Implementation of an Education Program for an Ultrasound-Guided Liposomal Bupivacaine Transversus Abdominis Plane (TAP) Block Protocol for Open Abdominal Procedures

Lisa O'Driscoll, DNP, CRNA, NC, USN
Robert G. Girolamo, DNP, CRNA
Christopher Crerar, DNP, CRNA
Walter Williamson, MSN, CRNA
Chad Moore, DNP, CRNA
Kenneth Wofford, PhD, CRNA
Raymond Bonds, DNP, CRNA

Anesthesia practitioners at the authors' facility had varying education and training with placing transversus abdominis plane (TAP) blocks and with the use of liposomal bupivacaine limiting the utilization of this regional anesthetic technique for patients undergoing abdominal surgical procedures. An expansive literature review suggested that ultrasound-guided liposomal bupivacaine TAP blocks were safe and effective for reducing postoperative pain scores, opioid use, and no reported adverse effects. Current literature findings were used to craft an educational intervention to update current practices among anesthesia practitioners. The purpose of the project was to develop and implement an educational intervention to improve the knowledge and confidence of all anesthesia providers at our facility when placing and managing liposomal bupivacaine TAP blocks in patients undergoing abdominal surgery. We used the Ajzen Theory of Planned Behavior to create an effective practice change, combined with skill acquisition through simulation, among anesthesia providers at our facility in performing ultrasound-guided liposomal bupivacaine TAP blocks. The implementation of a multistrategy education program using simulation resulted in a significant increase in knowledge and confidence among anesthesia practitioners.

Keywords: Exparel, liposomal bupivacaine, TAP block, transversus abdominis plane block.

Postoperative pain is widely experienced by patients undergoing abdominal surgery, impacting both patients and hospitals alike with decreased satisfaction, prolonged hospital stay, inappropriate opioid use, delayed healing and return to normal activity.[1-5] Ultrasound-guided peripheral nerve blocks, including field blocks in the transversus abdominis plane (TAP), are commonly recommended to effectively manage postoperative pain of the anterolateral abdominal wall.[6-16] Liposomal bupivacaine is a cost-effective strategy to extend the duration of field blocks beyond the traditional 8 hours, up to 72 hours.[17-20]

Insufficient familiarity with these strategies—both relatively new—had previously prevented our facility from widely offering patients TAP blocks with liposomal bupivacaine . Anesthesia practitioners have diverse backgrounds in their training programs. Informal interviews with anesthesia practitioners at our facilities confirmed that some practitioners had not been previously trained or had not had recent enough practice to feel confident in their ability to safely place a TAP block using liposomal bupivacaine, hereafter called LB-TAP block.

The purpose of the project was to develop and implement an educational intervention to improve the knowledge and confidence of all anesthesia providers at our facility when placing and managing LB-TAP blocks in patients undergoing abdominal surgery.

Literature Review

An electronic database search was conducted using Web of Science (Clarivate Analytics), The Cochrane Library, Cumulative Index to Nursing and Allied Health Literature, PubMed, Turning Research Into Practice, American Association of Nurse Anesthetists (AANA) abstracts, and the American Society of Anesthesiologists abstracts. The following search terms were used: *TAP, transversus abdominis plane block, abdominal surgery, laparotomy, colectomy, hysterectomy, liposomal bupivacaine,* and *Exparel* (the brand name of liposomal bupivacaine). Inclusion criteria were peer-reviewed publications about abdominopelvic surgery, patient's ASA physical status I to III, and patient age 18 to 65 years; expert opinions

