# Development and Implementation of an Ultrasound-Guided Peripheral Intravenous Catheter Insertion Training Program for Student Registered Nurse Anesthetists

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## Abstract

The use of ultrasound (U/S) in Nurse Anesthesia practice has recently been adopted by The American Association of Nurse Anesthetists (AANA) and The Council on Accreditation of Nurse Anesthesia Educational Programs (COA), which characterize U/S by its clinical impact on the reduction of complications, increased effectiveness of regional anesthesia, and enhanced quality of vascular catheter placement. The COA has strongly recommended that student registered nurse anesthetists (SRNA) have U/S education incorporated into their curriculum for its use both in regional anesthesia and vascular access. Currently, a Nurse Anesthesia Program (NAP) at a private university in the Midwest does not have a formal ultrasound training course within its curriculum to prepare its SRNAs for the clinical setting. Therefore, the purpose of the quality improvement project was to determine whether the implementation of a simulation-based U/S-guided peripheral intravenous catheter placement (U/SGPIV) training workshop would improve U/S clinical knowledge and skill proficiency among the NAP SRNAs. The project was framed using the quality improvement Plan-Do-Check-Act (PDCA) Model. The project was significant as it helped the NAP in its efforts to comply with the AANA guidelines and COA requirements in preparing its SRNAs for the perioperative arena.

## Introduction

- U/S proficiency has become a desirable skill for anesthesia providers; especially in the perioperative arena for rapid patient assessments and establishing vascular access
  - Peripheral intravenous catheter placement is one of the most common and essential procedures performed by Certified Registered Nurse Anesthetists (CRNAs)
- Anesthetists are increasingly utilizing U/S in daily practice for its reliability, accuracy, and safety when establishing regional blocks or intravenous access (Gupta et al., 2011)
  - Literature demonstrates that U/S-guided techniques for all anesthetic procedures in the perioperative arena have proven superior to traditional landmark methods
- The use of U/S for the insertion of peripheral intravenous (PIV) catheters is now recommended for nursing practice by:
  - American Institute of Ultrasound in Medicine (AIUM)
  - Association of Vascular Access (AVA)
  - American Association of Critical Care Nurses (AACN)
  - Infusion Nursing Society (INS)
  - American Association of Nurse Anesthetists (AANA)
  - Emergency Nurses Association (ENA)
- Knowledge and proficiency are required for the safe, effective use of U/S in such procedures

## Problem Statement & Significance

A NAP in the Midwest did not have a formal ultrasound training course within its curriculum to prepare SRNAs to utilize U/S in the clinical setting

- SRNAs lacked the knowledge and proficiency necessary to utilize this technology in the clinical setting, which:
  - Limits clinical experience
  - Increases risk of error
  - Increases risk of patient harm
- NAP audit revealed 54.7% of the program's SRNAs (N=64) had never received any U/S training prior to entering the program

The NAP recognized a critical need to effectively educate SRNAs in the utilization of U/S for PIV catheter placement in a simulation-based environment prior to entering their clinical practice rotations

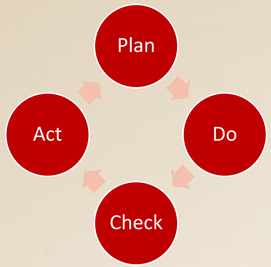
### PICO Question:

- (P) In nurse anesthesia students preparing for clinical rotations how does an (I) ultrasound-guided peripheral intravenous catheter placement training program, using simulation- based education methods compared (C) to no simulation-based ultrasound-guided peripheral intravenous insertion training program impact (O) U/S knowledge and skill proficiency among BSN-to-DNP SRNAs?

