Southern California CSU DNP Consortium

California State University, Fullerton
California State University, Long Beach
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RECOMMENDATION FOR CERTIFIED REGISTERED NURSE ANESTHETISTS TO PERFORM PERIPHERAL NERVE BLOCKS

A DOCTORAL PROJECT

Submitted in Partial Fulfillment of the Requirements

For the degree of

DOCTOR OF NURSING PRACTICE

By

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ABSTRACT

Currently at one Southern California medical center, of the over 2500 annual surgical cases where a peripheral nerve block (PNB) might be appropriate, less than 50 PNBs were done. Patients with ultrasound-guided PNBs report increased satisfaction secondary to better pain relief, fewer systemic complications, and faster recoveries as compared to other anesthetic techniques. Only anesthesiologists administer regional anesthesia at this facility; additional patients could benefit from PNBs due to the safety of this anesthesia type and its post-surgical potential for improved pain management. Adopting a credentialing process for CRNAs to provide PNBs will improve access to this type of anesthesia. Current literature and best practice evidence for CRNA administration of regional anesthesia were reviewed for this Doctor of Nursing Practice project and a policy for a credentialing/privileging process was developed. The literature indicated that graduates of accredited schools of anesthesia who successfully pass the National Certification Examination are qualified, entry-level practitioners capable of administering regional anesthesia. Ultrasound reduces the learning curves of novice providers, significantly improves provider proficiency, and could be used in a credentialing/privileging process. To improve patient access to PNBs, recommendations for implementing and evaluating a CRNA privileging process for PNB administration include: (a) establishing a pilot program to re-educate CRNAs in PNB administration supervised by regional anesthesia experts, (b) adopting standardized procedure guidelines outlining required competencies prior to privileging, and (c) evaluating the pilot program

by reviewing provider competence, assessing patient satisfaction at 24-hour postsurgical follow-up, and reassessing if sufficient PNB cases exist to maintain privileged provider competency.

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BACKGROUND

Credentialing is a process used by health care organizations to describe individuals who have met established professional standards. The process includes verification and assessment of a practitioner's state licensure, professional experience, and educational qualifications. For consumers and employers, a "credentialed" nurse symbolizes quality and achievement. To assure public safety and continued competency, a practitioner's credentials must be renewed regularly. If standards are no longer met, credentials can be withdrawn (Smolenski, 2005).

Once credentialed, the health care provider can apply for privileges. Privileges allow the health care provider to perform specific activities within their scope of practice. Each individual health care organization is responsible in determining a provider's competency, and the extent of those privileges (AANA, 2015).

Historical Look at Nurse Anesthesia

Evidence suggests that nurses began delivering anesthesia as early as the Civil War (Tunajek, 2005). Currently, there are more than 50,000 practicing Certified Registered Nurse Anesthetists (CRNAs) providing over 34 million anesthetics annually to patients throughout the United States (AANA, 2015). In addition, CRNAs remain active anesthesia providers to the U.S. military and most of rural America, often times delivering 100% of the anesthetic services in remote areas (AANA, 2015). Although practice settings vary, CRNAs are fundamentally prepared to deliver anesthesia in surgery, obstetrics, pain management, and trauma.

In order to be credentialed, CRNAs must meet these requirements: 1. Have obtained a Bachelor of Science in Nursing. 2. Hold a current registered nursing license. 3.

Have at least one-year acute care experience. 4. Have achieved a minimum of a master's degree from an accredited nurse anesthesia educational program. 5. Lastly, have passed a national board certification examination (AANA, 2015). The CRNA scope of practice is extensive, and includes, but is not limited to the following:

> Pre-anesthetic assessment and evaluation of the patient, developing an anesthetic plan, administering anesthetic and accessory drugs/fluids, managing patient airway and pulmonary status, facilitating emergence and recovery from anesthesia, discharging patient from post-anesthesia care and providing post-anesthesia follow-up evaluation, and implementing acute and chronic pain modalities (Tunajek, 2005).

Today, state and federal laws permit CRNAs to practice with or without physician supervision (Tunajek, 2005). As of November 13, 2001, the Department of Health and Human Services and the Centers for Medicare and Medicaid Services (CMS) revised the bylaws governing anesthesia service conditions for participating hospitals (Fullmer, 2012). The decision sustained the prerequisite for physician supervision of the nurse anesthetist; however, state governors were now permitted to opt out of the requirement (Fullmer, 2012).

According to the AANA (2015), California and 16 other states have since opted out the federal supervision requirement. On March 2012, The Court of Appeal of the State of California First Appellate District Division Four upheld the Superior Court's decision permitting CRNAs to continue practicing without physician supervision (Fullmer, 2012). In a recent guest editorial published in the AANA Journal, Lorraine Jordan, CRNA, PhD (2011) referred to a study by the Research Triangle Institute (RTI), conducted from 2001 to 2005, that discussed patient outcomes and CRNA supervision. The RTI's study showed that there was no difference in patient outcomes between the states that opted out of physician supervision and those that did not. The study also compared patient outcomes related to the different anesthetic services rendered by the anesthesiologist and those of the nurse anesthetist, and found no differences (Jordan, 2011).

Furthermore, CRNAs and anesthesiologists practice in a variety of anesthesia delivery models. According to Hogan, Seifert, & Simonson (2010), there are three distinct models. At either end of the spectrum, the CRNA or the anesthesiologist is the sole provider of anesthesia and bills accordingly. Between the two ends, the CRNA is either supervised or directed by an attending physician. Ultimately, the level of CRNA autonomy and existing economic factors determines an organization's delivery model. As a result of the recent installment of the Affordable Care Act, the *Report on the Future of Nursing* by the Institute of Medicine's (IOM), and the demand to reduce health care costs, hospitals and ambulatory surgery centers will need to re-evaluate their anesthesia delivery models and permit advanced personnel to practice to their fullest extent of practice (Mund, 2012).

Administration of Peripheral Nerve Blocks

In the past two decades, peripheral nerve blocks (PNB) have become the preferred method of anesthesia and postoperative analgesia in orthopedic and peripheral vascular surgery (Chelly, 2004). A peripheral nerve block is a procedure involving an injection of local anesthetic solution near or around a nerve to cause a sensory and a motor blockade to a particular area of the body. The result is a significant reduction in the amount of pain perceived by the patient.

PNBs administered preoperatively function on the theory of preemptive analgesia. By blocking pain signals prior to painful stimuli, desensitization of peripheral pain receptors occurs. The result is a decrease in the perception of pain that can extend well beyond the absorption of the anesthetic, and consequently reduces the analgesic requirements throughout the perioperative period (Hunt, Bourne, & Mariani, 2009). When used as an adjunct in multimodal pain therapy, PNBs work synergistically with other drugs agents to improve postoperative pain. Additionally, there are fewer side effects secondary to the reduced drug dosages used (Hebl et al., 2005).

Peripheral nerve blocks are especially useful in surgical cases involving patients taking anticoagulants, patients undergoing ambulatory surgery, and patients identified as American Society of Anesthesiologists (ASA) III and IV's (Chelly, 2004). Studies have shown patients receiving regional anesthesia have improved outcomes compared to those patients receiving general anesthesia for the same procedure. Benefits of peripheral nerve blocks include reduced postoperative nausea and vomiting, decreased opioid use, and a reduced number of unplanned admissions (Yauger et al., 2010). In addition, the use of peripheral nerve blocks have increased patient satisfaction secondary to decreased admission time and increased postoperative pain relief (Chelly, 2004).

Despite the benefits, potential risks exist when administering peripheral nerve blocks. Risks may include cardiac or neurologic toxicity, hematoma at the puncture site, block failure, and nerve damage (Chelly, 2004). In addition to these potential risks, anesthesiologists have argued that doing a minimal number of blocks, the time required for block placement, and the need to remain proficient are valid reasons why physicians, not CRNAs, should perform all peripheral nerve blocks.

However, recent advancements in ultrasound-guided regional anesthesia have caused a resurgence of regional anesthesia because of improved provider performance and increased patient safety. According to a systemic review conducted by Schnabel, Meyer-Friebem, Zahn, & Pogatzki-Zahn (2013), a provider's performance is improved when using ultrasound-guided peripheral nerve blocks as compared to the previous gold standard of nerve stimulation. Furthermore, ultrasound use has reduced the amount of local anesthetic necessary during block administration, reduced the onset time for the block to take effect, and reduced the number of complications associated with peripheral nerve blocks.

Needs Assessment

Currently, at a Southern California HMO facility, the anesthesia department consists of 11 Medical Doctors of Anesthesia (MDAs) and 29 CRNAs. From January 1, 2013 to December 31, 2013, the anesthesia providers were involved in more than 12,065 surgical procedures. The types of anesthesia consisted of approximately 7,000 general anesthetics, 1,200 regional anesthetics, and 3,900 local anesthetics administered alone or as a combination of the aforementioned anesthetics. Of these, roughly 50 peripheral nerve blocks were administered.

Practicing under the medical direction model, the ratio of MDAs to CRNAs is 1:3. Regardless of the practice arrangement, nurse anesthetists are the actual hands-on provider of more than 99% of the anesthetics, however, the anesthesiologists perform

100% of the peripheral blocks. It is unknown whether this practice of disallowing CRNAs to administer peripheral nerve blocks is common across the nation.

The health care system in the United States is rapidly changing. In order to meet projected health care needs and promote cost efficiency, all health care professionals need to practice to the fullest extent of their educational preparation, professional qualifications, and licensure (Mund, 2012). CRNAs, practicing at this southern California HMO facility, are credentialed within the work setting to administer spinals and epidurals for surgical and labor and delivery procedures. They are not credentialed to administer peripheral nerve blocks although these blocks are within their scope of practice. The purpose of this project is to review current literature, and evaluate best practice evidence in order to recommend credentialing for CRNAs to administer peripheral nerve blocks. This process could result in a systematic change to the current CRNA practice at this southern California HMO facility.

Supporting Framework

Frameworks help organize clinical projects and aid researchers develop plans for change. Frameworks give projects structure by setting limitations, labeling concepts, and identifying how those concepts are interrelated (Bonnel & Smith, 2014). The Promoting Action on Research Implementation in Health Services (PARIHS) framework will be used to guide this project. As seen in Figure 1, provider education, patient requirements, and ultrasound are identified factors influencing the complex processes of change necessary to implement a credentialing process for CRNAs to perform PNBs (Rycroft-Malone, 2004).

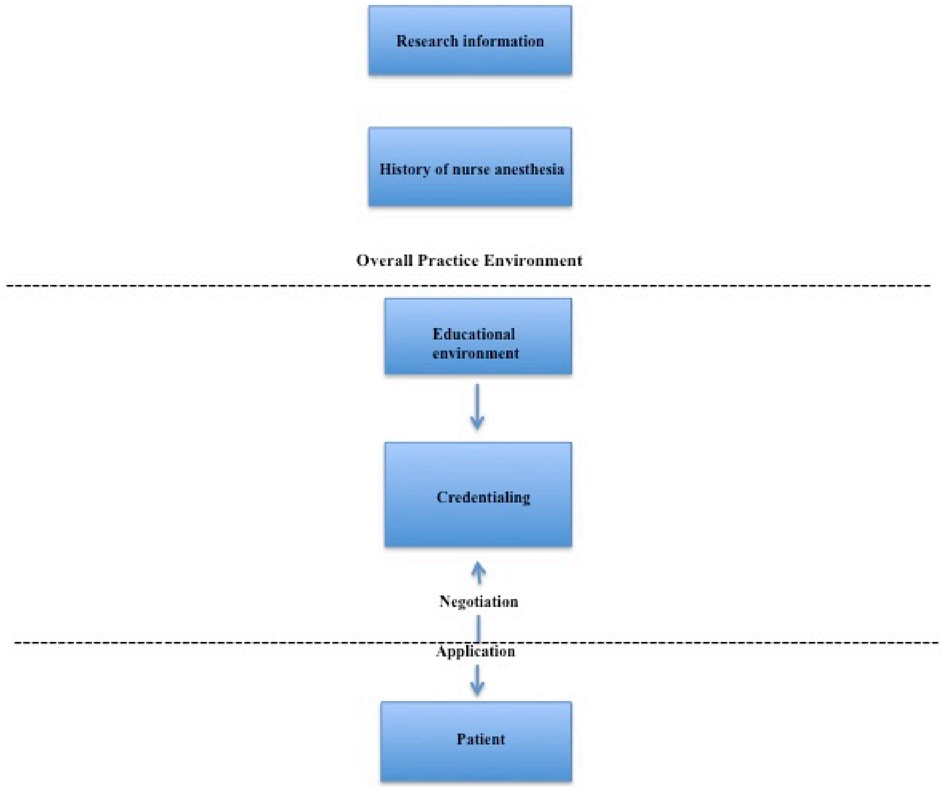

Figure 1. A conceptual framework identifying factors influencing CRNA credentialing.

The PARIHS framework was developed by a research team in the Royal College of Nursing Institute, and first published in 1998 (Kitson, Harvey, & McCormack, 1998). Since that time, Jo Rycroft-Malone and other team members have continued to develop and enhance the framework (Rycroft-Malone, 2004). The framework is based on the equation: SI = f (E, C, F). Each factor is represented as the following: SI = successful implementation, E = evidence, C = context, F = facilitation, and f = function of (Kitson et al., 2008). In short, successful implementation of research into practice is a function of the concurrent relationship between the type of evidence, the context or setting where the change is to occur, and the tools that will be used to facilitate the change (Kitson et al., 1998). Furthermore, because each factor is affected by the others, the framework argues that the factors be arranged on a low to high continuum (Rycroft-Malone, 2004).

Evidence

Within the PARIHS framework, evidence is seen as information gathered from different sources that have been proven to be reliable (Rycroft-Malone, 2004). Evidence attained from randomized control trials or qualitative studies; clinical experiences that are clear and confirmed through deliberation and analysis; and decision-making processes that include patient experiences and input are all examples of strong evidence (Kitson et al., 2008). As a result, successful implementation of research into practice is possible when evidence is located towards the higher end of the continuum.

In this project, research evidence will be obtained through a comprehensive review of literature. Clinical expertise will be incorporated as reported in educational standards. Patient experience will be examined using qualitative reviews and case studies. Lastly, local data will reflect information related to surgical statistics and budgeting.

Context

Context is described as the location or the situation in which the planned change is to occur (Kitson et al., 1998). It has been suggested that economic, political, societal, administrative, and cultural factors are all integral components of context (Rycroft-Malone, 2004). Therefore, context requires facilitators to take into consideration the powers that create and influence the atmosphere within a setting. In the PARIHS framework, culture, leadership, and evaluation are themes that support successful implementation of evidence-based practice (Kitson et al., 1998).

An organization's culture can be defined by its beliefs and attitudes towards health care, the morale of its employees, and the relationships between employees and administration. Furthermore, an organization's prevailing culture is greatly influenced by management style and decision-making processes. According to Rycroft-Malone (2004), learning cultures are more facilitative than ordering.

Leadership is the ability to stimulate others to purposely produce an outcome that would not have otherwise occurred (Search Inside Yourself, 2013). Leaders are innovators, therefore, they play a significant role in changing cultures and shaping settings (Rycroft-Malone, 2004). Through inspiration and motivation, leaders promote a shared vision to others and initiate change. Only through team effort can institution of a new ideal or advancement of an existing profession occur. Leaders who challenge, support, and encourage themselves and others to set high standards produce organizations with effective teamwork and clearly defined roles (Rycroft-Malone, 2004).

Evaluation is another essential element that determines an environment's readiness for change. According to Rycroft-Malone (2004), leaders must determine whether there is enough evidence to support the current practice or the need for a practice change. In either situation, evaluation is a necessary and ongoing process used to determine whether or not changes are effective and appropriate. Furthermore, evaluation must be realistic. In other words, it must take into consideration an organization's complexities, and its stakeholder's values and opportunities (Rycroft-Malone, 2004).

The work setting at my hospital is the context in which this potential change will be enacted. Stakeholders have been identified; the assessment of needs related to this project has been completed. Factors, related to practice and regional anesthesia, have been described. Thus, the context in which this credentialing process is to occur has been stated.

Facilitation

Facilitation is the skill that an individual uses to make something easier for others (Kitson et al., 1998). In the PARIHS framework, facilitation signifies a method where team members are introduced to evidence, instructed to interact with the concepts, and then attempt to discuss whether the concepts should be accepted or denied as part of the organization (Kitson et al., 2008). According to Rycroft-Malone (2004), the role of the facilitator is to affect the context or the setting where change occurs, and to assist the providers understand what evidence is being applied.

Ultimately, the purpose of facilitation is to help team members accomplish common goals using critical reflection and thoughtful analysis by creating a change in each individual member's mindset and actions (Kitson et al., 2008). Therefore, as practice evolves so does the role of the facilitator. For example, in the initial stages of change, facilitators often take a hands-on approach where members are given orders. As change continues to develop and members become independent, the role of facilitator transitions to one of mentorship where assistance and encouragement is key (Rycroft-Malone, 2004). Finally, in order to meet the demands of the change process, it is essential that facilitators remain flexible in their style of leadership, and posses an extensive array of skills and qualities (Rycroft-Malone, 2004). I will serve as the key facilitator for this project. I will develop a credentialing process to submit to key stakeholders that will serve as a foundation to structure change and develop practice at this Southern California HMO facility.

Low to High Continuum

As previously mentioned, the PARIHS framework is a conceptual model representing the elements necessary for the successful implementation of evidence into practice (Rycroft-Malone, 2004). The three elements: evidence, context, and facilitation have their own separate function, yet their relationships to one another are intertwined. As a result, the elements must be considered simultaneously on a high to low continuum (Kitson et al., 1998). According to Rycroft-Malone (2004), when the elements are at the high end of the continuum, successful implementation of evidence into practice is more likely to occur.

An example of the ideal situation is one where evidence is strong, mirrors professional ambitions, and meets patient needs. The context is open to change with supportive philosophies, strong leadership, and suitable evaluative systems. Finally, the type of facilitation must be appropriate for the degree of change that is occurring at the time (Rycroft-Malone, 2004).

The least successful situations are those where context and facilitation are low despite having strong research evidence (Kitson et al., 1998). Interestingly, in a case that evaluated the quality of care in a rehabilitation ward for the elderly, findings showed that the type, effort, and length of facilitation overcame and altered poor contextual circumstances to effectively apply research findings (Kitson et al., 1998). Therefore, the facilitator's role should not be underrated. According to Kitson et al. (1998), "little change happens to organizations without key drivers."

Purpose Statement

The purpose of my Doctor of Nursing Practice project is to recommend a credentialing and privileging process for CRNAs to administer peripheral nerve blocks for surgical patients. A major goal is to define the minimum competency required to perform these special procedures by a nurse anesthetist. In order to achieve this goal, four questions will be explored.

1) What are the current teaching practices and content covered in CRNA programs related to regional anesthesia?
2) What is the role of ultrasound use in guiding peripheral nerve blocks?
3) What number of procedures is required to attain proficiency? To maintain proficiency over time?
4) How does the use of peripheral nerve blocks improve quality of care and patient safety?

