THE USE OF ULTRASONOGRAPHY TO IMPROVE EPIDURAL EDUCATION

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School of Nursing
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DNP Project Approval Form

This is to certify that

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(Name of Student)

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The Use of Ultrasonography to Improve Epidural Education

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December 10, 2019

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Thank you mom, for your never-ending support.
Abstract

Literature recommends using ultrasonography (US) to assist anesthetists in finding and accessing the epidural space in individuals with atypical anatomy. Simulation allows for a safe environment to learn US on ultrasound-compatible neuraxial manikins. This Doctor of Nursing Practice (DNP) project compared perceived competence, confidence, satisfaction, and accuracy of epidural cannulation among student registered nurse anesthetists (SRNAs) using landmark technique versus those who received a neuraxial ultrasound in-service. Kolb’s Theory of Experiential Learning acted as the theoretical framework. A quasi-experimental design utilizing surveys along with skill assessments was used. One cohort performed epidurals on an ultrasound-compatible manikin using ultrasonography and the other cohort used traditional epidural techniques on the same manikin. An additional cohort of Certified Registered Nurse Anesthetists (CRNAs) completed an online survey on perceived confidence and competence of using US with epidural cannulation. Most CRNAs (62.5%) completing the online survey disagreed that they would be able to identify spinal anatomy using US while 62.5% agreed that US is helpful in guiding placement of epidurals in patients with atypical anatomy. For all in-person cohorts, there was a statistically significant improvement (P<0.05) for each topic in the perceived competence and confidence testing. Participants reported high levels of confidence and satisfaction. There lacked statistical significance between the control and intervention cohorts for needle insertion attempts and time cannulation times. Project results confirmed higher perceived competence and confidence scores after receiving an in-service on US applied to epidural insertion. Such in-services could be incorporated into anesthetist training in the clinical and classroom settings.

Keywords: Neuraxial, Spinal, Epidural, Ultrasound, Education
The epidural space is a series of lateral, posterior, and anterior compartments along the vertebral body, lamina and pedicles (Nagelhout, 2018). These compartments contain fat, nerves, and fibrous tissue (Nagelhout, 2018). Certified Registered Nurse Anesthetists (CRNAs) must have knowledge of the anatomical landmarks and the underlying neuraxial anatomy in order to visualize and safely guide a catheter to the epidural space. After accessing the epidural space, the anesthetist delivers large amounts of local anesthetic through a catheter to disrupt nerve transmission to allow for prolonged obstetrical and surgical anesthesia (Nagelhout, 2018; Pardo & Miller, 2018). For Student Registered Nurse Anesthetists (SRNAs), developing knowledge and skills to place and manage epidurals can prove to be difficult. This may be due to their preclinical education or the lack of opportunity for students at clinical sites to learn how to place and manage epidurals (Malina & Izlar, 2014; Wiggins, Morrison, Lutz, & O’Donnell, 2018).

To complement clinical education, simulation can improve procedural efficiency, decrease error rates, and positively affect quality of care and patient safety (Wiggins et al., 2018). A study conducted by Isaacs, Wee, Dubey, and Vaughan (2015) examining trainees’ perspectives on epidural training found that 84% of 207 anesthetists recommended the use of epidural simulation for training purposes. The use of a blended curriculum that includes lecture and simulation to improve understanding and skills to access the anatomy of the epidural space for anesthesia students has been supported by recent literature (Wiggins et al., 2018). A blended curriculum approach allows for the anesthesia student to utilize the safe environment of simulation to hone their epidural skills and establish competency. With simulation being an effective method for learning to perform epidurals, anesthetists are offered opportunity to further improve their understanding of epidural anatomy and cannulation skillset prior to performing these techniques in the clinical arena.
Background and Significance

The advantages of using ultrasonography in neuraxial anesthesia are multifaceted; this technology can allow the anesthetist to identify the interspace level, the midline of the spine, the optimal angle for needle insertion, as well as the depth of the epidural and subarachnoid spaces (Hasanin, Mokhtar, Amin, & Sayed, 2017). The simple use of a noninvasive probe placed on the skin of the patient will provide the anesthetist with this information. Having an image of the anatomy and knowing the depth of the epidural space can improve a nurse anesthetist’s chances of first-attempt successful cannulation of the epidural space.

For nurse anesthetists, having a solid technical foundation for epidural placement is important. However, many patients may present with atypical spinal anatomy, creating potential challenges in epidural placement for even the more experienced anesthetist. Evidence supports the use of ultrasonography to increase the first attempt success rate in patients with difficult surface anatomical landmarks (Lie & Patel, 2015). The use of ultrasonography has also been found to decrease the number of puncture attempts, puncture levels, needle redirection attempts, and reduced the time to insert the catheter when placing thoracic epidurals (Hasanin et al., 2017).

After neuraxial ultrasound training, the nurse anesthetist can incorporate this skillset into their clinical practice. Ultrasonography may also be incorporated into simulation for SRNAs to improve their simulation experience. Teaching sonoanatomy to anesthesia faculty and residents using phantom models has shown to improve perceived knowledge of lumbar spinal anatomy and sonoanatomy (VanderWielen, Harris, Galgon, VanderWielen, & Schroeder, 2014). As ultrasonography use increases in the clinical setting, this technology needs to be taught in the classroom to increase exposure to SRNAs. After gaining familiarity, SRNAs can practice and increase their use in the clinical setting, which may lead to higher success in the clinical setting.
Purpose, Aims, and Objectives

The University at Buffalo (UB) Nurse Anesthesia Program currently does not offer ultrasound training as it applies to neuraxial anesthesia. The program does offer ultrasound training for other procedures such as peripheral nerve blocks and vascular access. The current curriculum includes educating students about spinal and epidural anatomy along with a simulation day on epidural manikins. These manikins offer a realistic feel while using the epidural needle to cannulate the epidural space. Additionally, placement of the spinal or epidural within the appropriate anatomy on the manikin can be confirmed by the faculty. After the training, students transition into the clinical setting to gain experience on their patients.

The purpose of this DNP project was to compare perceived competence, confidence, satisfaction, and accuracy of epidural cannulation among SRNAs using landmark technique versus those who received a neuraxial ultrasound in-service. The aim of this project was to increase student competence, confidence, satisfaction, and accuracy of epidural cannulation through a neuraxial ultrasound training. This DNP project also aimed to assess perceived competence and confidence in regards to US-guided epidural placement in currently practicing CRNAs. Project objectives were to: 1) assess perceived competence and confidence in regard to US-guided epidural placement among currently practicing CRNAs with the utilization of an online survey that included demographic information; 2) assess perceived competence and confidence in regard to US-guided epidural placement among SRNAs with the utilization of an in-person survey that included demographics; 3) assess performance of SRNAs utilizing traditional techniques to place epidural catheter on an US-compatible manikin; 4) create and conduct a workshop utilizing both didactic and hands-on practice with US on human model; 5) assess performance of SRNAs utilizing only learned US techniques to place epidural on an US-
compatible manikin; 6) assess post-in-service perceived competence and confidence in regard to US-guided epidural placement in SRNAs with the utilization of an in-person survey; 7) assess post-in-service self-confidence and satisfaction utilizing modified National League for Nursing (NLN) survey; 8) perform statistical analyses on all collected data points; and 9) disseminate study findings to stakeholders and lead discussion regarding the strengths, limitations, and potential future implications of the in-service.

**DNP Essentials**

This DNP project met the American Association of Colleges of Nursing (2006) DNP Essentials I, III, and IV. DNP Essential I, *Scientific Underpinnings for Practice*, was addressed through the project’s focus on teaching and improving nurse anesthetist understanding of ultrasonography as it applies to epidural cannulation. In theory, the use of ultrasound on a patient with atypical anatomy is an effective strategy to enhance health care delivery to improve patient outcomes. DNP Essential III, *Clinical Scholarship and Analytical Methods for Evidence-Based Practice*, was addressed through conducting a review of the literature examining best evidence demonstrating the benefits of ultrasonography on patients with difficult anatomy. The literature also extensively reviewed techniques for using ultrasonography to identify the appropriate anatomy. Finally, DNP Essential IV, *Information Systems/ Technology and Patient Care Technology for the Improvement and Transformation of Health Care*, was addressed through the utilization of ultrasound (patient care technology) to improve health care.
Theoretical Framework

Prior to study participation, all subjects had exposure to ultrasonography. Each subject may have varying levels of expertise with the ultrasound machine from their clinical practice. This study applied a known technology to a new technique via simulation, which created a learning experience that the subjects could reflect upon. The concept of learning through experience and reflection is shared with Kolb’s Theory of Experiential Learning (Kolb, 1984). Kolb’s cyclical theory focuses on four main concepts: concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb, 1984). This theory allows the nurse to focus on their internal cognitive development to gain knowledge and expertise. The following discusses the four main concepts in Kolb’s Theory of Experiential Learning.

Concrete Experience

Kolb views learning as a holistic and adaptive process (Kolb, 1984). His theory begins this process with the learner having a concrete experience. This DNP project provided concrete experience through an epidural workshop that incorporated ultrasonography. The subjects were guided to apply the concepts of ultrasound to their previous knowledge of neuraxial anatomy. The marriage of their prior knowledge to a new application of ultrasound technology created an entirely new concrete experience.

