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Paravertebral Blocks in the Adult Thoracic Surgical Patient Enhancing Knowledge for the Anesthesia Provider

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Paravertebral Blocks in the Adult Thoracic Surgical Patient
Enhancing Knowledge for the Anesthesia Provider

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ABSTRACT

Background: Thoracic Epidural Analgesia (TEA) is currently the gold standard analgesia in adult thoracic surgical patients. TEA has medical complications like sepsis, neurological injury, spinal hematoma, and dural puncture. TEA is also contraindicated for patients with existing neurological or hematological comorbidities including patients under antiplatelet or anticoagulation therapy. These factors not only reduce the scope of administering TEA but also increase the risks of hemodynamic instability like hypotension and bradycardia. PVB can decrease medical complications, side effects, and increase patient satisfaction.

Aim: This quality improvement project aims to compare if PVB is more effective than TEA in terms of patient satisfaction, hemodynamic stability, and usage of opiates for pain management after thoracic surgery in adult patients.

Results: The study was done using 15 journal articles across a range of time to collect evidence from practice to inform clinical research and decisions on PVB usage. The results showed that PVB was more useful than TEA in managing pain. PVB improved the utilization and effectiveness of opiates, reduced side effects, improved hemodynamic stability, and supported better satisfaction amongst patients than TEA administration.

Discussion: The quality improvement project concluded that PVB has less risk of complications than TEA. PVB has certain risks of complications due to an incorrect or erroneous injection method and lack of knowledge of the anesthesia provider administering the PVB. Combining PVB with fentanyl can improve the duration of analgesia and experience of pain.

Conclusion: PVB is safer for patients undergoing thoracic surgery than patients undergoing TEA and pain is equally or more efficacious in the management of pain

Keywords: Thoracic paravertebral block; postoperative analgesia; thoracic epidural analgesia; cardiac surgical procedures; hemodynamic stability.

BACKGROUND

Introduction

Thoracic surgery is considered one of the most painful surgical procedures due to the complex intraoperative nature of the surgery.[1] Thoracic surgery is a broad umbrella for many procedures, such as Video-Assisted Thoracic Surgery (VATS), Lobectomy, Bronchoscopy, Thymectomy, Coronary Artery Bypass Grafting, and Valvular surgery. Thoracic surgery involves manipulating tissue and muscle. The risk of nerve damage can occur from the cut-down and wound retraction that occurs from the surgeon.[1,2] For this reason, pain arises as a result of the chest wall intrusion, possible fractured ribs, and injured peripheral nerves with central nervous system hypersensitivity.[2] Thoracic surgery involves hemodynamic changes, severe systemic inflammatory reactions, and poor control of postoperative pain.[1,3,4,5] Pain is triggered by chest wall movement, but unfortunately, the chest wall cannot be immobilized to control this pain, and the chest remains in constant motion.[2]

The American Pain Society suggests that pain should be treated as the 5th vital sign and regularly monitored as pulse and blood pressure, which concludes that pain is part of hemodynamics.[6] The pain decreases diaphragmatic movement and respiratory muscle leading ultimately to decrease respiratory function. Deterioration of the respiratory mechanics can lead to pulmonary complications such as hypoxia, atelectasis, retention of secretions, myocardial ischemia (MI), cerebrovascular accident (CVA), delayed wound healing, and prolonged hospital stay.[4,7,8] Neurogenic pain is associated with nerve damage resulting from chest wall intrusion is poorly sensitive to opioids.[2] Appropriate regional anesthetic techniques have been implemented

as alternative pain management in conjunction with general anesthesia to reduce perioperative complications, pain and improve patient outcomes.[3,7] This systematic review will focus on improving anesthesia technique and side effects in the adult patient undergoing thoracic surgery.

PROBLEM STATEMENT

Problem Identification, Background, & Scope of the Problem

The current gold standard for thoracic surgery pain management is thoracic epidural analgesia (TEA).[9,10,11] Epidural anesthesia blocks nerves that supply the chest with local anesthesia bilaterally at the spinal cord level. However, TEA carries the risk of severe complications, including epidural abscess, dural puncture, spinal hematoma, neurological injury, sepsis, and a failure access rate of 12%.[2,5] Epidural anesthesia is also contraindicated in patients taking anticoagulants or antiplatelet therapy, pre-existing neurological disease, difficult thoracic spine anatomy making TEA more selective. [5,6,9,11] TEA can cause hemodynamic instability with hypotension and bradycardia due to the bilateral block in the sympathetic nervous system, respiratory depression, hypotonia, urinary retention, and, in rare cases, paraplegia. [3.4.,6,8,12] Therefore, regional technique methods have been explored as an alternative for pain management.

Post thoracotomy pain is unilateral and related more to somatic and neuropathic pain for which a more selective nerve block can be effectively used.[2,5,9,12] Thoracic paravertebral block (PVB) is a regional block that provides comparable pain relief when compared to TEA with better outcomes.[9,13,14] There should be considerations when formulating an individualized plan of care for a patient's anesthetic and close observation of side effects that can increase patient satisfaction and outcomes.

Paravertebral Block (PVB) conception was founded in 1905 by Hugo Sellheim of Lepzig and was initially used as an alternative to spinal anesthesia to reduce both cardiovascular and respiratory side effects.[15] The PVB technique involves administering local anesthetic adjacent to the thoracic vertebra. Therefore, allowing local anesthesia where the spinal nerves arise from the intervertebral foramina.[16] PVB can be administered to anesthetized bilaterally and unilaterally in the thoracic surgery patient, unlike the Thoracic Epidural Anesthesia (TEA), which is bilateral.[1] Several studies demonstrate clinical efficacy when comparing PVB and TEA; however, fewer side effects and complications are reported with PVB.[5,9,11,13, 14, 17-19] TEA in the adult thoracic surgical patient can have side effects which consist of; pulmonary complications, hypotension, urinary retention, and post-op nausea and vomiting.[5,9,11,13,14,17-19] The purpose of this systematic review is to increase awareness, formulate an educational module and implement PVB in evaluating the side effects, patient satisfaction, and overall cost versus TEA in the thoracic surgical patient.

