Use of the Erector Spinae Plane Block for the Perioperative Pain Management of the Cardiac Surgical Patient: An Educational Module

Javier Daniel Luces  
*Florida International University*, jluce004@fiu.edu

Vince Gonzalez  
*Florida International University*, gonzalv@fiu.edu

John Bell

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Use of the Erector Spinae Plane Block for the Perioperative Pain Management of the Cardiac Surgical Patient: An Educational Module

A DNP Project Presented to the Faculty of the
Nicole Wertheim College of Nursing and Health Sciences
Florida International University

In partial fulfillment of the requirements
For the Degree of Doctor of Nursing Practice

By
Javier Luces MSN, RN

Supervised By
Dr. Vince Gonzalez DNP, CRNA
Dr. John Bell DNP, CRNA

Approval Acknowledged: ______________________________, DNAP Program Director

Date: ______________

Approval Acknowledged: ______________________________, DNP Program Director

Date: ______________
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ABSTRACT

Background: Regional anesthesia has been at the forefront of opioid-sparing anesthesia. It has been proven time and again to be an effective method of safely and effectively controlling pain throughout the surgical process. Cardiac surgery presents its challenges to performing regional techniques due to the excessive amount of anticoagulation required to perform this type of surgery. The thoracic erector spinae plane block is a promising technique that has been shown to provide adequate pain control and is a safe alternative in patients who are anticoagulated compared to other regional techniques.

Objectives: The purpose of this study is to increase anesthesia provider knowledge on the value of the use of the ESP block for cardiac surgery. A literature review including primary research studies addresses the PICO question: “In anticoagulated patients undergoing general anesthesia for cardiac surgery, are erector spinae plane blocks when compared to thoracic epidurals, thoracic paravertebral blocks, and traditional methods safer to use while providing adequate perioperative analgesia?” The literature review is utilized to deliver the educational structure to increase provider knowledge. The objective is to increase provider awareness to improve patient outcomes and satisfaction related to cardiac surgery.

Methodology: The primary methodology of the proposed project is to administer an online educational intervention to providers which focuses on the benefits of the ESP block for cardiac surgery. Pre- and post-assessment surveys will be used to measure the improvement of provider knowledge before and after the intervention. The likelihood of use and recommendation of the ESP block for cardiac surgery will also be assessed.

Results: There was an overall improvement in provider knowledge following the educational intervention. The likelihood of utilizing and recommending the ESP block improved overall as well.

Conclusions: The evidence shows that the thoracic ESP block is a promising safe and effective tool for patients undergoing cardiac surgery via sternotomy or thoracotomy compared to the thoracic epidural, thoracic paravertebral block, and traditional methods. More research must be conducted via randomized controlled trials to ensure its safety and effectiveness.

Keywords: Erector spinae plane block, cardiac surgery, adult, regional anesthesia, thoracic epidural, thoracic paravertebral block, traditional methods
INTRODUCTION

Description of Problem

High thoracic epidurals (HTEs) and thoracic paravertebral blocks (TPVBs) are not widely used for cardiac surgery due to the severity of the adverse effects of performing the blocks on anticoagulated patients. A significant complication from HTEs, especially in an anticoagulated patient, is the risk of epidural hematoma, which is known to cause severe neurologic deficits.\textsuperscript{1} It also is known to cause pruritis, nausea, vomiting, urinary retention, and in some cases, respiratory depression from epidural opioids.\textsuperscript{1} TPVBs, although a better option than HTEs with a lower incidence of complications, still carry the inherent risk of a spinal hematoma and epidural abscess.\textsuperscript{2} In addition to these, there is also the risk of accidental vascular puncture, hypotension, epidural or intrathecal spread, puncture of the pleura, and pneumothorax.\textsuperscript{3} The likelihood of pneumothorax and vascular puncture was higher using a bilateral block as opposed to a unilateral block, which would be required in complete blockage for sternotomy incision.\textsuperscript{3} The inherent risks of performing HTEs and TPVBs are unfortunate, most notably in anticoagulated cardiac surgical patients. Unless a regional technique is found that minimizes the significant risks while providing adequate blockade, high opioid use during cardiac surgery will continue to be utilized.

One of the most common surgeries in America is coronary artery bypass grafting (CABG), costing an average of $44,820.\textsuperscript{4} Fast-track, multimodal approaches to cardiac surgery have been proven to be safer for patients and more cost-effective than traditional methods of high opiate use.\textsuperscript{5} A key aspect of this approach is regional anesthesia. Thoracic erector spinae plane (ESP) blocks have been shown to have an adequate analgesic effect comparable to HTEs
on cardiac surgical patients. Considering that HTEs and TPVBs have similar pain control, it could be hypothesized that ESP blocks would have similar results in analgesia when compared to TPVBs. ESP blocks may potentially be the future of managing pain in cardiac surgery.

**Background and Significance**

Regional anesthesia has been at the forefront of opioid-sparing/free analgesia in recent years when it was discovered how dangerous opioids could be to those who liberally use them. There are many different regional techniques anesthesia providers utilize tailored to specific surgeries patients undergo. Traditionally, cardiac surgery has brought about its challenges regarding regional anesthesia due to the required presence of systemic heparinization intra- and postoperatively. This anticoagulated state brings about many risks related to the placement of HTEs and TPVBs, causing providers to administer them hesitantly. Considering HTEs and TPVBs are the gold standards in managing thoracic surgical pain, this has forced anesthesia providers to look towards other regional techniques that are as effective as these and safe to perform in an anticoagulated state.

ESP block is one of the newest regional techniques discovered in the last few years to treat chronic thoracic neuropathic pain and postoperative pain in thoracic surgery. The ESP block exerts its effects by diffusing local anesthetic anteriorly to the paravertebral and epidural spaces and laterally to the intercostal space at multiple levels blocking the nerves that supply the anterolateral wall of the thorax. This block is not only relatively superficial; it's also distant from significant vessels and nerves, pleura, and the spinal cord. These attributes make the ESP block a strong candidate for anticoagulated patients having cardiac surgery, considering the risk of serious complications is minimized. Multiple case studies in which the ESP block was performed for cardiac surgery showed adequate pain control with no adverse effects from anticoagulation.
Although more randomized controlled trials must be conducted to ensure the safety and efficacy of the ESP block, this regional technique shows promise for safely and effectively providing adequate perioperative analgesia for patients undergoing cardiac surgery.

**Purpose of the Study**

This study aims to increase anesthesia provider knowledge on the value of the use of the ESP block for cardiac surgery. A literature review including primary research studies addresses the PICO question: "In anticoagulated patients undergoing general anesthesia for cardiac surgery, are erector spinae plane blocks when compared to thoracic epidurals, thoracic paravertebral blocks, and traditional methods safer to use while providing adequate perioperative analgesia?" The literature review is utilized to deliver the educational structure to increase provider knowledge. The objective is to increase provider awareness to improve patient outcomes and satisfaction related to cardiac surgery.

**LITERATURE REVIEW**

**Purpose of the Literature Review**

Safely providing adequate analgesia for patients undergoing cardiac surgery using regional techniques presents significant challenges related to the significant amount of anticoagulation required during and after cardiopulmonary bypass. Finding a regional technique that provides adequate perioperative analgesia without serious adverse effects in anticoagulated patients is crucial. Without this technique, cardiac surgery will continue to rely heavily on opioids, which have been proven to cause more harm than good.

The first objective of this review is to determine whether ESP blocks are safe to use in anticoagulated patients. The second objective is to research whether ESP blocks have comparable or better pain control than TPVB, thoracic epidurals, and traditional methods. Once
ESP blocks have been proven to cause adequate perioperative analgesia, a plan will be put into place to include ESP blocks in future enhanced recovery after surgery (ERAS) protocols. The ESP block will be a crucial component of the ERAS protocols to ensure safe, cost-effective care for cardiac surgery patients.

**Methodology**

**Databases and Search Strategy**

The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement contains a 27 item checklist and a four-phase flow diagram that aims to aid authors in improving the reporting of systematic reviews and meta-analyses. It was utilized during this study to guide the search of this systematic review. The search used PubMed, Cumulative Index of Nursing and Allied Health Literature (CINAHL), MEDLINE (Proquest), and Excerpta Medica Database (EMBASE). To effectively search through these databases, a PICO format question was utilized to develop keywords and concepts. The keywords used include erector spinae plane block, cardiac surgery, adult, regional anesthesia, thoracic epidural, and thoracic paravertebral block. The PubMed database produced 70 articles, CINAHL yielded 26 articles, MEDLINE resulted in 21 articles, and EMBASE gave 81 articles. A total of 198 articles were found using these databases. Based on the PICO format, a clinical question was created to guide this research: (P) In anticoagulated patients undergoing general anesthesia for cardiac surgery, (I) are erector spinae plane blocks (C) when compared to thoracic epidurals, thoracic paravertebral blocks, and traditional methods (O) safer to use while providing adequate perioperative analgesia?