Reflective Observation

After the concrete experience, learners are able to consciously reflect on what happened. By observing and reflecting upon one’s experience, it becomes meaningful (Kolb, 1984). Reviewing one’s experiences allows the learner to consider their successes and failures. This opportunity was provided during the learning session (in-service), when the subject received
feedback as it related to their application of ultrasonography to their epidural cannulation techniques. After the instructors provided feedback, the subjects could additionally reflect on their learning experience.

**Abstract Conceptualization**

This step allows the subject to learn from their experience. The learner is able to use their reflection of the experience to modify an existing abstract concept or to generate new ideas (Kolb, 1984). The subjects in this DNP project were able to learn from their reflection on the experience of simulation in order to formulate how to better their epidural technique when using ultrasound. Abstract conceptualization will especially help CRNAs as they approach patients who may present with atypical neuraxial anatomy.

**Active Experimentation**

In order to assess improvement and to apply new concepts, the learner must be able to test their abilities and hypotheses that may have been drawn from the previous steps (Kolb, 1984). The subjects in this study tested their newly learned concepts and applied what they have conceptualized during a simulation experience. This experience also assessed their timing, competence, and accuracy of epidural cannulation.

The application of Kolb’s Theory of Experiential Learning allowed for subjects to use this learning experience to grow their epidural skillset. As a result of epidural workshop participation, the subjects were able to reenter the cycle of Experiential Learning at any point to apply their knowledge to clinical practice. This study allowed subjects to have an increased understanding of epidural anatomy and allowed for conceptualization of learned ultrasound imaging while applying active experimentation.
Literature Review

A review of the literature was conducted via Boolean search for the keywords spinal, epidural, ultrasound, and education using the modifiers “AND” and “OR”. This search was conducted using the following databases: MEDLINE, PubMed and CINAHL. The search was limited to the years 2014 to 2019, full text-articles, and articles published in the English language. Seven relevant articles resulted from the review and a summary of the articles is presented.

Arzola, Mikhael, Margarido, and Carvalho (2015) conducted a randomized control trial (RCT) that investigated the use of ultrasound imaging by second year anesthesia residents and anesthesia fellows on the spines of parturients with easily palpable lumbar spines. Subjects included 17 second-year anesthesia residents and five anesthesia fellows who were evaluated on time spent to insert an epidural catheter as well as the number of interspace levels attempted and the number of needle passes. Additional outcome measures included total procedural time, first pass success rate, total number of attempts to thread the epidural catheter, failure of analgesia, and patient satisfaction. A total of 128 patients were randomly allocated to their respective groups: 68 patients in the palpation group and 60 patients in the ultrasound group. Between the two cohorts, there was no significant difference in median epidural insertion time, number of needle passes, rate of analgesia, patient satisfaction, number of interspace levels attempted, and the ultrasound group had a longer total procedure time. In patients with easily palpable landmarks, the authors concluded that ultrasonography did not improve the ease of insertion of labor epidurals.

A study by Hasanin, et al. (2017) investigated preprocedural ultrasound examination against manual palpation in thoracic epidural placement. This random control trial (RCT)
included 48 patients undergoing elective abdominal surgeries and investigated the number of epidural placement attempts, puncture levels, and needle redirection attempts. Secondary endpoints included time of catheter insertion and complications. The preprocedural ultrasound group displayed a statistically significant lower number of puncture attempts, puncture levels, needle redirection attempts, and shorter total time for catheter insertion when compared to the manual palpation group. There was a lack of statistical significance in complication rate between the two cohorts. The authors concluded that the preprocedural ultrasound imaging increased the incidence of first pass success and reduced the procedural time in thoracic epidural cannulation.

Kessler, Morrigl, and Grau (2014) investigated the application of ultrasound to epidural cannulation in the form of simulation. This study utilized ultrasound scanning in the pre-puncture epidural phase to assess accuracy and quality of epidural needle placement on cadaver models. The study compared the pre-puncture group to a control group that cannulated based on landmarks, and found that the accuracy of epidural needle placement and quality of the procedure in the intervention group were superior to the control group. The placement of the epidural catheters was verified by computed axial tomography. The authors stated that the quality of the puncture was evaluated based on the depth and angle of the needle, the time needed from beginning of the puncture to the successful loss-of-resistance, the number of puncture attempts, the number of advances of the needle, the number of bone contacts with the needle tip, and the changes to another level if an unsuccessful puncture took place. The authors noted limitations due to potential structural visibility between live subjects and cadavers. Another limitation that was noted was the difficulty of positioning the cadavers; the researchers placed the cadavers prone, which is markedly different than the traditional sitting position.
Ramlogan et al. (2017) performed a randomized study that utilized a virtual reality simulation model using 14 anesthesia trainees who possessed no prior experience with neuraxial ultrasonography. This study was a pretest/posttest design with seven trainees taking “Test A” and the other seven trainees taking “Test B” as the pretest, then switching the test for each group after performing the one-hour training session. The educational tool used was an interactive online educational model was free to access. Both groups showed a statistically significant improvement in test scores after one hour of using the ultrasound interactive model. The authors reported that this study demonstrated an improvement of trainee test scores by 40% after one hour of using a web-based neuraxial ultrasound simulator.

Terblanche et al. (2014) developed a spinal ultrasound training program for anesthetists to determine its effect on the development of skills in those without any prior spinal ultrasound experience. This randomized study was conducted using 18 anesthetists and utilized two structured workshops, which were conducted one week apart. The subjects were then divided into two groups, one receiving a protocol-driven teaching plan, and the other receiving education that wasn’t protocol-driven. The protocol workshops included a ten-step training program that involved spinal ultrasound scanning of five different pregnant volunteers. The non-protocol training program involved interactive teaching methods on the same pregnant volunteers. Each workshop was followed by a practice session, in which experts rated the individual performance. The primary outcome measured was the mean difference on the individual performance using a global rating scale (GRS) between the two performances. The authors found no significant difference in the scores between the two teaching groups (protocol versus non-protocol), but did detect a statistically significant increased performance scores for both groups after the second
workshop. The authors reported that their results demonstrated that a programmed spinal ultrasound workshop with guidance and expert feedback leads to improved epidural insertions.

Vallejo (2017) conducted a systematic review on pre-procedural neuraxial ultrasound in neuraxial anesthesia within the previous decade. Based on 17 reviewed articles, the author found that pre-procedural ultrasound imaging enhances neuraxial performance in both spinal puncture and epidural cannulation procedures. The author concluded that neuraxial ultrasonography reduces the risk of failed or traumatic lumbar punctures and epidural catheterizations, the number of insertion attempts, and needle redirections.

VanderWielen et al. (2014) used a gel phantom model and video teaching compared to a control group to assess the ability of anesthetists to identify neuraxial sonoanatomy. This randomized study included 23 residents and 27 anesthesiologists who were divided into gel phantom, video teaching, and control cohorts. The intervention cohorts received education with either a hands-on gel training that used ultrasound technology or in the form of an instructional video. The control group did not receive any instructional training. All groups then used ultrasound to localize key anatomical features on a human model. All subjects then were asked to report perceived knowledge scores based on a Likert scale survey tool. Three weeks later, all study subjects were then asked to return to identify the same sonoanatomy features on the same human model. The authors reported a statistically significant improvement in spine sonoanatomy identification accuracy in both intervention groups when compared to the control group. Both intervention groups had higher level of improvement in perceived knowledge of basic spinal sonoanatomy versus the control group. The authors concluded that the use of hands-on gel phantom or instructional video training improved the knowledge of lumbar spine sonoanatomy in anesthesia staff and residents.
The literature demonstrated an advantage of using ultrasonography in patients with atypical or anatomy consisting of difficult-to-palpate landmarks. Additionally, the literature supported use of education and simulation to increase anesthesia provider knowledge and ability to identify landmarks with sonoanatomy. There is, however, a gap in the current literature that tests the use of ultrasonography as it applies to anesthesia provider confidence, competency, and success of epidural cannulation in the simulation setting. Furthermore, there is a lack of literature that tests ultrasound epidural training on nurse anesthetists.

Methods

Design

A quasi-experimental design in the form of questionnaires and an in-service was used to collect data. The subjects were assessed in the areas of self-confidence, satisfaction, competence, and perceived competence with epidural cannulation. Additionally, practicing CRNAs were polled about their clinical training and experience using ultrasonography with neuraxial anesthesia prior to the experimental phase by using an anonymous online survey. The experimental phase included a lecture and simulation scenario that utilized an ultrasound-compatible epidural manikin.

Setting

The in-service created for this study was conducted at the University at Buffalo (UB) School of Nursing (SON) in Buffalo, New York on November 26th, 2019 in a classroom setting which allowed for a multimedia presentation and hands on practice with a neuraxial manikin. The assessment portion of the study took place in a private SON examination lab.

Subjects and Recruitment
Upon receiving full approval from the UB’s Institutional Review Board (IRB) (Appendix A), subjects were approached to participate in this study (Appendices B and C). Inclusion criteria for all subjects necessitated clinical experience as an SRNA or a CRNA and being 18 years of age and older. All initial in-person surveys were given after a standardized consent to participate agreement was signed (Appendix D). The online surveys were only accessible after reading the consent form on Survey Monkey (Appendix E).