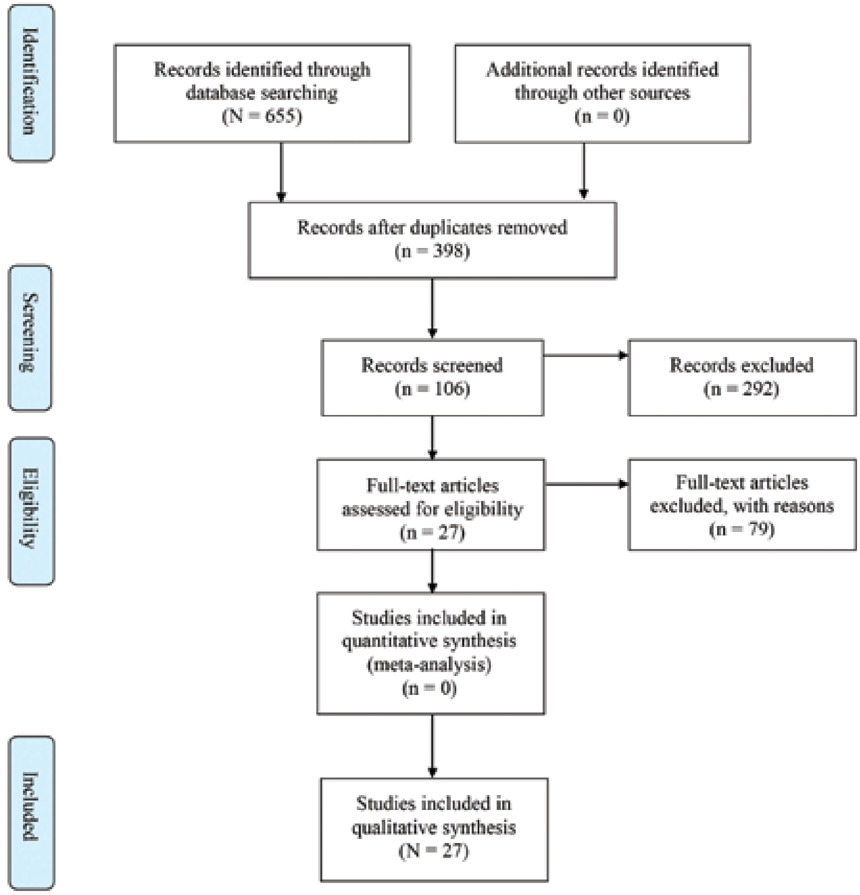

Figure 1. PRISMA Flowsheet

were excluded. Because the literature base was small concerning liposomal bupivacaine, case studies were included for liposomal bupivacaine but not for TAP blocks. After screening the initial 398 articles for inclusion criteria, we rated 27 articles for quality and level of evidence (Figure 1). Level of evidence was based on the Melnyk 7-level hierarchy, and the Strength of Recommendations Taxonomy (SORT) was used to evaluate quality.[21,22]

The 15 articles describing TAP block use included mostly high-level, high-quality "A" evidence, according to SORT criteria. Five of the 12 liposomal bupivacaine articles specifically addressed the use of liposomal bupivacaine in TAP blocks. Most of the liposomal bupivacaine articles were small, nonrandomized samples and of "B" quality per the SORT criteria. However, findings were consistent across studies: TAP blocks lowered postoperative pain scores and opioid consumption, with minimal to no adverse effects, and liposomal bupivacaine use was associated with lower pain scores and opioid consumption, shortened hospital stay, and increased patient satisfaction, with no adverse events reported.[3,4,10,18,23-43] Superior results were seen when liposomal bupivacaine and TAP blocks were used together.[10,34,36,42] The literature review and appraisal supports the use of liposomal bupivacaine for TAP blocks.

Methods

• ***Setting.*** This clinical evidence-based practice implementation project was set at a medium-sized military treatment facility within the continental United States. The facility has 8 operating rooms, 8 intensive care beds, and 20 medical surgical beds, and surgeons there perform approximately 300 surgeries per month. The anesthesia department staff, at the time the project was conducted, was comprised of 10 Certified Registered Nurse Anesthetists (CRNAs) and 6 anesthesiologists. The department has no formal regional anesthesia service; rather, all providers are trained in ultrasound-guided regional anesthesia and perform regional anesthesia for their own cases. Ultrasonography machines are readily available in the perioperative areas. Liposomal bupivacaine is readily available in the perioperative area, but no written policies governed its use in ultrasound-guided regional anesthesia at the outset of the project.

• ***Intervention.*** An educational program based on current research evidence was developed for the anesthesia

Phase 1: Purpose for the change
1. Assurance of sufficient time to inform the staff of the process improvement project
2. Communication of the benefits of the project to the provider: reduction in patient postoperative pain and provider skill acquisition and maintenance
3. Discussion about the education and support that providers will be given for this project
4. Assurance for providers that the clinical practice guideline will be simple and flexible to meet the needs of the facility and ensure sustainability of the endeavor
5. Identification of primary project supporters and informing the entire staff's training in the use of evidence-based practice techniques to reduce postoperative pain for our patients
6. Introduction to personnel and their specific roles in the project
Phase 2: Communication of the process and key staff
1. Provision of adequate resources and support personnel to the anesthesia staff
2. Implementation of training to educate the staff on all aspects of the project
3. Encouragement of provider feedback on ways the training can be improved to meet their needs
4. Encouragement of providers to make recommendations that would improve the practice guideline to ensure conciseness and clarity
5. Communication with providers to assess their opinions on the impacts and perception of the practice guideline
Incorporation of the feedback from providers, as appropriate, into the continued refinement of the practice guideline to demonstrate shared decision-making.

Table. Two-Phase Change Model[47]

practitioners by university-affiliated nurse anesthetists and an ultrasound-guided regional expert nurse anesthetist. The Ajzen Theory of Planned Behavior was the foundation of this educational intervention to translate the knowledge that LB-TAP blocks are an efficacious analgesic modality into clinical practice change at this hospital.[44] An effective educational intervention can optimize practitioners' attitudes about the utility of this pain control modality, providing an opportunity for the participants to reconcile prior attitudes with new subjective norms that include LB-TAP block use. An educational intervention can also be used to improve perceived skill proficiency, as a means of increasing perceived self-efficacy (ie, behavioral control), when promoting a new skill-based behavior such as placing a TAP block.[44,45] Thus, an educational intervention that seeks to improve knowledge should also be combined with an intervention that allows participants to demonstrate skill proficiency when skill performance is integral to the planned behavior change.[46]

The Two-Phase Change guidelines developed by Howes and Quinn were used as the organizing framework (Table) and guided the development, implementation, and sustainment of the process improvement project.[47] Phases 1 and 2 each highlighted 6 steps to successfully promote the implementation of a practice change. Phase 1 clarified the purpose for the change and the project to create change. Phase 2 encompassed the steps involved in the communication of the implementation process and the key personnel who were critical in the launch and sustainment of this practice guideline. Sustainment of this local practice update can be maintained through a collaborative creation and adoption of a local policy by the anesthesia department.