**Study Selection and Screening Method**
Many studies were found through the different databases that needed to be screened to ensure they were related to the PICO question. Endnote was a software tool that was used to remove duplicate studies and organize the studies found. Of the 198 articles found, 45 duplicates were removed, and 153 articles were screened. Refer to table 2 to understand the inclusion/exclusion criteria used to filter the remaining articles. One hundred thirty-three articles were excluded based on the exclusion criteria. Of the 20 articles left, seven will be used in this review based on the criteria and the PICO question.

<table>
<thead>
<tr>
<th>Table 1. Inclusion and Exclusion Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inclusion</strong></td>
</tr>
<tr>
<td>Population:</td>
</tr>
<tr>
<td>• Male and Female</td>
</tr>
<tr>
<td>• Adults</td>
</tr>
<tr>
<td>Type of procedure:</td>
</tr>
<tr>
<td>• ESP block</td>
</tr>
<tr>
<td>• Comparison of ESP block versus TPBP or HTE</td>
</tr>
<tr>
<td>• Cardiac surgery via midline sternotomy or thoracotomy</td>
</tr>
<tr>
<td>• Surgeries requiring thoracotomy</td>
</tr>
<tr>
<td>Primary outcomes:</td>
</tr>
<tr>
<td>• Decreased opioid use</td>
</tr>
<tr>
<td>• ESP block effectively controls pain in the perioperative setting</td>
</tr>
<tr>
<td>• Safe to use in anticoagulated patients</td>
</tr>
<tr>
<td>Type of study:</td>
</tr>
<tr>
<td>• English language</td>
</tr>
<tr>
<td>• Randomized controlled trials</td>
</tr>
<tr>
<td>• Publication date 2015-Present</td>
</tr>
<tr>
<td>• Case Studies</td>
</tr>
<tr>
<td>• Systematic reviews</td>
</tr>
<tr>
<td>• Meta-analysis</td>
</tr>
<tr>
<td>• Questionnaire</td>
</tr>
<tr>
<td>• Dissertations/theses</td>
</tr>
</tbody>
</table>
Figure 1. PRISMA Flow Diagram

Records identified through database searching (n = 198)

Records identified through other sources (n = 0)

Records after duplicates removed (n = 45)

Records screened (n = 153)

Records excluded (n = 133)

Full-text articles assessed for eligibility (n = 20)

Full-text articles excluded, with reasons (n = 13)

Studies included in qualitative synthesis (n = 7)
Collection, Analysis, and Data Items

The John Hopkins Evidence-Based Practice tool helps evaluate the quality and strength of evidence used for research. This tool uses level I-V to determine the strength of evidence and uses grades A-C to assess the quality of evidence. Level I consists of experimental studies, randomized control trials (RCTs), and these can be with or without meta-analysis. Level II consists of quasi-experimental studies and level III consist of non-experimental studies. Level IV is considered an opinion of respected authorities or nationally recognized expert committees and can include clinical practice guidelines (CPG), consensus panels, or case studies. Level V is based on experimental and non-research evidence. Grade A is evidence of high quality with clear aims and objectives showing consistent results. Grade B is considered evidence of good quality that has consistent results in a single setting. Grade C is evidence of low quality or with major flaws.

The investigator used the John Hopkins’ evidence appraisal tool to effectively and efficiently evaluate the studies. A table was made to aid in summarizing and classifying the features of each study. In this table, the level of evidence was provided. Along with the level of evidence, the table included: (1) Article citation and title, (2) the design/method of the study, (3) the sample and setting, (3) major variables studied, (4) measurement and data analysis, (5) findings of the study, and (6) conclusions.

Results

Study Selection

The four databases that were utilized yielded a total of 198 articles initially. Of the 198, 45 duplicates were removed, and a total of 153 articles were left for further review. After further inspection, 133 articles were excluded, and a total of 20 full-text articles were evaluated for their
suitability. A full-text evaluation was completed based on the inclusion and exclusion criteria, and 13 of the remaining were excluded for multiple reasons, including: pediatric population, type of procedure, any study published before 2015, and language other than English. Ultimately, the study selection resulted in 4 RCTs, one consecutive patient-matched controlled before-and-after study, and two case series that were used in this systematic qualitative review. This review answered the PICO question: "In anticoagulated patients undergoing general anesthesia for cardiac surgery, are erector spinae plane blocks when compared to thoracic epidurals, thoracic paravertebral blocks, or traditional methods, safer to use while providing adequate perioperative analgesia?" The four RCTs are level I evidence, while the study conducted by Macaire et al. (2019) is level II, and the two case series are level IV according to Johns Hopkins' appraisal scale. Table 2 provides a summary of all studies included in the systematic review.

<table>
<thead>
<tr>
<th>Author (Year) &amp; Level of Evidence</th>
<th>Study, Participants, Interventions, &amp; Setting</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Krishna et al. (2019) Level I</td>
<td>106 adult patients undergoing elective cardiac surgery who were randomly divided into group 1, ESP block, and group 2, conventional pain medications. 53 patients received USG single-shot bilateral ESP block with 3ml/kg of 0.375% ropivacaine and 53 received paracetamol 1gm every 6 hours and tramadol 50mg every 8 hours intravenously postoperative</td>
<td>The median pain score at rest after extubation in group 1 was 0 of 10 until hour 6, 3 of 10 at hour 8, and 4 of 10 at hours 10 and 12 post-extubation. These were significantly less in comparison with group 2 (p = 0.0001). Patients in group 1 had a significantly higher mean duration of analgesia (8.98 ± 0.14 hours), during which NRS was &lt; 4 of 10, compared with group 2</td>
</tr>
<tr>
<td>Singh et al. (2018) Level I</td>
<td>Fifty adult patients undergoing cardiac surgery were randomly assigned to Group A, TEA, and Group B, ESP block. 25 received a TEA bolus dose of 0.25% plain bupivacaine followed by a continuous infusion of 0.125% plain bupivacaine at the rate of 0.1ml/kg/h until 48 hours post-extubation. 25 received a USG continuous bilateral ESP block bolus dose of 0.25% plain bupivacaine 15 ml injected in each of the catheters</td>
<td>Comparable VAS scores were revealed at 0 h, 3 h, 6 h, and 12 h at rest and during cough in both groups. Group A had a statistically significant VAS score than Group B at 24 h, 36 h, and 48 h but the mean VAS in either of the groups was ≤4 both at rest and during cough. Incentive spirometry, ventilator, and ICU duration were comparable between the groups.</td>
</tr>
</tbody>
</table>
followed by continuous infusion of 0.125% plain bupivacaine at a rate of 0.1 ml/kg/h until 48h post-extubation

<table>
<thead>
<tr>
<th>Study (Year)</th>
<th>Population</th>
<th>Intervention</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fang et al. (2019)</td>
<td>94 pts scheduled for thoracotomy lung surgeries were randomly assigned to ESPB group and TPVB group. 47 received single-shot ESPB 20ml of 0.25% bupivacaine, then sufentanil PCA post-op. 47 received single-shot TPVB 20ml of 0.25% bupivacaine, then sufentanil PCA post-op</td>
<td>There were no significant differences in pain scores at rest and cough between the ESPB and TPVB groups in each of the first two days after surgery. No difference between the two groups was identified regarding postoperative sufentanil usage. There was no statistical difference in postoperative nausea and vomiting. There was significantly less hypotension, bradycardia, hematoma and a higher success rate of one puncture in the ESPB group.</td>
<td></td>
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<tr>
<td>Sobhy et al. (2020)</td>
<td>60 pts undergoing surgery requiring thoracotomy were randomly assigned to ESP group and C group, conventional opioids. 30 received single-shot US-guided ESP block with 20 ml 0.25% bupivacaine. 30 control group received traditional opioids</td>
<td>Results showed a significant decrease in total morphine consumption in the first 24 h postoperatively in the ESP group. Also, when comparing VAS score during rest and coughing, results showed a significant decrease in VASR and VASC at 6, 12, 18, and 24 h postoperatively in the ESP group.</td>
<td></td>
</tr>
<tr>
<td>Macaire et al. (2019)</td>
<td>67 patients were evaluated who underwent cardiac surgery. Twenty consecutive open cardiac surgery patients without ESPB block receiving IV morphine, IV nefopam, and paracetamol. 47 consecutive patients receiving continuous bilateral ESPB 0.25ml/kg/side of ropivacaine 0.5%, then 8 hours after loading dose, boluses of 0.2% ropivacaine every 6 hours</td>
<td>Morphine consumption in the first 48 hours was significantly decreased in the ESPB group, as was intraoperative sufentanil. Times to chest tube removal, first mobilization, pain (Visual Analogue Scale) values 2 hours after chest tube removal, pain values at rest 1 month after surgery, and postoperative adverse events were significantly decreased in the ESPB group. There was no difference between extubation time and pain during the first mobilization.</td>
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<tr>
<td>Adhikary et al. (2019)</td>
<td>A case series detailing five patients who underwent therapeutic anticoagulation after LVAD surgery via thoracotomy approach. Four pts received continuous ESP block with 20ml of 0.5% ropivacaine followed by constant infusion of 0.2% ropivacaine at 6 to 10 mL/h postoperatively for rescue analgesia. The fifth pt received the same dosage of continuous ESPB preoperatively.</td>
<td><strong>Case 1</strong> - A 46 kg, a 62-year-old woman underwent implantation of a HeartWare (Framingham, MA) LVAD for ischemic cardiomyopathy. Shortly after block completion, the patient described subjective numbness of the left hemithorax between the T3 to T9 dermatomes. Her NRS pain score on deep breathing decreased from 9/10 to 2/10, and her MIVs increased to 450 mL, accompanied by a decrease in her resting respiratory rate from 25 to 11 breaths per minute.</td>
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</tr>
</tbody>
</table>
Case 2- An 86 kg, 65-year-old man underwent explantation of a Heartmate II LVAD after myocardial recovery from the previous cardiomyopathy. Pt reported NRS pain scores of 10/10, MIVs less than 500ml. Within 2 hours of ESP block, his resting pain score had dropped to 0, his respiratory rate had decreased to 16 from 26 per minute, and his MIVs improved to 1,200 mL. The ESP infusion was continued for 72 hours, during which time his pain remained well controlled with NRS resting pain scores of 0 to 3/10, rising to 4/10 on coughing.

