Summer 8-22-2021

Simulation Education for Ultrasound Guided Peripheral Intravenous Catheter Insertion

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Simulation Education for Ultrasound Guided Peripheral Intravenous Catheter Insertion

A Doctor of Nursing Practice Project Defense

Presented in

Partial Fulfillment of the

Requirement for the Degree of

Doctor of Nursing Practice

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March 8, 2021

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Keywords: Ultrasound Guided Peripheral Intravenous Catheter (UGPIV), video-based learning, student registered nurse anesthetist (SRNA), peripheral intravenous (PIV)

Abstract: The purpose of this study was to evaluate student registered nurse anesthetist (SRNA) knowledge and confidence of ultrasound guided peripheral intravenous catheter insertion (UGPIV) before and after viewing an educational video. As a basis for developing a single group pre-test and post-test study, the dual coding theory was used. The authors hypothesize that SRNA knowledge and confidence would improve after an educational video intervention. A convenience sample of first, second, and third year SRNAs was used (N=31). The study participants completed a pre-survey to evaluate UGPIV knowledge and confidence, along with demographic questions. Participants were then instructed to view a ten-minute educational video designed by the authors. A post-survey was then administered which mirrored the pre-survey by having the participants answer the same knowledge and confidence questions. The authors found that the mean knowledge assessment score was statistically significant, an increase from 13.84 to 19.58 (p=0.005). While the mean confidence scores increased from 12.58 to 19.26, it was not statistically significant (p= 0.113). The authors incidentally found that students who had prior UGPIV training used UGPIV more in practice. This is significant because it shows that the educational intervention could be positively correlated with future UGPIV use. In conclusion, UGPIV video-based training improved baseline knowledge and confidence among SRNAs enrolled at NorthShore University HealthSystem.

Introduction

Obtaining peripheral intravenous (PIV) access is a fundamental skill required for anesthesia practice. Failure to place intravenous access can delay treatment, decrease patient satisfaction, and cause provider frustration resulting in more invasive methods in being utilized. Escalation to a more invasive approach, such as a central line placement, has the potential to cause undue harm to patients. These adverse outcomes include infection, pneumothorax, bleeding, and air embolism. Avoiding adverse outcomes calls for practitioners to utilize ultrasound as a means for obtaining vascular access. With appropriate training, anesthesia providers can utilize ultrasound for PIV access to further benefit the patient and the hospital system, as it is directly correlated with improved patient satisfaction and financial feasibility.[1,2]

Current research relating to UGPIV insertion is tailored towards emergency room providers and certified registered nurse anesthetists (CRNAs) who demonstrate increased confidence after simulation education. To date, there is insufficient research on the training of SRNAs in this area.[3] In addition, current research fails to identify how simulations were evaluated, which tools were used, or how these simulations were structured. Lastly, participant demographics were poorly defined, and it was not noted if individuals had prior ultrasound

experience. Noting these past deficiencies, our research addresses disparities between UGPIV knowledge and SRNA confidence through video-based simulation training.

Utilizing a pre-test/post-test design, our objective was to implement a simulation training exercise tailored towards the SRNA, with the objective of improving user knowledge and confidence while addressing the following research questions:

1. Does video-based training improve SRNAs' knowledge of ultrasound benefits in PIV placement?
2. Does video-based training improve SRNAs' knowledge of ultrasound theory?
3. Does video-based training improve SRNAs' confidence in ultrasound use and manipulation?
4. Does video-based training improve SRNAs' confidence in their ability to utilize ultrasound for PIV placement?

Methods and Materials

Study Design and Sample

A single group pre-test and post-test was used to evaluate changes in SRNA's knowledge and confidence after viewing an educational video simulation on UGPIV insertion. A video script was developed using current evidence-based practice and UGPIV placement guidelines from the American Society of

Echocardiography and the Society of Cardiovascular Anesthesiologists.[4] The survey and video script content was reviewed for content validity by a panel of six experts. All experts awarded perfect scores in clarity, relevance, simplicity, and consistency. The validated video script was then incorporated into the educational video.