Figure 2. Blue Phantom Ultrasound Training Model Used (top) and Corresponding Ultrasound Image (bottom)

Liposomal Bupivacaine (Exparel) and Transversus Abdominis Plane (TAP) Blocks Pre-Education Knowledge and Confidence Assessment

For each of the following multiple-choice questions, please select the most correct answer *and* then indicate the level of confidence with which you made your selection for questions 2-10.

This survey is anonymous and is intended to improve clinical practice through education.

1. Regional anesthesia that I provide is based on current evidence.
   a) Strongly disagree b) Disagree
   c) Neither agree nor disagree d) Agree
   e) Strongly agree

2. Our hospital utilizes appropriate regional anesthesia techniques for appropriate patient populations.
   a) True b) False

0% 10 20 30 40 50 60 70 80 90 100%
No Confidence Moderate Confidence Complete Confidence

3. The total dose of Exparel is ______ mg and is diluted with a total of ______ mL of ______.
   a) 266 mg/ 30 mL/ sterile saline
   b) 150 mg/ 40 mL/ sterile water
   c) 35 0mg/ 10 mL/ sterile saline
   d) 50 mg/ 20 mL/ sterile saline

0% 10 20 30 40 50 60 70 80 90 100%
No Confidence Moderate Confidence Complete Confidence

4. Exparel has a special ______ formulation that allows it to be delivered as a ______.
   a) liposomal; continuous infusion
   b) protein; continuous infusion
   c) liposomal; single shot
   d) protein; single shot

0% 10 20 30 40 50 60 70 80 90 100%
No Confidence Moderate Confidence Complete Confidence

5. The onset of action of Exparel is ______.
   a) 5 minutes b) 40 minutes
   c) 90 minutes d) 120 minutes

0% 10 20 30 40 50 60 70 80 90 100%
No Confidence Moderate Confidence Complete Confidence

6. The duration of action of Exparel is ______.
   a) 4-6 hours b) 6-12 hours
   c) 12-24 hours d) 24-72 hours

0% 10 20 30 40 50 60 70 80 90 100%
No Confidence Moderate Confidence Complete Confidence

7. The transversus abdominis plane (TAP) is located between the ______.
   a) internal and external oblique muscles
   b) internal oblique and transversus abdominis muscles
   c) transversus abdominis and rectus abdominis
   d) external oblique muscles and aponeurosis

0% 10 20 30 40 50 60 70 80 90 100%
No Confidence Moderate Confidence Complete Confidence

8. TAP blocks inhibit nociception from distal spinal nerve receptors that innervate the ______.
   a) abdominal skin, abdominal muscles, and parietal peritoneum
   b) abdominal muscles and parietal peritoneum
   c) abdominal skin only
   d) none of the above

0% 10 20 30 40 50 60 70 80 90 100%
No Confidence Moderate Confidence Complete Confidence

9. Innervation is supplied to the abdominal wall from these spinal nerves:
   a) T4-T12 b) T6-T12
   c) T7-L1 d) T12- S3

0% 10 20 30 40 50 60 70 80 90 100%
No Confidence Moderate Confidence Complete Confidence

10. TAP blocks can be performed with the use of ultrasound.
   a) True b) False

0% 10 20 30 40 50 60 70 80 90 100%
No Confidence Moderate Confidence Complete Confidence

Figure 3. Knowledge and Confidence Assessment

The topics in the education program were derived from established guidelines for formal regional anesthesia training programs: indications, technique, contraindications, and complications.[48] The program included a review of the anatomy and sonoanatomy of the anterolateral abdominal wall, how to perform a TAP block, and indications and contraindications for a TAP block, in addition to a review of the pharmacokinetics and pharmacodynamics of liposomal bupivacaine. Lecture, demonstration, and simulation modalities were provided to all anesthesia practitioners in small groups. Each anesthesia provider simulated the placement of an ultrasound-guided TAP block on a Blue Phantom ultrasound training model (CAE Healthcare, Figure 2) with specific sonoanatomy to the transversus abdominis plane immediately following the group lectures. All participation was voluntary.

• ***Measures.*** The efficacy of the educational intervention was assessed by comparing anesthesia practitioner knowledge and confidence scores before and after the educational intervention, and by observing anesthesia practitioners' ability to successfully place TAP blocks

Item	Score				
	1	2	3	4	5
Preparation for procedure (monitors, IV access etc)	Did not organize well		Equipment generally organized		All equipment organized
Patient interaction	No rapport; patient unaware; no sedation		Rapport generally established		Strong rapport established and maintained
Asepsis (sterile gloves, site and probe cleansing)	Many errors in asepsis		Generally proper aseptic technique		Excellent aseptic technique
Respect for tissue	Use of unnecessary force		Carefully handles tissue, occasional unintentional damage		Consistently handles tissue appropriately
Time and motion	Many unnecessary movements		Some unnecessary movements		Economy of movements, maximum efficiency
Instrument handling	Repeated tentative and awkward movements		Occasional awkward move		Fluid movement, no awkwardness
Flow of procedure	Frequent stops, unsure of next move		Some forward planning with reasonable progression		Obviously planned course of procedure, effortless flow
Knowledge of procedure	Deficient knowledge		Knows all important steps		Familiarity with all aspects of procedure
Overall performance	Very poor		Competent		Clearly superior
Overall should the candidate pass/fail:					

Figure 4a. Ultrasound-Guided Regional Anesthesia Competency Assessment Tool
Abbreviation: u/s, ultrasonography.
(Source: Adapted from Cheung et al,[49] 2012, figure 2.)