Case 3- A 94 kg, 59-year-old man presented for a HeartMate II to HeartMate III LVAD exchange due to pump thrombosis. Pt received continuous bilateral ESP block after 10/10 NRS pain and MIVs of 200ml. After the block, there was rapid improvement in NRS pain scores to 3/10 and in MIVs to 1,000 mL.

Case 4- A 33-year-old man presented for a HeartMate II to HeartMate III LVAD exchange due to pump thrombosis. Pt had NRS 8-10/10 pain and unmeasurable readings of MIV. After ESP block, pain improved to 6/10, narcotic requirements decreased, and MIVS improved to 2,000mL; over the next few days, pain scores improved to 2-3/10 max of 5/10.

Case 5- An 85 kg, 60-year-old man was scheduled for elective HeartWare LVAD implantation. NRS resting pain score of 2 to 3/10 and 5 to 6/10 with deep inspiration. Pt also received Oral Tylenol and IV hydromorphone 4mg POD 1 and 2

There were no adverse events related to catheter insertion or removal in the cases described here nor in the subsequent cases that the authors have performed to date.

Munoz-Leyva et al. (2019) A case series of five pts undergoing cardiac surgery via median sternotomy that were given continuous bilateral ESPB preoperatively using 20 ml of 0.25% bupivacaine with 2.5mcg/ml of epinephrine through each catheter. The postoperative regimen comprised of 0.125% bupivacaine at 8ml/h through each catheter as well as 1g of acetaminophen every 6 hours. IV hydromorphone given for

Case 1- A 71-year-old woman with severe aortic stenosis underwent bioprosthetic aortic valve replacement surgery. There were no episodes of breakthrough pain during the period of ESP catheter infusion. Subcutaneous enoxaparin (40 mg every 12 hours) also was started during this time as part of the management of postoperative atrial fibrillation. Static and dynamic pain remained well-controlled on oral acetaminophen (1 g every 6 hours) with NRS scores of 3 to 4/10 and 1/10,
breakthrough pain control if bolus injection of 15ml of 0.125% of bupivacaine was not effective. respectively. No opioids were required during her hospital stay. 

**Case 2-** A 49-year-old man with severe aortic insufficiency and aortic root dilation underwent a Bentall procedure with mechanical valve prosthesis. The patient reported breakthrough pain with movement at postoperative hour 4 and 32 (NRS 5/10 and 6/10, respectively). In both instances, this was managed by administering a bolus of 15 mL of 0.125% bupivacaine into each catheter, which restored adequate analgesia (static and dynamic NRS pain scores <4/10). No opioids were required during the period of ESP infusion. Anticoagulation with enoxaparin, 1 mg/kg every 12 hours, was started 48 hours following surgery.

**Case 3-** A 68-year-old man with critical disease of the proximal anterior descending and circumflex arteries underwent a 2-vessel coronary artery bypass graft surgery with internal mammary and saphenous vein grafts. The patient reported dynamic and static NRS pain scores of 3/10 and 1/10, respectively, and was started on oral acetaminophen (1 g every 6 hours) in addition to the ESP infusion. There were no episodes of breakthrough pain during his hospital stay, even after removing the ESP catheters.

**Case 4-** A 72-year-old man with a severe aortic insufficiency and aneurysmal aortic dilatation underwent bioprosthetic aortic valve replacement and repair of the supracoronary aortic root with a Dacron graft. During the first 24 hours of his postoperative care, the patient received an infusion of 0.5% lidocaine at 15 mL/h through each ESP catheter due to a temporary national shortage of bupivacaine; thereafter, he received 0.125% bupivacaine. Dynamic and static NRS pain scores were maintained at 2/10 and 0/10, respectively. There were no episodes of breakthrough pain or any requirement for opioids during his hospital stay.

**Case 5-** A 64-year-old woman with non-ST elevation myocardial infarction and critical disease of the proximal anterior descending and circumflex arteries underwent a 2-vessel coronary artery bypass graft surgery with internal mammary and saphenous vein grafts. On
arrival, the patient reported dynamic and static NRS pain scores of 8/10 and 4/10, respectively. A bolus of 15 mL of 0.125% bupivacaine was administered through each ESP catheter, which reduced pain scores by 50% after 15 minutes. Another episode of breakthrough pain occurred at postoperative hour 12 (dynamic and static NRS pain scores of 6/10 and 3/10, respectively). This again was treated successfully by bolus administration of 0.125% bupivacaine per protocol, reducing dynamic and static pain scores to 3/10 and 2/10 within 15 minutes. No further episodes of breakthrough pain were reported, even after the removal of the ESP catheters.

Study Characteristics

The 7 selected studies, when combined, had a total of 387 patients who received an ESP block for cardiac surgery via thoracotomy or sternotomy. One of the studies evaluated the effectiveness of the ESP block for surgery requiring thoracotomy. Each study used has similarities, but it also has some differences as well. For example, one study used bilateral single shot ESP block, two studies used continuous bilateral ESP block, two used continuous unilateral ESP block, and two utilized single shot unilateral ESP block. The unilateral ESP block was the technique applied for the cardiac surgeries requiring thoracotomy and the bilateral approach was the technique that applied cardiac surgeries via sternotomy.

Definitions and Findings of Outcomes

The studies that were conducted each showed in their way that ESP block, regardless of technique, was effective in controlling pain for cardiac surgery via a sternotomy or thoracotomy approach. The approach, whether sternotomy or thoracotomy, guides whether to use a unilateral or bilateral injection technique. The studies in which a continuous catheter was placed instead of single-shot proves to be a better approach to controlling pain in the first 48 hours of the surgery.
Despite being anticoagulated, patients were not found to have bleeding from continuous catheters. Other adverse effects, when compared to thoracic epidurals and thoracic paravertebral blocks, were also minimal.

**Risk of Bias**

Any study conducted has the potential for bias, whether intentional or unintentional. There are several sources of bias in studies, and the Cochrane Handbook Collaboration's Risk of Bias tool was utilized to evaluate whether there was bias in any of the seven studies used in this systematic review.\(^{35}\) 4 of the 7 studies had an overall low risk of bias since the samples were randomly selected. Performance bias must be considered. The RCTs used in this review were single-blinded, which may leave them open to bias, but it is a low risk. Attrition bias is another aspect of this tool. There was a low risk of bias in the studies for attrition.

**Discussion**

Based on the literature review, there was evidence discovered to suggest that the ESP block is both safe and effective in controlling perioperative pain in cardiac surgery.\(^ {6,7,10,13-19}\) When compared to other regional techniques like the HTE and TPVB, the ESP block was found to have similar pain control with fewer adverse effects.\(^ {1,2,6,7,13-15}\) In multiple cases studies, it was found that the ESP block was safely deployed in heavily anticoagulated patients after left ventricular assist device implantation.\(^ {18}\) Some limitations of the literature review include the need for further RCTs to increase the study's strength of the ESP block for cardiac surgery. This additional research would solidify the ESP block as the foundation for fast-track multimodal opioid-sparing cardiac surgery.

**METHODOLOGY**

**Setting and Participants**
An educational intervention will be conducted to accomplish the goals of this quality improvement project. This intervention will educate anesthesia providers on the safety and efficacy of the ESP block for cardiac surgery. The primary setting of this project will take place online with participants from Mount Sinai Medical Center in Miami Beach, Florida. Primary participants include certified registered nurse anesthetists (CRNAs) and Anesthesiologists employed with Miami Beach Anesthesia Associates (MBAA). The participants will be recruited voluntarily, and the anticipated sample size will be between 5-15 participants.

