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.
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

Figure 1. PRISMA Flowsheet
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. 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. 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.

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. 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.

Table. Two-Phase Change Model

<table>
<thead>
<tr>
<th>Phase 1: Purpose for the change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Assurance of sufficient time to inform the staff of the process improvement project</td>
</tr>
<tr>
<td>2. Communication of the benefits of the project to the provider: reduction in patient postoperative pain and provider skill acquisition and maintenance</td>
</tr>
<tr>
<td>3. Discussion about the education and support that providers will be given for this project</td>
</tr>
<tr>
<td>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</td>
</tr>
<tr>
<td>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</td>
</tr>
<tr>
<td>6. Introduction to personnel and their specific roles in the project</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase 2: Communication of the process and key staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Provision of adequate resources and support personnel to the anesthesia staff</td>
</tr>
<tr>
<td>2. Implementation of training to educate the staff on all aspects of the project</td>
</tr>
<tr>
<td>3. Encouragement of provider feedback on ways the training can be improved to meet their needs</td>
</tr>
<tr>
<td>4. Encouragement of providers to make recommendations that would improve the practice guideline to ensure conciseness and clarity</td>
</tr>
<tr>
<td>5. Communication with providers to assess their opinions on the impacts and perception of the practice guideline</td>
</tr>
</tbody>
</table>

Incorporation of the feedback from providers, as appropriate, into the continued refinement of the practice guideline to demonstrate shared decision-making.
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

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

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

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

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

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

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

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

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

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.

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation for procedure (monitors, IV access etc)</td>
<td>Did not organize well</td>
</tr>
<tr>
<td>Patient interaction</td>
<td>No rapport; patient unaware; no sedation</td>
</tr>
<tr>
<td>Asepsis (sterile gloves, site and probe cleansing)</td>
<td>Many errors in asepsis</td>
</tr>
<tr>
<td>Respect for tissue</td>
<td>Use of unnecessary force</td>
</tr>
<tr>
<td>Time and motion</td>
<td>Many unnecessary movements</td>
</tr>
<tr>
<td>Instrument handling</td>
<td>Repeated tentative and awkward movements</td>
</tr>
<tr>
<td>Flow of procedure</td>
<td>Frequent stops, unsure of next move</td>
</tr>
<tr>
<td>Knowledge of procedure</td>
<td>Deficient knowledge</td>
</tr>
<tr>
<td>Overall performance</td>
<td>Very poor</td>
</tr>
</tbody>
</table>

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

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**Figure 5.** Anesthesia Provider and Nursing Staff Knowledge and Confidence Results Before and After Teaching

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 ($n = 13$).
dence-based medicine assessment of ultrasound-guided regional anesthesia advisories, the lecturers observed and recorded 22 individual assessment points (Figure 4a and 4b). 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 in-
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. 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.

**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**


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