	Assessment steps	Not performed	Performed poorly	Performed well
1	Patient positioning			
2	Placement of u/s machine for proper visualization			
3	Selection of correct transducer probe			
4	Correct settings for depth and gain			
5	Appropriate holding of probe			
6	Orientation to u/s screen in relation to sides of probe			
7	Correct identification of anatomy and target			
8	Use of Doppler function to rule out vasculature			
9	Needle alignment to probe			
10	Ability to maintain view of needle			
11	Efficiency in regaining needle image			
12	Recognition of proper nerve stimulation (if utilized)			
13	Ensure current is no less than 0.2 mA if nerve stimulator used			
14	Ask for aspiration to rule out intravascular injection			
15	Visualization of needle tip prior to injection			
16	Ask for 1-2 ml local anesthetic injection to rule out intraneural/intravascular injection			
17	Ask patient or assess for signs of discomfort			
18	Ask for aspiration every 5 ml increments of injection			
19	Recognition of proper needle position			
20	Perform appropriate needle tip adjustment			
21	Assessment of ease of injection			
22	Recognition of correct local anesthetic spread in relation to nerve.			

Figure 4b. Ultrasound-Guided Regional Anesthesia Competency Assessment Tool
Abbreviation: u/s, ultrasonography.
(Source: Adapted from Cheung et al,[49] 2012, figure 2.)

in a simulation model with ultrasound guidance. The effectiveness of the project was assessed by performing anesthesia workload reviews to determine what proportion of eligible open abdominal surgery cases received an LB-TAP block in the 2 months before implementation and the 2 months after implementation.

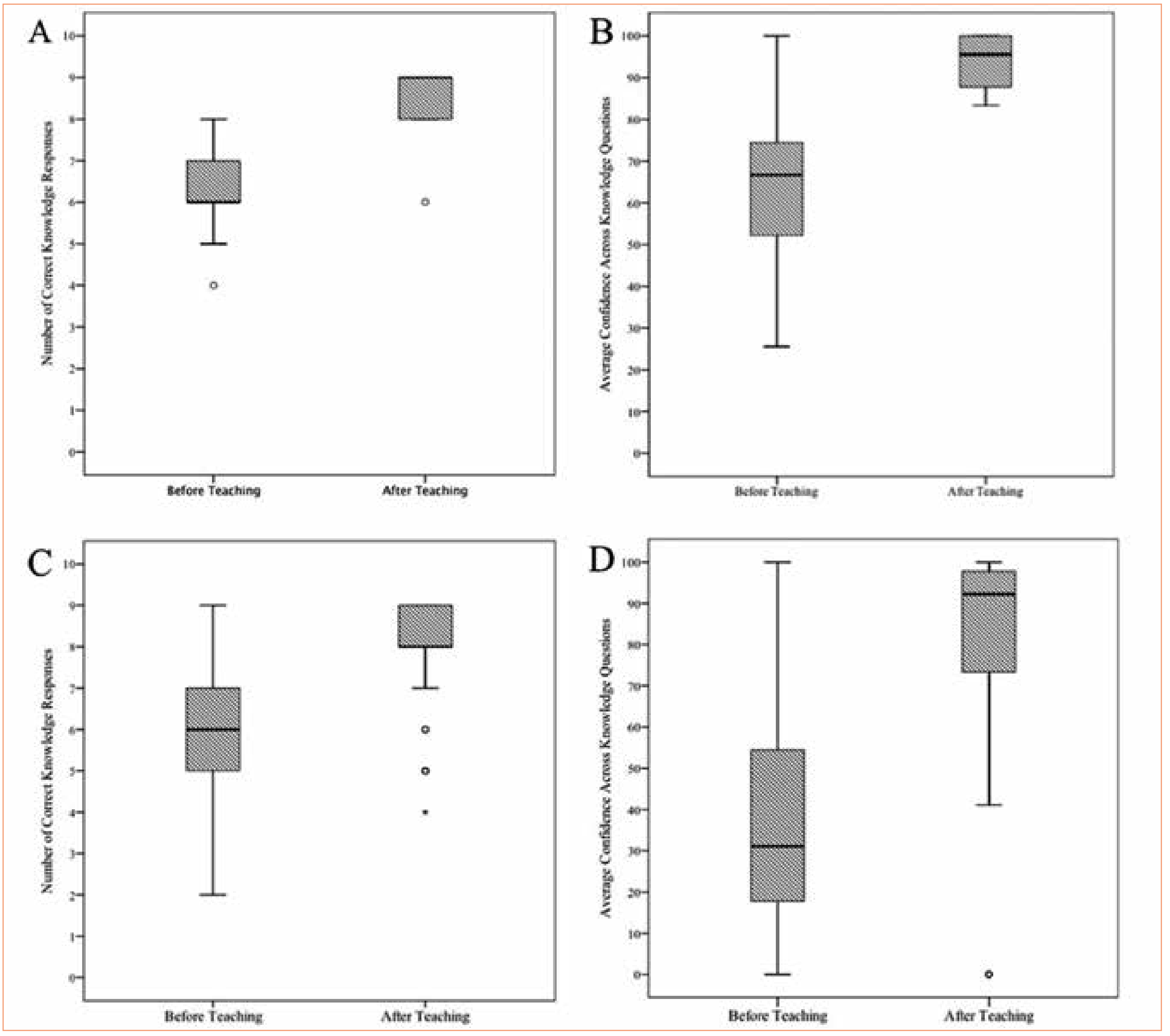

Figure 5. Anesthesia Provider and Nursing Staff Knowledge and Confidence Results Before and After Teaching[a]
[a]Panels A and B depict the number of correct responses to knowledge questions (A) and the average confidence level across knowledge questions (B) for anesthesia providers (n = 13).