METHODS

Methods According to the PARIHS framework, successful implementation of research into practice is a function of the three core elements- the level and nature of the evidence, the environment into which the research is to be placed, and the method in which the process is facilitated (Kitson et al., 1988). Recommendation of this credentialing process requires an understanding of the practice environment in which this application is to occur. Therefore, the key components within each section will be outlined as they relate to credentialing (see Figure 1).

A review of the literature related to each of the environments was conducted in order to answer the project questions.

- Key terms such as “satisfaction,” “safety,” “obesity,” “efficacy,” “peripheral nerve blocks,” “general anesthesia,” “regional blocks,” “nerve stimulation,” “ultrasound,” “neuraxial,” “pain,” and “analgesia” were used to search PubMed and Google Scholar for relevant literature.
- The number of peripheral nerve block procedures required to initially attain proficiency was assessed through a literature review. Key terms such as “learning curve,” “competency,” “proficiency,” “ultrasound,” “peripheral nerve block,” and “regional anesthesia” were used to search databases PubMed and Google Scholar.
- Additional studies were obtained by searching the references of all relevant articles.
- Searches were limited to journal articles published in English from January 1, 1997 to the present.

- The Council on Accreditation, the National Board of Certification and Recertification for Nurse Anesthetists, the California Board of Registered Nursing, and the American Association of Nurse Anesthetists websites were searched for relevant information.
- Additional information was gathered through discussions with the project chair, and the regional anesthesia experts.

FINDINGS

Educational Environment

The educational environment consists of those components that prepare the CRNA to practice anesthesia safely.

- The Council of Accreditation's (COA) standards on didactic and clinical requirements of peripheral nerve blocks for nurse anesthesia educational programs are highlighted.
- The National Board of Certification and Recertification for Nurse Anesthetists' (NBCRNA) national certification examination content outline was reviewed. Key elements related to regional anesthesia are presented.
- The role of ultrasound use in peripheral nerve block training was evaluated and is discussed. Supporting evidence from the literature is included.

COA Standards

The Council on Accreditation (COA) is the organizational body that ensures the nation's 113 accredited anesthesia programs meet established standards and provide a uniform education to all anesthesia students (COA, 2015). These standards speak to the program's governance, funding, curriculum, value, and responsibility (COA, 2015).

Accreditation serves several significant purposes. First, accreditation implies guaranteed quality regarding educational training through constant assessment and re-evaluation. Second, accreditation's primary objective is the advancement of quality nursing education and the production of knowledgeable providers. Lastly, a prerequisite for national certification eligibility is graduation from an approved accredited program (COA, 2015).

In regards to a program's curriculum, the COA proposes several fundamental criteria. First, the curriculum should continue to build on previous nursing education and clinical skills. Second, the length of the program must be at least 24 months. Third, the educational setting should promote learning and encourage professional development. Fourth, the curriculum should prepare graduates to achieve certification in the field of anesthesia (COA, 2015).

In order to prepare graduates for anesthesia practice, curriculum courses are meant to engage students in both didactic and clinical components. The didactic portion of the curriculum includes coursework emphasizing pharmacology, anatomy, and pathophysiology; principles related to anesthesia equipment and machinery; and research promoting evidenced based practice. The minimum number of hours dedicated to each component is pre-determined by the COA. By the year 2015, all accredited programs are required to integrate ultrasound into their curriculum (COA, 2015).

The clinical curriculum requires students to complete a minimum of 550 cases. Training consists of direct patient-provider interaction in various work environments and clinical scenarios. Through repeated exposure to different anesthetic practices and techniques, anesthesia students gain the ability and knowledge to safely manage patients throughout the perioperative process. The extensive list of clinical requirements that must be completed before graduation can be seen on the COA website. Otherwise, as seen in Appendix A, the COA (2015) recommends that the preferred, not required, number of cases related to the management and administration of peripheral anesthesia is 40.

Although accredited programs assure that a quality education will be accessible and delivered to all anesthesia students, programs cannot guarantee an individual graduate's qualifications. Therefore, individuals must obtain certification and licensure by successfully passing a national certification examination.

NBCRNA Examination Content

In 1945, the American Association of Nurse Anesthetists initiated the certification process for CRNAs. Presently, the National Certification Exam is managed by the NBCRNA, which includes the Council on Certification of Nurse Anesthetists (CCNA) and the Council on Recertification of Nurse Anesthetists (COR). The purpose of the NCE is to evaluate the knowledge, and critical thinking skills of eligible practitioners. As a result, the NCE content must reflect current anesthesia practice (NBCRNA, 2013).

Through the professional practice analysis (PPA), the NBCRNA confirms the examination content is valid, reasonable, and job-related. The PPA involves a process in which practicing anesthesia providers throughout the United States are asked to respond to job-related surveys. For example, survey questions may ask for information pertaining to a provider's demographics, experience in particular types of clinical settings, and the types and numbers of anesthetic procedures performed annually. Associations between the providers' responses, the current NCE questions, and the COA's program standards are then made. The result is an examination composed of questions representative of current practice, which tests whether eligible candidates are qualified to deliver safe, entry-level anesthesia (NBCRNA, 2013).

The examination's content material is comprehensive. Eligible candidates are expected to exhibit knowledge in a variety of topics, techniques, and procedures. The candidate's ability to utilize critical thinking across the extensive field of anesthesia is also necessary. As seen in Appendix B, the content outline suggests that a candidate be prepared in the area of regional anesthesia. In particular, topics related to the management and administration of peripheral nerve blocks, the pharmacology of local anesthetics, the management of local anesthetic complications, and the techniques related to ultrasound-guided nerve blocks as well as nerve stimulator nerve blocks (NBCRNA, 2013).

It must be re-emphasized that the examination's content outline is reflective of nationwide anesthesia practice. Therefore, from a practice perspective, it is essential all CRNAs practice to the full extent of their qualifications. Imposing practice restrictions would otherwise undermine the credibility of (re) certification. Furthermore, to ensure patient safety, and to comply with the NBCRNA's mandate for CRNA recertification, initial certification should not discourage CRNAs from seeking continuing education or training. Lastly, nursing anesthesia's movement towards entry-level doctoral education dictates that CRNAs continually strive to meet professional standards.

Ultrasound Training

Over the past two decades, the perioperative use of ultrasound has supplanted the previous gold standard peripheral nerve stimulation (PNS) as the principle guiding technique for regional anesthesia (Schnabel et al., 2013). The transition from PNS to ultrasound-guided regional anesthesia (UGRA) is explained by the different mechanisms each technique employs to verify peripheral nerves and deliver the spread of local anesthetic. PNS depends on the inverse association between the needle's proximity to the nerve and the reduction in the stimulating current. The target nerve is identified through the observable muscle contractions innervated by the nerve (Warman & Nicholls, 2009). Once the nerve is confirmed, a single injection of local anesthetic solution is introduced into the area (Antonakakis, Ting, & Sites, 2011).

Ultrasound, on the other hand, utilizes high frequency sound waves. Anatomical structures such as bone, fluid, and tissue reflect sound waves at different speeds due to their various densities and distances from the skin's surface. Using the link between structural distances and sound wave intensities, ultrasound images are created (Freudenrich, n.d.). Ultrasound delivers real-time imaging of anatomical structures, needle visibility, and local anesthetic spread so that necessary modifications to needle tip location can be made throughout serial injections (Antonakakis et al., 2011). The result is a more precise block with better success rates, reduced amounts of local anesthetics required, decreased performance time, faster onset time, and fewer complications as compared to nerve stimulation (Schnabel et al., 2013).

Despite the growing popularity of peripheral nerve blockade and the concurrent use of ultrasound, many anesthesia providers continue to lack formal ultrasound training. The rapid advancements in ultrasound technology and lack of exposure during residency or nurse anesthesia training may explain this discrepancy. The following studies pertaining to the role of ultrasound in peripheral nerve block training can be seen in Appendix C1.

To assess provider access to ultrasound training, Helwani, Saied, Asaad, Rasmussen, & Fingerman (2012) performed a cross sectional study to investigate current teaching practices in regional anesthesia. The researchers contacted 132 American Board of Anesthesiology-accredited residency programs thru email and/or traditional mail.

Based on a 60% survey response rate, workshops and/or other colleagues were shown to be the most common method of training utilized by teaching physicians who oversaw residents in ultrasound-guided peripheral nerve blocks. In addition, of those polled only 42% reported receiving training in residency, and 31% in fellowship (Helwani et al., 2012).

Although anesthesia providers consider ultrasound use the gold standard, only 25% of the responding programs believe ultrasound to be “a standard of care.” Interestingly, 41% of the respondents reported using ultrasound routinely to guide peripheral nerve block administration. Those who did not identified lack of proficiency, lengthy administration times, and lack of readily available ultrasound equipment as barriers to regular ultrasound use (Helwani et al., 2012).

Cheung et al., (2012) also attempted to identify training gaps in ultrasound-guided regional blocks through the development of an objective assessment tool. Using the Delphi method, an initial 30-item checklist related to performance was distributed to six independent teaching centers in Canada and the United States for review. After several revisions, the checklist was narrowed to 22-items.

Following the survey involving 18 anesthesia providers from 6 academic medical centers, the researchers concluded that a specific and objective evaluation tool was necessary to adequately assess training in regional anesthesia and define competency (Cheung et al., 2012). Based on the recommended checklist, visualization of the needle tip and proper identification of anatomical structures were identified as key variables for trainee skill acquisition.

Studies have supported the relationship between image quality, needle accuracy, and provider performance. As a result, regional anesthesia experts advocate the use of simulation-based training as a method to reduce a trainee's learning curve prior to their initial clinical experience (Shorten & O'Sullivan, 2010). In a study using ultrasound on cadaver models, all 64 providers easily distinguished targeted nerves and structures following a 9-hour workshop. Good visualization of injected solution in each region was obtained (Kessler, Moriggl, & Grau, 2013). The advantage of using cadavers, as opposed to the more commonly used puncture phantom models, is that a cadaver's imaging is similar to a living patient's (Kessler et al., 2012). The study's findings, however, are limited because the backgrounds of the participants are not disclosed.

Researchers have used other types of simulation models to determine the number of ultrasound-guided regional block procedures novices would need to perform in order to attain competency. In a randomized control study (Niazi, Haldipur, Prasad, & Chan, 2012), 2nd year anesthesia residents were separated into a simulation group and a conventional group. Both groups received 4 – ½ hour lectures related to ultrasound-guided regional anesthesia. The simulation group received additional 1-hour simulation training.

The findings revealed that the residents who had received simulation training in ultrasound-guided peripheral nerve block administration performed better than those who did not receive simulation training. In the clinical setting, 64% of the simulation group's PNBs were successful compared to fifty-one percent of the conventional group's PNBs, ($P = 0.016$). On average, the simulation group required fewer attempts than the non-simulation group before success was achieved (Niazi et al., 2012). The success of the simulation group's performance was credited to feedback and improved hand-eye coordination. However, the number of blocks needed to achieve proficiency could not be determined (Niazi et al., 2012). The study's findings were limited because of the lack of standardization related to block types and order, as well as the limited time spent training participants.

In similar but separate studies, researchers evaluated the learning curves of anesthesia residents related to ultrasound-guided PNBs using simulation models (Sites, Gallagher, Cravero, Lundberg, & Bilke, 2004; Baranauskas et al., 2008). In both studies, the residents' performance time and accuracy improved with each trial. In one study, the level of success in the resident's performance reflected the amount of training the resident had received (Baranauskas et al., 2008). Similarly, the other study demonstrated that the residents' learning curves were rapidly improved with repeated practice and trainer feedback. Failures to locate the needle and to properly identify anatomical structures were noted as common novice errors (Sites et al., 2004).

In a study using cadavers, researchers determined that trainees needed to perform a mean number of 28 trials before competency was achieved (Barrington, Wong, Slater, Ivanusic, & Owens, 2012). Acquiring the necessary skills to perform simulated ultrasound-guided peripheral nerve blocks was shown to occur relatively rapidly. Similar to other studies, Barrington et al. (2012) concluded that subsequent trials, trainer feedback, and needle tip acquisition improved the probability of PNB success. Notably, the researchers acknowledged the significance of recognizing trainees who are not proficient, and who may require additional supervised practice in the clinical setting.

In all previously mentioned studies, the researchers identified supervision and feedback during simulation training as key components to participant success. In a qualitative study aimed at identifying factors important to learning ultrasound-guided regional blocks (O'Sullivan, Shorten, & Aboulafia, 2011), similar findings were supported. Centered on 132 replies, trainers and trainees listed access to and regularity of clinical education opportunities in the company of a suitable trainer as the most important factors in learning ultrasound-guided peripheral nerve blocks (O'Sullivan et al., 2011).

The significance of simulation is that it permits trainees to practice repetitively in a non-threatening environment. The perception is that newly attained information and abilities will be transferred to the clinical setting (Shorten & O'Sullivan, 2010). However, training cannot always occur within the confines of a simulated environment. Therefore, ultrasound's impact on a resident's PNB performance within the clinical setting needs investigation.

Four studies assessed the effect ultrasound has on PNB performance. In all four studies, ultrasound was shown to increase success rates. In two studies, researchers attributed the increased success to image acquisition. In the study conducted by Geffen, Rettig, Koornwinder, Renes, & Gielen (2007), residents were able to visualize anatomical landmarks, accurately place the needle tip, and observe local anesthetic circumferential spread. As a result, 95% of the patients experienced a successful PNB. In addition, there were fewer complication noted secondary to less volumes of local anesthetic used (Geffen et al., 2007).

Similarly, in another study, overall performance time was decreased as the resident's ability to acquire and read the image improved. Despite the improvement to acquire the image more rapidly, the time to accurately place the needle was unchanged (Orebaugh et al., 2009). Nevertheless, the residents experienced a 97.3% success rate. Interestingly, the resident's prior experience in PNB was shown to have no influence on individual performance times. However, image acquisition was not totally independent, which may have impacted the times (Orebaugh et al., 2009). In other words, in the interest of patient safety, supervising anesthesiologists confirmed what the resident was seeing.

Grau, Bartusseck, Conradi, Martin, & Motsch (2003) and Rosenblatt & Fishkind (2003) conducted studies that attempted to determine the number of regional blocks that would need to be performed to attain proficiency using ultrasound as the lone adjunct. Although this study assessed the usefulness of ultrasound in epidural anesthesia, the findings are valuable. Success rates improved with ultrasound, as opposed to the more traditional "loss of resistance" method, because of the resident's ability to see anatomical structures (Grau et al., 2003). Residents were successful after performing 20 epidurals. After 45 epidurals, competency was achieved. Ultrasound was shown to improve the resident's knowledge and confidence. While the largest growth of learning occurred in the early stages, resident learning remained constant (Grau et al., 2003).

Similarly, residents performing ultrasound-guided interscalene PNBs had a 96.3% success rate. After performing 15 PNBs, 87.5% of the residents were able to perform the PNBs without assistance (Rosenblatt & Fishkind, 2003). The researchers concluded that the resident's level of confidence was an essential factor in the autonomous administration of PNBs. However, as a patient's body mass index increased, the resident's failure rate also increased (Rosenblatt & Fishkind, 2003).

To determine the best technique novices should employ when learning to perform ultrasound-guided PNBs, researchers compared the effect ultrasound plus nerve stimulation versus nerve stimulation alone had performance. In three separate studies, ultrasound plus nerve stimulation significantly improved performance times compared to nerve stimulation alone (Cataldo et al., 2012; Orebaugh, Williams, & Kentor, 2007; Thomas, Graham, Osteen, Porter, & Nossaman, 2011). However, only two of the three studies evaluated success rates, which showed no notable differences between the two techniques (Cataldo et al., 2012; Thomas et al., 2011).

In regards to complications such as nerve injury and local anesthetic systemic toxicity, the researchers in all three studies acknowledged that there was no clear advantage of using ultrasound plus nerve stimulation over nerve stimulation alone. In fact, no complications were reported in all three studies. In addition, the numbers of needle insertions and vascular punctures, as well as the onset times for peripheral nerve blockade, were significantly reduced when ultrasound was used (Orebaugh et al., 2007; Thomas et al., 2011).

Based on the findings of these three studies, ultrasound and nerve stimulation appear to be equally mastered and not related to experience or manual dexterity (Thomas et al., 2011). Also, for the novice provider, nerve stimulation plays a valuable role when learning ultrasound (Orebaugh et al., 2007). Lastly, improved performance and faster onset times of peripheral nerve blockade can potentially cut operating room costs (Thomas et al., 2011).

Patient Environment

The patient environment embraces the requirements patients consider fundamental to the standards of care, and are universally expected from their individual health care providers and medical procedures when requesting health care. These patient requirements or factors potentially influence provider practice, consumer satisfaction ratings, and a hospital's economic growth. Requirements such as patient satisfaction, safety, and efficacy related to peripheral nerve block administration were investigated and are discussed.

Patient Satisfaction

With the new pay-for-performance policy, patient satisfaction has become a significant outcome measure (Centers for Medicare & Medicaid Services, 2014). The level of satisfaction is an indication of the quality of care given. Although pain after surgery is an expected, uncontrolled pain can lead to poor patient outcomes. Outcomes, which include patient dissatisfaction, slow recovery, more incidences of nausea and vomiting, longer hospital stays, and diminished quality of life (Innis, Bikaunieks, Petrysben, Zellermeyer, & Ciccarelli, 2004).

Every patient perceives pain differently. As a result, each patient needs an anesthetic plan that is tailored to his or her needs. Studies exploring the effect of analgesic treatments on satisfaction have shown that the amount of pain experienced is inversely related to satisfaction (Berges, Ottenbacher, Smith, Smith, & Ostir, 2006). Therefore, before consenting to have a PNB, a patient wants to reassurance that PNBs are effective in relieving pain, and that they will be satisfied. Studies evaluating patient satisfaction related to peripheral nerve block anesthesia are presented in Appendix C2.

Six studies were identified. Two studies related patient satisfaction with the level of patient pain being reported using visual analog pain scales. Both were randomized control studies studying the analgesic effects of different PNB techniques. One study compared combined femoral and sciatic nerve blocks (FSNB) to epidural infusions in 60 patients having knee arthroplasty (Davies, Segar, Murdock, Wright, & Wilson, 2004). The other study compared pudendal nerve blocks (PuNB) to general anesthesia in 80 patients undergoing hemorrhoidectomy (Naja et al., 2006).

Two studies used questionnaires to determine patient satisfaction related to PNBs. In a prospective, cohort study, 9962 PNB patients were given questionnaires immediately following surgery and were followed-up with within 2 days postoperatively (Ironfield, Barrington, Kluger, & Sites, 2014). The other study was retrospective involving 202 patients with ultrasound-guided supraclavicular brachial plexus blocks (SuCBPB) for upper limb surgery (Gamo et al., 2014). In both studies, patient satisfaction was based on the patient's response to whether they would have the same type of anesthetic in the future.