First, second, and third year SRNAs enrolled at NorthShore University HealthSystem School of Nurse Anesthesia were used as the participants of this study. Criteria for enrollment in the study were actively enrolled students at NorthShore's School of Nurse Anesthesia. Sixty-nine eligible participants were notified via email of the study and thirty-three chose to participate. No written consent was obtained as consent was implied in the participation and completion of the surveys. IRB approval was obtained through DePaul University and NorthShore University HealthSystem.

Instruments

A pre-survey and post-survey were dispersed to the participants and were identical with relation to knowledge and confidence questions. The pre-survey involved a demographic section that addressed three questions: years of nursing experience, whether ultrasound training has been performed, and how often ultrasound has been used in practice by the study participant. The pre-survey was developed to measure perceived knowledge and confidence of UGPIV insertion

prior to viewing the educational video. A 5-point Likert scale was used ranging from strongly disagree to strongly agree.

The UGPIV knowledge assessment tool was developed utilizing Upton, Scurlock-Evans, and Upton's revised Student Evidence-based Practice Questionnaire (S-EBPQ) and examined the participants' knowledge of UGPIV benefits, difficulties of PIV placement, and ultrasound image interpretation.[5] The UGPIV confidence assessment tool was developed utilizing the National League for Nursing's *Student Satisfaction and Self-Confidence in Learning* and examined confidence in the utilization, manipulation and identification of the ultrasound machine.[6] The post-survey was a 5-point Likert scale ranging from strongly disagree to strongly agree.

An educational video was created and disseminated to participants as a form of educational intervention. The information presented was informed by current literature, practice guidelines, and by recommendations of the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists and tailored to SRNAs.[4] The video included both spoken, written, and visual demonstrations. Topics discussed included an introduction and scope of UGPIV, description and application in difficult IV placement scenarios and patient populations, implication and use in practice, ultrasound principles, and technique in PIV placement. Production of materials took place at NorthShore University

HealthSystem's Grainger Center for Simulation and Innovation. A facility-provided Sonosite ultrasound machine was provided. The video included both researchers as presenters, one serving as a volunteer for the demonstration and visualization of vascular structures.

Data Collection Procedures

Quantitative data was collected from nominal and ordinal data derived from electronic responses in Qualtrics, an online survey platform. Data was then imported into IBM SPSS Statistics 26 for analysis.[7] The respondents were given a 2-week window to access the surveys and educational video. A reminder email was sent after a week after the study was dispersed.

Data Analytic Procedures

All data was collected, entered, and analyzed using IBM SPSS Statistics 26. Sample demographic data was collected as nominal and ordinal data and presented as descriptive statistics including percentages and means. Measures of knowledge and confidence were collected via a 5-point Likert scale from strongly disagree-strongly agree and shown as means scores and compiled scores for knowledge and confidence questions separately. Data from the demographic survey was compared to the ordinal data of subsequent measures utilizing a two-tailed t-test for significance.

Results

Thirty-three SRNAs participated and responded to the survey. Two surveys were rejected in a case-wise deletion due to incompleteness, leaving a total sample of 31 SRNAs. Demographic information and correlations in respondent self-reported knowledge and confidence were then analyzed.

Respondents' years of nursing practice ranged from 3 to 14 years with a sample average of 7 years. 68% (n=21) reported not having formal training in UGPIV prior to this intervention. The frequency of ultrasound use for PIV placement in the clinical setting was reported as *never* or *rarely* by 68% (n=21) with the remaining 32% (n=10) responding with *sometimes* or *often*, with no one responding *always*. 70% of those who reported using UGPIV more frequently (*often, sometimes*) received prior formal training, while 14% of those who reported *rarely* or *never* using UGPIV lacked formal training (Table 1). Prior UGPIV training was significantly correlated with initial (pre-test) knowledge and confidence scores with those receiving prior training (n=10) reporting higher average scores (3.40) compared to those who have no received training (n=21) (1.09) on a 5-point Likert scale of agreement (1-disagree to 5-agree). There was no significant correlation between years of practice and prior training or current UGPIV use in practice.

Table 1.