Practitioner knowledge and confidence was assessed in a pen and paper questionnaire, which was developed by 2 university faculty and a local regional anesthesia expert and which consisted of 10 questions (Figure 3). Two questions were background questions to gauge the practitioners' opinion about how appropriately regional anesthesia was being implemented at the project site and whether they believed that they were practicing regional anesthesia according to the most recent evidence. Four questions were included to determine the practitioners' knowledge about the dosing, pharmacodynamics, and pharmacokinetics of liposomal bupivacaine. Four questions focused on the anatomy of a TAP block and the use of ultrasound guidance for TAP block placement. Each knowledge question required the respondent to make 2 responses: A multiple-choice or true/false response assessing the respondent's knowledge, and an 11-point Likert scale (in 10% intervals ranging from 0% confidence to 100% confidence) assessing the respondent's confidence that his or her answer was correct. The pre- and post-implementation assessments contained the same items.

Using the existing ultrasonography equipment and stimulating needles available in the anesthesia department, each anesthesia provider was also assessed on his or her ability to place a simulated TAP block on a Blue Phantom model that replicated the sonoanatomy of the transversus abdominis plane (see Figure 2). Using a validated task-specific checklist for ultrasound-guided regional block performance that mirrored the American Society of Regional Anesthesia and Pain Medicine's evidence-based medicine assessment of ultrasound-guided regional anesthesia advisories, the lecturers observed and recorded 22 individual assessment points (Figure 4a and 4b).[49] Each practitioner was evaluated on their ability to correctly describe the sonoanatomy, align the ultrasound probe to the anatomical landmarks, and place the stimulating needle into the transversus abdominis plane while maintaining needle visualization throughout the simulated block.

Anesthesia workload records were reviewed to assess the impact of the project on the rate of LB-TAP block placement for patients undergoing open abdominal surgery at the military treatment facility. All eligible cases for 3 months before implementation and 3 months after implementation were reviewed. Cases were coded as yes if the eligible patient received an LB-TAP block and no if they did not.

• ***Statistical Analysis.*** Data were entered into IBM SPSS Version 24 (IBM Corp) and checked for accuracy and completeness. Responses to knowledge questions were recoded as correct or incorrect. To allow for inclusion of all cases, the authors coded unanswered knowledge questions as incorrect, and coded unanswered confidence questions as 0% confident. The number of correct responses was summed to arrive at a knowledge score ranging from 0 to 9, with higher numbers indicating more questions were answered correctly. Item confidence scores were averaged to arrive at a mean confidence across all knowledge items.

Descriptive statistics, including frequencies, medians, and interquartile ranges (IQRs), were computed to characterize the sample. To assess the impact of teaching on provider knowledge and confidence, the investigators compared the pretest and posttest scores using the Wilcoxon signed rank test. To assess the impact of the project on the frequency of LB-TAP block in eligible patients, the Fisher exact test was used. Alpha was 0.05, two-tailed, for all tests.

• ***Ethical Considerations.*** The project was reviewed by an institutional review board (IRB) designee and determined to be an exempt performance improvement activity. Individually identifiable information was not collected or recorded as part of this project. Pre- and postimplementation examinations were scored and subsequently discarded. Examinations were marked in a nonidentifiable code that was specific only for licensure for the anesthesia practitioner examination. Therefore, risk of violating the confidentiality or privacy of participants was negligible.

Results

A total of 13 anesthesia providers—8 CRNAs and 5 anesthesiologists—received the intervention. One other anesthesiologist was not available to participate, and 2 CRNAs were involved in developing the project and did not participate to minimize bias in results. No provider refused to participate. Completeness of data ranged from 100% complete for the knowledge pretest to 98% complete for the confidence posttest.

When asked whether their regional anesthesia practice was evidence based before training, 1 provider strongly disagreed with the statement, whereas 12 providers either agreed or strongly agreed with the same statement. After training, 1 provider strongly disagreed, 1 provider neither agreed nor disagreed, and 11 providers either agreed or strongly agreed with the same statement. Before training, 11 of 12 providers agreed with the statement that current regional anesthesia practice was appropriate at the facility. After training, 10 of 12 providers agreed with the same statement.

After training, there was a significant increase in the knowledge scores among anesthesia practitioners ($n = 13$; median pretest score = 5, IQR = 1; median posttest score = 8, IQR = 0; $Z = 3.09$, $P = .002$; Figure 5, Panel A). Additionally, after training there was a significant increase in anesthesia practitioners' confidence scores ($n = 13$; median pretest score = 67%, IQR = 32%; median posttest score = 96%, IQR = 11%; Z = 3.06, P = .002; Figure 5, Panel B). All anesthesia practitioners ($n = 13$) were able to correctly place a simulated TAP block with minimal assistance using a validated evaluation tool.

During the 3 months before implementation, 6 eligible patients underwent open abdominal surgery, with none receiving an LB-TAP block. During the 3 months after implementation, 6 eligible patients underwent open abdominal surgery, 5 of whom received an LB-TAP block. Of note, the single eligible patient who did not receive an LB-TAP block was cared for by a provider who was not present for the training. This difference was significant ($P = .02$).

