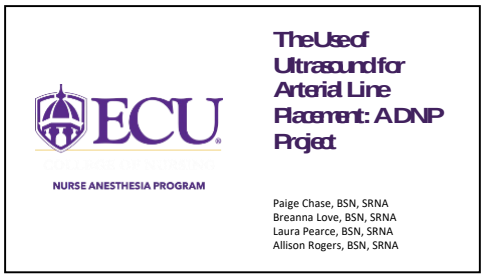
☒ **Not Human Subjects Research:** The UMCIRB office has determined that based on the description of the project, approval by the IRB is not necessary. Any changes or modifications to this project may be discussed with the UMCIRB office at that time to ensure those changes do not elevate the project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

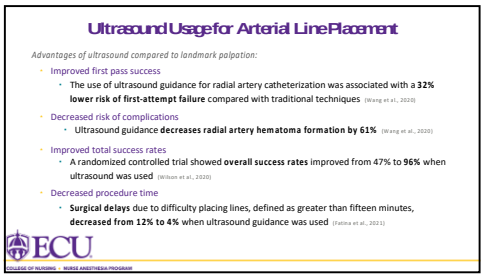
☐ **Human Subjects Research:** This project requires review by the IRB prior to initiation. An application in the electronic IRB submission system should be submitted.

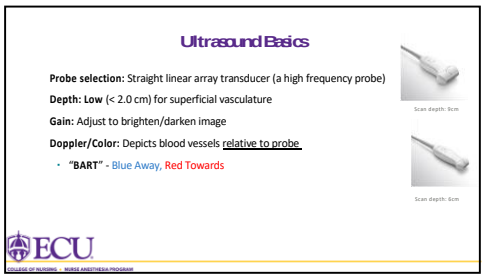
UMCIRB Office Staff Signature: [redacted] **Date:** 3/14/2024

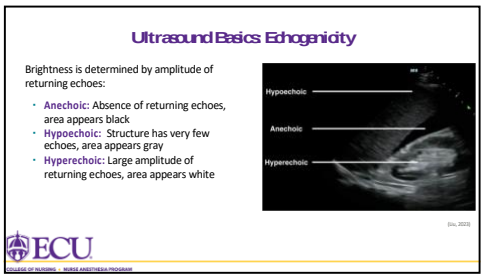
The UMCIRB office will contact you if any further information is needed to make this determination. Please note that if the UMCIRB office determines the activity is not human subjects research, then any presentation, publication, etc. should not refer to the activity as such.