### Literature Review:

- U/S utilization is a necessary skill for nurse anesthetists to meet the growing expectation for its use in clinical practice as an adjunct for perioperative procedures
- The professional and credentialling bodies for nurse anesthesia practice (the AANA and COA) recommended NAPs include U/S training as part of their formal curriculums.
- 32 studies reviewed:
  - Support the use of simulation-based education to improve the knowledge and proficiency of SRNAs in the basic use of U/S
  - Simulation-based education is a widely used, evidence-based method of education that has demonstrated an ability to improve knowledge and proficiency in a variety of clinical procedures

## Project Design & Description




### Purpose:

- To determine whether the implementation of a simulation-based U/S educational workshop could improve clinical knowledge and proficiency, involving the use of U/S and U/S-guided peripheral intravenous catheter placement among the NAP SRNAs

### Method:

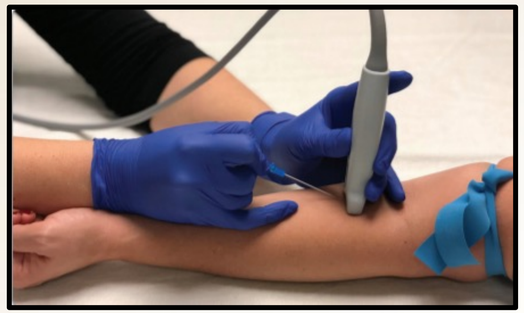
- Using a pretest/post-test interventional design with a convenience sample of 24 SRNAs, students underwent a U/S-guided peripheral intravenous (U/SGPIV) catheter insertion workshop consisting of both a didactic lecture and simulation-based training exercises in the NAP's clinical simulation laboratory

### Objectives:

- The project followed a traditional Plan-Do-Check-Act (PDCA) framework (Connelly, 2021; Moen & Norman, 2010; Taylor et al., 2014)
  1. **Plan**: Review and synthesize the evidence from the literature, AANA guidelines, and COA recommendations towards the development of a U/S training workshop using simulation-based techniques
  2. **Do**: Develop and implement a simulation-based U/SGPIV placement course
  3. **Check**: Evaluate the effects of the workshop on SRNA's clinical knowledge and proficiency related to U/S and U/SGPIV catheter placement
  4. **Act**: Develop plan for sustainability and present project findings, evidence-based recommendations, and a sustainment plan to the key program faculty stakeholders as well as NAP executive leaders

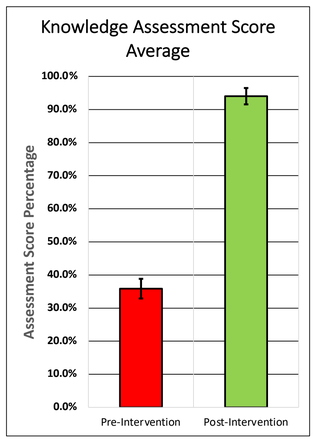
- **Setting:**
  - A large, urban, 434 bed level one trauma surgical center located in the Midwest
  - Implemented in the NAP's Medical Education Simulation Lab
  - The NAP Director and Nursing Lab Supervisor agreed to provide simulation-lab space, simulation mannequins, U/S equipment, and relevant supplies
- **Population:**
  - 24 adult, graduate SRNAs in the BSN-to-DNP program at a private university in the Midwest
  - All participants were registered nurses, who were enrolled full-time as graduate students in the program
- **Instruments:**
  - Ultrasound-Guided Peripheral IV Access (Basic Knowledge and Skill Proficiency) Assessment Clinical Observation Checklist Form
    - Used to evaluate the impacts of simulation-based U/SGPIV training intervention on SRNA clinical knowledge and proficiency when utilizing U/S to obtain intravenous access
- **Implementation:**
  - Participants completed a pre-intervention knowledge-based quiz
  - Didactic lecture on U/S use and U/SGPIV technique was delivered (1-hour course)
    - Concepts covered during the lecture included the U/S machine, U/S physics, U/S probes, U/S imaging, basic vascular anatomy of the arm, nerve identification, and step-by-step instructions for proper peripheral intravenous catheter placement utilizing U/S
  - Participants completed a post-intervention knowledge-based quiz
  - Quiz scores were collected; assessment data was anonymous and did not include any personal identifiers to protect the privacy of SRNA participants
  - Participants partook in simulation-based exercises (2-hour training)
    - BD Bard Site-Rite 6 U/S
    - Simulation-based educational mannequins
    - Workshop was based on the Infusion Therapy Standards of Practice (Infusion Nurses Society, 2016) and evidence from the literature for peripherally inserted intravenous catheters using U/S guidance
  - Participants successfully completed 3 post-interventional U/SGPIV insertions as a measure of skill proficiency
    - Project team members measured each participant's ability to utilize the U/S machines and correctly place a PIV catheter
  - Skill proficiency checklists were also collected; assessment data was anonymous and did not include any personal identifiers to protect the privacy of SRNA participants