Training and use of ultrasonography for neuraxial anesthesia among current CRNAs were assessed via an online questionnaire using Survey Monkey (Appendix F) which allowed CRNAs to anonymously answer questions from any computer or smartphone. This survey was posted on the “CRNA” Facebook site and remained open for one month.

A mirrored survey was completed by all in-person SRNA and CRNA subjects prior to participating in any portion of the study (Appendix F) and was issued along with the consent on the day of the in-service. Subjects were also asked to write their respective year in the UB anesthesia program on the survey. These subjects received an e-mail asking for in-person participation to this study two weeks prior to the in-service. The in-person groups were randomized based on order of response to the intervention and control groups to ensure an evenly distributed sample.

**In-service**

The in-service group was compared to a control group. On the day of the study, the control subjects performed epidural cannulation on manikins before experiencing the in-service. These students did not use the ultrasound machine in their performance of epidural cannulation. Once the control group finished, all subjects attended the ultrasound in-service. This was to ensure all subjects received the education material. After the in-service, the control group
completed the Post-Scenario Survey (Appendix G). Following the in-service, the intervention group utilized pre-procedural ultrasound.

The in-service was made up of a lecture that reviewed ultrasonography as it applies to neuraxial anesthesia. A PowerPoint presentation reviewed all pertinent information, and an interactive website was also be presented. This website illustrates ultrasonography images as applied to a virtual reality patient’s spine in real time.

The evaluator provided a demonstration on a live model and allowed the participants the opportunity to US scan the model in order to apply their knowledge. There was a short break followed by the US epidural simulation, which consisted of a private simulation using US guidance to place an epidural catheter. Each of the intervention group subjects received a follow-up survey (Appendix G) after completion of the US epidural simulation.

**Simulation**

The US-compatible manikin used was the GENESIS Epidural-Spinal Injection Simulator, which was generously provided for this study free of charge by EpiMed. After a brief introduction to the manikin, all subjects were instructed that this mock patient was requesting an epidural and was already sterilized, draped, and localized. Thus, the subjects were instructed to place an epidural catheter using a standard Tuohy needle and loss of resistance technique with saline. Catheter insertion was confirmed via direct visualization by the evaluator. The subjects were not required to dose the epidural. The control group placed the epidural using palpation and sight. The intervention group was required to place the epidural using only US guidance. After the catheter placement was confirmed, the simulation was complete.

**Data Collection**
The surveys included questions about demographics, simulation experience with epidural anesthesia, simulation experience with ultrasound and epidural anesthesia, estimated ultrasound experience, and estimated epidural experience. In addition, the survey measured perceived competence and self-confidence of placing epidurals and using ultrasonography to assist in epidural placement (Appendix F). The survey also allowed the subjects to provide a qualitative answer on their opinion of an in-service that utilizes ultrasonography and simulation to educate nurse anesthetists about anatomy and epidural placement. This survey is novel, as it focuses on the use of ultrasonography in neuraxial training, but was guided by multiple studies (Broom, Milne, & McGrady, 2018; Isaacs et al., 2015; and Luctkar-Flude et al., 2018).

Appendix G shows the post in-service questionnaire that was issued to all in-person subjects. This instrument has been developed from a validated 13 question, five-point Likert Scale, and was modified to be specific for this epidural in-service (National League for Nursing, 2005). The instrument was originally developed for medical surgical nursing. The post-scenario survey also includes two extra lines to record qualitative feedback on the in-service.

Appendix H shows the scale that was used to record student success for placement of epidural catheters in the manikins. The subjects were allowed up to three attempts. If the student accessed the arachnoid space, the researcher would make note. The time of catheter insertion started once the initial needle puncture was made and stopped once the Tuohy needle was removed and catheter placement was confirmed. This tool is novel and was not found in the literature, and thus will be a pilot tool. This tool is independent from student confidence and satisfaction, and may reflect understanding of epidural anatomy, retention of material, or user skill level.

Data Analysis
Quantitative data analysis was performed via the Statistical Package for the Social Sciences (SPSS). Descriptive data was generated then the pre and post-test confidence score comparisons were analyzed using paired $t$ tests. All other ordinal data was analyzed with Mann-Whitney $U$ tests. Median values, interquartile range, and statistical significance (using $P<0.05$) was be used to test the data’s validity. Qualitative data analysis was analyzed to identify trends of subject perceptions, suggestions for improvement, and comments in regards to this educational experience.

**Human Rights and Ethical Considerations**

All subjects were provided with a Permission to Take Part in a Human Research Study form, were informed that study participation was voluntary, and were informed that they could withdraw from study participation at any point. All subjects were asked to provide non-identifiable information which generated an anonymous code that corresponded to each response (Appendices F and G). This allowed for the correlation of confidence scores for the in-person cohorts and to ensure the absence of duplicate data for the online cohort. All data was recorded anonymously. Each simulation was conducted privately in a room with only the subject and the evaluator. All subject data will remain private and confidential. Data is stored on a password-protected computer and accessed only by the research team. The only risk of harm for subjects in this study was the small risk of needle stick injury. As a precaution, sterile needles were used and subjects wore gloves for personal protection. The subjects are all experienced in the clinical setting. Appropriate medical supplies were on site. No accidental injuries resulting from study participation occurred.
Results

Online Cohort

The online survey posted to the CRNA Facebook page yielded 16 responses. Of the 16 participants, 25% (4) were female and 75% (12) were male. The age ranges of the respondents was 62.5% (10) between 25-35 years old, 18.8% (3) between 36-45 years old, and 18.8% (3) between 56-65 years old. The highest degree held by most CRNAs was a Masters degree (62.5%, 10), followed by DNP (25%, 4), and other (12.5%, 2). Of the CRNAs who responded, 62.5% (10) had between 0-5 years of practice, 18.8% (3) between 6-10 years, and 18.8% (3) greater than 20 years of practice. Most of the CRNAs who responded, 56.3% (9), are employed in the hospital setting, 18.8% (3) in group practice, 18.8% (3) in both hospital and group, and 6.3% (1) in both hospital and private practice. The practice location of the CRNAs consisted of urban (25%, 4), suburban (18.8%, 3), rural (18.8%, 3), urban, suburban, and rural (25%, 4), and suburban and rural (12.5%, 2).

The Epidural Survey results, which illustrate perceived confidence and competence, are reflected in Table 1, while Figure 1 reflects the mean scores for each question. CRNAs who answered generally agree that they are competent when it comes to understanding spinal anatomy as well as the risks and complications of performing epidurals (mean 3.25), and that they are confident enough to perform epidurals (mean 3.06) (Figure 1). The CRNAs who answered this survey were neutral (mean 1.9375) on whether or not they believe ultrasonography helps to understand epidural anatomy in the novice anesthetist. The lowest mean score (1.4375) indicates that CRNA confidence in identifying appropriate anatomy with the US is unrealistic to neutral. However, the most believed US helps to guide the placement of epidurals in patients with atypical anatomy (mean 2.56)
The comments section of the survey provided qualitative data. Most (11) responses conveyed interest and willingness to learn the subject. Two responses expressed doubt, citing the fact that real patients move and the opinion that a novice should go by feel first to aid in the understanding of spinal anatomy.

**In-Person Cohort**

Of the local electronic mail requests for participation, zero CRNAs responded and 28 SRNAs responded. All other local invitations were electronically mailed to all CRNAs employed by an anesthesiologist group. Of the 28 participants, 71.4% (20) were female and 28.6% (8) were male. The age ranges of the respondents was 3.6% (1) under 25 years old, 82.1% (23) between 25-35 years old, and 14.3% (4) between 36-45 years old. There were 64.3% (18) 2\textsuperscript{nd} year SRNAs and 35.7% (10) 3\textsuperscript{rd} year SRNAs who participated. The participants were randomly divided into the control group or intervention group based on order of response. The intervention group consisted of 12 2\textsuperscript{nd} year and 2 3\textsuperscript{rd} year students, while the control group contained 6 2\textsuperscript{nd} year and 8 3\textsuperscript{rd} year students. Pearson chi square analysis showed a statistically significant difference in 2\textsuperscript{nd} and 3\textsuperscript{rd} year students between groups (P=0.018). Both groups contained 10 females and 4 males. These groups did not have statistically significant differences. The intervention group had the single person under 25 years old, 12 participants 25-35 years old, and 1 person 36-45 years old. The control group had 11 people 25-35 years old and 3 participants between 36-45 years old. Pearson chi square analysis did not find any statistical significance in ages between the cohorts.