Two studies assessed patient satisfaction using two criteria: The patient's consideration to have the same type of anesthetic again, and the patient's need for additional analgesics. One study consisted of 87 non-randomized patients with lumbar plexus sciatic nerve blocks (LPSNB) having total knee arthroplasty (Luber, Greengrass, & Vail, 2001). The other compared femoral-Genitofemoral nerve blocks (GFNB) to spinal anesthesia in 68 patients having long saphenous vein stripping surgery (Vloka et al., 1997).

There was a statistically significant reduction in 24-hour postoperative pain scores associated with the duration of the FSNBs compared to epidural infusion, $P = 0.004$ (Davies et al., 2004). Similarly, 92% of patients, with prior general anesthesia experience, thought recovery from total knee arthroplasty was much easier with a LPSNB. Ease of recovery was linked to the blocks average duration of 13.2 hours (Luber et al., 2001).

Postoperative pain scores, opioid consumption, the number of days with pain, and the time to discharge were all significantly reduced with PuNBs compared to general anesthesia in hemorrhoidectomy surgery, $P < 0.0001$ (Naja et al., 2006). Overall satisfaction was also significantly higher in the pudendal group compared to the general anesthesia group, 94.3% versus 32.4%, $P < 0.0001$ (Naja et al., 2006). For patients having long saphenous vein stripping, the need for intraoperative analgesics was significantly higher in the GFNB group than the spinal group, $P < 0.001$. However, the pain reported by the spinal group was significantly more than the GFNB group prior to discharge, $P < 0.05$ (Vloka et al., 1997). Complications related to back pain and headache were also significantly higher in the spinal group than the GFNB group, $P < 0.001$ and $P < 0.01$. As a result, the overall patient satisfaction for the GFNB group was significantly increased compared to the spinal group, $P < 0.01$ (Vloka et al., 1997).

Most of the patients responded, “yes” to repeating the PNB, 95% LPSNB, 94.3% PuNB, and 94.6% various PNBs. The researchers attributed the 83% “yes” rate in the SuCBPB group to a delay in follow-up and erroneous recall by the patients (Gamo et al., 2014). In the study conducted by Ironfield et al. (2004), the patients who responded “no” had significantly more pain and significantly lower satisfaction scores related to the amount of patient education provided and the amount of provider interaction that occurred, $P < 0.001$ (Ironfield et al., 2014).

The researchers concluded that there are many factors associated with patient satisfaction in the surgical setting. High levels of patient satisfaction are associated with the advantages PNBs have to offer compared to other anesthetic techniques such as fewer incidences of nausea and vomiting, faster recovery times, less opioid consumption, and longer durations of pain relief. Those who are at risk for being dissatisfied are generally younger in age, female, have more complications, and have more PNB failures (Ironfield et. al, 2014). Lastly, physician interaction and patient education are important factors in patient satisfaction (Ironfield et al., 2014).

PNB Safety

For most patients, if not all, safety is a primary concern when choosing a particular anesthetic modality. In order to gain acceptance, PNBs must demonstrate that their benefits outweigh their risks, and that they are adequate anesthetic alternatives. Real-time imaging is an intrinsic safety benefit of using ultrasound during PNB administration (Warman & Nicholls, 2009). Nevertheless, complications such as nerve injury can be worrisome to a patient. Studies evaluating the safety profile of ultrasound-guided PNBs are presented.

As seen in Appendix C3, two prospective reviews compared the complication rates of peripheral nerve blockade to neuraxial anesthesia. One study consisted of 487 French anesthesiologists self-reporting on the number of procedural complications in 158,083 regional blocks. (Auroy et al., 2002). The other review, comprised of 32 studies published from January 1, 1995 to December 31, 2005, identified only neurological complications (Brull, McCartney, Chan, & El-Beheiry, 2007). Once again, the largest studies in the group of 32 consisted of self-reporting.

In both studies, peripheral nerve injuries were more likely to occur when performing peripheral nerve blocks than neuraxial blockade. The rates of peripheral neuropathy reported for spinals, epidurals, and PNBs were 3.78:10,000, 2.19:10,000, and 2.84:100, respectively (Brull et al., 2007). Interscalene blocks had the highest incidence of peripheral neuropathy. However, serious complications such cardiac arrests were more likely to occur during a spinal anesthetic than a peripheral nerve block, 9 to 1 (Auroy et al., 2002).

Self-reporting was cited as a limitation in both reviews. Self-reporting has several consequences. First, the actual number of complications may be underestimated. Second, perhaps reporting anesthesiologists were more skilled than others so fewer complications were reported (Auroy et al., 2002). Lastly, the timing when follow-up occurred was considered an important determinant in identifying complications (Brull et al., 2007).

Three studies compared the safety profile of peripheral nerve blocks to general anesthesia (see Appendix C4). In two studies, peripheral nerve blocks were used as primary anesthetics. In the remaining study, a general anesthesia plus PNB group was compared to a general anesthesia only group. Patients who were administered PNBs as their primary anesthetic had fewer episodes of hypotension, pain, and nausea (Liu, Strodtbeck, Richman, & Wu, 2005; Liu et al., 2014). One study also reported that elderly patients who had a PNB as their primary anesthetic had faster recoveries from surgery

(Liu et al., 2014). It was noted that the addition of a PNB to a general anesthetic did not increase the risk of postoperative complications (Stundner et al., 2014).

Three studies compared the safety profile of ultrasound-guided PNBs plus nerve stimulation to nerve stimulation alone (see Appendix C5). In two large retrospective studies, four cases of seizure and three cases of peripheral nerve injury associated with nerve stimulation were identified among 5436 PNBs in 2009 (Orebaugh, Williams, Vallejo, & Kentor, 2009). One case of seizure and three cases of peripheral nerve injury associated with nerve stimulation and one case of peripheral nerve injury associated with ultrasound were identified among 9000 PNBs in 2012 (Orebaugh, Kentor, & Williams, 2012). In the latter study, peripheral nerve injury was still present 12 months after the PNB in 1 of 3 cases associated with nerve stimulation (Orebaugh et al., 2012). There were no reported cases of local anesthetic systemic toxicity, central neuraxial blockade, or cardiac arrest in either study.

In a third study, where 14, 505 PNBs were performed from January 2006 to December 2011, similar findings were reported. The incidence of seizure was a greater in the nerve stimulation group than the ultrasound sound group, $P = 0.006$ (Laur & Weinberg, 2012). In addition, there was no reported difference in peripheral nerve injury between groups, as well as no cases of local anesthetic systemic toxicity (Laur & Weinberg, 2012). The two studies performed by Orebaugh et al. (2012) concluded that severe complications associated with PNBs are rare. As a result, ultrasound-guided regional anesthesia with nerve stimulation is suitable for training.

Obesity

Obesity is defined as a body mass index (BMI) > 30 kg/m2. Obesity causes anatomical and physiological changes that can increase anesthesia related risks. Regional anesthesia offers the obese patient several benefits. Benefits include better pain control, reduced narcotic use, and the avoidance of general anesthesia and its systemic effects (Brodsky & Mariano, 2011). However, obesity can pose procedural challenges for the provider performing the PNB. Challenges related to the proper positioning of the patient, the correct identification of anatomical structures, and the availability of adequate equipment (Brodsky & Mariano, 2011). As a result, obese patients are at an increased risk of complications. As seen in Appendix C6, studies assessing the safety profile associated with PNB administration in this subpopulation of patients are evaluated.

In a study consisting of approximately 2000 patients receiving supraclavicular PNBs with nerve stimulation, paresthesia was more prevalent in the obese than the non-obese, $P < 0.01$ (Franco, Gloss, Voronov, Tyler, & Stojiljkovic, 2006). In a similar study evaluating axillary brachial plexus blocks using nerve stimulation, there was a 3-times higher incidence of axillary artery puncture and paresthesia in the obese compared to the non-obese (Hanouz et al., 2010). In both of these studies, the success rates for the obese patients were less than the non-obese patients, 94.3% versus 97% and 91% and 98%, respectively. The researchers acknowledged that the PNBs were more difficult to perform in obese patients (Franco et al., 2006).

In a retrospective review of 528 patients receiving an ultrasound-guided interscalene block, a high BMI was linked to a significant increase in postoperative pain, $P < 0.001$, and nausea and vomiting, $P = 0.025$ (Schroeder et al., 2012). There were no other complications noted. The researchers concluded that despite the difficulties in performing PNBs in obese patients, PNBs are safe and effective (Schroeder et al., 2012). However, in a randomized control study of 24 obese patients having lateral popliteal-sciatic nerve blocks, ultrasound significantly reduced procedural pain (1.5 versus 5; $P < 0.001$) and improved performance times (206 seconds versus 577 seconds; $P < 0.001$) compared to nerve stimulation (Lam et al., 2014). No complications were noted. Based on the results, ultrasound was more useful than nerve stimulation in the obese patient.

PNB Efficacy

Depending on the context, there are 2 definitions used to define efficacy in regional anesthesia. First, a successful block is one in which the targeted nerve area is completely covered by local anesthetic. Second, a successful block is one in which surgery can be done without any supplemental anesthetic techniques (Nowakowski, Bierylo, Duniec, Kosson, & Lazowski, 2013). The benefit of using ultrasound while performing a PNB is that the provider can visualize the location where the local anesthetic is being deposited. As a result, ultrasound has considerably changed the perception of PNBs. Nevertheless, a patient who consents to have a PNB wants to know that the block will do what it was intended to do (will be successful). Studies evaluating the impact of ultrasound guidance on PNB efficacy are discussed (see Appendix C7).

Five studies were reviewed to assess the efficacy of ultrasound compared to other techniques to administer PNBs. Two studies, one of which was a meta-analysis, studied the success rates of ultrasound-guided PNBs compared to nerve stimulation and landmark techniques (Chan et al., 2007; Gelfand, Lesley, Murphy, Isaac, & Kumar, 2010). Another meta-analysis assessed PNB success according to block failures related to ultrasound versus nerve stimulation guidance. Block failure was stated as insufficient surgical analgesia requiring additional narcotics or conversion to general anesthesia (Abrahams, Aziz, Fu, & Horn, 2009). In a randomized control study where 40 patients were administered a 3-in-1 PNB, a successful PNB was determined by the quality and onset of a sensory block (Marhofer et al., 1997).

There was a statistically significant difference in the success rates of PNBs when ultrasound was used compared to nerve stimulation, 82.8% versus 62.9%, P = 0.01 (Chan et al., 2007). The success rates of specific blocks, such as brachial plexus, axillary, and sciatic-popliteal, were statistically increased with ultrasound use compared to other techniques (Gelfand et. al., 2010). Block failure was also significantly less with ultrasound compared to nerve stimulation, relative risk (RR) 0.41, 95% confidence interval (CI) 0.26 – 0.66, $P < 0.001$ (Abrahams et al., 2009). Conversely, in a retrospective review of 20 studies, there were no reportable differences between ultrasound and nerve stimulation (Koscielniak-Nielsen, 2008).

In one study, the onset of sensory blockade was 29% faster when using ultrasound instead of nerve stimulation, $P = 0.001$ (Abrahams et al., 2009). Similar findings were reported in patients receiving a 3-in-1PNB. The onset of sensory blockade was significantly reduced with ultrasound compared to nerve stimulation, 16 minutes versus 27 minutes, $P < 0.05$ (Marhofer et al., 1997). In this study, 95 % of the patients who had received a PNB with ultrasound reported suitable analgesia compared to only 85 % of patients who had receive their PNB with nerve stimulation (Marhofer et al., 1997). Duration was also reported to be 25% longer with ultrasound compared to nerve stimulation, $P < 0.001$ (Abrahams et al., 2009).

There were no major complications reported. Although the total number of incidences was minimal, vascular punctures and transient paresthesias were reported in 4 of the 5 studies. In one study, the incidence of vascular puncture was significantly reduced with ultrasound compared to nerve stimulation, RR 0.16, 95% CI 0.05 – 0.47, P = 0.001 (Abrahams et al., 2009).

Based on the findings, 4 of the 5 studies agreed that ultrasound with or without nerve stimulation increased overall PNB efficacy. The improved success rates were attributed to the provider's ability to visualize the nerves, surrounding structures, needle tip, and spread of injected local anesthetic (Gelfand et al., 2010). As a result, providers who do not routinely perform PNBs are encouraged to use ultrasound (Abrahams et al., 2009). Furthermore, during training, the use of nerve stimulation helps with nerve confirmation (Koscielniak-Nielsen, 2008).

Credentialing Environment

The credentialing environment includes recommended activities that prepare the CRNA for peripheral nerve block administration. Upon completion of these activities and through recognition of professional and technical competence, CRNAs may then request practice privileges.

- Clinical experts in the field of regional anesthesia are identified. These experts are committed to supporting staff in performing peripheral nerve blocks in the clinical setting.
- The current delineation of CRNA privileges at the unspecified Southern California HMO facility was considered.

- The American Society of Regional Anesthesia's education and training recommendations in ultrasound guided regional anesthesia were evaluated.
- Data related to the annual number of surgeries performed at this Southern California HMO facility beginning with the period January 1, 2013 and ending December 31, 2013 was collected. Based on this data, clinical experts determined the number of procedures that would benefit from peripheral nerve blocks.
- Based on knowledge obtained from the activities above, and from clinical experts' opinions and experiences, the most common types of peripheral nerve blocks applicable to this surgical setting were determined.
- Strategies for successful implementation of peripheral nerve block administration at the clinical level are recommended. Proctoring, performance-based reviews, and re-credentialing guidelines are included.
- Educational preparation and continuing education proposed for preparation of CRNAs to perform peripheral nerve blocks include (a) an interactive computer-based module made available to staff through iBook, (b) a recommendation for CRNAs to attend regional workshops and to obtain continuing education units, and (c) a referral to the American Association of Nurse Anesthetists website to identify appropriate continuing education programs.

Credentialing and Core Privileges

On a global scale, the educational requirements between the two types of anesthesia providers may differ, but the services they provide often overlap and are at times difficult to distinguish. The CRNAs scope of practice is clearly outlined and unobstructed by state law because of California's opt-out. However, everyday practice is affected by a hospital's policies and procedures (Kalist, Molinari, & Spurr, 2011). In order to successfully negotiate a practice change at this southern California HMO facility, data found for each of the PARIAHS environments and elements of the credentialing and privileging process must be compiled into a recommendation to support CRNA practice to include peripheral nerve blocks.

The American Association of Nurse Anesthetists (AANA) issued *Guidelines for Core Clinical Privileges for Certified Registered Nurse Anesthetists* to assist hospitals' Credentialing Committees in delineating CRNA practice privileges. The process providers must complete to become credentialed within a health care facility to deliver care is known as clinical privileging. Credentialing describes the acknowledgement of professional and procedural competency, and the standards used to evaluate a provider requesting clinical privileges (AANA, 2015).

Core privileges outline the extent to which CRNAs are permitted to practice within a clinical setting, and are dependent on the provider's training, knowledge, and ability. Core privileges are managed and approved by the hospital's Credentialing Committee (AANA, 2015). Privileges should reflect the vast array and intricate nature of CRNA practice. Therefore, CRNAs should be privileged to perform fundamental procedures and designated activities. As stated in the AANA guidelines (2015), privileges "should not be overly restrictive."

The AANA's recommended core clinical privileges include preoperative patient assessment, intraoperative patient management, postoperative patient care, and other clinical tasks. Under each category, the functions of the CRNA are listed and can be seen on the AANA website. In regards to this project, and listed under the intraoperative patient management category, the AANA recommends that the CRNA perform and manage epidurals, spinals, all types of peripheral nerve blocks, intercostal blocks, ocular blocks, and local infiltration blocks.

The AANA recognizes that the core privileges they recommend are only guidelines. Based on organizational needs, each health care facility will determine the privileges and duties of their providers (AANA, 2015). However, the AANA also encourages CRNAs to maintain responsibility for requesting clinical privileges, and to maintain knowledge related to current anesthesia practice. As a result, CRNAs are required to obtain continuing education units and reapply for re-credentialing every 2 years.

Standardized Procedure Guidelines

California's Board of Registered Nursing's (BRN) Article 7 recommends that health care organizations prepare standardized procedure guidelines. As seen in Appendix D, the guidelines are intended to safeguard clients and to provide consistency in procedure development (BRN, 2011). Standardized procedures refer to a hospital's policies and protocols that are developed to regulate provider performance, functions, and activities. The provider can only function at the capacity outlined in the standard procedure policy. The provider must also show proof that he or she is educated, trained, and competent to perform the specified duties (BRN, 2011).

The BRN's standardized procedure guidelines must be considered when analyzing the southern California HMO's current delineation of privileges for CRNAs.

The guidelines must also be studied when constructing a standardized procedure policy for CRNAs to perform peripheral nerve blocks (see Appendix E).

Current CRNA Privileges

The southern California's HMO's policy and procedure section regarding the CRNA scope of practice adhere to the BRN's standardized procedure guidelines (see Appendix D). The functions of the CRNA are clearly stated. In general, the CRNA is privileged to perform the following: Perform a preoperative assessment of the surgical patient. Collaborate with the attending anesthesiologist to determine the appropriate anesthetic and technique for the patient's procedure. Perform and manage the anesthetic care during the intraoperative period to maintain the safety of the patient. These functions include tracheal intubation, blood and fluid loss management, cardiovascular and respiratory support, and the identification of irregular patient reactions to anesthesia.

The policy states that the patient's anesthetic care is the overall responsibility of the attending anesthesiologist. In addition, the CRNA is required to show evidence of certification and licensure, as well as competence in the duties performed. Lastly, the Chief of Anesthesia is responsible for approving specific CRNA privileges.

In regards to procedures and proctoring related to regional anesthesia, the CRNA is observed and evaluated by the Chief Anesthesiologist or a designated proctor performing a minimum of 20 regional blocks. The proctor signs and dates the proctoring form if the CRNA performed the procedure adequately. Otherwise, if improvement in CRNA performance is needed, immediate feedback is given and documented. Once twenty proctored forms documenting competence are completed, the Chief of Anesthesia reviews the forms and submits a request for CRNA privileges. Currently, CRNAs are privileged to perform and manage spinal and epidural anesthetics for surgical and laboring patients without physician supervision. However, CRNAs are not privileged to administer peripheral nerve blocks.

HMO Facility Data

At this southern California HMO facility, CRNAs are not privileged to administer PNBs. Set aside the debatable organizational barriers, which are possibly preventing CRNA privileging in ultrasound-guided regional anesthesia, the primary reason stated was the lack of opportunities to maintain provider proficiency. In order to determine whether enough opportunities to maintain proficiency exist, unidentified data related to the number of surgical procedures performed from January 1, 2013 to December 31, 2013 was obtained and assessed with consent from the Department of Anesthesiology administrator (see Appendix F). Additionally, an evaluation of the yearly data would help identify surgical patients who would possibly benefit from PNBs.