Current UGPIV Use		**Prior Formal Training**	
		Yes (n=10)	No (n=21)
Never	11 (35%)	3 (14%)	18 (86%)
Rarely	10 (32%)		
Sometimes	3 (10%)	7 (70%)	3 (10%)
Often	7 (22%)		
Always	0 (0%)	**Total (N=31):** 10 (32%)	21 (68%)

Four self-reported knowledge questions were asked using a 5-point Likert scale of agreement (1-disagree to 5-agree). Combining the 4 questions into a knowledge composite score, possible responses could range from 4 to 20. In the pre-test survey, respondents reported an average of 13.8 (Min=6, Max=20) in their level of UGPIV knowledge. Post-test responses increased to 19.6 (Min=16, Max 20) (Table 2, Figure 1). Utilizing a paired T-test, this correlation was found to be statistically significant (0.005).

Table 2. Knowledge-Based Questions

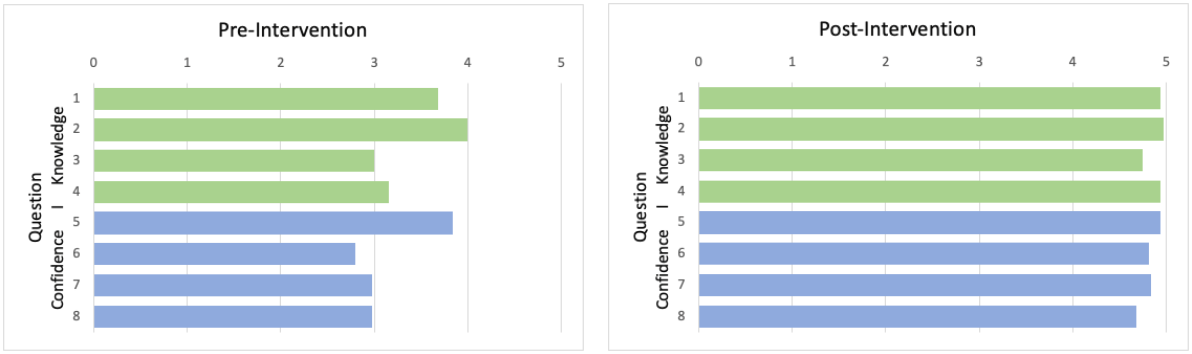
Question	Pre	Post	Composite Score		
			Pre	Post	Sig
1. I am able to explain the benefits of US in PIV placement	3.68	4.94	13.84	19.58	0.005
2. I am able to interpret patient factors that lead to difficult PIV placement	4.00	4.97			
3. I am able to distinguish between hyperechoic, hypoechoic, anechoic and vascular structures	3.00	4.74			
4. I am able to describe the steps in obtaining an image of a vein for PIV insertion	3.16	4.94			

Similarly, four self-reported confidence questions were asked using a 5-point Likert scale of agreement (1-disagree to 5-agree). Combing the 4 questions into a confidence composite score, possible responses could range from 4 to 20. In the pre-test survey, respondents reported an average of 12.6 (Min=4, Max=20, SD) in their level of UGPIV confidence. Post-test responses increased to 19.3 (Min=16, Max 20). Although the mean score has increased, utilizing a paired T-test found this correlation not to be significant (0.113) (Table 3, Figure 1).

Table 3. Confidence-Based Questions

Question	Pre	Post	Composite Score		
			Pre	Post	Sig
5. I am confident in my ability to identify clinical situations where ultrasound would be beneficial	3.84	4.94	12.58	19.26	0.113
6. I am confident in my ability to manipulate ultrasound controls for better image clarity	2.80	4.81			
7. I am confident in my ability to manipulate ultrasound probe for vascular assessment	2.97	4.84			
8. I am confident in my ability to utilize ultrasound for PIV placement in the clinical setting	2.97	4.68			

Figure 1.



Discussion

The researchers designed and implemented an instructional video for SRNAs on UGPIV catheter insertion aimed at increasing knowledge and confidence in the assessment, application, and proficiency of the skill. This study reinforces the benefit of training on special procedures/skills to increase provider proficiency and outcomes mirror that of previous studies on UGPIV education. Across all self-reported questions, respondents conveyed increases in knowledge and confidence in UGPIV insertion following video-based education. Another major finding was that respondents who received prior training utilized UGPIV more in practice and had higher initial knowledge and confidence scores. There were no significant correlations between length of nursing career with relation to current use of UGPIV in practice. Years of nursing experience was also not correlated with higher initial knowledge and confidence scores. We can

hypothesize this could be related to lack of institutional UGPIV training, which further supports the purpose of our study.