## Outcomes & Evaluation



- **Data Analysis:**
  - Microsoft Excel
  - A paired (dependent samples) 2-tailed *t*-test was utilized to compare the average pre-intervention knowledge score to the average post-intervention knowledge score
  - The null hypothesis was that the difference between the means is equal to zero, indicating no statistically significant increase or decrease in scores after the intervention

| Individual | Pre-Intervention Assessment Score | Post-Intervention Assessment Score |
|---|---|---|
| 1 | 37.5% | 100.0% |
| 2 | 37.5% | 100.0% |
| 3 | 37.5% | 87.5% |
| 4 | 37.5% | 100.0% |
| 5 | 50.0% | 100.0% |
| 6 | 50.0% | 100.0% |
| 7 | 37.5% | 100.0% |
| 8 | 25.0% | 100.0% |
| 9 | 12.5% | 100.0% |
| 10 | 37.5% | 100.0% |
| 11 | 12.5% | 100.0% |
| 12 | 50.0% | 100.0% |
| 13 | 37.5% | 62.5% |
| 14 | 25.0% | 62.5% |
| 15 | 37.5% | 75.0% |
| 16 | 25.0% | 100.0% |
| 17 | 62.5% | 100.0% |
| 18 | 25.0% | 100.0% |
| 19 | 50.0% | 87.5% |
| 20 | 62.5% | 100.0% |
| 21 | 12.5% | 87.5% |
| 22 | 25.0% | 100.0% |
| 23 | 37.5% | 100.0% |




- **Evaluation:**
  - The analysis showed an extremely statistically significant difference in the scores for the pre-intervention (M=0.36, SD=0.14) and the post-intervention (M=0.94, SD=0.12) assessments; t(22)= -15.92, p = 1.48E-13
  - These results rejected the null hypothesis at an alpha level of 0.05, and even at an alpha level of 0.01, strongly suggesting that the U/SGPIV training course had a significant impact on the knowledge assessment scores. Specifically, the results suggested that the training course significantly increased knowledge pertaining to U/S
  - Each student was observed safely and successfully performing U/SGPIV cannulation 3 times, demonstrating skills proficiency
  - The consensus of the students demonstrated an appreciation for the course and a newfound feeling of familiarization with U/S

## Conclusions & Recommendations

### Conclusions:

- The implementation of a simulation-based U/SGPIV educational workshop significantly increased both U/S knowledge and proficiency amongst first-year SRNAs
- The educational workshop can be used by the NAP faculty in the future to introduce first-year SRNAs to the basics of U/S and allow students to become more familiar with U/S utilization for clinical procedures, such as IV cannulation
- The new knowledge and skills will aid the SRNA immensely when learning to employ U/S for regional anesthesia and point-of-care U/S assessments

### Limitations:

- Small sample size (decreased from 24 to 23 students, due to one participant's leave of absence from the program)
- Insufficient time for pre-intervention and post-intervention simulation training
  - Only one four-hour class period in The Basic Principles of Nurse Anesthesia I course was apportioned for implementation
- Limited resources in the simulation lab
  - Only two simulation mannequin arms were available to the NAP for the U/SGPIV training workshop
- Pandemic precautions

### Sustainment Plan:

- Recommendations for future implementation of the training workshop for the following class of SRNAs and beyond
- Given the statistically significant success of the training workshop, future implementation will require minimal changes
- No alterations will be made to the content of the training workshop, including the PowerPoint presentation and subsequent simulation exercises
- The implementation will follow the procedures outlined in the project
- The barriers and limitations require the training workshop to be more efficient
  - There will be no pre-intervention skills proficiency check to save time and resources
  - During the post-intervention skills proficiency check, each SRNA will only be required to complete three successful PIV cannulations
  - The remaining project investigator will prepare to incorporate the recommended changes and implement for the next cohort

## References

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## Full Report

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