During the year 2013, there were 12,065 total surgical procedures performed in the main operating rooms and the minor procedure room. The numbers of cases were categorized by anesthesia type. Twelve hundred of those surgical procedures involved regional anesthetics. In order to calculate the number of peripheral nerve blocks performed, anesthesia cases identified by the terms “block,” and “nerve block” were added together. Based on the criteria, 48 peripheral nerve blocks were performed during the year. Two hundred seventeen retrobulbar blocks were excluded because the ophthalmologists perform the blocks in the operating room. The data collection methodology is a limitation, which may explain the low number of PNBs recorded. A single data collector reads the charts, identifies the surgical procedures, notes the types of anesthetics administered, and inputs the findings into a database.

Regional anesthesia experts, an anesthesiologist and a CRNA, evaluated the data by pairing the surgical procedure to the type of peripheral nerve block that would be appropriate to perform. Based on the experts' evaluation, there were more than 2,527 opportunities for PNBs to be performed at this facility. Once patient contraindications, patient refusals, surgeon rejections, and other operating room factors are considered, the actual number of PNBs that would be performed could potentially decrease.

Two hundred twenty-nine vascular cases, which included arteriovenous grafts and carotid endarterectomies, were excluded because vascular surgeons in this facility administer the local anesthetic directly. However, the regional experts acknowledged that anesthesia providers should be performing brachial plexus, and superficial and deep plexus blocks for these types of procedures. The regional experts also identified 373 breast cases that could potentially benefit from paravertebral blocks. Ultimately, these breast cases were excluded because of the risk-benefit ratio of the peripheral nerve block.

The largest number of PNB opportunities was in orthopedics. The other surgical services that could have benefited from PNBs included general surgery, obstetrics, and gynecology. Based on the common types of surgical procedures being performed, the regional anesthesia experts recommended the following types of peripheral nerve blocks: transverse abdominis plane block, popliteal block, femoral block, hypogastric block, brachial plexus block, ankle block, digit block, lumbar plexus block, sciatic block, and axillary block.

The discrepancy between the possible PNBs that could have been performed and the actual number of PNBs that were performed supports that there are sufficient PNB opportunities to maintain provider proficiency. Surgical patients who could benefit from having a PNB are being missed. Privileging CRNAs to perform PNBs could close this gap. With access to more anesthesia providers who are readily trained to perform PNBs, there would be an increase in the number of potential patients being identified and more opportunities for patients to receive PNBs. Through informal discussions, many CRNAs at this southern California HMO facility have expressed interest in performing PNBs. Although many of them had training in school related to PNBs and nerve stimulation, very few have had recent exposure to performing PNBs and ultrasound use. Referencing the American Society of Regional Anesthesia and Pain Medicine and the European Society of Regional Anesthesia and Pain Therapy Joint Committee's recommendation for a postgraduate pathway, a PNB pilot program is recommended to educate and train practicing CRNAs to administer PNBs (Sites et al., 2009).

A Plan for Practice Change

In order to successfully implement privileging for CRNA administration of peripheral nerve blocks at this Southern California HMO facility, a plan to initiate a pilot PNB program related to the education and training of CRNAs in practice is recommended. The benefits of a dedicated program include the following: Increased CRNA exposure to PNB procedures, increased numbers of patients identified as PNB candidates, and increased numbers of actual PNBs performed annually. A proposed policy summarizing the criteria-based mechanisms, used to evaluate competence, is included (see Appendix E).

Two regional anesthesia experts, including an anesthesiologist and a CRNA, have agreed to serve as Ultrasound-guided Regional Anesthesia (UGRA) coordinators and will lead the pilot program. They will choose three CRNAs to begin UGRA training.

CRNAs will be chosen based on their years of experience, interest in performing peripheral nerve blocks, safety record, and any other criteria deemed necessary by the UGRA coordinators. Limiting the number of initial trainees is intentional and required to ensure both the appropriate supervision of trainees, and the safety of patients.

Successful PNB administration requires theoretical knowledge and hand-eye coordination. Using clinical experience and knowledge, the UGRA coordinators categorized the PNBs into groups based on the required skill level of the trainee and the degree of difficulty to perform the PNB (see Table 1). Factors associated with PNB difficulties are deep nerve depths resulting in poor image resolution and difficult needle visualization; small nerves which are difficult to identify; and proximity of the nerve to other anatomical landmarks with the potential to produce serious harm (Sites et al., 2009).

Table 1

Level Of Expertise Associated With Type of Peripheral Nerve Block.

Beginner level	Intermediate level	Expert level
Axillary brachial plexus	Interscalene	Continuous catheters
Femoral	Supraclavicular	Infraclavicular
Saphenous	Transverse abdominis plane	Lumbar plexus
Sciatic/Popliteal	Ilioinguinal	
Ankle		
Digital		

As a means of reducing PNB complications and improving trainee success, the UGRA coordinator will determine on a case-by-case basis whether ultrasound-guidance or ultrasound-guidance with a nerve stimulator will be used to identify target nerves and anatomical landmarks. Reports indicate that inexperience with ultrasound can cause novice providers to misread ultrasound images (Antonakakis et al., 2011). Therefore, with a history of effectiveness and safety, nerve stimulation is recommended as a secondary training adjunct. By generating an observable muscle twitch associated with a specific nerve, nerve stimulation helps confirm target nerves.

Program responsibilities of the UGRA coordinators include, but are not limited to, the following: The UGRA coordinators will recommend UGRA workbooks, online didactic websites, and regional workshops as part of a structured teaching curriculum. Through the Kaiser School of Anesthesia, Jenn Thompson's CRNA, DNP interactive-computer based module will be made available to trainees. The benefits of interactive-computer training are 24-hour access, increased trainee participation and knowledge recall, and the potential to be cost-effective by reducing the need for additional trainers.

In a simulation workroom or nonclinical location, UGRA coordinators will help trainees develop technical skills. The UGRA coordinators will provide in-services related to the proper handling and maintenance of the ultrasound equipment. Using trainees or other volunteers, they will recommend and demonstrate ultrasound-scanning techniques pertaining to each type of PNB. Additional simulation training offered through outside agencies would be required to enhance the trainee's needling skills.

In the patient setting, the UGRA coordinator and the trainee will collaborate and agree on eligible PNB patients and the type of PNB to be administered. The UGRA coordinators will proctor all trainee administered PNBs, and provide immediate feedback related to trainee performance. The UGRA coordinators will also evaluate the trainee's competency and determine when the trainee is ready to be advanced to a more difficult type of PNB. Based on the proctored results, the UGRA coordinators and the Chief

Anesthesia will recommend granting of privileges to the hospital's Credentialing Committee.

CRNA trainees will be required to show initiative and self-direction. They will be required to attend regional anesthesia workshops, seminars, and conferences where emphasis is placed on ultrasound-guided peripheral nerve blocks and simulation training. In addition, trainees will need to participate in quality improvement projects. This may include participating in journal clubs related to PNB research, keeping logbooks related to complications and successes, and presenting at monthly meetings regarding case studies. In order to request privileges to administer PNBs, CRNA trainees will need to complete the core competencies summarized in the PNB policy (see Appendix E). If privileges are granted, CRNA trainees will need to maintain skills and knowledge by actively performing PNBs in the clinical setting and by obtaining continuing education units.

Lastly, the pilot program's success is dependent on support from leadership and departmental staff. By demonstrating the benefits of CRNA administered PNBs to the organization and the patients, the required support can be obtained. Through increased operating room output, successful patient outcomes, and savings in other areas, the initial startup cost of the program can be offset (Tan, Chin, & Chan, 2010). In addition, CRNA PNBs can prove to be a valued service.

CONCLUSION AND RECOMMENDATIONS

Conclusion

At a time when health care is at a crossroads, and hospital metrics are transitioning to patient-centered outcomes, regional anesthesia and the advancement of ultrasound technology are giving consumers access to an alternative anesthetic technique. The foundation for PNB success is embedded in ultrasound's functionality. Ultrasound allows the user real-time imaging of the needle tip's position in relation to the nerves and the surrounding anatomical structures, the ability to visualize the injection of local anesthetic, and the capability of repositioning the needle tip if necessary (Brodsky & Mariano, 2011). By comparing peripheral nerve blockade to general anesthesia and central neuraxial blockade, anesthesia providers have reported the potential benefits of peripheral nerve blocks.

For many patients, the fear of needles, the idea of being awake in the operating room, and the thought of nerve injury, often causes them to choose general anesthesia over regional anesthesia (Thomas et al., 2011). However, when the two anesthetic techniques were compared, studies show that patients who received peripheral nerve blocks had fewer episodes of intraoperative hemodynamic instability, less complaints of pain, and fewer requests for additional analgesics (Liu et al., 2014). There were also fewer complaints of nausea and vomiting, as well as quicker recovery times from the systemic effects of anesthesia, and therefore, shorter stays in the postoperative unit (Liu et al., 2005). General anesthesia did, however, have the distinct advantage of being quicker to induce/perform than peripheral nerve blockade (Liu et al., 2005).

Comparison studies between peripheral nerve blocks and central neuraxial blockade confirmed that the complication rates of both techniques are rare. In a study of 158,000 regional blocks, 77 serious complications were reported. Cardiac arrests and respiratory failures were more common in spinals, whereas, seizures and peripheral nerve injuries were more prevalent in peripheral nerve blocks (Auroy et al., 2002). Otherwise, studies had mixed results in determining whether lower extremity peripheral nerve blocks were better than epidurals and spinals. The distinct advantages of lower extremities blocks were less risk of urinary retention and earlier ambulation times related to the contralateral leg not being affected by the PNB (Vloka et al., 1997).

Furthermore, the elderly and the obese are two groups of patients that potentially benefit from peripheral nerve block administration. Often associated with co-morbidities, the elderly are at an increased risk for postoperative complications, and mortality. In a study comparing the quality of PNBs to general anesthesia, a group of elderly patients undergoing total knee arthroplasty with a PNB experienced less cognitive effects than those who had general anesthesia. As a result, the PNB patients returned back to baseline functioning more quickly (Liu et al., 2014).

Obese patients are also at risk for anesthetic complications because of structural changes. PNBs can help obese patients avoid the systemic effects of general anesthesia, however, they can be challenging to perform. Despite having marginally slower performance times and slightly lower success rates compared to non-obese patients, studies show that ultrasound-guided PNBs can be safely performed in obese patients with negligible complications (see Appendix C6).

Overall, ultrasound has improved success rates, improved safety, and increased satisfaction related to peripheral nerve blocks. Multiple studies show that improved success and safety are associated with the provider's ability to visualize the nerves, surrounding structures, needle tip, and spread of injected local anesthetic (Gelfand et al., 2010). In addition, patients with ultrasound-guided PNBs express greater satisfaction because they have better pain relief, fewer complications, less nausea and vomiting, and speedier recoveries as compared to other anesthetic techniques.

Studies also validate the use of ultrasound in PNB training. With ultrasound, PNB administration is no longer a "blind" procedure performed independently by a trainee. Both the supervisor and the trainee view ultrasound images simultaneously, which enables the supervisor to assist with needed corrections prior to local anesthetic injection (Abrahams et al., 2009). As a result, ultrasound has improved the success rates, and the performance times of novice providers. The learning curve is rapid with practice and feedback (Sites et al., 2004).

Ultrasound has also been shown to improve proficiency. Residents, who performed interscalene PNBs, obtained proficiency after 15 trials. According to Rosenblatt et al. (2003), proficiency mirrors a provider's confidence level. Although the exact number of PNBs required for competency is debatable, a study using human cadaver models showed that 28 PNBs were required (Barrington et al., 2012). According to the American Society of Regional Anesthesia and Pain Medicine and the European Society of Regional Anaesthesia and Pain Therapy Joint Committee the ability to master ultrasound-guided regional anesthesia is extremely individualized so the exact number of procedures required to attain proficiency is unknown (Sites et al., 2009).

Although ultrasound appears to be superior to nerve stimulation, ultrasound use is heavily operator dependent (Fowler et al., 2008). The practitioner must not only have knowledge of human anatomy, but also the capability to accurately read ultrasound images (Sites et al., 2009). Therefore, novice providers are encouraged to use nerve stimulation as adjunct while training (Orebaugh et al., 2007). Once proficient, providers must maintain proficiency by continuous practice in the clinical setting.

As a consequence of the rapid growth in ultrasound technology and its incorporation into the in the field of regional anesthesia, the anesthesia community acknowledges that many providers have not received formal training in ultrasound-guided regional anesthesia. Currently, anesthesia providers gain knowledge and training from other colleagues, regional workshops, and online courses. In order to address this training deficiency, accredited anesthesia programs are required to incorporate ultrasound into their curriculum by 2015 (Council on Accreditation, 2015).

The Council on Accreditation practice standards requires CRNAs to be educated and trained in the broad spectrum of anesthesia practice, which includes regional anesthesia. Centered on the NBCRNA's examination content outline, regional anesthesia is viewed as an entry-level, job-related practice requirement, making it a necessary component of CRNA certification and licensure. CRNAs at this southern California HMO facility are privileged to perform spinal and epidural anesthetics, but are not privileged to perform PNBs. The reason given for not privileging CRNAs is that there are not enough opportunities to perform PNBs to maintain provider proficiency.

Based on the data collected from this facility for the year 2013, the rationale preventing CRNA privileging is unfounded. Estimates show that there were over 2,500 potential patients who could have possibly been offered a PNB for their surgical procedure. The recommendation to privilege CRNAs to perform PNBs is a necessary practice change at this facility. First, privileging would increase patient access to receive PNBs and the benefits PNBs have to offer. Second, privileging would give CRNAs, at this facility, an opportunity to grow professionally. The recommended pilot program is a pathway that would enable CRNAs to be re-educated and re-trained to perform PNBs under the supervision of regional experts. Furthermore, using standardized procedural guidelines, would not only ensure the safety of patients, but also provide trainees an outline of required competency skills that need to be completed prior to privileging.

Recommendations

Propose the implementation of the practice change by presenting an executive summary (Appendix E) highlighting the evidence in each of the PARIHS environments along with the proposed policy for CRNA credentialing to perform PNBs. This should be presented to the Anesthesia Department administrators and medical director, anesthesia staff, and to other involved parties in practice decisions within the hospital.

Evaluate the pilot program by (a) anesthesia provider review of the competence of CRNA’s completing the training process for peripheral nerve block privileging, (b) assess patient safety and satisfaction with peripheral nerve blocks to include, but not limited to, the post-surgical review of ambulatory patients the day following discharge, and (c) review if sufficient peripheral nerve block cases are available for privileged providers to maintain competence.

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APPENDIX A

THE COUNCIL ON ACCREDITATION'S CLINICAL REQUIREMENTS

CLINICAL EXPERIENCES	Minimum Required Cases	Preferred Number of Cases
METHODS OF ANESTHESIA		
General anesthesia	350	
Induction, maintenance, and emergence		
Intravenous induction	200	
Inhalation induction	10	25
Mask management	25	40
Laryngeal mask airways (or similar devices)	25	40
Tracheal intubation		
a. Oral	200	
b. Nasal		10
Total intravenous anesthesia	10	25
Emergence from anesthesia	200	
Regional techniques		
Management	30	
Administration[2] (total of a, b & c)	25	
a. Spinal		50
b. Epidural		50
c. Peripheral		40
Monitored anesthesia care	25	50

[2] Students must have experience in each category.

Excerpt taken from the Council on Accreditation (2015). *Accreditation standards, policies, and procedures.* Retrieved February 1, 2015, from http://www.home.coa.us.com/accreditation/

APPENDIX B

THE NBCRNA'S NATIONAL CERTIFICATION EXAMINATION CONTENT OUTLINE

NBCRNA National Certification Examination (NCE) Content Outline

III. Basic Principles of Anesthesia (30%)
- A. Preoperative assessment and preparation of patient
- B. Fluid/blood replacement
  1. Fluid therapy (crystalloids and colloids)
  2. Hemotherapy (blood component therapy)
- C. Positioning (Technique, Physiologic alterations, Complications)
  1. Prone
  2. Supine
  3. Lithotomy
  4. Lateral
  5. Sitting
  6. Beach chair
  7. Trendelenburg
  8. Reverse Trendelenburg
- D. Interpretation of data
  1. Lab tests
  2. Diagnostic data
  3. Intraoperative monitoring data
- E. Airway management, including difficult airway
  1. Mask
  2. Cricothyrotomy
  3. Fiberoptics
  4. Intubation
  5. Supralaryngeal management
- F. Local/regional anesthetics (Technique, Physiologic alterations, Complications)
  1. Infiltration
  2. Topical
  3. Regional blocks
     - a. Subarachnoid block
     - b. Epidural block
     - c. Combined spinal/epidural
     - d. Caudal block
     - e. Brachial plexus block
     - f. Airway blocks
     - g. IV regional (Bier) block
     - h. Retrobulbar/peribulbar block
     - i. Ankle block
     - j. Digital block
     - k. Wrist block
     - l. Sciatic block
     - m. Femoral block
     - n. Popliteal block
  4. Ultrasound guided nerve block
  5. Nerve stimulator guided nerve block
- G. Monitored anesthesia care/conscious sedation

Excerpt taken from the National Board of Certification & Recertification for Nurse Anesthetists (2013). *120th National certification examination (NCE) candidate handbook*. Retrieved February 1, 2015, from http://www.nbcrna.com/certification/

APPENDIX C

TABLES OF EVIDENCE

Table C1

The Role of Ultrasound in Peripheral Nerve Block Training

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Assess residents' learning curves r/t US PNB (Baranauskas et al., 2008)	Randomized control study Variables: Performance time Amount of US training	9- Residents (Yrs 1-3) 3- Groups: Each group had 1 resident from each year of residency Group 1: Received information r/t US and PNB techniques, 2 hrs training w/ model Group 2: Received information r/t US and PNB techniques, 1 hrs training w/ model Group 3: Received information r/t US and PNB techniques, no training Model: Olive, dark agar layer (4 cm) Experienced MDAs supervised Hospital Sao Paulo	3- Attempts Tasks: Structure visualization, needle tip contacting olive, needle tip repositioning Flaws: improper visualization, incorrect needle placement, incidental needle contact w/ bowl Evaluations made by independent blind observer	Performance times: Group 1: (37.63 sec) w/o flaws Group 2: (64.40 sec) w/ 2 flaws Group 3: (93.83 sec) w/ 12 flaws	More training = more confidence = better performance Model used: reproducible and inexpensive Limitations: Few subjects No statistical analysis No pre- and post resident evaluations to compare