All in-person participants completed both the pre-workshop perceived competence and confidence surveys as well as the post-workshop perceived competence and confidence surveys (Figure 2). There was a significant difference in the scores for pre-workshop question 1
(M=2.21, SD=0.738) and post-workshop question 1 (M=3.0, SD=0.609); p=0.000. There was a significant difference in the scores for pre-workshop question 2 (M=2.61, SD=0.685) and post-workshop question 2 (M=3.0, SD=0.471); p=0.013. There was a significant difference in the scores for pre-workshop question 3 (M=1.61, SD=0.916) and post-workshop question 3 (M=2.68, SD=0.612); p=0.000. There was a significant difference in the scores for pre-workshop question 4 (M=1.36, SD=0.621) and post-workshop question 4 (M=2.25, SD=0.799); p=0.000. There was a significant difference in the scores for pre-workshop question 5 (M=2.71, SD=0.713) and post-workshop question 5 (M=3.5, SD=0.577); p=0.000. There was a significant difference in the scores for pre-workshop question 6 (M=0.96, SD=0.793) and post-workshop question 6 (M=3.18, SD=0.863); p=0.000. There was a significant difference in the scores for pre-workshop question 7 (M=2.68, SD=0.819) and post-workshop question 7 (M=3.5, SD=0.577); p=0.000. It is noteworthy that additional T-tests were performed on the post in-service scores between the intervention and control groups, and a statistical significance was only found in question 5, comparing the control group (M=3.71, SD=0.469) and the intervention group (M=3.29, SD=0.611); p=0.047.

All participants performed the Satisfaction with Current Learning and Self-Confidence in Learning Survey. The participants for both cohorts reported a high level of satisfaction with learning, and there was a significant difference in scores for the intervention group (M=23.86/25, SD=2.538) and the control group (M=21.86/25, SD=2.476); p=0.045. The participants for both cohorts reported high levels of self-confidence in learning, and there was a significant difference in scores for the intervention group (M=37.29/40, SD=3.197) and the control group (M=33.43/40, SD=4.702); p=0.017. A Pearson correlation score of 0.775 shows a positive
correlation that those who were more satisfied were also those who were more self-confident in their learning experience.

There was not a significant difference in successful placement attempt number between the control group (M=1.57 attempts, SD=0.756) and intervention group (M=1.29 attempts, SD=0.611); p=0.479. There was not a significant difference in time from initial needle puncture to epidural placement between the control group (M=181.79 seconds, SD=90.494) and intervention group (200.0 seconds, SD=90.994); p=0.600.

Discussion

This DNP project assessed the use of US for epidurals by currently practicing CRNAs in the form of an online survey. The majority of CRNAs polled were confident in their ability to perform epidural cannulation (M=3.06). Most of the polled CRNAs (62.5%, 10) agreed that US helps to guide placement in patients with atypical anatomy. However, 62.5% (10) CRNAs disagreed that they felt competent enough to identify neuraxial landmarks with US. This may indicate an educational need for anesthesia providers. If providers believe US to be beneficial to guide epidural placement in patients atypical anatomy, an increased familiarity with the technique may increase its use.

Kolb’s Theory of Experiential Learning served as an excellent framework for the in-person cohort. The subjects were able to have a concrete experience with the didactic and hands-on learning in-service. After receiving feedback on their technique by the in-service instructor, they were given opportunity to reflect on their experience and form abstract concepts as to how they could improve their technique. This time allowed subjects to process the instructors’ suggestions and to think about what changes could be made. Finally, the subjects were able to
test their concepts in the active experimentation phase, which involved the direct application on US-compatible epidural manikins.

The simulation results of this study were consistent with the reported literature. There were no significant differences in the number of puncture attempts nor time from initial needle puncture to epidural placement. The US-compatible epidural manikin presented with typical anatomy, and the lack of statistical significance in the aforementioned categories is consistent with data from the works of Arzola et al. (2015). With US guidance being particularly useful in patients with atypical anatomy, perhaps the data may show statistically significant differences if the manikin was scoliotic or had an obese presentation.

There was a statistically significant improvement in each question of the perceived competence and confidence survey when comparing post-in-service to pre-in-service scores. There was also a high degree of satisfaction and self-confidence in learning between in both in-person cohorts, with a statistically increase in both scores for those who performed epidurals using US on the manikin. The improvement in all scores and high degree of satisfaction and self-confidence is consistent with findings by VanderWielen et al. (2014), Terblanche et al. (2014), and Ramlogan et al. (2017). After receiving such an in-service resulting in increased competence, the anesthesia provider is more likely to incorporate this technique into their practice. If an anesthetist is able to perform this technique, then patients requesting neuraxial anesthesia with difficult anatomy may experience a higher quality of care.

**Conclusion**

This DNP project revealed that a lack of perceived competence and confidence with US guided epidural cannulation among CRNAs and SRNAs existed and that a reasonable approach to improving perceived competence and confidence was an in-service combining didactic and
hands-on teaching with simulation. The in-service created for this DNP project has the potential to change practice of CRNAs when encountering a difficult epidural or spinal anesthetic placement. For example, if the anesthetist is unable to achieve a spinal or epidural anesthetic, US imaging could be obtained prior to abandoning the neuraxial anesthetic for an alternative form of anesthesia that may be less desirable or less safe. The high degree of satisfaction and self-learning reported by the subjects indicated that the in-service was effective in teaching US guided epidural cannulation among CRNAs and SRNAs. Free-text comments included in the surveys indicated a desire among SRNAs to use this technology more and to incorporate the in-service into the current UB SON Nurse Anesthesia curriculum.

This project contributed to advance practice nursing and addressed multiple DNP Essentials. First, the in-service teaching SRNAs a new technique to improve their practice was reflective of DNP Essential I, Scientific Underpinnings for Practice. The in-service was structured to review neuraxial anatomy as applied to the subjects already learned foundation and expanded their understanding using new, scientific, teachings. Secondly, this project embodied DNP Essential III, Clinical Scholarship and Analytical Methods for Evidence-Based Practice, by being supported by extensive literature review on the current implications of US applied to neuraxial anesthesia. Lastly, DNP Essential IV, Information Systems/ Technology and Patient Care Technology for the Improvement and Transformation of Health Care, was addressed. This was evident throughout the project as use of US technology applied in a new way to improve patient care may lead to improved patient outcomes among nurse anesthetists. This project has the potential to advance clinical practice and education of CRNAs by using current technology to improve their understanding of a complex clinical subject. With improved understanding of the neuraxial structure and the ability to use this technology on patients who present with atypical
anatomy, subjects are able to give patient-specific anesthesia, improving analgesia and quality of care. The introduction of ultrasound training via lecture and simulation improved students’ perceived understanding of epidural anatomy. With this improved understanding of epidural anatomy, using a needle on a three-dimensional model may prove to be less cumbersome and the student may have improved epidural skills. This would translate into more accurately placed epidural catheters, which would provide improved analgesia and increased patient satisfaction.

**Strengths and Limitations**

The limitations of this project show attainable areas in which this study may be improved. One barrier to this study was the small sample size of all cohorts. There was an inability to recruit local CRNAs, which may be due to the fact that the invitation was sent less than one month before the workshop was conducted. Instead of only CRNAs employed by local hospital facilities, the inclusion of additional anesthesia groups may have also yielded more participants. This small sample size may be attributed to the short period of time allotted between IRB approval and the workshop date. If more time was afforded, there also may have been more CRNA responses to the online survey. There also existed a lack of homogeneity between 2nd and 3rd year SRNAs between the control and intervention groups, which may have been mitigated with more participants or different recruitment strategies.

Another possible limitation may be the quality of imaging on the US compatible manikin. Although the US was able to produce sufficient imaging, the ability to evaluate depth via visualization of ligamentum flavum and dura was not able to be achieved. The exploration of different simulators should be a priority if additional studies are to take place. Not only was the quality of the simulator a possible factor, but the quality of the US machine as well. Different US machines should also be investigated prior to conducting additional studies.
One strength of this study is the opportunity to increase the scope of this research to include currently practicing anesthetists in the hospital setting. This study was a cost-effective way to assess the understanding of US as applied to neuraxial anesthesia in currently practicing CRNAs. This assessment has led to the identification of a learning opportunity that has the potential to change providers’ practice. The study also demonstrated a cost-effective way to increase knowledge, competence, confidence, and satisfaction in learning. Furthermore, this learning environment does not have the potential to compromise patient safety. The overwhelming enthusiasm of the in-person subjects to incorporate this technique into their practice may have positive influences on patient care.