Discussion

We designed the educational sessions to include multiple formats in order to appeal to auditory, visual, and kinesthetic learners. The implementation of a multistrategy education program using simulation resulted in a significant increase in knowledge and confidence among anesthesia practitioners, transforming local clinical practices and significantly increasing the utilization of this modality at our facility. Military treatment facilities continually have high staff turnover rates because of frequent personnel relocations, thus making sustainment of practice changes challenging. To sustain this practice change, a clinical policy detailing the utilization of LB-TAP blocks was incorporated into the anesthesia department's policies and procedures, which all newly arrived providers review during orientation.

Limitations of this evidence-based practice project include the assessment of skill proficiency with a task trainer and the decision to not collect and analyze individual patient-level outcomes, such as pain scores. Although simulation is an effective tool for skill development, additional skill and proficiency may be needed when one is working with real patients, because of extremes in body habitus and altered anatomy.[50] However, the results suggest that, as a group, providers felt comfortable enough after training to perform LB-TAP blocks in 83% of eligible patients. These results may not be generalizable, because our intervention was delivered to staff members who already had extensive experience with performing ultrasound-guided regional anesthesia for orthopedic procedures. The decision to rely on anesthesia administrative records (ie, proportion of eligible patients receiving an LB-TAP block) rather than patient records (ie, patient pain scores) to assess the patient impact was made to ensure the feasibility of the project. Accessing patient records would have required a higher level of IRB review, and the added delay might have caused the project to overrun its deadline for completion. However, we were comfortable with this decision given that a substantial and consistent evidence base supports the effectiveness of LB and TAP blocks, alone or in conjunction, for the treatment of postoperative pain.[3,4,7,10,18,19,23-43]

Conclusion

Anesthesia practitioners can acquire and sustain knowledge and skill in the performance of underutilized regional anesthetic techniques through the creation of an educational and simulation intervention. The increase in self-efficacy and skill proficiency can change local practice behaviors in regional analgesic techniques, enhancing the multimodal analgesic options that can be offered to patients who undergo various surgical procedures.