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Use CADS model to quantify number of procedures novices needed to perform = competency Use predefined scoring system in US needle skills (Barrington et al., 2012)	Randomized control study Observational Variables: competency, number of procedures performed, time to complete procedure.	9 frozen/thawed CADS 15 random, novice anesthetists with < 5 US PNBs performed. Technique demonstrated & supervised by lead researcher 14- month period. Participants performed 30 sciatic PNB with 15 min break after 10^{th}/20^{th} attempt.	Time to complete procedures recorded. Competency evaluation: US needle visibility (0 = TV, 1 = TPV, 2 = TPVS x2, 3 = TPVS x3) Probe steadiness (0 = Steady, 1 = Unsteady) Tip visible @ injection (0 = TV, 1 = TNV) Learning curve = CC AFR = 10%, UFR = 20%. Below h0 = PRO, above h1 = not PRO, h0 to h1 = Undetermined	Pro (n = 6), not Pro (n = 5), Undetermined (n = 4) Mean # trials (28) = competency No Statistical Sig: Trial # & reduced procedure time Statistical Sig: Needle Visibility & injection Participants recruited later in study had better success rate (*P* < .001)	Competency: 28 supervised trials needed Participant success r/t supervision and feedback PNB success r/t visibility of needle and LACS Limitations: Inappropriate LACS CADS availability CC must include correct input parameters

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Determine whether US + NS versus NS alone influences success rates and performance times of residents performing Po PNBs (Cataldo et al., 2012)	Randomized control study Prospective Variables: Outcomes (PNB success rate, SB onset, performance time) Groups: US + NS versus NS alone Resident's education	70- PTs, hallux valgus surgery, Po PNB, randomized to US + NS or NS alone, April 2008 – June 2009 IC: Age ≥ 18 yrs, ASA < III, BMI < 30 EC: PT refusal, Neuro. Dz, infection at site, Coagulopathy 2- 2nd year residents w/ NS experience; No US or Po PNB experience, given US didactic, 2 days US training Supervision: 2- MDAs w/ PNB experience US: 7.5 – 12 MHz probe NS: 21 gauge needle, 0.4 mA current Technique: Injection at Tibial and Peroneal nerves Solution: 0.75% RV (10 ml) and 2% LC (10 ml)	Time to perform PNB: T1 = Tibial PNB time (Needle to Tibial LACS) T2 = Peroneal PNB time (Tibial PNB to Peroneal LACS) Time of PNB onset: SB and MB assessed q 5 min for 30 min SB quality (used ice): 2 - Normal, 1 – Partial, 0 – Complete MB function: 2 – No change, 1 – Partial, 0 – complete loss Rate of PNB success: No sensation after 30 min LACS and no pain during surgery PT satisfaction rated: VS, S, USF Statistical analysis: Student's T-test, Mann-Whitney, Chi-square, (*P* < 0.05)	No Sig. US + NS versus NS alone in rate of success and time of SB onset (*P* > 0.05) Performance time Sig. improved in US + NS than NS alone (*P* < 0.05) US: Tibial = all visualized Peroneal = 31 visualized 2- PTs required GA MB at 30 min: US + NS (85.7% PTs) > NS (62.8%); (*P* < 0.05) No complications Satisfaction: (US + NS > NS) US + NS: VS (68.5%); S (25.71%); USF (5.71%) NS: VS (42.85%); S (34.28%); USF (22.85%)	US did not change success rate, but improved resident's performance time r/t PNB administration Efficacy (94.2%) both techniques High satisfaction r/t reduced block time Limitations: Small sample = difficulty identifying complications; results may differ w/ larger sample Difficult to compare r/t variability in resident's skill/experience Bias r/t resident's NS experience and their US learning curve

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Develop objective assessment tool Detect training gap in UGRB (Cheung et al., 2012)	Delphi method Variables: Assessment tool for UGRB Reviewers' feedback obtained via questionnaires	2 authors educated in UGRB wrote 30 item Cklist r/t performance in UGRB 18 reviewers: anesthetists/educators, > 6 yrs experience in UGRB, dedicated UGRB program 6 independent teaching centers in Canada/USA	1st round: Score Cklist - yes (inclusion) or no (exclusion) 5 point Likert scale: (0 - extremely irrelevant, 1 - irrelevant, 2 - neutral, 3 - important, 4 - extremely important) Cklist revised via feedback & resent for 2nd/3rd rounds. Priori decision: exclude items < 20% supported	1st round: 18 completed, 13 new items added. Suggestions included change phrasing, add elements, and combine groups 2nd round: 15 completed, no new items added, 4-items removed (1 < 20%, 3 were redundant) Suggestions: focus on UGRB specific skills 3rd round: 10 completed, 4 of 6 teaching centers, combined 3 items in 1, 2 items removed 22 item final Cklist	Delphi method nullified peer influence. Based on opinion not EBP 2nd/3rd round = item refinement. Dropout rate r/t convergence to consensus OAT eliminate bias, generalized to all UGRB, detect gaps in training Future study needed to validate Cklist for usability, reliability, and learning outcomes

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Assess needle insertion/placement using US in posterior technique (Geffen et al., 2007)	Prospective, Observational study Variables: Correct needle placement US	21- PTs, ASA I – II, shoulder/upper extremity surgery, BPB w/ GA 4- residents w/ no experience Supervisor: 2 yrs. UGRB experience Patient position: Sitting, head flexed, done in PNB room	Needle entry: 3 - 3.5 cm from midline, sagittal plane, level Cricoid. Initial current: 1 mA, pulse duration .1 ms Correct placement: current < 0.5 mA, needle depth noted SB: pinprick C3 - T1 (0 - Normal, 1 - Partial, 2 - None) MB: ABD shoulder, elbow flexion (0 - Normal, 1 - Partial, 2 - None) Postop pain scale: 10 cm VAS PT satisfaction 4- point scale: (0 - VUS, 1 - USF, 2 - S, 3 - VS) Complications: Horner's, dysphonia, dyspnea, and LAST	Accuracy (median range) = 2 attempts LACS r/t US: 1st 7- PTs volume = .5 ml/kg, the remaining PTs volume reduced to .25 ml/kg 20/21 (95%) PTs had successful blocks r/t LACS Postop pain score: 1.8	US for BPB (posterior approach) valuable LM easily seen/less complications using US US can lead to reduced local anesthetic use US when teaching trainees to perform PNBs improves success rate Limitations: Larger study needed to show US advantages over non-US techniques

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Assess usefulness of US in teaching residents epidural anesthesia (Grau et al., 2003)	Randomized control study Prospective Variables: Outcome (Success rate) Learning curve Groups: US, LOR	600 OB epidurals performed by residents Resident experience: 10 – 30 SAB; 5 – 16 epidurals 2 Groups: LOR: Braun (17 gauge Tuohy) US: Pre-identification of entry point, distance and direction of needle insertion, followed by LOR technique (5.0 MHz curved probe) Supervision by 1 MDA EC: No consent, emergencies, contraindications to OB epidurals	Success = Sufficient OB epidural, < 3 attempts, VAS < 1, no change in technique Failure: Supervisor involvement Statistical analysis: Chi-squared, Student's t-test	LOR: 10 epidurals = 60% success rate; 50 epidurals = 84% success rate US: 10 epidurals = 86% success rate; 50 epidurals = 94% success rate Constant increase in learning curve Success rate: US > LOR ($P < 0.001$)	Success rate improved w/ US over LOR Learning curve: Early growth that levels off Success = 20 epidurals Competency = 45 epidurals US useful for teaching OB anesthesia, can improve knowledge/confidence Limitations: Small study group Learning US and epidurals at same time

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Determine current teaching practice in regional anesthesia Determine prevalence US use in PNB (Helwani et al., 2012)	Cross-sectional survey design Variables: Rate of US use in teaching PNB Surveys	Survey sent via email/postal mail/Survey Monkey to 132 American Board of Anesthesia-accredited residency programs (2010) # Residents determined using FRIEDA. Survey 13 questions: 1st 5 questions r/t # PNB/week, type, technique. 2 questions r/t reasons using/not-using US. Remaining questions r/t US skill acquisition, demographics, and US use in PNBs	Data validated/ outliers using VDFDA 1st 5- questions analyzed for 82 programs Remaining questions analyzed for 80 programs	88% performed > 20 PNB/week 46% performed > 40 PNB/week 50% performed > 10 continuous PNB/week 75% relied on US to guide PNBs 79% used real time US w/o NS 19% used US with NS Providers attained US skills via RA workshops (79%), colleagues (74%), residency (42%), or fellowship (31%)	Response rate 60% US is gold standard in efficacy (36%) & safety (63%), yet only 25% of programs use it as standard of care Barriers: Providers lack training and/or unavailable US equipment Limitations: Responders data only Survey does not evaluate quality/ adequacy training Study reflects 2010 practice

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Evaluate visibility of nerves, structures, and feasibility using UGRB in CADS (Kessler et al., 2013)	Post-test Design Variables: CADS anatomical structure visibility US	12- CADS Age 62-94 yrs 7-female, 5-male Ht. 155 – 176 cm Wt. 40 - 71kg BMI: 14.36 - 25.46 kg/m2 Imaging: 38 mm linear transducer Kessler et al. evaluated CADS using US SEM: (Fixative ingredients/10 1) 0.3 1-Glycerol 85% 0.0625 1-Phenol 90% 9.637 1-Ethanol 96% D2 denatured	US Brachial Plexus: 1) IS, 2) Supra Clv., 3) Infra Clv., 4) Ax US Lumbar/Sacral Plexus: 1) Inguinal, 2) Subgluteal, 3) Popliteal Evaluate visibility of simulated PNB using 10-20 ml NS-UE/ FN 20-30 ml NS-sciatic Evaluate CADS: Used 64 participants, 9- hour workshop with teacher ratio 1:5 Rating scale (1 = no agree, 5 = agree) r/t 5 questions: 1) comfort, 2) realistic, 3) better tool, 4) recommend, 5) ready	Target nerves identified easily. Spread of solution good in each region CADS imaging similar to living PTs 86% of participants answered all questions Mean values of questions: 1) 2.25 (± 1.21) 2) 4.05 (± 1.01) 3) 3.96 (± 1.01) 4) 4.56 (± 0.93) 5) 3.82 (± 1.02) 1year follow up: 72% of participants answered all questions with similar results	Current models: 1) Puncture phantoms 2) hands on workshops. Disadvantages: Not realistic, low durability, high cost CADS models: Advantages: Realistic, better (anatomic variability, spread of solution, visibility of nerves/muscles) Limitations: No Blood flow, low (compressibility, vein imaging) Increased BMI reduces visibility Limitations: Participant background was not clarified

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Evaluate simulator training in UGRB success rates amongst novice providers Determine number of UGRB procedures r/t proficiency (Niazi et al., 2012)	Randomized control study Variables: UGRB proficiency # Procedures performed and/or teaching sessions	30 - 2nd year anesthesia residents between 2008 -2010 at Toronto Western Hospital, University of Toronto EC: Previous UGRB experience, continuous catheters, and CNB Teaching session: 4- ½ hour lectures 2 groups: 1) Simulation: 1 hour w/ trainer prototype, M-turbo US plus teaching session 2) Conventional: Teaching session w/o simulation Both groups observed UGRB	Logbook for successful/failed UGRB over 3 weeks Successful UGRB: Surgical block w/o supplemental PNB, < 15 min, w/o verbal cues Supervisor blinded to groups Chi-square test was used to compare the number of successful blocks in each group. Cusum analysis used to monitor block performance.	20 logbooks returned – 10 in each group Conventional group: 191 PNBs attempted (98 successful) Simulation: 225 PNBs (144 successful) (51% vs. 64%; P = 0.016) Conventional group: 4/10 felt proficient. Average 7 attempts before success SIM: 8/10 felt proficient Average 5 attempts before success (80% vs. 40%; P = 0.0849)	1 hour simulation + teaching sessions = UGRB success & proficiency Reasons: Feedback, improved hand-eye coordination r/t simulation Limitations: Blocks performed not standardized by order or type Only 3- week rotation Unable to determine # PNBs required = proficiency

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Evaluate US + NS on resident's performance times in PNB administration (Orebaugh et al., 2007)	Retrospective study Variables: Outcomes (Performance time, # Needle inserts, # vascular punctures, PNB effectiveness) Types of guidance: NS US + NS Residents	De-identified data in consecutive PNB PTs r/t supervised resident rotation, gathered by principal author over 7 months University of Pittsburgh PNB types: IS, Ax, Fem, PFB NS: needle (25 - 50 mm, 22 gauge), current (0.5 – 0.2 mA), solution (0.5% or 0.75% RV < 40 ml) US + NS: transducer (5 – 10 MHz, 38 linear probe), current (0.5 mA), visualization of LACS 14- Residents: 1st to 3rd year, didactic (NS, US, anatomy), asked to alternate types of guidance (decision made prior to PT interview)	Performance time = start of needle insert to injection of local # Needle inserts = # times needle withdrawn and redirected # Vascular punctures = # times free flow of blood in tubing PNB effectives = SB (touch/pain) and MB (strength) assessed Statistical analysis: Mann-Whitney test, Chi-squared, ($P < 0.05$)	Performance time: US + NS (1.8 min) < NS (6.5 min); ($P <$ 0.001) # Needle inserts: US + NS (2) < NS (6); ($P <$ 0.001) # Vascular punctures: US + NS < NS; ($P =$ 0.03) No difference: Complications, LAST, nerve injury, or PNB failure	UGRB can be performed by supervised residents w/o delays, excess needle punctures, or vascular punctures Valuable to include NS when learning US No obvious advantage of US + NS over NS alone r/t complications Limitations: De-identified data negates valuable variables Investigator bias Small sample size Total time to conduct each type of guidance not collected Learning curves could not be established because specific resident information was not gathered

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Determine impact of resident's experience on time required to administer IS PNB and success rates (Orebaugh et al., 2009)	Retrospective study, Observational Variables: Performance times Success rates Resident's experience over 4- week rotation	University of Pittsburgh 222 consecutive IS PNB PTs 21 Residents: 7- 1st/2nd year (no experience); 12- 3rd year (< 10 PNB); 2- 4th year (< 60 PNB) PNB rotation: Didactic r/t anatomy, NS and US training CADS and PTs Supervised verbal feedback from MDA US: SonoSite NS: (50 mm, 22 gauge), current (<0.8 mA) Solution: 0.75% RV (20 – 25 ml) Study length: 7 months to obtain minimum 45 cases per week	Weekly assessments of outcome variables: Performance time: skin contact w/ US probe to anesthetic injection PNB effectiveness assessed 15 min after LACS SB: Assessed by cold, scale 0 (complete block), 1 (partial), 2 (No block) MB: Assessed by arm strength, scale same as above Failed PNB: Score > 2 or those that required GA or supplemental PNB Statistical analysis: Independent samples t-test, Mann-Whitney, Chi-squared, Fisher's exact test	Success rate: 97.3% (no change over rotation and no difference between residents) PNB failures: 6 (27%); 5 successful re-do's, 1 = GA Paresthesia: 6 resolved cases Image visualization decreased over time; time for needle placement did not Overall performance time decreased (*P* < 0.014)	Residents succeeded 90% in early and late stages of rotation Confirms usefulness of US in training residents Performance time decrease r/t image visualization BMI negatively impacted performance times and success rates Limitations: No resident randomization r/t type of guidance Image visualization was not completely independent, thus impacting performance time

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Identify factors important to learning UGRB as perceived by trainers/trainees Research question: Not specifically stated (O'Sullivan et al., 2011)	Structured, prospective design-based approach Use of FG, SSI, & Questionnaires	Tertiary referral university-affiliated Teaching Hospital (Ireland) PFG: local trainers, trainees, 1 PT (had previous UGRB) = 31 anesthetists practice teaching & learning UGRB Database: 907 anesthetists	PQ (open format, no limit response) led to DQ (series SSI/FG with trainees) DA done after DC Themes identified with determinants grouped that led to questionnaires Emailed November 2009 by Irish COA to database www.surveymonkey.com 1- Email reminder sent 3wks later Survey closure: 1 month	PQR: 94% returned in 5weeks 26/31 fully completed DQR: 113/873 respondents (12.9%) w/ 93 fully completed MID to UGRB: sufficient opportunity (30.9%) MII to UGRB: Insufficient opportunity/time (41.5%)	MID to learning UGRB was frequent exposure to learning opportunities, and appropriate PT, trainee, trainer at same time/setting Worrisome: DQR = 17.6% described self as competent 37.5% trainers ≠ describe self as competent Limitations: DC from SI. RR low: 12.9%

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Determine # IS PNB required by residents to be proficient (Rosenblatt et al., 2003)	Survey design Questionnaire Variables: Questions r/t experience, PT BMI, supervision, PNB effectiveness Residents	Mount Sinai School of Medicine 7/2001 – 2/2002 17- Residents: 1st and 2nd year (5- 2nd years had prior IS PNB knowledge) Supervision: 7- MDAs (2 – 24 PNBs/MDA) Local administered by another provider (40 ml total local anesthetic) Investigator blinded to resident identifiers NS: needle (22 gauge), current (0.42 mA)	Resident experience (how many PNBs performed) PT BMI PNB effectiveness: Success = Effective for surgery w/ minimal sedation	82- IS PNB Resident experience: 1 – 15 IS PNB/resident MDA involvement inversely r/t resident experience Success rate: 96.3% (79/82) Resident experience: 7 – 9 PNB = 50% residents capable of performing solo; > 15 PNB = 87.5% Increased BMI = Increased resident failure 24- hour follow-up = no complications noted	Learning occurs rapidly within 1st 20 trials Residents were successful after 15 PNBs performed Level of confidence essential factor in autonomous administration of PNB and determinant in # PNBs required for proficiency Limitations: No description of resident's confidence level MDA teaching style; comfort level w/ residents

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Evaluate learning curve in UGRB (Sites et al., 2004)	Prospective study Non-experimental Variables: Learning curve Resident performance in UGRB	10- anesthesia residents: 6- male, 4- female, average age (29 ± 6 yrs.), (4- 1st year, 4- 2nd year, 2- 3rd year) Raw turkey breasts: Length = 19 cm Width = 9 cm Skin retracted, olive 4 cm from skin, skin replaced Olive: Length = 1 cm Cavity diameter = 0.7 cm Instruction via 32- item poster and 10- slide power point r/t equipment & technique Anesthesia expert 1 > 300 UGRB Anesthesia expert 2 > 200 UGRB	6 consecutive breast cyst aspirations After each trial, anesthesia expert gave feedback r/t performance Video data measured performance r/t accuracy, time, errors, image quality Data analyzed by anesthesia experts 1 & 2	Average score = 23% & 18% r/t describing components & function of US Average time to complete tasks = 44 ± 9 min Average time for advice = 197 ± 23 seconds Performance time decreased between trials: 2nd = 38%, 3rd = 48%. Collectively, improved accuracy w/ each trial: trial 1 = 31-mistakes, trial 6 = 1-mistake	Learning curve is rapid with practice/ feedback Relevant human error: 7 out of 10 anesthesia residents lost needle location during trial; Noted difficulty in longitudinal plane Failure = Failure to locate structures prior to needle insert Limitation: Turkey breasts model