**Description of Approach and Project Procedures**

The principal methodology of the proposed quality improvement project is to create and present an online educational intervention to anesthesia providers from MBAA. This project will focus on the safety and efficacy of utilizing the ESP block for the perioperative pain management of cardiac surgical patients. Participants are expected to complete an online pre-test to assess the providers' knowledge of cardiac surgery and the ESP block. Next, the participants will watch an approximately 8 minute PowerPoint educating providers on cardiac surgery and the importance of having safe and effective perioperative pain management. This video will discuss the anatomy associated ESP block, the technique of performing the ESP block, as well as compare this block to other regional techniques. Educating providers is crucial to improving patients' safety and having effective outcomes when they undergo cardiac surgery. Finally, the participants will partake in a post-test to evaluate whether any knowledge was gained regarding the ESP block for cardiac surgery. It will also assess the likelihood of the participants to recommend or use this technique for cardiac surgery. The data attained from this post-test will deliver feedback regarding the impact of the educational presentation. From this feedback, it may be determined how to best expand provider knowledge regarding the ESP block for the
perioperative pain management in cardiac surgery moving forward. The results of this intervention will also establish if further provider education is required and if it will be helpful to the practice of other anesthesia providers.

**Protection of Human Subjects**

The recruitment participants for this study will include CRNAs employed with MBAA who work at Mount Sinai Medical Center in Hollywood, Florida. This population is significant because they directly provide care to patients who undergo cardiac surgery and would potentially benefit from the education delivered. This, in turn, would serve to improve patient outcomes following cardiac surgery. Recruitment will be conducted via email invitation to all CRNAs and Anesthesiologists. Participation in this study is voluntary, and there will be no consequences if participants decide to withdraw. There are no perceived risks to the study as it only requires the time spent by each participant in the educational intervention.

**Data Collection**

The primary data collection methods will include a pre-and post-assessment survey to establish the effects of the educational intervention. These surveys will be conducted through Qualtrics and will comprise of 9 questions focusing on knowledge and practice. 2 more questions will evaluate the likelihood of recommending and use of the ESP block for cardiac surgery. The pre-test survey will assess current knowledge and perceptions of the material that will be presented. The post-test survey will establish whether knowledge was gained from the educational intervention. It will also determine whether providers will put what they have learned into practice. The instrument reliability and validity will be measured per the intervention provided and its effectiveness for the participants. The data collected will be confidential, and no subject identifiers will be recorded during any component of the study.
Data Management and Analysis Plan

The co-investigator for this project will be the DNP student. This co-investigator will be responsible for administering the survey. Excel software will be utilized to establish whether participants received any knowledge and possibly adapt their practice in response to the educational intervention. Each question will be measured, and the responses documented to identify the knowledge base before and after the intervention and the practical applications of the intervention. Through the statistical analysis, the study results will detect patterns. These patterns will be used to determine the effectiveness of the educational intervention and its impact on clinician practice. The co-investigator will store the collected data in a password-protected laptop computer.

RESULTS

Participant Demographics

The pre-test demographics are seen in Table 3.

Table 3. Pre-test Participant Demographics

<table>
<thead>
<tr>
<th>Demographics</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Participants</td>
<td>9 (100%)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>4 (44.4%)</td>
</tr>
<tr>
<td>Female</td>
<td>5 (55.5%)</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
</tr>
<tr>
<td>18 – 29 yr</td>
<td>3 (33.3%)</td>
</tr>
<tr>
<td>30 – 49 yr</td>
<td>6 (66.6%)</td>
</tr>
<tr>
<td>50 – 60 yr</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>&gt; 60 yr</td>
<td>0 (0%)</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>7 (77.7%)</td>
</tr>
<tr>
<td>Caucasian</td>
<td>2 (22.2%)</td>
</tr>
<tr>
<td>African American</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Position</td>
<td>Count (%)</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>MDA</td>
<td>1 (11.1%)</td>
</tr>
<tr>
<td>CRNA</td>
<td>8 (88.8%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Education</th>
<th>Count (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Masters</td>
<td>1 (11.1%)</td>
</tr>
<tr>
<td>Doctorate</td>
<td>8 (88.8%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Years of Practice</th>
<th>Count (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–2 yr</td>
<td>3 (33.3%)</td>
</tr>
<tr>
<td>2–5 yr</td>
<td>3 (33.3%)</td>
</tr>
<tr>
<td>5–10 yr</td>
<td>1 (11.1%)</td>
</tr>
<tr>
<td>Over 10 yrs</td>
<td>2 (22.2%)</td>
</tr>
</tbody>
</table>

9 participants accepted being a part of this educational intervention. Of these 9 participants, there were more females (n=5, 55.5%) than males (n=4, 44.4%). Over half of the participants were between the ages of 30-49 years (n=6, 66.6%), while the rest were between the ages of 18-29 years (n=3, 33.3%). The only ethnic groups who participated in this study were Hispanic (n=7, 77.7%) and Caucasian (n=2, 22.2%). Among the participants, a majority had a doctorate level degree (n=8, 88.8%), the minority being a master’s level degree (n=1, 11.1%). As of years of practice as an anesthesia provider; 0-2 years (n=3, 33.3%), 2-5 years (n=3, 33.3%), 5-10 years (n=1, 11.1%), over 10 years (n=2, 22.2%).

**Pre-test Knowledge about ESP block for Cardiac Surgery**

9 participants completed the pre-test evaluating their current knowledge and insights about the ESP block and cardiac surgery. Most of the participants (88.8%) knew the proper location of the ESP block is to be performed at a level of T5-T7. Additionally, over half of the participants (66.6%) understood that the ESP block shows a minimal risk of bleeding in the anticoagulated patient. None of the participants (0%) had an understanding that the ESP block...
can be done in cardiac surgery using single-shot unilateral, single-shot bilateral, continuous unilateral, and continuous bilateral approaches. Two of the participants (22.2%) correctly answered that the average cost of a CABG is $44,820. Another two participants (22.2%) understood that the ESP block did not have any of the complications mentioned. All the participants (100%) correctly answered that regional anesthesia is a crucial aspect of fast-track multimodal approaches to cardiac surgery. Only one participant (11.1%) knew that TPVB, HTE, and intercostal blocks should be avoided in cardiac surgery. Two participants (22.2%) comprehended that a bilateral ESP block at T5 spinous process provides analgesia from T2-T9. Over half of the participants (77.7%) knew that the ESP block is performed by inserting the Tuohy needle superior to the ultrasound probe using an in-plane approach in the cephalad to caudal direction. Surprisingly over half of the participants were extremely likely (44.4%) or somewhat likely (22.2%) to use the ESP block for cardiac surgery. One participant (11.1%) was neither likely nor unlikely, and two participants (22.2%) were somewhat unlikely to use the ESP block for cardiac surgery. Just over half of the participants were either extremely likely (33.3%) or somewhat likely (22.2%) to recommend using the ESP block for cardiac surgery. The rest of the participants were neither likely nor unlikely (22.2%) or somewhat unlikely (22.2%) to recommend using the ESP block for cardiac surgery.

**Post-test Knowledge about ESP block for Cardiac Surgery**

All 9 participants completed the post-test evaluating their current knowledge and insights about the ESP block and cardiac surgery. All of the participants (100%) knew the proper location of the ESP block is to be performed at a level of T5-T7. Additionally, there was increased understanding (88.8%) that the ESP block shows a minimal risk of bleeding in the anticoagulated patient. Many participants (77.7%) still didn't know that the ESP block can be done in cardiac
surgery using single-shot unilateral, single-shot bilateral, continuous unilateral, and continuous bilateral approaches. Knowledge was significantly increased as 77.7% of participants correctly answered that the average cost of a CABG is $44,820. 7 participants (77.7%), as opposed to 2 (22.2%), understood that the ESP block did not have any of the complications mentioned. There was no change in participants (100%) that correctly answered that regional anesthesia is a key aspect of fast-track multimodal approaches to cardiac surgery. Two more participants for a total of 3 (33.3%) learned that TPVB, HTE, and intercostal blocks should be avoided in cardiac surgery. Significant learning took place amongst most participants (88.8%) that a bilateral ESP block at T5 spinous process provides analgesia from T2-T9. There was no change in knowledge (77.7%) about how the ESP block is performed by inserting the Tuohy needle superior to the ultrasound probe using an in-plane approach in the cephalad to caudal direction. After the educational intervention, participants were either extremely likely (55.5%) or somewhat likely (33.3%) to use the ESP block for cardiac surgery. One participant (11.1%) remained to be neither likely or unlikely, and none of the participants (0%) were somewhat unlikely or extremely unlikely to use the ESP block for cardiac surgery. There was an increase in participants being either extremely likely (55.5%) or somewhat likely (33.3%) to recommend use of the ESP block for cardiac surgery. There were decreases in participants being neither likely nor unlikely (11.1%) or somewhat unlikely (0%) to recommend use of the ESP block for cardiac surgery.