REFERENCES

1. Centers for Disease Control and Prevention. Inpatient surgery. Available at: http://www.cdc.gov/nchs/fastats/inpatient-surgery.htm.Published 2014. Accessed October, 2018.
2. Lapmahapaisan S, Tantemsapya N, Aroonpruksakul N, Maisat W, Suraseranivongse S. Efficacy of surgical transversus abdominis plane block for postoperative pain relief following abdominal surgery in pediatric patients. *Paediatr Anaesth.* 2015;25(6):614-620.
3. Brady RR, Ventham NT, Roberts DM, Graham C, Daniel T. Open transversus abdominis plane block and analgesic requirements in patients following right hemicolectomy. *Ann R Coll Surg Engl.* 2012;94(5):327-330.
4. Favuzza J, Brady K, Delaney CP. Transversus abdominis plane blocks and enhanced recovery pathways: making the 23-h hospital stay a realistic goal after laparoscopic colorectal surgery. *Surg Endosc.* 2013; 27(7):2481-2486.
5. Petersen PL, Stjernholm P, Kristiansen VB, et al. The beneficial effect of transversus abdominis plane block after laparoscopic cholecystectomy in day-case surgery: a randomized clinical trial. *Anesth Analg.* 2012;115(3):527-533.
6. American Association of Nurse Anesthetists. Care of Patients Receiving Analgesia by Catheter Technique: Position Statement and Policy Considerations (formerly Provision of Pain Relief by Medication Administered via Continuous Catheter or Other Pain Relief Devices, 2011). Available at: https://www.aana.com/docs/default-source/practice-aana-com-web-documents-(all)/care-of-patients-receiving-analgesia-by-catheter-techniques.pdf?sfvrsn=d30049b1_4. Published 2017. Originally accessed March 3, 2017. Updated link accessed October 3, 2018.
7. Abdul Jalil RM, Yahya N, Sulaiman O, et al. Comparing the effectiveness of ropivacaine 0.5% versus ropivacaine 0.2% for transabdominis plane block in providing postoperative analgesia after appendectomy. *Acta Anaesthesiol Taiwan.* 2014;52(2):49-53.
8. Rafi AN. Abdominal field block: a new approach via the lumbar triangle. *Anaesthesia.* 2001;56(10):1024-1026.
9. Ripollés J, Marmaña Mezquita S, Abad A, Calvo J. Analgesic efficacy of the ultrasound-guided blockade of the transversus abdominis plane—a systematic review [Portuguese]. *Rev Bras Anestesiol.* 2015;65(4):255-280.
10. Hutchins J, Vogel RI, Ghebre R, et al. Ultrasound-guided subcostal transversus abdominis plane infiltration with liposomal bupivacaine for patients undergoing robotic-assisted hysterectomy: a retrospective study. *Intl J Gynecol Cancer.* 2015;25(5):937-941.
11. Calle GA, López CC, Sánchez E, et al. Transversus abdominis plane block after ambulatory total laparoscopic hysterectomy: randomized controlled trial. *Acta Obstet Gynecol Scand.* 2014;93(4):345-350.
12. McDonnell JG, O'Donnell B, Curley G, Heffernan A, Power C, Laffey JG. The analgesic efficacy of transversus abdominis plane block after abdominal surgery: a prospective randomized controlled trial. *Anesth Analg.* 2007;104(1):193-197.
13. Siddiqui MR, Sajid MS, Uncles DR, Cheek L, Baig MK. A meta-analysis on the clinical effectiveness of transversus abdominis plane block. *J Clin Anesth.* 2011;23(1):7-14.
14. Tolchard S, Davies R, Martindale S. Efficacy of the subcostal transversus abdominis plane block in laparoscopic cholecystectomy: comparison with conventional port-site infiltration. *J Anaesthesiol Clin Pharmacol.* 2012;28(3): 339-343.
15. Wassef M, Lee DY, Levine JL, et al. Feasibility and analgesic efficacy of the transversus abdominis plane block after single-port laparoscopy in patients having bariatric surgery. *J Pain Res.* 2013;6:837-841.
16. Urigel S, Molter J. Transversus abdominis plane (TAP) blocks. *AANA J.* 2014;82(1):73-79.
17. US Food and Drug Administration. Drug approval package for Exparel (bupivacaine liposome) Injectable Suspension. Available at: https://www.accessdata.fda.gov/drugsatfda_docs/nda/2011/022496Orig1s000TOC.cfm . Published 2012. Updated 2016. Originally accessed March 3, 2017. Updated link accessed October 3, 2018.
18. Cohen SM. Extended pain relief trial utilizing infiltration of Exparel, a long-acting multivesicular liposome formulation of bupivacaine: a phase IV health economic trial in adult patients undergoing open colectomy. *J Pain Res.* 2012; 5:567-572.
19. Melchor JR, Mezquita SM, Gurumeta AA, Vecino JM. Analgesic efficacy of the ultrasound-guided blockade of the transversus abdominis plane: a systematic review. *Braz J Anesthesiol.* 2014;.
20. Allen TM, Cullis PR. Liposomal drug delivery systems: from concept to clinical applications. *Adv Drug Deliv Rev.* 2013;65(1):36-48.
21. Melnyk BM. Level of evidence plus critical appraisal of its quality yields confidence to implement evidence-based practice changes [editorial]. *Worldviews Evid Based Nurs.* 2016;13(5):337-339.
22. Ebell MH, Siwek J, Weiss BD, et al. Strength of Recommendation Taxonomy (SORT): a patient-centered approach to grading evidence in the medical literature. *Am Fam Physician.* 2004;69(3):548-556.
23. Bharti N, Kumar P, Bala I, Gupta V. The efficacy of a novel approach to transversus abdominis plane block for postoperative analgesia after colorectal surgery. *Anesth Analg.* 2011;112(6):1504-1508.
24. Conaghan P, Maxwell-Armstrong C, Bedforth N, et al. Efficacy of transversus abdominis plane blocks in laparoscopic colorectal resections. *Surg Endosc.* 2009;24(10):2480-2484.
25. Abdallah FW, Laffey JG, Halpern SH, Brull R. Duration of analgesic effectiveness after the posterior and lateral transversus abdominis plane block techniques for transverse lower abdominal incisions: a meta-analysis. *Br J Anaesth.* 2013;111(5):721-735.
26. Freir NM, Murphy C, Mugawar M, Linnane A, Cunningham AJ. Transversus abdominis plane block for analgesia in renal transplantation: a randomized controlled trial. *Anesth Analg.* 2012;115(4):953-957.