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Determine whether residents' performance times are improved w/ US + NS compared to NS (Thomas et al., 2011)	Randomized control study Prospective Variables: Performance times Other outcomes (Success rates, complications, PT satisfaction) Residents Type of guidance: US + NS NS	41- PTs, randomized, ASA I – III, shoulder surgery, IS BPB, MAC or GA EC: PT refusal, infection, Neuro disorder, allergy to local Residents: 1^{st} – 3^{rd} year w/ no to minimal experience; MDA supervision Solution: 1.5% MV (20 ml) and 0.75% RV (20 ml) and epinephrine (3 micrograms/ml) Groups: US + NS: probe (13.6 MHz); needle (22 gauge); 40 ml total solution NS: needle (22 gauge); current (< 0.4 mA); 40 ml total solution	Performance time: Skin application US or NS to anesthetic injection Blinded investigator experienced in SB and MB assessments SB: no feeling to cold MB: no arm movement 2- week follow-up r/t complications, PT satisfaction Statistical analysis: Chi-squared; t-tests (grouped or paired); (P < 0.05)	41 PTs: US (22); NS (19) Performance time: US (4.3 min) < NS (10 min), (P = 0.009) SB: US (12 min) < NS (19 min), (P = 0.02) MB: US (20.2 min) < NS (13.5 min), (P = 0.03) Complications: None PNB success: US (95%); NS (91%), (P = 0.63) Satisfaction: Post and 2- week satisfaction: (P = 0.08) PT desire to have same technique: (P = 0.45); US (17/19 PTs) NS (17/21 PTs)	Shorter performance time when residents used US versus NS (5.5 min difference) Faster SB and MB in US decreases operating room costs versus NS PT and surgeon satisfaction are essential Both US and NS are equally mastered and not r/t experience or manual dexterity Limitations: Lack of readily available US equipment and trained staff in all hospitals

Note. AFR = Acceptable Failure Rate; ASA = American Society of Anesthesiologists; Ax = Axillary; BMI = Body Mass Index; BPB = Brachial Plexus Block; CADS = Cadavers; CC = Cusum Curve; Cklist = Checklist; Clv = Clavicular; Cm = Centimeter; CNB = Central Neuraxial Block; COA = College of Anesthetists; DA = Data Analysis; DC = Data Collection; DQ = Detailed Questionnaire; DQR = Detailed Questionnaire Respondent; Dz = Disease; EC = Exclusion Criteria; Fem = Femoral; FG = Focus Groups; FRIEDA = Fellowship Residency Electronic Interactive Database Access; FSTP = Formal Structured Training Program; GA = General Anesthesia; Ht = Height; IC = Inclusion Criteria; IS = Interscalene; Kg = Kilogram; LACS = Local Anesthetic Circumferential

Spread; LAST = Local Anesthetic Systemic Toxicity; LC = Lidocaine; LM = Landmarks; LOR = Loss of Resistance; MA = Milliamp; MAC = Monitored Anesthesia Care; MB = Motor Block; MDA = Medical Doctor of Anesthesiologists; MID = Most Important Determinant; MII = Most Important Impediment; Min = Minute; ML = Milliliters; MM = Millimeter; MS = Millisecond; MV = Mepivacaine; Neuro = Neurological; NS = Nerve Stimulator; OAT = Objective Assessment Tool; OB = Obstetrical; PFB = Popliteal Fossa Block; PFG = Preliminary Focus Group; PNB = Peripheral Nerve Block; Po = Popliteal; Postop = Postoperative; PQ = Preliminary Questionnaire; PQR = Preliminary Questionnaire Respondent; PRO = Proficient; PT = Patient; Q = Every; RR = Response Rate; R/T = Related To; RV = Ropivacaine; S = Satisfied; SAB = Spinal Anesthetic Block; SB = Sensory Block; SEM = Special Embalming Method; SI = Single Institution; Sig = Significance; SSI = Semi-structured Interviews; TNV = Tip Not Visible; TPV = Tip Partially Visible; TPVS = Tip Partially Visible Without; TV = Tip Visible; UFR = Unacceptable Failure Rate; UGRB = Ultrasound Guided Regional Blocks; US = Ultrasound; USF = Unsatisfied; VAS = Visual Analog Scale; VDFDA = Visual Data Frequency Distribution Analysis; VS = Very Satisfied; VUS = Very Unsatisfied; W/ = With; W/O = Without; Wt = Weight; Yrs = Years; ≠ = Did Not; = = Equals/Means; ≥ = Greater Than/Equal To; ≤ = Less Than/Equal To; # = Number; + = Plus.

Table C2

Studies Evaluating Patient Satisfaction Related To Peripheral Nerve Block Anesthesia

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Compare benefits of FSNB to EI (Davies et al., 2004)	Randomized control study Variables: Outcomes (VAPS, RO, PT satisfaction) Types of RA: FSNB, EI	60 PTs IC: ASA I-III, TKR EC: Allergy, refuse consent or tourniquet, failed block Groups: EI: L3-L4, L4-L5, bolus 0.5% BV 7 ml, Inf 0.25% BV FSNB: 3-in-1, current ≤ 0.5 mA, 0.375% BV 55 ml (Both groups received GA, PCA)	PTs assessed postop: D/C from PACU, 6H, 24H, 48H VAPS (100 mm linear) Morphine use PT satisfaction Statistical analysis: VAPS: Significance = 10 mm difference Non-parametric/Ordinal = Mann-Whitney U Parametric = Student's t-test	30 PTs per group (1 – excluded r/t failed epidural block) No significance in performance time Pain scores: FSNB < EI at 24H ($P = 0.004$) Complete analgesia recovery: EI (23/30) > FSNB (16/30); No significance Total RO: No difference Satisfaction: No difference Complications: No difference Urine retention: EI > FSNB	No difference in analgesic benefits Benefits of pre-emptive analgesia not evident Difficulty inserting FSNB catheters EI: Nurses acceptance of PTs high pain levels lead to disappointing results Variable pain scores r/t low PCA use: avoidance N/V, PTs acceptance of pain Many factors affect satisfaction Limitation: Study protocol

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Investigate outcomes, PT satisfaction r/t US SuCBPB (Gamo et al., 2014)	Retrospective review Variables: Outcomes: Success rate, performance time, need for AA, complications, PT satisfaction Type of anesthesia: US SuCBPB	202 PTs: Female (98), Male (104), Age (13 – 82 yrs.), upper limb surgery (left (105), right (97)) US: 12 MHz or 14-6 MHz probe Needle: 23 gauge, 60 mm Solution: 0.75% RV/1% LC (1:1) w/ or without epinephrine (1:200,000)	PT questionnaire: 5 elements (total satisfaction, pain during procedure, comfort level and level of analgesia during surgery, desire to repeat SuCBPB) Scale: VSat, Sat, DSat, VDSat Success defined as no GA or AA required	PT questionnaire: Response rate 142 PTs (70.3%) Desire to repeat US SuCBPB 118 PTs Success Rate: 201 PTs Performance time: 3.9 min Need for AA: 51PTs (25.4%) Complications: Horner's 20 PTs (10%)-transient	US SuCBPB useful Advantage: increased success rate, decreased performance time, minimal complications Disadvantage: Delayed onset time (40-60 min) r/t LACS Limitations: Timing of questionnaire 7 and 14 days postop = erroneous recall

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Determine PT satisfaction and desire to repeat PNB in future surgeries (Ironfield et al., 2014)	Prospective, non-experimental, cohort design Variables: PT satisfaction (desire to repeat PNB in future) r/t PNB	9969 PNB cases (7/1/2011-3/31/2013) IRORA database (Australia/New Zealand) Questionnaire: 11 items Topics r/t information provided, pain, MDA interaction Primary question: Desire to have same anesthetic in similar operation Postop questionnaire given within 2 days direct contact or telephone by independent investigator IC: Age > 17 yrs., received PNB prior to surgery alone or as combination, PNB done by IRORA MDA EC: PNB done after surgery	Primary question: Similar operation, similar anesthetic type (Yes/No) Questionnaire r/t information and interaction scored on 5 point Likert scale: (5-completely Sat to 1-completely DSat) Questionnaire r/t pain scored on 4 point Likert scale: (4-severe to1-none) Statistical analysis: Cronbach alpha Mann-Whitney Spearman correlation ($P < 0.05$)	Questionnaire response rate: 6142 (61.6%) Primary question: Yes (5809) = 94.6% No (333) = 5.4% 90% PTs or > (completely) satisfied w/ provided information and interaction PTs who responded No: Lower scores r/t information and interaction ($P < 0.001$); Motor weakness (moderate/severe); Pain score also low, but low internal consistency (Yes) PT characteristics: Older, male, feeling sedated during PNB administration	Decreased desire to repeat PNB associated with young age, female, pain, complications, block failure PTs perception that PNB improves postop pain Physician interaction is crucial to PT education r/t PNB Limitations: Construct validity (factors possibly missing or not identified) Selection bias No comparative data (no control group)

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Determine PT satisfaction r/t LPSNB for TKR (Luber et al., 2001)	Non-randomized clinical study Variables: LPSNB Outcomes (success rate, PT satisfaction)	87 PTs – consecutive, TKR Subset PT (identify postoperative AA) Dedicated PNB team, PNB room LPSNB used Winnie et al. technique; Labatt approach; NS Solution: 0.5% BV or 0.5% RV w/ epinephrine Duke University Medical Center	Sufficiency of PNB before and during surgery 40 PTs: determine first call for postoperative AA request Telephone survey: PT satisfaction Survey (Yes/No) w/ 7 items noted: Prior surgery; Prior GA, Recall, Pain in surgery, Acceptable postoperative pain relief, Satisfaction w/ PNB, Consider having PNB again	Average age: 60.7 yrs. Average weight: > 84 kg Gender: Male (34%); Female (65%) ASA status: > II 6 PTs required repeat PNB (3 failed) 16 PTs (18%) required GA Success rate PNB alone: 68/87 PTs (78%) Pain relief: 13.2 hours average duration 99% PTs took survey; 92% w/ prior GA experience thought LPSNB recovery was easier; 33 PTs thought LPSNB superior 92% overall satisfaction PTs who would agree to LPSNB again: 95% Failure rate: 22% for surgery	PT satisfaction associated to duration of PNB (> 13 H pain relief), early physical therapy, and minimal bladder catheterization, decreased nausea

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Determine if PuNB provide better PT analgesia for hemorrhoidectomy than GA (Naja et al., 2006)	Prospective, Randomized study Variables: Outcomes (Postoperative pain, opioid consumption, PT satisfaction, length of stay) Type of anesthesia: GA or PuNB w/ NS	80 PTs, age (20 – 69 yrs.), hemorrhoidectomy Groups: GA (40 PTs); PuNB w/ NS (40 PTs) EC: CRF, Coagulopathy, BNO, Not able to do phone follow-up GA: Fentanyl, propofol, atracurium, sevoflurane, nitrous, oxygen PuNB: Lithotomy, 22 ga NS, current 0.5-0.6 mA Solution: 2% LC (6 ml), 2% LC (6 ml) w/ epinephrine (5 mcg/ml), 0.5% BV (5 ml), fentanyl (50 mcg), clonidine (150 mcg) Data gathered by RN (blinded to groups)	SB: Pinprick VAPS: None (0); Worst (100) at (6, 12, 24, 36, 48 H) and (3, 4, 5, 6 days) r/t rest, walking, sitting After hospital D/C: Record days before resuming ADLs without pain Level of satisfaction done w/ 1 month telephone follow-up Questions r/t Sat, moderately Sat, DSat; Consider having PuNB again or recommend PuNB N/V and complications recorded Statistical Analysis: Student's T, chi squared, ANOVA (P < 0.05)	Postop VAPS, opioid consumption, fewer days r/t pain, quicker D/C: PNB < GA (P < 0.0001) Overall satisfaction, consider having PNB again: PNB PTs (94.3%) > GA PTs (32.4%); (P < 0.0001)	PuNB = adequate for surgery PTs w/ PuNB have less postop pain, require less postop pain medicine, are discharged earlier, and return to ADLs sooner. Duration of pain relief r/t pre-emptive analgesia Limitations: PuNB technique resulting in high failure rate Blinding is difficult

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Determine whether FNB w/ GFNB offers superior analgesia than SAB to PTs having LSVS (Vloka et al., 1997)	Randomized control study Variables: Outcomes: Pain related components, complications, and PT satisfaction Type of anesthesia: SAB or FNB w/ GFNB	68 PTs total having LSVS 36- FNB PTs, supine, 22 ga 50 mm needle, current ≤ 0.4 mA 3% CPC (30 ml) and 1% LC (7 ml) 32- SAB PTs, sitting, midline, L3-4, pencil point (24 ga, 90 mm), 5% hyperbaric LC (65 mg), supine, SB assessed (10 min after) All blocks done in operating room, same surgeon for procedures, D/C done by blinded MDAs and RNs PACU AA: Morphine SSU AA: Tylenol w/ codeine	PACU: Nausea/pain q 15 min PACU time: Admitting time to D/C to SSU SSU: D/C criteria (vital signs, ADLs, N/V) SSU time: Admitting time to D/C home Hospital time: In operating room to D/C home 24H follow-up done by blinded MDA Questions r/t experience, pain, complications PT satisfaction assessed: Consider having anesthetic type again or endorse it (yes or no)	AA requirements in surgery: FNB > SAB (*P* < 0.001) Longer recovery (PACU and SSU) for SAB PTs Pain requiring AA before D/C home: FNB < SAB (*P* < 0.05) Back pain: 17 SAB PTs (53%) versus 3 FNB PTs (8%); (*P* < 0.001) Headache: 5 SAB PTs (16%) versus 0 FNB; (*P* < 0.01) PT satisfaction: 36 FNB PTs = yes 6 SAB PTs = no (*P* < 0.01)	FNB led to quicker recovery, reduced complications, improved PT satisfaction The duration of SB from FNB reduced AA required in PACU, despite return of motor function = ambulation AA requirements in surgery may be r/t PT's anxiety regarding manipulation of the extremity

Note. AA = Additional Analgesia; ADL = Activities of Daily Living; ASA = American Society of Anesthesiologists; BNO = Bladder Neck Obstruction; BV = Bupivacaine; CPC = Chloroprocaine; CRF = Chronic Renal Failure; D/C = Discharge; DSat = Dissatisfied; EC = Exclusion Criteria; EI = Epidural Infusion; FNB = Femoral Nerve Block; FSNB = Femoral Sciatic Nerve Block; GA = General Anesthesia; GFNB = Genitofemoral Nerve Block; H = Hours; IC: Inclusion Criteria; Inf = Infusion; IRORA = International Registry of Regional Anesthesia; Kg = Kilograms; L = Lumbar; LACS = Local Anesthetic Circumferential Spread; LC = Lidocaine; LPSNB = Lumbar Plexus Sciatic Nerve Block; MA = Milliamps; MDA = Medical Doctor of Anesthesia; Mg = Milligrams; Min = Minute; ML = Milliliters; MM = Millimeter; NS = Nerve Stimulator; PACU = Post Anesthesia Care Unit; PCA = Patient Controlled Analgesia; Postop = Postoperative; PT = Patient; PuNB = Pudendal Nerve Block; Q = Every; RA = Regional Anesthesia; RO = Rescue Opioids; RN = Registered Nurse; R/T = Related To; RV = Ropivacaine; SAB = Spinal Anesthetic Blockade; Sat = Satisfied; SB = Sensory Block; SSU = Short-stay Unit; SuCBPB = Supraclavicular.

Table C3

Safety Profile: Trials Comparing Peripheral Nerve Blocks Versus Neuraxial Anesthesia

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Incidence and characteristics of major complications r/t RA (Auroy et al., 2002)	Prospective survey Self-reporting of complications and number/types of RA procedures	8150 French MDAs mailed invite to participate in survey/hotline August1, 1998 – May 31, 1999	Survey divided 5 periods/ 2 mo. each Experts accessible 24/7 via hotline to answer questions r/t complications Complications: 1) Cardiac arrest. 2) Acute resp. failure. 3) Seizures. 4) Peripheral nerve injury. 5) Cauda equina synd. 6) Paraplegia. 7) Cerebral comp. 8) Meningeal synd. 9) Death Classifications: 1) Unrelated to RA. 2) R/T RA. 3) Unclassified Booklets used to report number/types of RA procedures	487 MDAs participated 158,083 regional blocks performed (41,251 spinals, 35,379 epidurals, 1,474 combined spinal-epidurals, 50,223 PNB) Underestimated reporting: 5% spinal, 3% epidural, 2% PNB 68 MDAs reported 77 serious complications Cardiac arrests: 9 spinals, 1 PNB (PLPB) Resp. failure: 2 spinals, 2 PNB (PLPB) Seizures: 1 epidural, 6 PNB Peripheral nerve injury: 9 spinal, 12 PNB (NS used in 9 pts.)	Significant # new blocks such as PLPB Regional blocks increased 12-fold in 16 yrs. Reporting MDAs are more skilled/perform more blocks so have fewer complications Low incidence of complications r/t improved practice/MDA information Neuro complications occur despite use of NS Limitations: self-report (underestimation)

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Identify Neuro complications after common RA techniques (Brull et al., 2007)	Prospective review MEDLINE search Key words: “anesthesia, spinal,” “anesthesia, epidural,” “nerve block,” and “adverse effects.”	32 studies published in English between Jan. 1, 1995 and Dec. 31, 2005 Studies reporting only adverse Neuro complications after RA are examined	CNB studies w/ min. of 1000 spinal or epidural RA included Quality of evidence graded I-III Rate of Neuro injury by CNB reported as *n*: 10,000 Rate of Neuro injury by PNB reported as *n*: 100	32 studies received grade II-2: Evidence from well-designed cohort or case-control studies Spinal anesthesia higher risk of radiculopathy or peripheral neuropathy (3.78:10,000) to epidural anesthesia (2.19:10,000) Rate of permanent Neuro injury after spinal (0-4.2:10,000) compared to epidural (0-7.6/10,000) Most studies of PNB involve upper extremity blocks Interscalene blocks are highest risk (2.84:100) Only 1 case of permanent nerve neuropathy reported in 16 studies	Heterogeneity and quality of studies requires restraint when inferring validity of risk estimates Identification of nerve injury is complex and uneven in studies possibly resulting in underreporting/ over reporting Timing of follow-up and who conducts them influences identification of complications Limitation: Largest studies reflect self-reporting

Note. CNB = Central Nerve Blockade; Comp = Complication; Dec = December; Jan = January; MDA = Medical Doctor of Anesthesia; Mo = Months; Neuro = Neurological; NS = Nerve Stimulator; PLPB = Posterior Lumbar Plexus Block; RA = Regional Anesthesia; Resp = Respiratory; R/T = Related To; Synd = Syndrome; Yrs = Years; # = Number.