**Future Implications and Recommendations**

This DNP project should be built upon with future studies. Increasing the scope of this study by implementing the in-service in multiple sites and recruiting CRNAs and anesthesiologists would produce stronger data. If successful, refresher and continuing education (CE) courses following the guidelines set forth by this project’s deliverable may be created. The in-service created for this project may also be included into SRNA curriculum. As anesthetic implications for US are constantly growing, the utilization of a deliverable such as the one developed in this study allows providers to stay current with this emerging technique. Another future study would be to repeat this study utilizing US compatible manikin with atypical anatomy or to use a live model with atypical anatomy to increase neuraxial US scanning proficiency. Finally, the lack of anesthetists’ perceived competence with identifying neuraxial sonoanatomy may contribute to the lack of use in practice, which could be the topic of future qualitative studies. Investigating why CRNAs hesitate to incorporate US into their neuraxial
algorithm is another possible avenue. Is there a lack of education, and if so would these CRNAs be willing to learn and incorporate this technique into their practice?
ULTRASOUND EPIDURAL EDUCATION

References


Table 1

*Online Epidural Survey Results (N=16)*

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Ultrasonography helps to understand epidural anatomy in the novice anesthetist

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I can identify appropriate anatomy with the ultrasound machine to place an epidural catheter

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Ultrasonography helps to guide placement of epidurals in patients with atypical anatomy

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Figure 1. Online Epidural Survey

![Online Epidural Survey](image_url)
Figure 2. In-Person Epidural Training Surveys

In-Person Epidural Training Surveys

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Appendix A

UB IRB Approval Letter

October 28, 2019

Dear Joseph Wilkens,

On 10/23/2019, the University at Buffalo IRB reviewed the following submission:

<table>
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<th>Type of Review:</th>
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<td>Title of Study:</td>
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<tr>
<td>Investigator:</td>
<td>Joseph Wilkens</td>
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<tr>
<td>IRB ID:</td>
<td>STUDY00003830</td>
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<td>Funding:</td>
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<td>Documents Reviewed:</td>
<td>• Appendix 3- Epidural Evaluation Tool, Category: Other; • In-Person Consents V 2, Category: Consent Form; • Appendix 1- Epidural Training Survey, Category: Surveys/Questionnaires; • scientificreview wilkens.pdf, Category: Other; • 503 IRB Version 6, Category: IRB Protocol; • Request for participation- online cohort Version 2, Category: Recruitment Materials; • Ultrasound Lecture, Category: Other; • Request for participation- in-person cohorts-version 2, Category: Recruitment Materials; • Appendix 2- Post- Scenario Survey, Category: Surveys/Questionnaires; • Online consent, Category: Consent Form;</td>
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The University at Buffalo Institutional Review Board has considered the submission for the project referenced above on 10/23/2019 and determined it to be Exempt.

In conducting this study, you are required to follow the requirements listed in the Investigator Manual (HRP-103), which can be found by navigating to the IRB Library within the Click system.

UBIRB exemption is given with the understanding that the most recently approved procedures will be followed and the most recently approved consenting documents will be used. If modifications are needed that may change the exemption determination, please contact the
UB IRB Office. Also, see the Worksheet: Exempt Determination (HRP-312) for information on exemption criteria and categories.

As principal investigator for this study involving human participants, you have responsibilities to the SUNY University at Buffalo IRB (UBIRB) as follows:

1. Ensuring that no subjects are enrolled prior to the IRB approval date.

2. Ensuring that the UBIRB is notified of:
   - All Reportable Information in accordance with the Reportable New Information Smart Form.
   - Project closure/completion by submitting a Continuing Review/Modification/Study Closure Smart Form in Click.

3. Ensuring that the protocol is followed as approved by UBIRB unless minor changes that do not impact the exempt determination are made.

4. Ensuring that the study is conducted in compliance with all UBIRB decisions, conditions, and requirements.

5. Bearing responsibility for all actions of the staff and sub-investigators with regard to the protocol.

6. Bearing responsibility for securing any other required approvals before research begins.

If you have any questions, please contact the UBIRB at 716-888-4888 or ub-irb@buffalo.edu.
Appendix B

Online Survey Group- Online Request

Dear Certified Registered Nurse Anesthetists,

My name is Joseph Wilkens and I am a senior Student Registered Nurse Anesthetist at the University at Buffalo School of Nursing. I am conducting a research study titled The Use of Ultrasonography to Improve Epidural Education. This project has the potential to advance clinical practice and education of CRNAs by using current technology in order to improve their understanding of a complex clinical subject. This ultrasound workshop may enhance the subjects understanding of neuraxial anatomy, while increasing their competence, confidence, and accuracy in performing epidural cannulation.

If interested, you must meet the following criteria:
- You are an adult.
- You are able to speak English sufficiently to consent and participate in this study.
- You are a currently practicing CRNA.

This online survey portion of the research project should take roughly ten minutes. There is only one survey per person for this portion of the study. The survey will take place on Survey Monkey, which can be accessed from any device that is connected to the internet.

After clicking the associated link, you will be taken to a page with consent information. After completing reading the consent information, you will consent by clicking a link to Survey Monkey. Within Survey Monkey, you prompted to answer four questions to generate a subject de-identification code. Next, you will record your demographics. Lastly, you will answer seven Likert Scale questions in regards to epidural procedures, and have the option to detail your opinions in regards to an US-guided epidural in-service.

If you have any questions, you can feel free to contact me at wilkens2@buffalo.edu. If you are willing to participate in this study, you may click the link below. By clicking this link and participating in this survey, you consent to be a part of this research project.
Appendix C

In-Person Group, Electronic Request

Participant Group 2: SRNA in-person group- Request to Participate in a Research Study
Participant Group 3: CRNA in-person group- Request to Participate in a Research Study

Dear Certified Registered Nurse Anesthetists and Student Registered Nurse Anesthetists,

My name is Joseph Wilkens and I am a senior Student Registered Nurse Anesthetist at the University at Buffalo School of Nursing. I am conducting a research study titled The Use of Ultrasonography to Improve Epidural Education. This project has the potential to advance clinical practice and education of CRNAs by using current technology in order to improve their understanding of a complex clinical subject. This ultrasound workshop may enhance the subjects understanding of neuraxial anatomy, while increasing their competence, confidence, and accuracy in performing epidural cannulation.

If interested, you must meet the following criteria:
- You are an adult.
- You are able to speak English sufficiently to consent and participate in this study.
- You are a currently practicing CRNA, second year SRNA, or a third year SRNA.
- You must be able to be present for the research procedures at the University at Buffalo South Campus, Wende Hall, B08.

We expect that you will be involved in this portion of the study approximately four hours. Based on the order of your on-line RSVP, you will be randomized into either the pre-lecture simulation or post-lecture simulation group.

Once you are on-site, you will be asked to participate in the following:

Procedure 1: Perform the pre-procedural survey. This will take place over the course of ten minutes.

Procedure 2a: Performing epidural cannulation on manikin. This group will not receive any pre-procedural lecture and will ask to perform the intervention using traditional learned techniques.

Procedure 2b: Performing epidural cannulation on manikin using preprocedural US technique. This group will receive pre-procedural US education as it pertains to epidural cannulation.

Procedure 3: US epidural education lecture. This lecture will provide a review of neuraxial anatomy and will apply ultrasonography.

Procedure 4: Post-procedural survey. This will take place over the course of ten minutes.

If you have any questions, you can feel free to contact me at wilkens2@buffalo.edu. If you are willing to participate in this study, please e-mail Joseph Wilkens at wilkens2@buffalo.edu for further information.
Appendix D

In-Person Permission to Take Part in a Research Study

University at Buffalo Institutional Review Board (UBIRB)
Office of Research Compliance | Clinical and Translational Research Center Room 5018
875 Ellicott St. | Buffalo, NY 14203
UB Federalwide Assurance ID#: FWA00008824

Participant Group 2: SRNA in-person group- Adult Consent to Participate in a Research Study
Participant Group 3: CRNA in-person group- Adult Consent to Participate in a Research Study

Title of research study: The Use of Ultrasonography to Improve Epidural Education

Version Date: Version 1
Investigator: Joseph Wilkens

Key Information: The following is a short summary of this study to help you decide whether or not to be a part of this study. More detailed information is listed later on in this form.

Why am I being invited to take part in a research study?
You are being invited to take part in a research study because you may meet the following criteria:

- You are an adult.
- You are able to speak English sufficiently to consent and participate in this study.
- You are a currently practicing CRNA, second year SRNA, or a third year SRNA.
- You must be able to be present for the research procedures at the University at Buffalo South Campus, Wende Hall, B08.

What should I know about a research study?

- Someone will explain this research study to you.
- Whether or not you take part is up to you.
- You can choose not to take part.
- You can agree to take part and later change your mind.
- Your decision will not be held against you.
- You can ask all the questions you want before you decide.

Why is this research being done?
This project has the potential to advance clinical practice and education of CRNAs by using current technology in order to improve their understanding of a complex clinical subject. With improved understanding of the neuraxial structure and the ability to use this technology on patients who present with atypical anatomy, subjects will be able to give patient-specific anesthesia, improving analgesia and quality of care.
This project will investigate SRNA and currently practicing CRNAs’ competence, perceived confidence with US-guided epidural placement, and satisfaction with US-guided epidural education.

This study is expected to identify current gaps in knowledge and may be used to guide ultrasound education in the future. This may lead to the development of a future in-service that can be used to educate future SRNAs and currently practicing CRNAs.

How long will the research last and what will I need to do?
We expect that you will be in this research study for approximately 4 hours.

You will be asked to participate in the following:

Procedure 1: Perform the pre-procedural survey. This will take place over the course of ten minutes.

Procedure 2a: Performing epidural cannulation on manikin. This group will not receive any pre-procedural lecture and will ask to perform the intervention using traditional learned techniques.

Procedure 2b: Performing epidural cannulation on manikin using preprocedural US technique. This group will receive pre-procedural US education as it pertains to epidural cannulation.

Procedure 3: US epidural education lecture. For subjects in group 2a, this will occur after all subjects have performed their epidural skills demonstration. For subjects in group 2b, this lecture will take place before performing epidural skills demonstration.

Procedure 4: Post-procedural survey. This will take place over the course of ten minutes.

More detailed information about the study procedures can be found under “What happens if I say yes, I want to be in this research?”

Is there any way being in this study could be bad for me?