27. Wahba SS, Kamal SM. Analgesic efficacy and outcome of transversus-abdominis plane block versus low thoracic-epidural analgesia after laparotomy in ischemic heart disease patients. *J Anesth.* 2014;28(4):517-523.
28. Farag E, Guirguis MN, Helou M, et al. Continuous transversus abdominis plane block catheter analgesia for postoperative pain control in renal transplant. *J Anesth.* 2015;29(1):4-8.
29. Bamigboye AA, Hofmeyr GJ. Local anaesthetic wound infiltration and abdominal nerves block during caesarean section for postoperative pain relief. *Cochrane Database Syst Rev.* 2009;(3):CD006954.
30. Charlton S, Cyna AM, Middleton P, Griffiths JD. Perioperative transversus abdominis plane (TAP) blocks for analgesia after abdominal surgery. *Cochrane Database Syst Rev.* 2010;(12):CD007705.
31. Walter CJ, Maxwell-Armstrong C, Pinkney TD, et al. A randomised controlled trial of the efficacy of ultrasound-guided transversus abdominis plane (TAP) block in laparoscopic colorectal surgery. *Surg Endosc.* 2013;27(7):2366-2372.
32. Findlay JM, Ashraf SQ, Congahan [sic] P. Transversus abdominis plane (TAP) blocks: a review. *Surgeon.* 2012;10(6):361-367.
33. Gasanova I, Grant E, Way M, Rosero EB, Joshi GP. Ultrasound-guided transversus abdominal plane block with multimodal analgesia for pain management after total abdominal hysterectomy. *Arch Gynecol Obstet.* 2013;288(1):105-111.
34. Feierman DE, Kronenfeld M, Gupta PM, Younger N, Logvinskiy E. Evaluation of Exparel use in a transversus abdominis plane (TAP) block for prolonged postoperative analgesia in subjects undergoing open umbilical hernia repair. *Anesthd Analg.* 2013;116():272-272.
35. Gastevski D. Infiltration of liposome bupivacaine into the transversus abdominis plane for postsurgical pain management in a 39-year-old female undergoing laparoscopic cholecystectomy. *Pain Med.* 2014;15(8):1312-1315.
36. Feierman DE, Kronenfeld M, Gupta PM, Younger N, Logvinskiy E. Liposomal bupivacaine infiltration into the transversus abdominis plane for postsurgical analgesia in open abdominal umbilical hernia repair: results from a cohort of 13 patients. *J Pain Res.* 2014;7:477-482.
37. Sternlicht A, Shapiro M, Robelen G, Vellayappan U, Tuerk IA. Infiltration of liposome bupivacaine into the transversus abdominis plane for postsurgical analgesia in robotic laparoscopic prostatectomy: a pilot study. *Local Reg Anesth.* 2014;7:69-74.
38. Boland E, Gillespie M, Apostolides G. Multimodal pain management: does the use of Exparel (bupivacaine extended-release liposome injection) minimize postoperative narcotic requirements in colorectal patients undergoing abdominal operations [abstract]. *Dis Colon Rectum.* 2014;57(5):E303.
39. Morales R Jr, Mentz H 3rd, Newall G, Patronella C, Masters O 3rd. Use of abdominal field block injections with liposomal bupivicaine [sic]to control postoperative pain after abdominoplasty. *Aesthet Surg J.* 2013;33(8):1148-1153.
40. Marcet JE, Nfonsam VN, Larach S. An extended paIn relief trial utilizing the infiltration of a long-acting Multivesicular liPosome foRmulation Of bupiVacaine, Exparel (IMPROVE): a Phase IV health economic trial in adult patients undergoing ileostomy reversal. *J Pain Res.* 2013;6:549-555.
41. Vogel JD. Liposome bupivacaine (Exparel) for extended pain relief in patients undergoing ileostomy reversal at a single institution with a fast-track discharge protocol: an IMPROVE Phase IV health economics trial. *J Pain Res.* 2013;6:605-610.
42. Jrebi N, Szeto P, Hoedema R, et al. TAP block with Exparel decreases postoperative pain and narcotic use in elective colorectal patients [abstract]. *Dis Colon Rectum.* 2014;57(5).
43. Bupivacaine liposomal injection (Exparel) for post surgical pain. *Med Lett Drugs Ther.* 2012;54(1387):26-27.
44. Ajzen I. Perceived behavioral control, self-efficacy, locus of control, and the theory of planned behavior. *J Appl Soc Psychol.* 2002;32(4):665-683.
45. Plant JL, van Schaik SM, Sliwka DC, Boscardin CK, O'Sullivan PS. Validation of a self- efficacy instrument and its relationship to performance of crisis resource management skills. *Adv Health Sci Educ.* 2011;16(5):579-590.
46. Ramsingh D, Rinehart J, Kain Z, et al. Impact assessment of perioperative point-of-care ultrasound training on anesthesiology residents. *Anesthesiology.* 2015;123(3):670-682.
47. White KM, Dudley-Brown S. *Translation of Evidence into Nursing and Health Care Practice.* 1st ed. New York, NY: Springer Publishing Co; 2011.
48. Baydar H, Duru LS, Ozkardesler S, Akan M, Meseri RD, Karka G. Evaluation of education, attitude, and practice of the Turkish anesthesiologists in regional block techniques. *Anesthesiol Pain Med.* 2013;2(4):164-169.
49. Cheung JJ, Chen EW, Darani R, McCartney CJ, Dubrowski A, Awad IT. The creation of an objective assessment tool for ultrasound-guided regional anesthesia using the Delphi method. *Reg Anesth Pain Med.* 2012;37(3):329-333.
50. Oppenheimer AJ, Fiala TGS, Oppenheimer DC. Direct transversus abdominis plane blocks with Exparel during abdominoplasty: *Ann Plast Surg.* 2016;77(5):499-500.

AUTHORS

Lisa O'Driscoll, DNP, CRNA, NC, USN, principle investigator at the Uniformed Services University of the Health Sciences, Bethesda, Maryland. Email: lisa.odriscoll.2865@gmail.com.

Robert G. Girolamo, DNP, CRNA, Uniformed Services University of the Health Sciences, Bethesda, Maryland. Email: ggirolamo@gmail.com.

Christopher Crerar, DNP, CRNA, assistant professor at the Uniformed Services University of the Health Sciences, Bethesda, Maryland. Email: chris_crerar@yahoo.com.

Walter Williamson, MSN, CRNA, staff nurse anesthetist, United States Navy, Great Lakes, Illinois. Email: walter.williamson2@va.gov.

Chad Moore, DNP, CRNA, assistant site director and assistant professor at the Uniformed Services University of the Health Sciences, Bethesda, Maryland. Email: chad.moore@usuhs.edu.

Kenneth Wofford, PhD, CRNA, assistant professor at the Uniformed Services University of the Health Sciences, Bethesda, Maryland. Email: kenneth.wofford@usuhs.edu.

Raymond Bonds, DNP, CRNA, site director and assistant professor at the Uniformed Services University of the Health Sciences, Bethesda, Maryland. Email: raymond.bonds@usuhs.edu.

DISCLOSURES

The authors have declared no financial relationships with any commercial entity related to the content of this article. The authors did not discuss off-label use within the article.

No financial support or grants were received for the project.

MILITARY DISCLAIMER

The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense or the United States Government.