Table C4

Safety Profile: Trials Comparing Peripheral Nerve Blocks Versus General Anesthesia

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Compare single shot RA versus GA for ambulatory surgery (Liu et al., 2005)	Meta-analysis Variables: RA: central neuraxial blocks; PNB GA Outcomes: Recovery time, discharge time, side effects	The National Library of Medicine's Medline database & Cochrane Database of Systemic Reviews Studies from 1966 – 4/2005 comparing single shot RA versus GA 15 CNB (1003 PTs) and 7 PNB (359 PTs) trials EC: hospitalized PTs, continuous RA techniques, MAC cases, LIA IC: Adults ≥ 19 yrs., no minimum sample size per study	PACU/ASU discharge outcomes & criteria defined by each study Outcomes: induction time, N/V, PACU pain scores, rate of rescue analgesia, time in recovery (PACU/ASU), patient satisfaction Analysis using random effects model Significance ($P < 0.05$) Dichotomous outcomes: Mantel-Haenszel method (95% CI) Continuous outcomes: inverse variance method (95% CI)	CNB/PNB = Longer induction times (8-9min) CNB/PNB = Lower PACU pain scores & rescue analgesia CNB ≠ Lower PACU time or nausea Increased ASU time 35 min PNB = Bypass PACU, lowered PACU time by 24 min, lowered rate of nausea, increased PT satisfaction. Did not lower ASU time	RA more advantageous than GA, but did not shorten ASU time Alteration in CNB technique/ discharge criteria may decrease recovery time 8 min PNB induction time may indicate proficiency Discharge criteria for PNB may not be suitable (comfort level of MDAs r/t long acting PNB) Limitations: Heterogeneity of studies, small number of patients, constant change in practice, data weighted on sample size not quality

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Compare quality of PNB versus GA in elderly TKR PTs (Liu et al., 2014)	Randomized control study Variables: Quality of postop recovery Type of anesthesia provided	213 PTs w/ TKR from June – September 2013 IC: 65-90 yrs. old, elective TKR, ASA I-III, MMSE EC: Coag defect, psych Dz., DD, VAD, infection at PS Anesthesia and Operation Center of the Chinese People's Liberation Army General Hospital Randomized 2 groups: PNB: LPSB w/ NS, 0.35% RV, propofol GA: LMA, 100% O2, combined propofol – remifentanil INF Postop MM analgesia: PCA (sufenta INF), parecoxib, oxycodone, tropisetron	PQRS assess DF, DB, & WR. Given Preop (1-4D) & postop (15min, 40min, 1D, 3D, 7D) Recovery = Return to BV PT outcomes assessed using Likert scale (pain, nausea, ADL, emotive, physiology	108 GA PTs & 105 PNB PTs w/ no significant difference Induction time: PNB>GA (20.1 versus 8.4 min); IOCDD: PNB<GA (*P*<0.001); Intraoperative BP/HR: PNB>GA (*P*<0.001); Physiology recovery: PNB>GA until 1D (*P*<0.001); Pain & nausea profile: PNB>GA (*P*<0.001), equal by 3D; emotive: PNB>GA (*P*<0.001) PQRS: PNB>GA (*P*<0.001), equal by 7D Recovery all outcomes: PNB>GA (*P*<0.001), equal by 7D PT satisfaction high for both groups w/ no difference No LAST complications	PNB = Quicker recovery in all PT outcomes, less intraoperative BP/HR variation, decreased analgesic requirements (pain recovery significant at 15min/40min) PNB shift focus from hospital outcomes to PT centered outcomes Less sedation/GA improves long-term recovery Limitations: Emotive/Cognitive domains complex and unable to definitively determine influencing factors (e.g. sleep patterns, delirium, low baseline PQRS scores)

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
To determine whether UE PNB impact PT postop complications/ mortality/ hospital stays when added to GA for TSA (Stundner et al., 2014)	Retrospective study Variables: Frequency of UE PNB added to GA. Complications/mortality r/t addition of UE PNB Impact of UE PNB on resources.	De-identified data from Premier Inc. January 2007 to September 2011 IC: Identified PTs having TSA using code ICD-9-CM and GA Further divided into 2 groups: GA alone and GA w/ UE PNB EC: PTs only w/ PNBs	Two-sample T test: Continuous/discrete variables Pearson chi-square tests: Categorical variables Outcomes r/t complications: Separate MV logistic RG Association type of anesthesia and hospital stay: MV negative binomial RG Adjusted ORs: MV logistics RG (95% CI) Adjusted IRRs: Negative binomial RG (95 % CI)	17,157 PTs (20.9% combined PNB and GA) GA PTs similar comorbidities: DM (21.4%), MI (6.13%), & obesity (13.2%) No significant difference in complications between groups No difference in hospital stays (Combined: 2.27D to GA: 2.32D)	Addition of PNB to GA does not increase risk of postop complications Limitations: Did not accurately identify PND at time of occurrence = No significant difference in nerve injury between groups Unable to determine whether NS or US was used, & amount of anesthetic used Errors in coding can not be excluded

Note: ADL = Activities of Daily Living; ASA = American Society of Anesthesiologists; ASU = Ambulatory Surgery Unit; BP = Blood Pressure; BV = Baseline Value; CI = Confidence Interval; Coag = Coagulation; D = Day; DB = Digits Back; DD = Drug Dependence; DF = Digits Forward; DM = Diabetes Mellitus; DV = Dependent Variable; Dz = Disease; EC = Exclusion Criteria; E.G. = For Example; GA = General Anesthesia; HR = Heart Rate; IC = Inclusion Criteria; INF = infusion; IOCDD = Intraoperative Cumulative Drug Dose; IRRs = Incident Rate Ratios; IV = Independent Variable; LAST = Local Anesthetic Systemic Toxicity; LIA = Local Infiltration Analgesia; LMA = Laryngeal Mask Airway; LPSB = Lumbar Plexus Sciatic Block; MAC = Monitored Anesthesia Care; MI = Myocardial Infarction; Min = Minute; MMSE = Mini Mental Score Examination; MV = Multivariable; NS = Nerve Stimulator; N/V = Nausea/Vomiting; ORRs = Odds Ratios; O2 = Oxygen; PACU = Postoperative Ambulatory Care Unit; PCA = Patient Controlled Analgesia; PNB = Peripheral Nerve Block; PND = Peripheral Nerve Damage; Postop = Postoperative; PQRS = Postoperative Quality of Recovery Scale; Preop = Preoperative; PS = Puncture Site; Psych = Psychiatric; PT = Patient; RG = Regression; RV = Ropivacaine; TKR = Total Knee Replacement; TSA = Total Shoulder Arthroplasty; UE = Upper Extremity; US = Ultrasound; VAD = Visual Auditory Disorder; W/ = With; WR = Word Recall; Yrs = Years; ≠ = Does Not Equal; = = Equal.

Table C5

Safety Profile: Trials Comparing Ultrasound Guidance Versus Nerve Stimulation

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Compare safety outcomes: LMNS versus USNS (Laur et al., 2012)	Observational, retrospective study Variables: Complications: PNI and LAST Type of anesthetic technique: LMNS or USNS	Data obtained from UOPASMC (January 2006 to December 2011) PTs treated for sports medicine problems	Time frame comparison r/t practice transition: 28 mo. (practice was 90% LMNS to = Split between LMNS and USNS). 44 mo. (= Split to > 90% UTNS)	44 mo. = 7092 USNS versus 2209 LMNS (Difference in PNI lasting 6-12 mo.) Total 14,505 PNBs performed: 9069 = USNS; 5436 = LMNS (No difference in PNI, yet LMNS > frequency of seizures than USNS (*P* = 0.0061)	USNS decreases PNI lasting > 6 mo. Study signifies practice change from LMNS to USNS Limitations: Study included young healthy PTs, unable to generalize LAST to other types of PTs PNBs predisposed to LAST are not included All procedures included NS = Confounding variable Study sample is underpowered to determine PNI = Potential Type II error (9216 PTs per group required to show USNS definitively improves safety)

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Identify frequency of complications r/t USNS compared to LMNS alone performed by supervised residents (Orebaugh et al., 2009)	Retrospective study Variables: Complications associated w/ both forms of guidance Types of PNB measured: IS, Ax, Fem, SC, PS	5436 PNBs (3290 LMNS, 2146 USNS) Data obtained from UOPMC QI Database (January 1, 2006 to April 30, 2008) EC: Specific PNBs done solely by particular technique 2 groups predetermined by MDA & Resident prior to PT exam & training needs PNB w/ LMNS: current of 0.25 - 0.5 mA USNS: 5 - 10 MHz linear transducer, LMNS current of 0.8 - 1.0 mA MDAs = 5 Yrs experience w/ LMNS, 200 PNB using USNS Residents = little/no experience to 20-30 USNS PNB performed	Definitions: Seizure = TC within 30 min PNB w/ LOC Cardio toxicity = S/S of hypotension, irregular cardiac rhythms, cardiac arrest PNI = Sensory or motor abnormality (Resolved within 6 mo. not included) Numerator = Sum of complications associated w/ type of technique Denominator = Total # of cases per technique	LMNS – 5 seizures USNS – No seizures Seizures: LMNS BPB (4/988) versus USNS BPB (0/1313) (*P* = 0.044) LMNS - 3 PNI (Posterior PS block: decreased sensation, pain, & motor deficiency) USNS – 0 PNI PNI: LMNS (3/475) versus USNS (0/401) (*P* = 0.255) No LTI, CNB, or LAST	Significant adverse occurrences are rare in PNB (0.4% seizures using NS). However, still significant when comparing USNS and LMNS Complications are decreased because USNS allows visualization of needle tip and LACS Limitations: Lack of rigor Potential bias r/t an institution's desire for new practice pattern Inability to obtain PNI as an outcome = underreporting Epinephrine not used in anesthetic solution = no marker for IVI

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Identify complications r/t LMNS versus USNS performed by residents (Orebaugh et al., 2012)	Retrospective study Variables: Complications associated w/ LMNS and USNS PNBs of interest: IS, Ax, Fem, SC	De-identified data obtained from UOPMC (May 2008 to December 2011) 2 groups predetermined by MDA & Resident prior to PT exam & training needs Residents performing PNBs under MDA supervision PNI determined by MDA or resident after 2 day follow-up EC: PNBs not completed, & performed solely by landmarks CP for PNB: RV, MV & RV, dilute BV PNB w/ LMNS: current 0.25 – 0.5 mA USNS: 5 - 10 or 6 – 13 MHz linear transducer, LMNS current of 0.5 - 1.0 mA	Definitions: Seizure = TC within 60 min PNB w/ LOC. Cardio toxicity = S/S of hypotension, irregular cardiac rhythms, cardiac arrest. PNI = Sensory or motor abnormality (Resolved within 6 mo. not included) Numerator = Sum of complications associated w/ type of technique Denominator = Total # of cases per technique Complication rates = 95% CI (per 1000 PNB) Time frame comparison r/t practice transition: 28 mo. (practice was 90% LMNS to = Split between LMNS and USNS). 44 mo. (= Split to > 90% USNS) Stat analysis = 2-tailed Fisher (*P* < 0.05) Stat analysis = 2-tailed chi sq. w/ YC (*P* < 0.05)	9000 plus PNBs performed 1 – Seizure r/t LMNS occurred 4 – PNI: 3 r/t LMNS, 1 r/t USNS (All < 12 mo.) 1 – PNI r/t LMNS > 12 mo. PNI (< 12 mo.) occurring in LMNS (3/2209) significantly > USNS (1/7092) (*P* = 0.003) No incidence of Pneumo, CNB, or Cardio Arrest Comparison of both studies: 9069 USNS PNBs 5436 LMNS PNBs No difference in PNI Seizures: LMNS (6/5436) > USNS (0/9238); (*P* = 0.0061)	No incidences of LAST by supervised residents Large #cases & rarity of complications = USNS safety (and suitable for training) Can not verify safety without NS Future studies: Compare USNS and US without NS, addition of analgesics to PNBs Limitations: Potential bias r/t non-randomization of PTs Generalizability: Due to high #PNBs performed by residents. PTs are young, healthy Epinephrine use not required in CP of PNB administration

Note: Ax = Axillary; BPB = Brachial Plexus Block; BV = Bupivacaine; Cardio = Cardiovascular; CI = Confidence Intervals; CNB = Central Neuraxial Block; CP = Clinical Pathways; Fem = Femoral; IS = Interscalene; IVI = Intravascular Injection; LACS = Local Anesthetic Circumferential Spread; LAST = Local Anesthetic Systemic Toxicity; LMNS = Landmark Nerve Stimulation; LOC = Loss of Consciousness; LTI = Local Tissue Injury; MDA = Medical Doctor of Anesthesia; Mo = Months; MV = Mepivacaine; NS = Nerve Stimulator; PNB = Peripheral Nerve Blocks; Pneumo = Pneumothorax; PNI = Peripheral Nerve Injury; PS = Popliteal Sciatic; PT = Patient; QI = Quality Improvement; R/T = Related To; RV = Ropivacaine; SC = Sciatic; Sq = Square; S/S = Signs/Symptoms; Stat = Statistical; TC = Tonic-clonic; UOPASMC = University of Pittsburgh Ambulatory Sports Center; UOPMC = University of Pittsburgh Medical Center; USNS = Ultrasound Nerve Stimulation; W/ = with; YC = Yates Correction; Yrs = Years; = = Equals; > = Greater Than; < = Less Than; # = number.

Table C6

Safety Profile: Influence Of Obesity On Peripheral Nerve Block Guidance

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Determine whether BMI impacts success rate & noted complications r/t SC PNBs (Franco et al., 2006)	Retrospective study Variables: Success rate Complication rate PT BMI	Consecutive SC PNB (February 1996 to April 2003) JHS Hospital of Cook County; Rush University Medical Center Note: NS protocol present. Current = 0.8 mA (1732 of 2020 cases) 1.5% MV (35-40 ml) + 1:200,000 epinephrine (Lengthy cases 0.2% TC added to above solution) No SCPNB excluded	Obesity = BMI 30.0 – 39.9 kg/m2 Morbid obesity ≥ 40 kg/m2 Residents given 10 min to complete PNB PNB grades: Good = SB within 30 min, no AA; Partial = Some AA required; Failed = GA required Grouped responses: Fingers (F or E), Wrist (F or E), Other Comparison: Non-obese (BMI < 30) to Obese (BMI ≥ 30); Significance (P < 0.05) Data Variables: Continuous = unpaired t- tests; Categorical = chi squared; Subgroups = Tukey-Kramer MCT	SC PNB#: Non-obese = 1565 (77.5%); Obese = 455 (22.5%) Success rate: Non-obese = 97.3%; Obese = 94.3% (*P* < 0.01) Better PNBs: Non-obese > Obese (*P* < 0.01) Paresthesia: Obese > Non-obese (*P* < 0.01) Resident success rate: Non-obese (87%) > Obese (68%) 2 – Seizures noted: 1 – Non-obese female 1 – Obese male No pneumothorax	SC PNB are more difficult in obese = decreased success rate Despite difficulty, successful resident PNBs recorded in 70% obese PTs Overall, PNB success was 94% obese PTs Complications between groups insignificant

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Determine whether obesity influences success rates and noted complications r/t ABPBs (Hanouz et al., 2010)	Prospective, observational study Variables: ABPB performed on obese PTs Success rates and complications	Data from routine care (PT verbal consent obtained) at Centre Hospitalier, France January 2005 to June 2006 PTs having upper extremity surgery w/ ABPB PNBs performed by MDAs, > 5 yrs. experience, TIT: MC, Med, Rad nerves; Current = 0.4 mA, 6-20 ml 0.5% RV	BMI, Obesity ≥ 30 kg/m2; Minimal current for motor response; PNB time (1st LM palpation to needle withdraw); Pain visual scale: 0 -100 PNB grades: Successful = No AA; Failed = Some AA or GA required Success rate: Study required 56 obese and 504 non-obese PTs to note 10% difference Complications r/t LAST, IVI, Paresthesia PT satisfaction (future interest in repeating PNB) when leaving PACU Data Variables: Continuous = Mann-Whitney U or t-test; Categorical = Contingency tables or Fisher exact ($P < 0.05$)	605 ABPBs performed: 85 (14%) obese (3 PTs morbidly obese) PNB time significant (obese > non-obese) 97% Success rate: non-obese (98%) > non-obese (91%); (P = 0.003) Obesity > risk of failure (P = 0.001) 71 (12%) acute complications (axillary artery puncture, paresthesia): Obese (27%) > non-obese (9%); (P = 0.01) 93% PT satisfaction: Non-obese (94%) > Obese (87%); (P = 0.03)	Obesity reduces success, increases occurrence of complications (3 times), increases performance time PNB results in increased PT satisfaction. Obese PTs less satisfied r/t increased performance time and/or needle redirecting Limitations: Can not apply results to other PNBs due to differences in specific PNBs performed Only skilled MDAs performed the PNBs. Some factors of PT satisfaction may have been neglected

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Compare performance times and outcomes r/t US or NS in obese PTs (Lam et al., 2014)	Randomized control, single-blinded Variables: Performance times Outcomes Type of peripheral guidance: US or NS	24 Obese PTs, randomized to NS or US, foot/ankle surgery w/ LPSNB University of New Mexico HSC IC: ASA I-III, ≥ 18 yrs., BMI > 30 kg/m2 EC: DM, Infection at site, existing PNI 4 MDAs: blinded, each administered PNB according to assigned technique, > 5 yrs. experience in PNB NS: Current = 0.4 mA or less; US: 28-mm high frequency probe 20 ml 1.5% MV PTs & Investigator: blinded to technique	Block evaluation: TN and CPN every 5 min up to 30 min for motor/sensory loss (> 30 min = failed block) Assessment- Same scale for motor & sensory block: 2 (no change), 1 (reduced), 0 (complete block); Postop follow-up: PACU & within 72 hrs. Performance time defined as: When MDA touched PT to final anesthetic injection in seconds (NS = landmark palpation, US = antiseptic application) Other measured outcomes: # needle redirections (withdrawn & angle change), patient satisfaction (scale 0-10), procedural pain (scale 0-10) Data Variables: Continuous = Mann-Whitney U; Categorical = Chi squared or Fisher exact ($P < 0.05$)	No failed PNB Performance time (sec): NS (577); US (206); ($P < 0.001$) Needle redirections: NS (20); US (3.5); ($P < 0.001$) Procedural pain: NS (5); US (1.5); ($P < 0.001$) PT satisfaction: NS (5); US (10); ($P < 0.001$) No complications noted	US use results in faster performance times, less procedural pain, and increased satisfaction in obese PTs US assists nerve identification/ localization more so than NS Promote PNB when possible for obese PTs Limitations: Performance bias PT bias r/t muscle twitching and NS Results not generalizable; can vary r/t type of PNB or equipment

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Influence of BMI on outcomes using US w/ NS for ISB (Schroeder et al., 2012)	Retrospective review Variables: Outcomes (Performance time, Postop N/V, PACU pain scores, Complications) BMI	528 PTs; shoulder arthroscopy; ISB + GA (12/7/2006 to 9/16/2008) Obesity = BMI > 30 kg/m2; morbid obesity = BMI > 35 kg/m2 EC: Age < 18 yrs., PTs having AP/Hemi-AP Dedicated PNB room; mid–senior residents overseen by trained MDAs US w/ NS current 0.5 mA (No MB/SB assessment) University of Wisconsin	PTs ASA, surgery procedure, performance time, LAV, opioid consumption/ N/V, complications Pain score (0 – 10): 0 = no pain, 10 = intolerable pain BMI association to outcomes via least squares/regression model	BMI significantly increases: postop pain (*P* < 0.001); performance time (*P* < 0.018); opioid consumption (*P* < 0.001) BMI r/t postop N/V (*P* = 0.025) BMI r/t complications: none (*P* = 0.103)	BMI increases postop pain, performance time, opioid consumption Unclear how US + NS influenced obesity results Obesity obscures landmarks resulting in increased difficulty of ISB placement, yet safe. Incomplete analgesia = NV Limitations: No MB/SB assessment to determine success of ISB Assumption: Obese may routinely require more pain medicine

Note: AA = Additional Analgesia; ABPB = Axillary Brachial Plexus Block; AP = Arthroplasty; ASA = American Society of Anesthesiologists; BMI = Body Mass Index; CPN = Common Peroneal Nerve; DM = Diabetes Mellitus; E = Extension; EC = Exclusion Criteria; F = Flexion; GA = General Anesthesia; Hrs = Hours; HSC = Health Sciences Center; IC: Inclusion Criteria; ISB = Interscalene Block; IVI = Intravascular Injection; Kg/m2 = Kilogram per meter squared; LAST = Local Anesthetic Systemic Toxicity; LAV = Local Anesthetic Volume; LPSNB = Lateral Popliteal Sciatic Nerve Block; MA = Milliamps; MB = Motor Block; MC = Musculocutaneous; MCT = Multiple Comparison Tests; MDA = Medical Doctors of Anesthesia; Med = Median; Min = Minutes; ML = Milliliters; MV = Mepivacaine; NS = Nerve Stimulator; N/V = Nausea/Vomiting; PACU = Post Anesthesia Care Unit; PNB = Peripheral Nerve Block; PNI = Peripheral Nerve Injury; Postop = Postoperative; PT = Patient; Rad = Radial; R/T = Related To; RV = Ropivacaine; SB = Sensory Block; SC = Supraclavicular; Sq = Squares; TC = Tetracaine; TIT = Triple Injection Technique; TN = Tibial Nerve; US = Ultrasound; W/ = With; Yrs = Years; = = Equals; ≥ = Greater than/equal to; < = Less Than; # = Number; + = Plus.