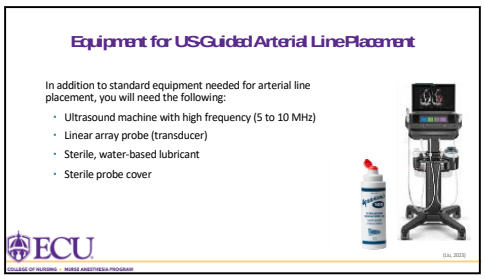
Appendix E
Educational Resources

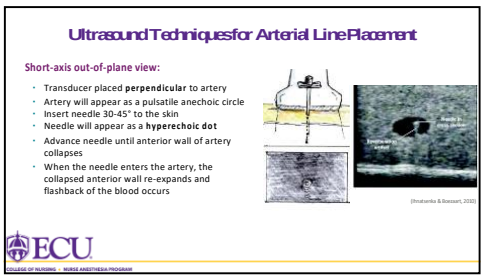


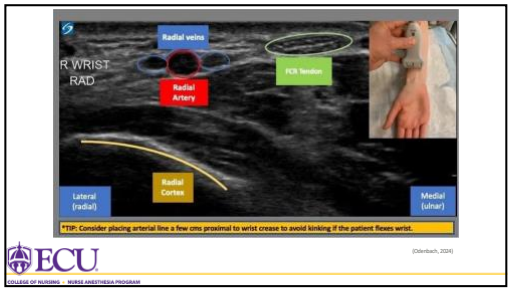











Radial veins
R WRIST
RAD
FCR Tendon
Radial Artery
Radial Cortex
Lateral (radial)
Medial (ulnar)
*TIP: Consider placing arterial line a few cms proximal to wrist crease to avoid kinking if the patient flexes wrist.
(Odenbach, 2024)
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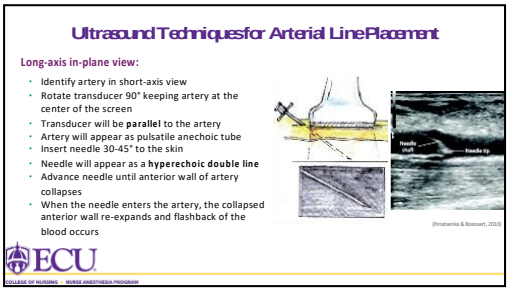
Ultrasound Techniques for Arterial Line Placement
Long-axis in-plane view:
Identify artery in short-axis view
Rotate transducer 90° keeping artery at the center of the screen
Transducer will be parallel to the artery
Artery will appear as pulsatile anechoic tube
Insert needle 30-45° to the skin
Needle will appear as a hyperechoic double line
Advance needle until anterior wall of artery collapses
When the needle enters the artery, the collapsed anterior wall re-expands and flashback of the blood occurs
Needle shaft
Needle tip
(Ihnatsenka & Boezaart, 2010)
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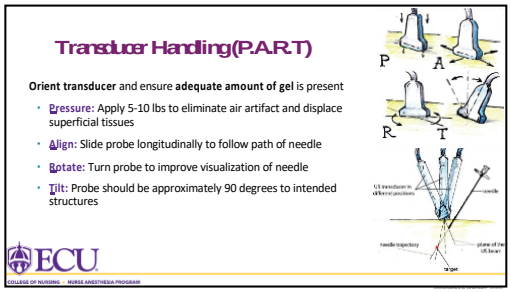
Transducer Handling (P.A.R.T)
Orient transducer and ensure adequate amount of gel is present
Pressure: Apply 5-10 lbs to eliminate air artifact and displace superficial tissues
Align: Slide probe longitudinally to follow path of needle
Rotate: Turn probe to improve visualization of needle
Tilt: Probe should be approximately 90 degrees to intended structures
P
A
R
T
US transducer in different positions
needle
needle trajectory
plane of the US beam
target
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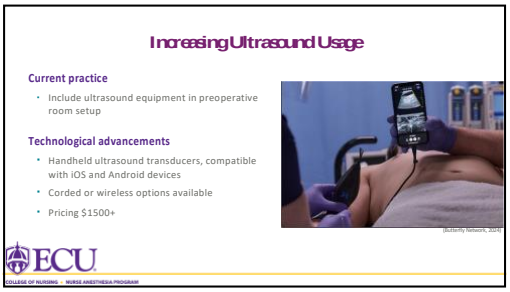
Increasing Ultrasound Usage
Current practice
Include ultrasound equipment in preoperative room setup
Technological advancements
Handheld ultrasound transducers, compatible with iOS and Android devices
Corded or wireless options available
Pricing $1500+
(Butterfly Network, 2024)
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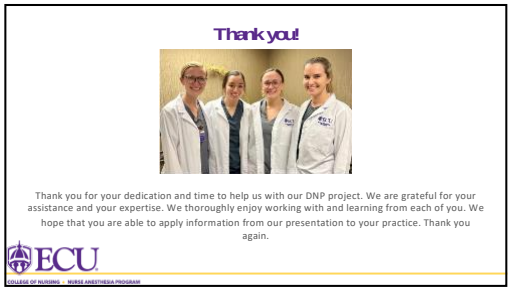
Thank you!
Thank you for your dedication and time to help us with our DNP project. We are grateful for your assistance and your expertise. We thoroughly enjoy working with and learning from each of you. We hope that you are able to apply information from our presentation to your practice. Thank you again.
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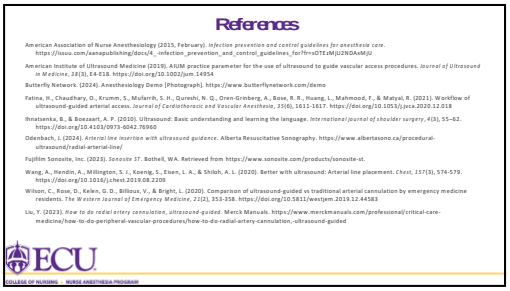
References
American Association of Nurse Anesthesiology (2015, February). Infection prevention and control guidelines for anesthesia care. https://issuu.com/aanapublishing/docs/4_-infection_prevention_and_control_guidelines_for?fr=sOTExMjU2NDAxMjU
American Institute of Ultrasound Medicine (2019). AIUM practice parameter for the use of ultrasound to guide vascular access procedures. Journal of Ultrasound in Medicine, 38(3), E4-E18. https://doi.org/10.1002/jum.14954
Butterfly Network. (2024). Anesthesiology Demo [Photograph]. https://www.butterflynetwork.com/demo
Fatima, H., Chaudhary, O., Krumm, S., Mufarrih, S. H., Qureshi, N. Q., Oren-Grinberg, A., Bose, R. R., Huang, L., Mahmood, F., & Matyal, R. (2021). Workflow of ultrasound-guided arterial access. Journal of Cardiothoracic and Vascular Anesthesia, 35(6), 1611-1617. https://doi.org/10.1053/j.jvca.2020.12.018
Ihnatsenka, B., & Boezaart, A. P. (2010). Ultrasound: Basic understanding and learning the language. International journal of shoulder surgery, 4(3), 55–62. https://doi.org/10.4103/0973-6042.76960
Odenbach, J. (2024). Arterial line insertion with ultrasound guidance. Alberta Resuscitative Sonography. https://www.albertasono.ca/procedural-ultrasound/radial-arterial-line/
Fujifilm Sonosite, Inc. (2023). Sonosite ST. Bothell, WA. Retrieved from https://www.sonosite.com/products/sonosite-st.
Wang, A., Hendin, A., Millington, S. J., Koenig, S., Eisen, L. A., & Shiloh, A. L. (2020). Better with ultrasound: Arterial line placement. Chest, 157(3), 574-579. https://doi.org/10.1016/j.chest.2019.08.2209
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
Liu, Y. (2023). How to do radial artery cannulation, ultrasound-guided. Merck Manuals. https://www.merckmanuals.com/professional/critical-care-medicine/how-to-do-peripheral-vascular-procedures/how-to-do-radial-artery-cannulation,-ultrasound-guided
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Appendix F
Pre- and Post-Implementation Survey Questions