**Table 4.**

**Differences in Pre- and Post-test Responses**

<table>
<thead>
<tr>
<th>CORRECT RESPONSES</th>
<th>PRE-TEST</th>
<th>POST-TEST</th>
<th>DIFFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>THE THORACIC ESP BLOCK IS PERFORMED BY INJECTING LOCAL ANESTHETIC AT WHICH LEVELS? T5-T7</td>
<td>88.8%</td>
<td>99.9%</td>
<td>11.1%</td>
</tr>
<tr>
<td>WHICH OF THE FOLLOWING STATEMENTS ARE TRUE REGARDING THE ESP BLOCK? THE ESP BLOCK SHOWS MINIMAL RISK OF BLEEDING IN THE ANTICOAGULATED PATIENT</td>
<td>66.6%</td>
<td>88.8%</td>
<td>22.2%</td>
</tr>
<tr>
<td>WHICH OF THE FOLLOWING TECHNIQUES ARE EFFECTIVE FOR MANAGING PAIN IN CARDIAC SURGERY? (SELECT ALL THAT APPLY) SINGLE-SHOT UNILATERAL ESP BLOCK, CONTINUOUS UNILATERAL ESP BLOCK, SINGLE-SHOT BILATERAL ESP BLOCK, CONTINUOUS BILATERAL ESP BLOCK</td>
<td>0%</td>
<td>33.3%</td>
<td>33.3%</td>
</tr>
<tr>
<td>THE AVERAGE COST OF A CABG IS: $44,820</td>
<td>22.2%</td>
<td>77.7%</td>
<td>55.5%</td>
</tr>
<tr>
<td>COMPLICATIONS OF THE ESP BLOCK INCLUDE: NONE OF THE ABOVE</td>
<td>22.2%</td>
<td>55.5%</td>
<td>33.3%</td>
</tr>
<tr>
<td>A KEY ASPECT OF FAST-TRACK, MULTIMODAL APPROACHES TO CARDIAC SURGERY INCLUDES WHAT? REGIONAL ANESTHESIA</td>
<td>100%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>THE FOLLOWING REGIONAL TECHNIQUES SHOULD BE AVOIDED IN THE ANTICOAGULATED PATIENT: (SELECT ALL THAT APPLY) THORACIC PARAVERTEBRAL BLOCK, THORACIC EPIDURAL, INTERCOSTAL BLOCK</td>
<td>11.1%</td>
<td>33.3%</td>
<td>22.2%</td>
</tr>
<tr>
<td>BILATERAL ESP BLOCK AT THE T5 SPINOUS PROCESS PROVIDES ANALGESIA FROM: T2-T9</td>
<td>22.2%</td>
<td>88.8%</td>
<td>66.6%</td>
</tr>
<tr>
<td>THE ESP BLOCK IS PERFORMED BY INSERTING THE TUOHY NEEDLE ____ TO THE ULTRASOUND PROBE USING AN ____ APPROACH IN THE CEPHALAD TO CAUDAL DIRECTION: SUPERIOR; IN-PLANE</td>
<td>77.7%</td>
<td>77.7%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table 5.

Difference in Pre- and Post-test Likelihood of Use in Practice

| HOW LIKELY ARE YOU TO USE THE ESP BLOCK FOR CARDIAC SURGERY | PRE-TEST | POST-TEST | DIFFERENCE |
| EXTREMELY LIKELY | 44.4% | 55.5% | 11.1% |
| SOMEWHAT LIKELY | 22.2% | 33.3% | 11.1% |
| NEITHER LIKELY NOR UNLIKELY | 11.1% | 11.1% | 0% |
Table 6.

Difference in Pre- and Post-test Likelihood of Recommendation

<table>
<thead>
<tr>
<th>HOW LIKELY ARE YOU TO RECOMMEND USE OF THE ESP BLOCK FOR CARDIAC SURGERY</th>
<th>PRE-TEST</th>
<th>POST-TEST</th>
<th>DIFFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXTREMELY LIKELY</td>
<td>33.3%</td>
<td>55.5%</td>
<td>22.2%</td>
</tr>
<tr>
<td>SOMEWHAT LIKELY</td>
<td>22.2%</td>
<td>33.3%</td>
<td>11.1%</td>
</tr>
<tr>
<td>NEITHER LIKELY NOR UNLIKELY</td>
<td>22.2%</td>
<td>11.1%</td>
<td>-11.1%</td>
</tr>
<tr>
<td>SOMEWHAT UNLIKELY</td>
<td>22.2%</td>
<td>0%</td>
<td>-22.2%</td>
</tr>
<tr>
<td>EXTREMELY UNLIKELY</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Summary of Data

The results show there was an overall gain in knowledge between the pre- and post-test surveys. 7 out of the 9 participants (77.7%) showed improvement in knowledge in their post-test surveys. The remaining 2 participants (22.2%) had a decrease in knowledge regardless of the education delivered. Generally speaking, there was a net gain difference in questions answered correctly in the post-test surveys. Pre-test assessments showed an average score of 45% compared to an average score of 71%. The overall average improvement between pre- and post-test surveys was 26%. After partaking in this educational intervention, 22.2% of the participants changed from somewhat unlikely (22.2%) to use the ESP block for cardiac surgery to either somewhat likely (11.1%), or extremely likely (11.1%). 33.3% of the participants also changed from neither likely or unlikely (11.1%) or somewhat unlikely (22.2%) to recommend using the ESP block for cardiac surgery to somewhat likely (11.1%) or extremely likely (22.2%).
DISCUSSION

Limitations

Limitations of the QI project include a small sample size. The survey was sent to all anesthesia providers at MBAA via email, but many chose not to partake in the educational intervention. A larger sample size would have increased the strength and trustworthiness of the study. Considering the delivery of the study was done completely online, this may have limited or swayed the results. Not all participants are self-directed learners, and it is possible that participants may have completed the study in an environment not favorable to learning. A more controlled, in-person setting could have generated more accurate results.

Future Implications

The results of this study are significant in shaping strategies available to participants that will improve knowledge and potentially change practice to improve outcomes in patients undergoing cardiac surgery. According to the data collected, the educational intervention provided was effective in increasing anesthesia provider knowledge on the ESP block and its current role in decreasing perioperative pain and opioid consumption. Due to this educational intervention, there was an increase in the likelihood of utilizing the ESP block for this patient population among the anesthesia providers involved in the study. The content of this educational intervention can be applied to a wider audience of anesthesia providers and thereby further increasing provider awareness.

CONCLUSION

Cardiac surgery is an invasive, painful procedure that can cause debilitating consequences if perioperative pain is not managed properly. While there are many different techniques currently being utilized to control perioperative pain related to cardiac surgery, many
of these have adverse reactions which may further put patients at risk for poor outcomes.

Regional anesthesia is the foundation for controlling pain perioperatively for many different surgeries. Deploying a regional anesthetic during cardiac surgery is challenging due to the significant anticoagulation required. The ESP block is a fairly non-invasive regional anesthetic that shows promising pain control with no significant adverse effects, even in the anticoagulated patient. Although more studies, including RCTs, must be conducted to ensure the safety and efficacy of the ESP block during cardiac surgery, it is a promising technique that anesthesia providers may one day use in their everyday practice. Increasing provider awareness of this emerging technique is the first step in ensuring that anesthesia providers don’t have to shy away from a regional anesthetic for cardiac surgery.
## Appendix A: Matrix Table