PIV placement is a critical component of anesthesia practice. Although essential to practice, few studies have been published on the training of nurse anesthetists in UGPIV and none were found on the training of SRNAs. Currently, the Council on Accreditation for Nurse Anesthetists requires SRNAs to demonstrate proficiency in PIV insertion, however, ultrasound use is not required. As ultrasound use continues to increase in the clinical setting, providers must be knowledgeable and confident in utilizing this technology *before* use in practice.[8] Education is paramount to provider competence which demonstrates this study being valuable at increasing clinical proficiency.

Strengths and Limitations

Overall, 31 responses were collected and analyzed, representing 45% of current SRNAs enrolled in NorthShore's School of Nurse Anesthesia. The results of our study portrayed significance and the researchers suggest it can be easily replicated and integrated into other institutions. The simplicity of our surveys, in combination with a brief video, prevented respondent fatigue.

Several factors pose limitations to our study. First, our sample size was small which limits broad application of our results. Our research indicates further studies are warranted. The surveys and results also may have also been limited by

the close-ended nature of ordinal data collection as well as respondent bias in interventional surveys and self-reported influences.

Conclusion

This study explored the benefit of video-based education with regards to SRNA knowledge and confidence of UGPIV insertion. Overall, major findings included an increase in overall knowledge and confidence scores and, after utilizing formal training, providers utilized this skill more frequently in practice. While we believed years of nursing experience would improve knowledge and confidence with UGPIV, this was unfounded. As an easily reproduceable tool and video, the intervention may provide a model for SRNA UGPIV insertion beyond this study's setting while providing an outline for the educational intervention of similarly applicable skills in nurse anesthesia.

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Appendix: **Journal of the IANA, Submission Guidelines for Authors**

The Journal of the IANA welcomes original manuscripts that are not under consideration by another journal. The article subjects must be pertinent to the specialty of anesthesia and those that relate to the broad professional domain of a nurse anesthetist. Manuscripts published in the Journal of the IANA will become the sole property of the Illinois Association of Nurse Anesthetists. All manuscripts should be submitted to the Editorial Manager at ianajournal@gmail.com. Manuscripts must be submitted using AMA Style.

•Survey/Review – Assimilates, describes, and critically evaluates previously published material to aid in evaluating new concepts. The article should include a title page, abstract (200 words maximum), 3 to 5 keywords, text (subdivided into Introduction, History and Review of Literature, Discussion of State of the Art, and Summary), and references. If applicable, figures (with legends) and tables should be provided.

Required Format

•*Title Page* – Submitted as a separate file. ~~Include manuscript title, authors' names and credentials, professional position, current employer, city, and state. Provide~~ a correspondence address, email address, telephone number, and an acknowledgment section, if needed. Author identification should appear only on the title page of the manuscript.

•*Author Information* – A short biographical sketch of each coauthor, with principal author indicated, must accompany the title page of the manuscript. Please include an email address that can be published for the principal author.

•*Keywords* – Provide 3 to 5 keywords.

•*Abstract* – The abstract (maximum of 200 words) will appear as the italicized portion preceding the main text. The abstract of the article should include a brief description of the purpose, hypothesis, or theoretical background of the article, followed by 2 to 3 sentences describing the method of the study or the nature of the review. For a research article, include how the data were analyzed. Continue with 2 to 3 sentences devoted to the major points or results noted in the article. Finally, provide a conclusion or take-home message. An abstract of a case report should provide a summary of the case and a discussion. When abstracting a review article, provide a concise summary of the salient points addressed in the review.

•*Figures* – Clearly reproducible photographs, diagrams, and graphs should be labeled as "Figure 1," "Figure 2," etc., depending on their sequence in the manuscript, and on separate pages. Resolution of digital photographs must be at least 300 pixels per inch.

•*Tables* – Tables should be double-spaced and submitted separately from figures. Tables should be numbered as "Table 1," "Table 2," etc., depending on their sequence in the manuscript, on separate pages, and descriptively titled.

References

A maximum of 50 references are allowed. Cite references in the numerical order that they appear in the text. Consult AMA Manual of Style, 10th edition, for complete rules on references.