There exists a small risk of self-inflicted needle stick. The physical risk of this poses a miniscule risk for infection. In the event of a needle stick, medical supplies (band-aids, soap, and water) are on-site.

More detailed information about the risks of this study can be found under “Is there any way being in this study could be bad for me? (Detailed Risks)”

Will being in this study help me in any way?

We cannot promise any benefits to you or others from your taking part in this research. However, possible benefits include:

- Increased familiarity with ultrasonography.
- Education associated with US and epidural anatomy.
There are no benefits to you from your taking part in this research. We cannot promise any benefits to others from your taking part in this research.

**What happens if I do not want to be in this research?**
Participation in research is completely voluntary. You may choose not to enroll in this study.

Your alternative to participating in this research study is to not participate.

**Detailed Information:** The following is more detailed information about this study in addition to the information listed above.

**Who can I talk to?**
If you have questions, concerns, or complaints, or think the research has hurt you, talk to the research team at **607-215-3488 or wilkens2@buffalo.edu** You may also contact the research participant advocate at 716-888-4845 or **researchadvocate@buffalo.edu**.

This research has been reviewed and approved by an Institutional Review Board (“IRB”). An IRB is a committee that provides ethical and regulatory oversight of research that involves human subjects. You may talk to them at (716) 888-4888 or email **ub-irb@buffalo.edu** if:

- [ ] You have questions about your rights as a participant in this research
  - [ ] Your questions, concerns, or complaints are not being answered by the research team.
  - [ ] You cannot reach the research team.
  - [ ] You want to talk to someone besides the research team.
  - [ ] You want to get information or provide input about this research.

**How many people will be studied?**
We expect about 50 people will be in this portion research study.

**What happens if I say yes, I want to be in this research?**
We expect that you will be involved in this portion of the study for approximately four hours. Based on the order of your on-line RSVP, you will be randomized into either the pre-lecture simulation or post-lecture simulation group.

Once you are on-site, you will be asked to participate in the following:

Procedure 1: Perform the pre-procedural survey. This will take place over the course of ten minutes. This pre-procedural survey will be identical for all subjects and will include a subject de-identifying table, a demographic table, and a pre-procedural survey. This survey consists of seven Likert Scale questions and a free text area to state your opinions on this type of research study.

Procedure 2a: Performing epidural cannulation on manikin. This group will not receive any pre-procedural lecture and will ask to perform the intervention using traditional learned techniques. This will take place in a private simulation room with cameras and a one-way mirror. A researcher will be in the room to record specific procedural outcomes, they will not answer any questions. The scenario will be a simple epidural cannulation with the supplies in the room. The
can be performed on a manikin and this manikin will already be sterile and draped. Once cannulation has been established, the simulation will end.

Procedure 2b: Performing epidural cannulation on manikin using preprocedural US technique. This group will receive pre-procedural US education as it pertains to epidural cannulation. This will take place in a private simulation room with cameras and a one-way mirror. A researcher will be in the room to record specific procedural outcomes, they will not answer any questions. The scenario will be a simple epidural cannulation utilizing pre-procedural US using the supplies in the room. The cannulation will be performed on a manikin and this manikin will already be sterile and draped. Once cannulation has been established, the simulation will end.

Procedure 3: US epidural education lecture. For subjects in group 2a, this will occur after all subjects have performed their epidural skills demonstration. For subjects in group 2b, this lecture will take place before performing epidural skills demonstration. This lecture will provide a review of neuraxial anatomy and will apply ultrasonography.

Procedure 4: Post-procedural survey. This will take place over the course of ten minutes. The survey will include the de-identifying questionnaire to link to your previous survey. The post-survey will include 13 Likert Scale questions, as well as two free text response areas.

What are my responsibilities if I take part in this research?
If you take part in this research, you will be responsible to perform the pre-scenario and post-scenario surveys. You will also be asked to perform the simulation scenario.

Inform the primary researcher if you are unable to participate. Contact Joseph Wilkens at 607-215-3488 or wilkens2@buffalo.edu

Inform the research team if you are injured.

What happens if I say yes, but I change my mind later?
You can leave the research at any time it will not be held against you. If you have completed any portion of the study, the information will be recorded and used for the study.

Inform the primary researcher if you are unable to participate. Contact Joseph Wilkens at 607-215-3488 or wilkens2@buffalo.edu

Is there any way being in this study could be bad for me? (Detailed Risks)

- Possible self-inflicted needle injury from epidural tray. The physical risk of this poses a miniscule risk for infection. In the event of a needle stick, medical supplies (band-aids, soap, and water) are on-site.

What happens to the information collected for the research?
Efforts will be made to limit the use and disclosure of your personal information, including research study and medical or education records, to people who have a need to review this information. We cannot promise complete secrecy. Organizations that may inspect and copy your information include the IRB and other representatives of this organization.
Will I get paid for my participation in this research
You will not be paid for participating in this study.

What will happen to my information and samples?
Your information or samples that are collected as part of this research will not be used or distributed for future research studies, even if all of your identifiers are removed.

What will I be told about clinically relevant research results?
Your information and samples will not be used for future studies.

Signature Block for Capable Adult
Your signature documents your permission to take part in this research. By signing this form you are not waiving any of your legal rights, including the right to seek compensation for injury related to negligence or misconduct of those involved in the research.

________________________________________  __________________________
Signature of subject Date

________________________________________
Printed name of subject

________________________________________  __________________________
Signature of person obtaining consent Date

________________________________________
Printed name of person obtaining consent
Appendix E

Online Group Permission to Take Part in a Human Research Study

University at Buffalo Institutional Review Board (UBIRB)
Office of Research Compliance | Clinical and Translational Research Center Room 5018
875 Ellicott St. | Buffalo, NY 14203
UB Federalwide Assurance ID#: FWA00008824

Participant Group 1: Survey Group- Adult Verbal Consent to Participate in a Research study

Title of research study: The Use of Ultrasonography to Improve Epidural Education

Version Date: Version 1

Investigator: Joseph Wilkens

Key Information: The following is a short summary of this study to help you decide whether or not to be a part of this study. More detailed information is listed later on in this form.

Why am I being invited to take part in a research study?

You are being invited to take part in a research study because you may meet the following criteria:

- You are an adult.
- You are able to speak English sufficiently to consent and participate in this study.
- You are a currently practicing CRNA.

What should I know about a research study?

☐ Someone will explain this research study to you.

☐ Whether or not you take part is up to you.

☐ You can choose not to take part.

☐ You can agree to take part and later change your mind.

☐ Your decision will not be held against you.

☐ You can ask all the questions you want before you decide.

Why is this research being done?

This project has the potential to advance clinical practice and education of CRNAs by using current technology in order to improve their understanding of a complex clinical subject. With improved understanding of the neuraxial structure and the ability to use this technology on patients who present with atypical anatomy, subjects will be able to give patient-specific anesthesia, improving analgesia and quality of care.

This project will investigate currently practicing CRNAs perceived confidence with US-guided epidural placement and satisfaction with US-guided epidural education.

How long will the research last and what will I need to do?
We expect that you will be in this research study for 10 minutes.
You will be asked to participate in an online survey. This will be a one-time survey that consists of answering questions to illicit a de-identifying code, participant demographics, and seven-question Likert Scale survey related to epidural training. There is also an area for a free-text response in regards to the subjects opinions on an ultrasound-guided epidural workshop.

More detailed information about the study procedures can be found under “What happens if I say yes, I want to be in this research?”

**Is there any way being in this study could be bad for me?**

No, this study will not cause harm to the subjects.

More detailed information about the risks of this study can be found under “Is there any way being in this study could be bad for me? (Detailed Risks)”

**Will being in this study help me in any way?**

There are no benefits to you from your taking part in this research. We cannot promise any benefits to others from your taking part in this research.

**What happens if I do not want to be in this research?**

Participation in research is completely voluntary. You may choose not to enroll in this study.

Your alternative to participating in this research study is to not participate.

**Detailed Information:** The following is more detailed information about this study in addition to the information listed above.

**Who can I talk to?**

If you have questions, concerns, or complaints, or think the research has hurt you, talk to the research team at **607-215-3488** or **wilkens2@buffalo.edu** You may also contact the research participant advocate at 716-888-4845 or **researchadvocate@buffalo.edu**.

This research has been reviewed and approved by an Institutional Review Board (“IRB”). An IRB is a committee that provides ethical and regulatory oversight of research that involves human subjects. You may talk to them at (716) 888-4888 or email **ub-irb@buffalo.edu** if:

- □ You have questions about your rights as a participant in this research
- □ Your questions, concerns, or complaints are not being answered by the research team.
- □ You cannot reach the research team.
- □ You want to talk to someone besides the research team.
- □ You want to get information or provide input about this research.

**How many people will be studied?**

We expect about 50 people to be enrolled in the survey portion of this research.

**What happens if I say yes, I want to be in this research?**

This online survey portion of the research project should take roughly ten minutes. There is only one survey per person for this portion of the study. The survey will take place on Survey Monkey, which can be accessed from any device that is connected to the internet.
After completing the consent process, you will be prompted to answer four questions to generate a subject de-identification code. Next, you will record your demographics. Lastly, you will answer seven Likert Scale questions in regards to epidural procedures, and have the option to detail your opinions in regards to an US-guided epidural in-service.