Table C7

Efficacy Profile: Trials Comparing Ultrasound Guidance Versus Nerve Stimulation

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Determine whether US is superior to NS in localizing nerves (Abrahams et al., 2009)	Systematic review, meta-analysis Randomized control studies comparing US w/ NS use to perform PNB Keywords: US, RA, NS, IS, Ax, Fem, Sciatic, popliteal nerve	13 human studies Database: Ovid, Cochrane, Google Scholar Published: January 1, 1990 – September 1, 2008 in any language Search included journal archives; electronic databases	Studies scored for quality of methodology by 2 authors Scored on 9 items: Randomization, blinding of PTs, IC/EC, description of study, similarity in anesthetic care except use of NS, comparable block methods between groups, well-defined outcomes, blinding of investigators, statistical analysis Max score = 13 Good = 11 or > Fair = 6 – 10 Poor = < 5 (Excluded) 7 studies = Fair 6 studies = Good	13 studies (946 PTs) Block failure: US < NS (RR 0.41, $P < 0.001$) Conversion to GA or SA: US < NS (RR 0.28, $P = 0.002$) Procedure time: US < NS (1 min less, $P = 0.003$) Onset time of SB: US < NS (29% faster, $P = 0.001$); no significant difference in MB Duration: US > NS (25% longer, $P < 0.001$) Complications r/t vascular puncture: US < NS (RR 0.16, P = 0.001) No differences in paresthesia or other major complications	PNB efficacy improved by US: increased success, decreased performance times, increased duration, lower incidence of vascular puncture Studies showing no difference between US and NS may not be reported US improves resident performance (those who do not perform PNB regularly) because of visualization Limitations: Only a few studies included in analysis Can not control for study's methodology Selection bias r/t outcomes reported Blinding of PTs r/t techniques is difficult

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Determine success rate r/t US use in ABPB (Chan et al., 2007)	Randomized control study Variables: PNB guidance: NS, US, US + NS Success rate of ABPB	188 PTs, hand surgery w/ ABPB IC: age ≥ 18 yrs., ASA I-III, weight 50-110 kg, height ≥ 150 cm EC: Allergy/infection to ABPB, Neuro-Disorder, Psych-Disorder, narcotic abuse 3 groups: NS w/ current ≤ 0.5 mA, US w/ 5-12 MHz linear probe, US + NS PNBs performed by MDA or supervised resident 2% LC + 1:200,000 epinephrine + 0.5% BV	Onset/progression SB and MB q 5 min for 30 min SB/MB graded scale: 2- normal, 1- decreased, 0- absent Inadequate PNB = AA Procedure time: NS- axillary palpation to injection; US- probe application to injection Postop Follow-up: Day 2 & 7 to identify complications Data Variables: Independent = t-test; Non-parametric = Mann Whitney; Frequency = chi square ($P < 0.05$)	PNB success rate: US (82.8%) and USNS (80.7%) > NS (62.9%); (P = 0.01 and 0.03) Adequate analgesia: US (95%) and USNS (92%) > NS (85.5%); (P = 0.07 and 0.26) Performance time: US (9.3 min) > NS (11.2 min) and USNS (12.4 min) No major complications Transient paresthesia: US and NS = 13 PTs; USNS = 9 PTs Localized Pain: NS (10 PTs), US (3 PTs), USNS (3 PTs) Incomplete SB r/t radial nerve location and visualization at 30 min: US (14%) and USNS (16%) > NS (31%)	US w/ or without NS increases ABPB success Adequate analgesia delivered via US use, especially surgical anesthesia Radial nerve = deep, difficult visualizing Limitation: Injection endpoint: Determined by US view of needle, and not NS current = difference in US and USNS Failed nerve identification and misreading of LACS = Failure for 100% PNB success

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Determine whether US or non-US use influences success rates (Gelfand et al., 2010)	Meta-analysis Randomized control studies Variables: PNB guidance: LM, NS, US Success rate of PNB Keywords: US, PNB, BrP, InC, SuC, IS, Ax, Fem, Sciatic-popliteal nerve	16- Randomized control studies PubMed (1966 – 8/15/2009) IC: no minimum age limit or sample size, elective surgery EC: US + other technique, no information comparing degree of effects John Hopkins Medical Center	Success rates of single-shot PNB using US versus non-US techniques Definition success: PNB for surgery without AA or GA Random-effects model ($\alpha \leq 0.05$)	16- studies (1,264 PTs) Success rate: US versus non-US (RR = 1.11, $P < 0.0001$) US versus NS (RR = 1.11, $P = 0.0001$) Success rate in specific PNB (US versus non-US): BrP: (RR = 1.11, $P = 0.0001$) Sciatic-popliteal: (RR = 1.22, $P = 0.002$) ABPB: (RR = 1.13, $P = 0.05$)	US improved success rates of PNB over other non-US techniques Success rates r/t direct visualization especially in difficult PTs Improved performance time and fewer complications r/t visualizing nerves and needle tip Limitations: Small sample size Definitions of success vary in studies Caution generalizing results r/t provider experience performing PNB

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Validate USs prospective benefits over non-US techniques (Koscielniak-Nielsen, 2008)	Retrospective review Variables: PNB guidance: LM, NS, US Benefits and outcomes of PNB Keywords: US, PNB, RA	20 studies Database: MEDLINE, EMBASE Published: 1966 – December 31, 2007 in English, German, French, Spanish IC: Clinical journals; human studies; studies + abstracts; meta-analysis, randomized control studies	Benefit comparison between US and US + NS r/t visualization Nerves; visualization LM; visualization of Needle; assessment of LACS) Outcomes (performance time, complications) r/t US versus non-US techniques	Nerve visualization: NS did not add any benefit to US use (2 studies); NS aided nerve confirmation in US training LM visualization: Ax artery important LM for BrP block; LACS essential for PNB success US reduced performance time and needle attempts significantly Vascular puncture: inconclusive Paresthesia: US better than LM, similar to NS Pneumothorax: US (0) PNB success: No difference US to NS Onset time and LA doses reduced using US	Visualization of nerves improved w/ US, but NS helps w/ confirmation No difference in PNB effectiveness between US and NS Limitations: Potential missing data r/t one-third of studies accepted for analysis Definitions r/t methodology and primary endpoints in studies varied No attempt at meta-analysis

Purpose (source)	Design, key variables	Sample, setting	Measures	Key findings	Author conclusions, limitations
Determine whether US helps 3-in-1 PNB performance (Marhofer et al., 1997)	Randomized control study Variables: PNB guidance: NS, US Quality, Onset, complications r/t 3-in-1 PNB	40 PTs Groups: US, NS, (20 PTs each) IC: ASA I-III, hip surgery post trauma EC: PT refusal, contraindications LA 1 person performed all PNB US: 7.5 MHz linear probe, Sprotte (24 gauge, 7 cm) NS: Winnie PV technique, Sprotte (24 gauge, 7 cm) 0.5% BV 20 ml	Quality and onset SB: pinprick bilateral legs q 10 min for 60 min Rating scale: 100% (no change) to 0% (complete SB) Definitions: Onset: 30% decreased sensation of initial value Wilcoxon test, Analysis of Variance ($P < 0.05$)	Onset SB: US (16 min) < NS (27 min); ($P < 0.05$) Quality SB: US (15%) > NS (27%); ($P < 0.05$) Suitable analgesia: US (95% PTs) versus NS (85% PTs) US visibility in 17 PTs (85%); Unable in 3 PTs (1 PT = failed block) Complications: Arterial puncture (3- NS) No difference: age, gender, height, weight	US decreases onset time, improves SB quality, reduces complications r/t 3-n-1 PNB Improved outcomes r/t direct visualization of needle tip and LACS US decreases amount of LA required for PNB analgesia, improves LM identification in difficult PTs

Note: AA = Additional Analgesia; ABPB = Axillary Brachial Plexus Block; ASA = American Society of Anesthesiologists; Ax = Axillary; BrP = Brachial Plexus; BV = Bupivacaine; CI = Confidence Interval; CM = Centimeters; EC = Exclusion Criteria; Fem = Femoral; GA = General Anesthesia; IC = Inclusion Criteria; InC = Infraclavicular; IS = Interscalene; Kg = Kilograms; LA = Local Anesthetics; LACS = Local Anesthetic Circumferential Spread; LC = Lidocaine; LM = Landmarks; MA = Milliamps; MB = Motor Block; MDA = Medical Doctor of Anesthesia; MHz = Mega Hertz; Min = Minutes; Ml = Milliliters; Neuro = Neurological; NS = Nerve Stimulator; PNB = Peripheral Nerve Block; Postop = Postoperative; Psych = Psychiatric; PT = Patient; PV = Paravascular; Q = Every; RA = Regional Anesthesia; RR = Risk Ratio; R/T = Related To; SA = Spinal Anesthesia; SB = Sensory Block; SuC = Supraclavicular; US = Ultrasound; W/ = With; Yrs = Years; α = Alpha; ≥ = Greater Than/Equal To; ≤ = Less Than/Equal To; ± = Plus/Minus.

APPENDIX D

THE BOARD OF REGISTERED NURSING'S STANDARDIZED PROCEDURE GUIDELINES

Standardized Procedure Guidelines

(a) Standardized procedures shall include a written description of the method used in developing and approving them and any revision thereof.
(b) Each standardized procedure shall:
(1) Be in writing, dated and signed by the organized health care system personnel authorized to approve it.
(2) Specify which standardized procedure functions registered nurses may perform and under what circumstances.
(3) State any specific requirements, which are to be followed by registered nurses in performing particular standardized procedure functions.
(4) Specify any experience, training, and/or education requirements for performance of standardized procedure functions.
(5) Establish a method for initial and continuing evaluation of the competence of those registered nurses authorized to perform standardized procedure functions.
(6) Provide for a method of maintaining a written record of those persons authorized to perform standardized procedure functions.
(7) Specify the scope of supervision required for performance of standardized procedure functions, for example, immediate supervision by a physician.
(8) Set forth any specialized circumstances under which the registered nurse is to immediately communicate with a patient's physician concerning the patient's condition.
(9) State the limitations on settings, if any, in which standardized procedure functions may be performed.
(10) Specify patient record keeping requirements.
(11) Provide for a method of periodic review of the standardized procedures.

Excerpt taken from the Board of Registered Nursing (2011). *Standardized procedure guidelines*. Retrieved March 8, 2015, from http://www.rn.ca.gov/pdfs/regulations/npr-i-19.pdf

APPENDIX E

PROPOSAL FOR PRIVILEGING CERTIFIED REGISTERED NURSE ANESTHETISTS TO PERFORM NERVE BLOCKS

America's health care system is rapidly changing. Health care organizations are focused on improved quality of care and patient outcomes. For patients undergoing orthopedic, obstetrical, gynecological, and general surgeries, improved pain management, safety, and patient satisfaction are enhanced by the administration of peripheral nerve blocks. Currently, of the over 2500 annual cases where a peripheral nerve block (PNB) might be appropriate, less than 50 PNBs were utilized as all PNBs were administered by anesthesiologists. Additional patients could benefit from this type of anesthesia and Certified Registered Nurse Anesthetists (CRNAs) could provide these. The Institute of Medicine recommends that nurses practice to the full extent of the educational preparation, professional qualifications, and licensure.[1] Adopting a credentialing process for CRNAs to provide PNBs in our facility will benefit patient care.

Four questions relevant to this proposal are:

1) What are the current teaching practices and content covered in CRNA programs related to regional anesthesia?
2) What is the role of ultrasound use in guiding peripheral nerve blocks?
3) What number of procedures is required to attain proficiency? To maintain proficiency over time?
4) How does the use of peripheral nerve blocks improve the quality of care and patient safety?

Curricula in accredited school of anesthesia prepare the CRNA to competently and safely administer peripheral nerve blocks. Graduates who successfully complete the

National Board of Certification and Recertification for Nurse Anesthetists' Certification Examination are recognized as qualified, entry-level practitioners capable of administering regional anesthesia.[2]

Ultrasound is the prime guiding technique for regional anesthesia because it delivers real-time imaging of anatomical structures, needle tip location, and local anesthetic spread. The result is a more precise block with better success rates, decreased performance times, and fewer complications. The required number of peripheral nerve blocks to achieve provider proficiency ranges from 15 to 28.[3,4] Ultrasound use, also, significantly improves the learning curves of providers during training. [4,5]

Ultrasound-guided peripheral nerve blocks are safe and effective anesthetic alternatives, which improve patient satisfaction because of their prolonged analgesia and reduced systemic effects. Based on the HMO facility's 2013 surgical data, a significant need to improve patient access to peripheral nerve blocks has been identified. To facilitate this action, it is recommended CRNAs be privileged to perform peripheral nerve blocks.[6,7,8]

Recommendations for implementing and evaluating a privileging process for CRNAs to provide peripheral nerve blocks include:

1) Establish a pilot program that would enable CRNAs to be re-educated and re-trained to perform peripheral nerve blocks under the supervision of regional experts.
2) Adopt standardized procedural guidelines that would provide trainees an outline of required competencies that would need to be completed prior to privileging. See attached proposed policy.

3) Evaluate the pilot program by (a) anesthesia provider review of the competence of CRNA's completing the training process for peripheral nerve block privileging, (b) assess patient safety and satisfaction with peripheral nerve blocks to include, but not limited to, the post-surgical review of ambulatory patients the day following discharge, and (c) review if sufficient peripheral nerve block cases are available for privileged providers to maintain competence.

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Section:
ANESTHESIOLOGY

PERIPHERAL NERVE BLOCK POLICY: CRNA CORE COMPETENCY

PURPOSE

To outline the method for granting privileges to perform for certified registered nurse anesthetists.

POLICY

1. An Ultrasound-guided Regional Anesthesia (UGRA) Coordinator will supervise all CRNA trainee administered peripheral nerve blocks (PNBs)

2. In addition to education and training required for certification and licensure, CRNAs must receive and demonstrate competency in peripheral nerve block administration.

3. Specific privileges requested by each CRNA will be subject to approval by the Chief of Anesthesiology.

PROCEDURE – Proctoring of Peripheral Nerve Blocks

1. An UGRA Coordinator will observe and evaluate the CRNA performing a minimum of 10- beginner level PNBs, 20- intermediate level PNBs, and 20- expert level PNBs. Note: The trainee must complete the minimum number of PNBs in each skill level before advancing to the subsequent skill level.

2. If the procedure is performed appropriately, the UGRA Coordinator dates and signs the proctoring forms. If improvements in technique are required, it will be indicated on the proctoring form. The required number of proctoring forms associated with the skill level must be completed.

3. The Chief of Anesthesia will review the proctoring forms and make a recommendation to the hospital's Credentialing Committee to request CRNA privileging.

Proctoring of CRNAs

A. PNB Orientation
There will be a six-month to one year PNB orientation period. The length of the orientation will depend on the availability of cases for proctoring.

B. Clinical Proctoring

An UGRA Coordinator will proctor CRNAs for the minimum number of PNBs required to demonstrate competency.

The CRNA will need to demonstrate competency in the following areas related to UGRA PNB administration:

Patient Care

- Selects appropriate patients.
- Explains UGRA procedures using terminology patient understands.
- Applies ASA monitors.
- Administers suitable sedation.
- Performs suitable PNBs.

Ultrasound knowledge

- Explains and comprehends device functions.
- Recognizes benefits and limitations of procedures.
- Distinguishes between out-of-plane and in-plane views.
- Identifies normal anatomic landmarks and nerves using ultrasound imaging.
- Recognizes anatomic deviations.
- Learns UGRA procedures.
- Demonstrates proper equipment maintenance and cleaning.

Professionalism

- Accepts constructive criticism.

Technical skill

- Visualizes major anatomic structures.
- Uses out-of-plane view to identify nerves.
- Recognizes normal anatomy from anatomic variations.
- Chooses appropriate needle approach.
- Maintains sterile technique.
- Maintains needle tip visualization throughout procedure.
- Incorporates use of nerve stimulation appropriately.
- Uses test dose to confirm correct needle tip placement. Makes any necessary modifications.
- Visualizes local anesthetic spread throughout injection.
- Maintains patient safety

Adapted from *Regional Anesthesia and Pain Medicine*. 2009;34(1):40-46.

APPENDIX F

DATA RELEASE FORM: DEPARTMENT ADMINISTRATOR ANESTHESIOLOGY

February 18, 2015

To: Joseph Arellano, CRNA

FROM: Doris J. Tanaka, Department Administrator
Anesthesiology

RE: Surgical Data for your Project

This memo is to confirm that you have my permission to use surgical data for your project. It is understood that the data only contains numbers, types of procedures and anesthetics done at our facility during 2013. There are no patient related information in this data, and as such, there should be no patient identifying information within the project. In addition, it is understood that this facility will remain an anonymous institution for your project.

I am happy to support your endeavors to further your education through this process. Good luck to you.