<table>
<thead>
<tr>
<th>Citation and Theme of the article</th>
<th>Design/Method</th>
<th>Sample/Setting</th>
<th>Major Variables Studied and Their Definitions</th>
<th>Measurement and Data Analysis</th>
<th>Findings</th>
<th>Conclusions</th>
<th>Appraisal: Worth to Practice/Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Krishna et al. (2019). Bilateral erector spinae plane block for acute postsurgical pain in adult cardiac surgical patients: A randomized controlled trial</td>
<td>A prospective, randomized, controlled, single-blinded study examining the analgesic efficacy of bilateral ESP block compared with conventional treatment for pain after cardiac surgery in adult patients</td>
<td>106 adult patients undergoing elective cardiac surgery n=53 received an USG single-shot bilateral ESP block with 3ml/kg of 0.375% ropivacaine before anesthesia induction n=53 received paracetamol 1gm every 6 hours and tramadol 50mg every 8 hours intravenously postoperatively</td>
<td>Group 1= ESP block Group 2= IV medications</td>
<td>The clinical data were summarized and analyzed using SPSS version 21. Data expressed as mean ± standard deviation or median (minimum and maximum) and percentage as appropriate for continuous and categorical variables. Data were tested for normality using the Kolmogorov-Smirnov test. An unpaired Student t test was used to compare continuous variables. For comparison of ordinal categorical data, the Pearson chi-squared test and Mann-Whitney U test were used. A value of p &lt; 0.05 was considered statistically significant.</td>
<td>The postoperative pain level after extubation and duration of analgesia during which NRS was &lt; 4 of 10 was compared between the groups. The median pain score at rest after extubation in group 1 was 0 of 10 until hour 6, 3 of 10 at hour 8, and 4 of 10 at hours 10 and 12 postextubation. These were significantly less in comparison with group 2 (p = 0.0001). Patients in group 1 had a significantly higher mean duration of analgesia (8.98 ± 0.14 hours), during which NRS was &lt; 4 of 10, compared with group 2 (4.60 ± 0.12 hours) (p = 0.0001).</td>
<td>ESP block provided superior analgesia for a longer duration compared with intravenous paracetamol plus tramadol regimen</td>
<td>Level I</td>
</tr>
</tbody>
</table>
Singh et al. (2018) Comparison of continuous thoracic epidural analgesia with bilateral erector spinae plane block for perioperative pain management in cardiac surgery

<table>
<thead>
<tr>
<th>A prospective, randomized comparative clinical study comparing TEA with ESP block for perioperative pain management in pts having cardiac surgery via median sternotomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 adult patients undergoing cardiac surgery</td>
</tr>
<tr>
<td>n=25 received a TEA bolus dose of 0.25% plain bupivacaine followed by a continuous infusion of 0.125% plain bupivacaine at the rate of 0.1 ml/kg/h until 48 hours postextubation</td>
</tr>
<tr>
<td>n=25 received an USG continuous bilateral ESP block bolus dose of 0.25% plain bupivacaine 15 ml injected in each of the catheters followed by continuous infusion of 0.125% plain bupivacaine at rate of 0.1 ml/kg/h until 48h postextubation</td>
</tr>
</tbody>
</table>

<p>| Group A= TEA |
| Group B= ESP block |
| Visual analog scale (VAS) was recorded in both the groups during rest and cough at the various time intervals postextubation. Both the groups were also compared for incentive spirometry, ventilator, and ICU duration. Statistical analysis was performed using the independent Student's t-test. A value of $P &lt; 0.05$ was considered statistically significant. Data were expressed as a mean ± standard deviation. Categorical data were analyzed using Chi-squared test and Independent t-test was used to analyze the continuous variables. A two-tailed value of $P &lt; 0.05$ was considered statistically significant. Statistical analysis was performed using MedCalc software version 12.2.1.0 |
| Comparable VAS scores were revealed at 0 h, 3 h, 6 h, and 12 h ($P &gt; 0.05$) at rest and during cough in both the groups. Group A had a statistically significant VAS score than Group B ($P \leq 0.05$) at 24 h, 36 h, and 48 h but mean VAS in either of the Group was ≤4 both at rest and during cough. Incentive spirometry, ventilator, and ICU duration were comparable between the groups. |
| ESP block is easy to perform and can serve as a promising alternative to TEA in optimal perioperative pain management in cardiac surgery. |
| Level I |</p>
<table>
<thead>
<tr>
<th>Study (Year)</th>
<th>Design</th>
<th>Participants</th>
<th>Intervention</th>
<th>Comparator</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sobhy et al. (2020)</td>
<td>Ultrasound-guided single-dose erector spinae plane block for postoperative analgesia in thoracotomy patients: a prospective, randomized, observer-blind study.</td>
<td>A randomized single-blind controlled clinical trial investigating the efficacy of US-guided ESP block in analgesia after thoracotomies</td>
<td>60 pts</td>
<td>n=30 received single-shot US-guided ESP block with 20 ml 0.25% bupivacaine</td>
<td>ESP group C group= control group receiving opioids</td>
</tr>
<tr>
<td>Fang et al. (2019)</td>
<td>Ultrasound-guided preoperative single-dose erector spinae plane block following thoracotomy surgery: a single center randomized controlled double-blind study.</td>
<td>A single center randomized controlled double-blind study comparing the effectiveness of ESP block with TPVB for thoracotomy incisions</td>
<td>94 pts scheduled for thoracotomy lung surgeries</td>
<td>n=47 received single shot ESPB 20ml of 0.25% bupivacaine, then sufentanil PCA post-op, n=47 received single shot TPVB 20ml of 0.25% bupivacaine, then sufentanil PCA post-op</td>
<td>ESPB group TPVB group</td>
</tr>
</tbody>
</table>

Note: ESPB = epidural single-shot paravertebral block, TPVB = thoracic paravertebral block, US = ultrasound, VAS = visual analogue scale, PCA = patient-controlled analgesia, morphine, and sufentanil.
controlled clinical trial.

Macaire et al. (2019)
Ultrasound-guided continuous thoracic erector spinae plane block within an enhanced recovery program is associated with decreased opioid consumption and improved patient postoperative rehabilitation after open cardiac surgery—A patient-matched, A consecutive, patient-matched, controlled before-and-after study

<p>| | | |</p>
<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>
| 67 total patients | Group 1: FTP protocol without ESPB | The aim of the present study was to demonstrate the effectiveness of ESPB by detecting an almost 30% difference in 48-hour total morphine consumption between the 2 groups of patients. The sample size was estimated at 20 patients per group ($\alpha = 0.05$; $\beta = 0.20$ expected difference). Categorical variables are expressed as number and percentage, and quantitative variables are expressed as median [interquartile range] or mean ± standard deviation. The Shapiro-Wilk test was used to test the normality of continuous variables. Univariate analysis was performed between continuous variables with the Student $t$ test or
|       |       |       |
|       |       |       |
| n=20 consecutive open cardiac surgery patients without ESPB block receiving IV morphine, IV nefopam, and paracetamol | Group 2: FTP protocol with ESPB | Morphine consumption in the first 48 hours was significantly decreased in the ESPB group (40 [25-45] mg in the control group compared with 0 [0-0] mg in the ESPB group [p < 0.001]) as was intraoperative sufentanil (0.8 [0.6-0.9] µg/kg/h and 0.2 [0.16-0.3] µg/kg/h, respectively; p < 0.001). Times to chest tube removal, first mobilization, pain (Visual Analogue Scale) values 2 hours after chest tube removal, pain values at rest 1 month after surgery, and postoperative
|       |       |       |
| n= 47 consecutive patients receiving continuous bilateral ESPB 0.25ml/kg/side of ropivacaine 0.5%, then 8 hours after loading dose, |       | A bundle of care including a continuous bilateral ESPB is associated with a significant decrease in intraoperative and postoperative opioid consumption, optimized rapid patient mobilization, and chest tube removal after open cardiac surgery. | Level II
controlled before-and-after study.

boluses of 0.2% ropivacaine every 6 hours

the Mann-Whitney test for the non-Gaussian variables. Categorical variables were compared with the chi-square or Fisher exact test, as appropriate. Multivariate analysis was performed in order to study the respective influence of covariates considered clinically significant or significantly reported in the univariate analysis on ESPB. A test was considered significant if p < 0.05. Statistical analysis was performed using SAS, Version 11

adverse events were significantly decreased in the ESPB group. There was no difference for extubation time and pain during first mobilization.

Adhikary et al. (2019)
Continuous erector spinae plane block as an effective analgesic option in anticoagulated patients after left ventricular assist device implantation: A case series.

A case series detailing five patients who underwent therapeutic anticoagulation after LVAD surgery via thoracotomy approach. Four pts received continuous ESP block to manage acute post-thoracotomy pain. The fifth pt received the continuous ESPB preoperatively

4 cases received continuous ESP blocks with 20ml of 0.5% ropivacaine followed by continuous infusion of 0.2% ropivacaine at 6 to 10 mL/h postoperatively for rescue analgesia and removed at the discretion of acute pain service

1 case received continuous ESP block with same dosage preoperatively and continued until the discretion of acute pain service

n/a

Case 1- A 46 kg, 62-year-old woman underwent implantation of a HeartWare (Framingham, MA) LVAD for ischemic cardiomyopathy. Shortly after block completion, the patient described subjective numbness of the left hemithorax between the T3 to T9 dermatomes. Her NRS pain score on deep breathing decreased from 9/10 to 2/10, and her MIVs increased to 450 mL, accompanied by a decrease in her resting respiratory rate from 25 to 11 breaths per minute.

Case 2- An 86 kg, 65-year-old man underwent explantation of a Heartmate II LVAD after myocardial recovery from previous cardiomyopathy. Pt reported NRS pain scores of 10/10, MIVs less than 500ml. Within 2 hours of ESP block, his resting pain score had dropped to 0, his respiratory rate had decreased to 16 from 26 per minute, and his MIVs improved to

Case 3- A 33-year-old man presented for a HeartMate II to HeartMate III LVAD exchange due to pump thrombosis. Pt had NRS 8-10/10 pain and unmeasurable readings of MIV. After ESP block, pain improved to 6/10, narcotic requirements decreased, and MIVS improved to 2,000mL, over the next few days, pain scores improved to 2-3/10 max of 5/10.