**What are my responsibilities if I take part in this research?**
If you take part in this research, you will be responsible to complete the survey.

**What happens if I say yes, but I change my mind later?**
You can leave the research at any time it will not be held against you. Your data will not be recorded.

**Is there any way being in this study could be bad for me? (Detailed Risks)**
*There are no known risks associated with an online survey.*

**What happens to the information collected for the research?**
Efforts will be made to limit the use and disclosure of your personal information, including research study and medical or education records, to people who have a need to review this information. We cannot promise complete secrecy. Organizations that may inspect and copy your information include the IRB and other representatives of this organization.

Your personal information will not be recorded. Your response to all categories is voluntary and will generate de-identifiable data.

**What will happen to my information and samples?**
Your information and samples will not be used for future studies.

**What will I be told about clinically relevant research results?**
*Individual results will not be shared.*

**Electronic Consent for Adults**
By clicking on the survey link below, you are verbally providing your permission to participate in this study. By doing so you are not waiving any of your legal rights, including the right to seek compensation for injury related to negligence or misconduct of those involved in the research.
Appendix F

Epidural Survey

Subject De-identification

The following information will be used to generate an anonymous linkage code to match data from different surveys. This information will not require your name or any other identifying information.

Please complete the following items to generate your anonymous code.

First letter in mother’s first name: ___  First letter in father’s first name: ___

First digit in your social security number: ___  Last digit in your social security number: ___

Example: My mother’s first name is Gloria and my father’s first name is Joaquin. My social security number is 123-45-6789. My unique identification code would be: GJ19.

General Information (Please check boxes, where appropriate)

<table>
<thead>
<tr>
<th>Sex</th>
<th>Male</th>
<th>Female</th>
<th>Other ________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>&lt;25</td>
<td>25-35</td>
<td>36-45</td>
</tr>
</tbody>
</table>

Degree (Please check all that apply) (for CRNAs)

<table>
<thead>
<tr>
<th>MS</th>
<th>Ph.D.</th>
<th>CRNA</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNP</td>
<td>Other</td>
<td>________</td>
</tr>
</tbody>
</table>

Number of years in practice (if CRNA)

| 0-5 | 6-10  | 11-15 | 16-20 | >20 |

Practice setting (for CRNAs)

| Hospital | Private Practice | Group Practice | Community Health Center/Clinic |

Practice location(s) (for CRNAs) (Please check all that apply)

| Urban | Suburban | Rural | Reservation |
### Epidural Training Survey

<table>
<thead>
<tr>
<th></th>
<th>0- (very unrealistic/ strongly disagree)</th>
<th>1- (unrealistic/ disagree)</th>
<th>2- (neutral)</th>
<th>3 –(realistic/ agree)</th>
<th>4- (very realistic/ strongly agree)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have a thorough understanding of spinal anatomy</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>I have a good understanding of the risks and complications involved</td>
<td></td>
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<tr>
<td>I feel confident enough to perform epidurals</td>
<td></td>
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<tr>
<td>I know how to troubleshoot if I’m having difficulty</td>
<td></td>
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</tr>
<tr>
<td>Ultrasonography helps to understand epidural anatomy in the novice anesthetist</td>
<td></td>
<td></td>
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<tr>
<td>I can identify appropriate anatomy with the ultrasound machine to place an epidural catheter</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Ultrasonography helps to guide placement of epidurals in patients with atypical anatomy</td>
<td></td>
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</tr>
</tbody>
</table>

What are your opinions in regards to an in-service that utilizes ultrasound technology on an ultrasound-compatible manikin?
Appendix G

Post-Scenario Survey for Epidural Training

Subject De-identification

The following information will be used to generate an anonymous linkage code to match data from different surveys. This information will not require your name or any other identifying information.

Please complete the following items to generate your anonymous code.

First letter in mother’s first name: ___  First letter in father’s first name: ___
First digit in your social security number: ___  Last digit in your social security number: ___

Example: My mother’s first name is Gloria and my father’s first name is Joaquin. My social security number is 123-45-6789. My unique identification code would be: GJ19.

Post-Scenario Survey for Epidural Training

<table>
<thead>
<tr>
<th>Satisfaction with Current Learning</th>
<th>SD</th>
<th>D</th>
<th>UN</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The teaching methods used in this simulation were helpful and effective.</td>
<td></td>
<td></td>
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<tr>
<td>2. The simulation provided me with a variety of learning materials and activities to promote my learning the epidural curriculum.</td>
<td></td>
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<tr>
<td>3. I enjoyed how my instructor taught the simulation.</td>
<td></td>
<td></td>
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<tr>
<td>4. The teaching materials used in this simulation were motivating and helped me to learn.</td>
<td></td>
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<tr>
<td>5. The way my instructor(s) taught the simulation was suitable to the way I learn.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Self-confidence in Learning</td>
<td>SD</td>
<td>D</td>
<td>UN</td>
<td>A</td>
<td>SA</td>
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<tr>
<td>6. I am confident that I am mastering the content of the simulation activity that my instructors presented to me.</td>
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<td>7. I am confident that this simulation covered critical content necessary for the mastery of epidural curriculum.</td>
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<td>8. I am confident that I am developing the skills and obtaining the required knowledge from this simulation to perform necessary tasks in a clinical setting</td>
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<td>9. My instructors used helpful resources to teach the simulation.</td>
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<td>10. It is my responsibility as the student to learn what I need to know from this simulation activity.</td>
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<td>11. I know how to get help when I do not understand the concepts covered in the simulation.</td>
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<td>12. I know how to use simulation activities to learn critical aspects of these skills.</td>
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</tbody>
</table>
13. It is the instructor's responsibility to tell me what I need to learn of the simulation activity content during class time..

How can this education in-service be improved?

Comments:

**Epidural Training Survey**

<table>
<thead>
<tr>
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placement of epidurals in patients with atypical anatomy

| What are your opinions in regards to an in-service that utilizes ultrasound technology on an ultrasound-compatible manikin? |  |  |  |  |
Appendix H

Evaluation of Epidural Placement

<table>
<thead>
<tr>
<th>Subject/Year</th>
<th>Successful placement on first attempt</th>
<th>Successful placement on second attempt</th>
<th>Successful placement on third attempt</th>
<th>Unsuccessful placement within first three attempts</th>
<th>Wet tap (epidural needle placed in arachnoid space)</th>
<th>Time from initial needle puncture to epidural placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1/X</td>
<td></td>
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<td>#2</td>
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</table>
Oral Defense PowerPoint

1. Using Ultrasoundography to Improve Epidural Education
   - Joseph Williams
   - Fall 2019

2. Epidural Anesthesia
   - Central nervous block used for a variety of procedures in obstetrics, orthopedics, and thoracic surgery
   - Can be used to deliver either analgesia or anesthetics
   - Allows for control of sensory and motor blockade superior to spinal anesthesia
   - Useful in postoperative period to deliver long-term pain control

3. Epidural Anatomy
   - The epidural space is a network of blood vessels and adnexal compartments along the vertebral body, vertebra, and paravertebral
   - Contains fat, nerves, and connective tissue

4. Accessing the Epidural Space
   - Further anteriorly, the epidural space is reached by placing a needle through skin, subcutaneous tissue, and fascia to enter the epidural space
   - Nerve roots then pass through the needle and enter the epidural space
The Role of Ultrasound in Neuraxial Anesthesia

- Glidewell when apprehension of traditional landmarks is difficult.
- Ultrasound (US) is useful in determining the skin and tissue planes.
- Allows the anesthesiologist to measure the distance from the skin to the epidural space (myelography/biopsy of local puncture).

Significance

- To assess Certified/Registered Nurse Anesthetist (CRNA) opinions, perceived competency, and confidence with US for epidural placement, especially in patients with atypical anatomy.
- Project has the potential to enhance clinical practice and education of anesthetists.
- To use current technology to improve healthcare (improve analgesia).

Purpose

- Primary objectives: To improve anesthetist understanding of epidural anatomy and neuroanatomy.
- Secondary objectives:
  - To improve confidence scores and competency of student registered nurse anesthetist (SRNAs) and CRNAs while performing epidural cannulation on manikins.
  - To query training and use of ultrasonography for neuraxial anesthesia in currently practicing CRNAs/CRNAs (both cohorts).

Project Question

- For novice anesthetists, does the use of an in-service focusing on preprocedural ultrasonography for epidural stoe in ultrasound-compatible needles improve understanding of anatomy, needleless access, and perceived competence of epidural cannulation?
Kolb's Theory of Experiential Learning

- Concrete Experience
- Active Experimentation
- Reflective Observation
- Abstract Conceptualization

Concrete Experience
- Doing/acting on the environment

Active Experimentation
- Planning/trying out what you have learned

Reflective Observation
- Observing/reflecting on the experience

Abstract Conceptualization
- Understanding/learning from the experience

Literature Review
- Review of databases MEDLINE, PubMed, and CINHAL
- Limited to the years 2014-2019
- Produced seven relevant articles
- Key terms: Epidural, ultrasound, education with modifiers "AND" and "OR"
**Literature Review**
- Demonstrates advantage of US in patients with atypical anatomy and neuraxial epidurals (fewer puncture attempts, needle redirection, shorter procedure times).
- Does not demonstrate advantages in obstetric patients with typical anatomy (mixed data).
- Literature suggests the use of education and simulation to decrease knowledge and ability to identify landmarks with US.
- In cadaver studies, higher quality attempts with US-guided epidural insertion.
- Fall humans study found to improve perceived knowledge of spinal anatomy.