Pre-Implementation Survey Questions

1. **How long have you worked in anesthesia?**
   a) < 2 years
   b) 2 to 5 years
   c) 6 to 10 years
   d) >10 years

2. In the past two weeks, how often have you placed arterial lines in the perioperative setting?
   a) None
   b) 1-3 cases
   c) 4-6 cases
   d) 7-10 cases
   e) > 10 cases

3. In the past two weeks, how often have you utilized ultrasound for arterial line placement in the perioperative setting?
   a) None
   b) 1-3 cases
   c) 4-6 cases
   d) 7-10 cases
   e) > 10 cases

4. I am confident in my ability to use ultrasound guidance for arterial line placement.
   a) Strongly disagree
   b) Disagree
   c) Neutral
   d) Agree
   e) Strongly agree

5. I am likely to use ultrasound-guidance for arterial line placement.
   a) Strongly disagree
   b) Disagree
   c) Neutral
   d) Agree
   e) Strongly agree

6. Have you ever received education on ultrasound-guided arterial line placement?
   a) Yes
   b) No
   c) Unsure

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

a) Strongly disagree
b) Disagree
c) Neutral
d) Agree
e) Strongly agree

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

a) None
b) Inadequate education/training on ultrasound-guided arterial catheterization
c) Lack of available ultrasound machinery
d) Prolonged procedure set-up and duration
e) Other: _____

Post-Implementation Survey Questions:

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

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

a) None
b) 1-3 cases
c) 4-6 cases
d) 7-10 cases
e) > 10 cases

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

a) None
b) 1-3 cases
c) 4-6 cases
d) 7-10 cases
e) > 10 cases

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

a) Decreased
b) Unchanged
c) Increased

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

a) Strongly disagree
b) Disagree
c) Neutral
d) Agree

e) Strongly agree

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

a) Strongly disagree
b) Disagree
c) Neutral
d) Agree
e) Strongly agree

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

a) Strongly disagree
b) Disagree
c) Neutral
d) Agree
e) Strongly agree

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

a) None
b) Inadequate education/training on ultrasound-guided arterial catheterization
c) Lack of available ultrasound machinery
d) Prolonged procedure set-up and duration
e) Other: _____

Appendix G
Email to Project Participants

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

Dear CRNAs,

Thank you for considering participating in a quality improvement (QI) project titled "The Use of Ultrasound for Arterial Line Placement: A DNP Project." The purpose of this project is to assess CRNA perceptions of an educational resource addressing use of ultrasound when placing arterial lines at [redacted].

Participation is voluntary and will involve completing a short pre-intervention survey, viewing a brief presentation, utilizing an ultrasound resource tool 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 presentation should take less than 5-10 minutes to complete. The surveys were created and are completed using Qualtrics® survey software. The use of ultrasound 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 provide link here.

Following completion of the survey, view the presentation and ultrasound resource tool (see attached). Additional copies of the ultrasound resource tool are available in the anesthesia workroom and on the ultrasound machines in the perioperative area.

Again, thank you for your participation in our quality improvement project. I will be at [redacted] in the CVOR from April 8, 2024 to April 22, 2024. If you have any questions, you may also reach out to me or Dr. Travis Chabo by email at any time.

Sincerely,

Paige Chase, SRNA
chasep12@students.ecu.edu

Travis Chabo, PhD, CRNA
Clinical Assistant Professor and Program Director
chabot14@ecu.edu

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

Hello CRNAs,

I just wanted to send a quick reminder about the ongoing DNP Project on "The Use of Ultrasound for Arterial Line Placement: A DNP Project." (original email below). If you've already filled out the pre-survey and viewed the presentation, 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. There are still ultrasound resource tools located in the anesthesia workroom and on the ultrasound machines in the perioperative area if you haven't already received one. You may use these at your discretion. After the end of next week, I will begin sending out the post-surveys.
Links:
Pre-survey
Presentation

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

Sincerely,
Paige Chase, SRNA
ECU Nurse Anesthesia Program
Class of 2025

Post-Survey Email to Participants (3)

Dear CRNAs,

Thank you to everyone who has already completed my pre-survey and viewed the video. 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 a video!). The link to the pre-survery is here, and you can follow it up by watching the presentation here. Ultrasound resource tools are available for your 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 link to the post-survey. 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. I look forward to coming back to [redacted] soon.

Sincerely,
Paige Chase, SRNA
ECU Nurse Anesthesia Program
Class of 2025

Final Thank You Email to Participants (4)

Dear CRNAs,

I just wanted to say thank you so much to everyone for helping me out with my DNP Project! I have collected all 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. And if you liked the presentation and resource, and found it useful, you can continue to use the handouts located in the anesthesia workroom.

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

Take care,
Paige Chase, SRNA
ECU Nurse Anesthesia Program
Class of 2025