Case 4- A 33-year-old man presented for a HeartMate II to HeartMate III LVAD exchange due to pump thrombosis. Pt had NRS 8-10/10 pain and unmeasurable readings of MIV. After ESP block, pain improved to 6/10, narcotic requirements decreased, and MIVS improved to 2,000mL, over the next few days, pain scores improved to 2-3/10 max of 5/10.

Case 5- An 85 kg, 60-year-old man was scheduled for elective HeartWare LVAD implantation. NRS resting pain score of 2 to 3/10 and 5 to 6/10 with deep inspiration. Pt also received Oral Tylenol and IV hydromorphone 4mg POD 1 and 2

There were no adverse events related to catheter insertion or removal in the cases described here nor in the subsequent cases that the authors have performed to date. Continuous ESP block thus is a feasible option for managing post-thoracotomy pain in the presence of anticoagulation. Continuous ESP block is a relatively simple and safe option that produced significant opioid-sparing and improved analgesia after LVAD

Level IV
| Munoz-Leyva et al. (2019) | Bilateral continuous erector spinae plane (ESP) blockade for perioperative opioid-sparing in median sternotomy. | A case series of five pts undergoing cardiac surgery via median sternotomy receiving continuous bilateral ESPB to provide opioid-sparing analgesia | Five patients were given continuous bilateral ESPB preoperatively using 20 ml of 0.25% bupivacaine with 2.5mcg/ml of epinephrine through each catheter. The postoperative regimen comprised of 0.125% bupivacaine at 8ml/h through each catheter as well as 1g of acetaminophen every 6 hours. IV hydromorphone given for breakthrough pain control if bolus n/a | Case 1 - A 71-year-old woman with severe aortic stenosis underwent bioprosthetic aortic valve replacement surgery. There were no episodes of breakthrough pain during the period of ESP catheter infusion. Subcutaneous enoxaparin (40 mg every 12 hours) also was started during this time as part of the management of postoperative atrial fibrillation. Static and dynamic pain remained well-controlled on oral acetaminophen (1 g every 6 hours) with NRS scores of 3 to 4/10 and 1/10, respectively. No opioids were required during her hospital stay. Case 2 - A 49-year-old man with severe aortic insufficiency and aortic root dilation underwent a Bentall procedure with mechanical valve prosthesis. The dynamic and static NRS pain scores were maintained at 2/10 and 0/10, respectively. There were no episodes of breakthrough pain. Case 4 - A 72-year-old man with a severe aortic insufficiency and aneurysmal aortic dilatation underwent bioprosthetic aortic valve replacement and repair of the supracoronary aortic root with a Dacron graft. During the first 24 hours of his postoperative care, the patient received an infusion of 0.5% lidocaine at 15 mL/h through each ESP catheter due to a temporary national shortage of bupivacaine; thereafter he received 0.125% bupivacaine. dynamic and static NRS pain scores were maintained at 2/10 and 0/10, respectively. | In summary, the preoperative insertion of ESP catheters allowed the authors to significantly reduce perioperative opioid consumption in patients undergoing median sternotomy, while continuing to provide excellent analgesia. The authors were able to extubate all but 1 of the patients in the operating room, a strategy that may reduce the length of ICU stay. In the authors’ opinion, it is also a simpler strategy that may reduce the length of ICU stay. Level IV |
| Case 1 | Injection of 15ml of 0.125% bupivacaine was not effective. |
| Case 2 | Patient reported breakthrough pain with movement at postoperative hour 4 and 32 (NRS 5/10 and 6/10, respectively). In both instances, this was managed by administering a bolus of 15 mL of 0.125% bupivacaine into each catheter, which restored adequate analgesia (static and dynamic NRS pain scores <4/10). No opioids were required during the period of ESP infusion. Anticoagulation with enoxaparin, 1 mg/kg every 12 hours was started 48 hours following surgery. **Case 3** - A 68-year-old man with critical disease of the proximal anterior descending and circumflex arteries underwent a 2-vessel coronary artery bypass graft surgery with internal mammary and saphenous vein grafts. The patient reported dynamic and static NRS pain scores of 3/10 and 1/10, respectively, and was started on oral acetaminophen (1 g every 6 hours) in addition to the ESP infusion. There were no episodes of breakthrough pain during his hospital stay, even after removal of the ESP catheters. |
| Case 4 | Pain or any requirement for opioids during his hospital stay. **Case 5** - A 64-year-old woman with non-ST elevation myocardial infarction and critical disease of the proximal anterior descending and circumflex arteries underwent a 2-vessel coronary artery bypass graft surgery with internal mammary and saphenous vein grafts. On arrival, the patient reported dynamic and static NRS pain scores of 8/10 and 4/10, respectively. A bolus of 15 mL of 0.125% bupivacaine was administered through each ESP catheter, which reduced pain scores by 50% after 15 minutes. Another episode of breakthrough pain occurred at postoperative hour 12 (dynamic and static NRS pain scores of 6/10 and 3/10, respectively). This again was treated successfully by bolus administration of 0.125% bupivacaine per protocol, reducing dynamic and static pain scores to 3/10 and 2/10 within 15 minutes. No further episodes of breakthrough pain were reported, even after removal of the ESP catheters. |
| | Technique compared to ultrasound-guided TPVB because the target (the tip of the transverse process) is more superficial and highly visible on ultrasound. In addition, the lack of proximity to the neuraxis, major nerves, or blood vessels, combined with the compressibility of the site, also minimizes the risk of clinically significant hemorrhage or hematoma. Under these circumstances, the most recent guidelines issued by the American Society of Regional Anesthesia and Pain Medicine support the judicious use of the ESP block even in anticoagulated patients. |
Appendix B: IRB Exemption

MEMORANDUM

To: Dr. Vicente Gonzalez  
CC: Javier Luces  
From: Maria Melendez-Vargas, MIBA, IRB Coordinator  
Date: April 6, 2021  
Protocol Title: “Use of the Erector Spinae Plane Block for the Perioperative Pain Management of the Cardiac Surgical Patient: An Educational Module”

The Florida International University Office of Research Integrity has reviewed your research study for the use of human subjects and deemed it Exempt via the Exempt Review process.

IRB Protocol Exemption #: IRB-21-0119  
IRB Exemption Date: 04/06/21  
TOPAZ Reference #: 110242

As a requirement of IRB Exemption you are required to:

1) Submit an IRB Exempt Amendment Form for all proposed additions or changes in the procedures involving human subjects. All additions and changes must be reviewed and approved prior to implementation.
2) Promptly submit an IRB Exempt Event Report Form for every serious or unusual or unanticipated adverse event, problems with the rights or welfare of the human subjects, and/or deviations from the approved protocol.
3) Submit an IRB Exempt Project Completion Report Form when the study is finished or discontinued.

Special Conditions: N/A

For further information, you may visit the IRB website at [http://research.fiu.edu/irb]

MMV/em
Re: IRB Waivers for Quality Improvement Projects with Miami Beach Anesthesiology Associates

The following students have proposed some interdepartmental education modules. These quality improvement projects are internal projects belonging to Miami Beach Anesthesiology Associates. Internal review board approval is not necessary for our departmental improvement projects per Mount Sinai Medical Center’s advocate, Yvonne Ortiz.

The projects will involve surveying anesthesia providers from Miami Beach Anesthesiology Associates at Mount Sinai Medical Center of Florida. Then educational modules performed by the students will be giving a pre-test, Zoom recorded educational module with a post-test lasting less than 20 minutes.

The following projects have been proposed and approved by our educational department and deem these projects IRB exempt.