**METHODS AND DATA COLLECTION**

**Design**
- Observational
- Online platform: self-paced, self-study
- Demographic questions/validated scales for data collection
- Randomized assignment
- Demographic questionnaire/validated scales for data collection
- Preprocedural survey that assesses online content survey
- Emphasizing phases included obstetric patient and anesthesia assistants on US competency.
- Final Procedural Evaluation survey

**Setting and Subjects**
- Inpatient:
  - University of Buffalo, Viola Hall 214 and private interview room
- Online:
  - Web-based platform titled "Certified Registered Nurse Anesthetist" Facebook page
  - Private community that currently has over 2,000 members
  - Created in 2018
  - 16 responses
- Incision criteria: at least 18 years old and current CRNA with clinical experience
Ultrasound Epidural Education

Protection of Human Rights and Ethical Considerations
In-person cohort:
- All subjects were provided with a written letter and consent form
- Used de-identification tool to create surveys, and prevent non-identifiable data
- All subject data stored on password-protected computer
- Fax machine/data accuracy
- Simulation performed in private room with only evaluator present
- Only safety concern was need-based injury

Online cohort:
- All subjects were provided with a written letter and consent form
- Used de-identification tool to create surveys, and prevent non-identifiable data
- All subject data stored on password-protected computer

De-identification
- Used for both online (to ensure lack of duplicate responses) and in-person cohorts (to correlate answers)
- Table of demographics included

Table 1: de-identification tool

<table>
<thead>
<tr>
<th>Tool</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>XX</td>
<td>XX</td>
</tr>
<tr>
<td>XX</td>
<td>XX</td>
</tr>
</tbody>
</table>

Example: My mother's first name is XX and her father's first name is XX. My social security number is XX. My email address is XX.

Web-Based Poll
- Survey for Systematic Training
- Unified Clinical Practice
- Pre-service survey for optional training
- Post-test on CPOA Practice test
- Link to SurveyMonkey
- Identifies remain anonymous
- Labeled/used for one month

NOTE: Repeat student surveys and pre-surveyed students' responses were not included in survey

Experimental Cohorts
- All in-person subjects received demographic questionnaires, standardized consent form, and pre-test survey (see previous slide)
- Subjects were intended to be local CPOA, second-year, and third-year students volunteering to enroll in inquiry
- Cohorts randomly divided based on order of responses
Experimental Design
- Intervention group versus control group
- Control group performed epidural simulation on mannequin without receiving in-service (including US)
- Intervention group received in-service immediately followed by simulation performance
- Intervention group received in-service then performed epidural simulation utilizing US
- All participants completed post-intervention Student Satisfaction and Self-Confidence in Learning questionnaires as well as the perceived competence questionnaires

In-Service
- Completion of PowerPoint lecture that reviewed ultrasound applied to neonatal anesthesia
- Demonstration took place on human model
- Subjects were allowed time to see the US machines, then time to reflect on experience
- Their intervention group performed epidural simulation utilizing US
- Evaluated using tool based on previous studies

Evaluation of Skills
- Used for all subjects
- Modified from included studies

Post-Scenario Survey
- In addition to confidence scores
- Adaptable to National League for Nursing, ICN, Western Standards and Self-Confidence in Learning instrument
- Inverted 5-question, five-point Likert scale
- Also asked how this in-service can be improved
- Survey allowed for comments as well

Table 1: Evaluation of Skills Performance

<table>
<thead>
<tr>
<th>Subject</th>
<th>Intervention Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skill A</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Skill B</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Skill C</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

Note: The table above is a fictional example of how the data might be presented.
ULTRASOUND EPIDURAL EDUCATION

Data Analysis
- Performed using Statistical Package for the Social Science (SPSS)
- Analyzed competence (self-evaluation), perceived competence, self-confidence, and satisfaction
- Used independent t-test between intervention group and control groups for comparison
- Generated and analyzed descriptive statistics including median and standard deviation of competency scores
- Perceived competence, self-confidence, and satisfaction scores analyzed with paired t-tests

Data Analysis in Review: Online Cohort
- 16 responses
- Based on Five-point Likert Scale for Perceived Competence
  - (1) strongly disagree to (5) strongly agree
- Seven Questions
- Free text of opinions on ultrasound competency: mandatory in-service

Data Analysis: In-person cohort
- 28 participants
- Based on Five-point Likert Scale for Perceived Competence (pre and post)
- Based on NUN Student Satisfaction and Self-Confidence in Learning Instrument
  - 10 question, five-point scale
  - Sections to suggest improvements and comments
- Modified exploratory evaluation tool

RESULTS
ULTRASOUND EPIDURAL EDUCATION
Results: The Simulation

Simulation Results, Continued

CONCLUSIONS

- Project assessed the use of US for epidural in CNAs currently practicing
- Assessed and analyzed IFNA and competence of epidural placement in US versus traditional method
- Assessed perceived competence and confidence scores of epidural placement
- Also reviewed satisfaction scores based on devices
**Conclusion: Online Study**
- Majority of participants are confident in their ability to perform epidural catheterizations.
- Improved their options for choosing ultrasound for the first time (62.5% disagree they are competing).
- CRNAs most agree that US helps guide placement in patients with altered anatomy (62.5%).

**Conclusion: In-Person Cohorts**
- There was a significant difference in performance between the control and intervention cohorts.
- The use of this intervention significantly increased perceived competence and confidence of using US to identify appropriate sites and access the epidural space within 2nd and 3rd year CRNA/VA at UB.
- There remained a high level of satisfaction and self-efficacy among all participants post-test with the intervention, and self-efficacy is highest in those who received the intervention during the simulation.

**Future Implications**

**Strengths / Limitations**

**Limitations**
- Small sample size for all cohorts.
- Unable to confirm online cohort CRNA status.
- Lack of homogeneity between 2nd and 3rd year students between schools.
- Lack of CRNA participation.
- Limited to patients with typical anatomy.
- Quality of US imaging unavailable.
Future Implications

- Bring this delivery to hospitals (include OR/IRs)
- Possible inclusion into curricula
- Conduct this study on larger scale
- Would be interesting to see the delivery with stethoscope

DNP Essentials

1. Scientific Underpinnings for Practice: This study is focused on teaching and implementing successful understanding of ultrasound as it applies to epidural anesthetic. In theory, the use of ultrasound on a patient with spinal anesthesia is an effective strategy to enhance care delivery and improve patient outcomes.

2. Clinical Scholarship and Analytical Methods for Evidence-Based Practice: The revised literature review demonstrates the benefits of US on patients with difficult anatomy. The literature review extensively reviews the techniques for using the US to identify the appropriate anatomy.

3. Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Healthcare Practice: This project and its supporting literature utilize patient care technology (ultrasound) to improve health care.

References

[List of references]

References

[List of references]
Deliverable: The In-service

- The in-service consists of a combination of didactic, demonstration with hands on scanning of human model, and simulation on US compatible manikin.

- In-service participants arrive and take perceived competence and confidence survey (Appendix F).

- Brief lecture is given consisting of epidural anatomy review, cannulation technique, neuraxial sonoanatomy, and details on how to use epidural probe to identify sonoanatomy.

- The instructor allows participants to scan human model(s) with US machine(s) and provides constructive feedback on how to obtain appropriate imaging and where to mark to create target for injection.

- Participants are given time to ask questions and to formulate thoughts on how to improve their technique.

- The participants then test their skills on US compatible manikin.

- The participants will then complete a post-in-service perceived competence and confidence survey as well as satisfaction and self-confidence survey (Appendix G).
NAVIGATING NEURAXIAL ANATOMY WITH ULTRASOUND GUIDANCE

Joseph Wilkins

Ultrasound in Epidural Anesthesia

- Purpose and objectives: To improve anatomical understanding of epidural anatomy, enhance confidence, and accuracy in performing epidural anesthesia.
- This brief presentation will go over neural anatomy and will focus on using ultrasound to visualize pertinent landmarks.
- Will be accompanied by in-service that also utilizes hands-on experience with US on live model.
- This is only for novice sonographers and not for advanced training.

Epidural Anesthesia

- Central neuraxial block that is used for a variety of procedures in obstetrics, orthopedics, and abdominal surgeries.
- Can be limited to deliver only analgesia or anesthesia.
- Allows for control of sensory and motor blockades superior to spinal anesthesia.
- Is useful in postoperative period to deliver long-term pain control.

Epidural Anatomy

- The epidural space is a series of lateral, posterior, and anterolateral compartments along the vertebral body, nerve roots, and caudae.
- Contains fat, nerves, and fibrous tissues.

References:

Simulation
- Spinal ultrasound compatible manikin
- Perform epidural cannulation using your prior knowledge and experience to incorporate the US technique learned today
- Remember to close the bag (not what is in your aperture kit) and do not worry about test dose contents
- Patient will be prepped and draped
- Focus solely on technique

Questions?
- Thank you

References