**Alyssa Staubitz**: An Education Intervention on The Use of Aprepitant versus Ondansetron in the Prevention of Postoperative Nausea and Vomiting (PONV) in Adult Patients Undergoing General Anesthesia

**Erik Gonzalez**: PECS II Block and its Role in Reducing Opioid Consumption and Acute Postoperative Pain in Mastectomy Patients: An Evidence Based Educational Module

**Michael Otte**: An Education Intervention on The Use of Continuous Perioperative Dexmedetomidine Infusion to Reduce Opioid Consumption in Adult Patients Undergoing Spinal Lumbar Surgery

**Brittany Williams**: Use of a Structured Educational Program to Expand the Knowledge of CRNAs Regarding Post-Traumatic Stress Disorder and the Existing Body Of Research of 3,4-Methylenedioxymethamphetamine Assisted Psychotherapies in Patients Suffering from this Disorder and Others Alike

**Israel Lopez**: Educational Intervention Regarding the Effectiveness of Single Dose Intraoperative Methadone Reducing Post-Operative Opioid Consumption at 24-48 Hours: A Quality Improvement Project

**David Luth**: Transcutaneous Electrical Acupoint Stimulation to Decrease Opiate Utilization in Surgical Patients: An Evidence Based Educational Module

**Weslin Roldan**: Pharmacological Evidence-Based Algorithm in the Management of Awake Fiberoptic Intubation: A Quality Improvement Project

**Karina Grubb**: Educational Intervention Regarding the Utilization of P6 Acustimulation to Decrease PONV in Women 18 Years of Age and Older: A Quality Improvement Project
**Danielle Agostino:** Education Intervention Regarding Utilization of the Quadratus Lumborum Block for Post-Operative Analgesia Following Abdominal Surgery

**Cesar Lopez:** Prophylactic Administration of Methylene Blue to Surgical Patients to Prevent Hypotension after Cardiopulmonary Bypass: An Educational Module for Anesthetic Practice

**Javier Luces:** Use of the Erector Spinae Plane Block for the Perioperative Management of the Cardiac Surgical Patient: An Education Module

Please don’t hesitate to contact our department with any questions and/or concerns

Kindly,

Gerald P. Rosen M.D., FASA  
Miami Beach Anesthesiology Associates  
Program Director, Anesthesiology Residency  
Mount Sinai Medical Center  
4300 Alton Road, Miami Beach, FL  
Gerald.rosen@msmc.com  
grosen167@me.com  
305 469-8348
CONSENT TO PARTICIPATE IN A QUALITY IMPROVEMENT PROJECT
“Use of the Erector Spinae Plane Block for the Perioperative Pain Management of the Cardiac Surgical Patient: An Educational Module”

PURPOSE OF THE PROJECT
You are being asked to be in a quality improvement project. The goal of this project is to increase anesthesia provider’s awareness of the safety and efficacy of utilizing the thoracic ESP block for cardiac surgery through an education module.

DURATION OF THE PROJECT
Your participation will require about 25 minutes of your time.

PROCEDURES
If you agree to be in the project, we will ask you to do the following things:
Complete and sign a consent form for participation, complete a pre-test questionnaire, view an approximately 10 minute long educational presentation online, and asked to complete the post-test questionnaire.

RISKS AND/OR DISCOMFORTS
There are no foreseeable risks with you for participating in this project.

BENEFITS
The following benefits may be associated with your participation in this project: An increase in the knowledge associated with the benefits of utilizing thoracic ESP blocks for cardiac surgery. Utilizing this technique in clinical practice may be associated with increased patient satisfaction and improved patient outcomes.
ALTERNATIVES
There are no known alternatives available to you other than not taking part in this project. However, if you like to receive the educational material given to the participants in this project, it will be provided to you at no cost.

CONFIDENTIALITY
The records of this project will be kept private and will be protected to the fullest extent provided by law. If, in any sort of report, we might publish, we will not include any information that will make it possible to identify you as a participant. Records will be stored securely, and only the project team will have access to the records.

COMPENSATION & COSTS
There is no cost or payment to you for receiving the health education and/or participating in this project.

RIGHT TO DECLINE OR WITHDRAW
Your participation in this project is voluntary. You are free to participate in the project or withdraw your consent at any time during the project. Your withdrawal or lack of participation will not affect any benefits to which you are otherwise entitled. The investigator reserves the right to remove you without your consent at such time that they feel it is in the best interest.

RESEARCHER CONTACT INFORMATION
If you have any questions about the purpose, procedures, or any other issues relating to this research project, you may contact Javier Luces. at 786-972-5072, jluce004@fiu.edu or Dr. Vince Gonzalez at 305-348-0062, gonzalv@fiu.edu

IRB CONTACT INFORMATION
If you would like to talk with someone about your rights of being a subject in this project or about ethical issues with this project, you may contact the FIU Office of Research Integrity by phone at 305-348-2494 or by email at ori@fiu.edu

PARTICIPANT AGREEMENT
By clicking the button below, you have read the information in this consent form and agree to participate in this project.
Appendix D: QI Project Survey

Pretest and Posttest Questionnaire:

Thoracic ESP block for Cardiac Surgery

INTRODUCTION

The primary aim of this QI project is to improve the knowledge of anesthesia providers pertaining to the safety and efficacy of the use of thoracic ESP block for cardiac surgery.

Please answer the question below to the best of your ability. The questions are in multiple choice and true and false format and are meant to measure knowledge and perceptions on the thoracic ESP block.

PERSONAL INFORMATION

1. Gender: Male Female Other________

2. Age: ______

3. Ethnicity:

   Hispanic   Caucasian   African American   Asian

   Other________________

4. Position/Title: ____________________________

5. Level of Education: Bachelors Masters Doctorate Other

   __________

6. How many years have you been an anesthesia provider?

   Over 10   5-10 years   2-5 years   1-2 years
QUESTIONNAIRE

1. The thoracic ESP block is performed by injecting local anesthetic at which levels?
   a. T1-T2
   b. T12-L3
   c. T5-T7
   d. C7-T2

2. Which of the following statements are true regarding the ESP block?
   a. The ESP block shows significant risk of bleeding in the anticoagulated patient
   b. The ESP block shows minimal risk of bleeding in the anticoagulated patient
   c. Bleeding is never a concern when performing an ESP block
   d. The ESP block shows moderate risk of bleeding in the anticoagulated patient

3. Which of the following techniques are effective for managing pain in cardiac surgery? (Select all that apply)
   a. Single-shot Unilateral ESP block
   b. Continuous Unilateral ESP block
   c. Single-shot Bilateral ESP block
   d. Continuous Bilateral ESP block

4. The average cost of a CABG is:
   a. $52,800
   b. $74,340
   c. $44,820
   d. $29,480

5. Complications of the ESP block include:
a. Pneumothorax  
b. Spinal cord injury  
c. Vascular puncture  
d. None of the above

6. A key aspect of fast-track, multimodal approaches to cardiac surgery includes what?
   
   a. Regional Anesthesia  
   b. Opioids  
   c. IV medications  
   d. Off-pump techniques

7. The following regional techniques should be avoided in the anticoagulated patient:  
   (Select all that apply)
   
   a. Thoracic paravertebral block  
   b. Thoracic ESP block  
   c. Thoracic epidural  
   d. Intercostal block

8. Bilateral ESP block at the T5 spinous process provides analgesia from
   
   a. C5-T7  
   b. T2-T9  
   c. T4-T9  
   d. T2-T7

9. The ESP block is performed by inserting the Tuohy needle ____ to the ultrasound probe using an _____ approach in the cephalad to caudal direction
a. superior; in-plane
b. inferior; in-plane
c. superior; out-of-plane
d. inferior; out-of-plane

10. How likely are you to consider using thoracic ESP block for cardiac surgical patients?
   a. Most likely
   b. Somewhat likely
   c. Somewhat unlikely
   d. Most unlikely

11. How likely are you to recommend thoracic ESP block for cardiac surgery?
   a. Most likely
   b. Somewhat likely
   c. Somewhat unlikely
   d. Most unlikely
Appendix E: QI Educational Module

Learning Goals
Upon hearing this education module, the anesthesia provider will understand:

- The need for safe and effective regional techniques in cardiac surgery
- Risks and benefits of different regional techniques
- Adverse effects of regional techniques
- How to handle unexpected complications

Acute and Chronic Pain After Cardiac Surgery
- Approximately 2 million patients who undergo cardiac surgery each year experience postoperative pain, which is a significant factor in patient recovery.
- Postoperative pain negatively affects patient mobility and recovery.
- Effective pain management is crucial in decreasing clinical pain and increasing patient satisfaction and productivity.

High Thoracic Epidural Adverse Effects

- Epidural hematoma
- Pruritis
- Nausea and Vomiting
- Urinary retention
- Respiratory depression
- Failure rate as high as 15%

Erector Spinae Plane Block

- The erector spinae muscle is a group of muscles that run along the spinous processes of the vertebrae.
- The ESP block is performed by injecting local anesthetic from the paravertebral space or the interlaminar space between the vertebrae.
- The ESP block can be performed on both sides to cover the entire thoracic and lumbar spine.

Advantages of ESP Block for Cardiac Surgery

- Produces anesthesia similar to TIVA without a potential muscle-plausa interaction
- Spread of anesthetic from T2 to T9
- Provides excellent sensory and motor blockade
- Enhances analgesia with smaller doses of anesthetic
- Safer and better alternative in anticoagulated patients
- Minimal adverse effects, if any, have been associated with the ESP block.
The ESP block may be the future of regional anesthesia in cardiac surgery.

In the studies conducted, pain control was achieved with the same efficacy as HTE and TPVA.

Unfortunately, more randomized control trials must be conducted in the future to ensure its safety and efficacy.

Although more studies must be conducted, it is a promising technique that may be safely used in the anticoagulated cardiac surgical patient.

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