Consequences of the Problem

The incidence of cardiovascular and pulmonary diseases are drastically increasing.[24] In turn, the use of antiplatelet therapy, such as aspirin and clopidogrel, is escalating worldwide.[24] Current guidelines by the American Heart Association (AHA) recommend twelve months of dual antiplatelet therapy with potent antiplatelet agents in the setting of Acute Coronary Syndrome.[25] ETA is contraindicated in patients taking antiplatelet therapy, and the use of Paravertebral analgesia has been an alternative to epidural analgesia for Thoracotomy.[21] PVB may elude the risk of TEA preserving a better hemodynamic response and patient outcome. Davies et al[12] reported that “epidural analgesia is considered to be the best method of pain relief

after major surgery"; and as stated, the gold standard of care in thoracic patients continues to be TEA despite evidence that PVB is as effective as TEA, but with fewer side effects.[5,9,11,13,18,19]

Yatin et al[7] concluded that PVB is a safe and effective technique for postoperative analgesia after robotic-assisted CABG and is compared to TEA regarding the quality of analgesia. In 2010, Schnabel et at[23] reported that PVB perioperative is an effective method to improve postoperative pain after breast cancer. In 2012, Andrea MH et al[26] also concluded that "PVB decreased the risk of chronic pain after breast cancer surgery in about one every five women." A Randomized Control Trial (RCT) conducted in 2016 showed PVB is equally as effective as TEA in providing analgesia to Video-Assisted Thoracic Surgery (VATS) and lobectomy with a better safety profile.[9] Less plasma concentrations of cortisol and glucose are released in PVB with fewer opioid-related side effects and less hypotension than TEA. [2,5]

In 2019, Haihui et al[3] conducted a study, n=120, elderly patients and assessed postoperative cognitive function and serum adiponectin (ADP) levels undergoing elective lobectomy; the study showed that patients who underwent general anesthesia (GA) combined with PVB versus GA combined with TEA demonstrated better effects which may be related to the release of ADP. Several properties, including anti-inflammatory, antioxidant, and glucose-lowering effects, are associated with ADP release.[3]

Additional studies performed by Yamauchi Yet at.[11], Richardson J et at.[14], and Scarfe AJ et at.[19] demonstrated that continuous PVB reduces the occurrence of nausea and vomiting, hypotension, and urinary retention compared to epidural analgesia and especially for patients with contraindications for TEA; offering a basis for enhanced postoperative mobilization regimen.[17] Urinary retention in patients undergoing epidural anesthesia is reported between five and seventy percent after surgery.[19,21] Indwelling urinary catheter results from urinary retention

and increases the risk of Catheter-Associated Urinary Tract Infection (CAUTI). Under the Centers for Medicare and Medicaid Services (CMMS), there are reduction programs for healthcare-associated infections, and CAUTI can ultimately affect the organization's finances

Knowledge Gaps

Recent studies have reported that ultrasound-guided thoracic paravertebral block combined with GA has gradually replaced epidural anesthesia for thoracic surgery. The use of PVB produces a unilateral somatic and sympathetic block,[12] which is advantageous for unilateral thoracic surgical procedures. Although PVB was created as an alternate technique because of its feared hazards of cardiovascular and respiratory collapse,[17] the lack of knowledge and undervalue advantages of this block remains underappreciated for the anesthesia provider. Many anesthesia providers lack knowledge and education about PVB. The anesthesia provider should identify when PVB outweighs the benefits of TEA, such as when TEA is contraindicated with antiplatelet treatment, therapeutic anticoagulation, hemostatic disorders, or coagulopathies, and potentially technically difficult epidural catheter insertion.[11,14]

Meta-analyses [10,12,14,19,21,23] have demonstrated that PVB has a better side-effect profile because it is associated with less postoperative urinary retention, nausea, vomiting, and hypotension. Offering PVB with a multimodal analgesic technique can address the profusion of pain for patients undergoing surgery;[1-23] provide an anesthetic alternative analgesic approach for patients with contraindication for TEA;[11] and deliver better side-effect profile associated with pulmonary complications and hemodynamic factors.[12] Awareness of this alternative approach is vital for effective postoperative analgesia, less postoperative nausea and vomiting, less hypotension, reduction in pulmonary complication, reduced morbidity, quicken recovery, improve patient outcome, and reduce hospital cost.[11-14]

Proposal Solution

The primary objective of postoperative analgesia is to decrease anxiety and pain after a complex surgery for a better recovery. The proposal of PVB for postoperative analgesia will be associated with longer duration of analgesia, significant positive hemodynamic difference in preoperative and postoperative values, [6] decreased side effects, [9] complications, optimal patient outcomes, and overall cost-effectiveness. [2-23] In all randomized-controlled trials, patients performing PVB, the degree of pain after surgery was minimum, and the recovery was optimal compared to TEA. [1-23] The patient satisfaction with the analgesic technique postoperative was suitable. This systematic review will advocate that PVB is a suitable anesthetic option for patients undergoing thoracic surgery, especially where central neural blocks are contraindicated. Education is crucial for PVB awareness and enhancing knowledge for the anesthesia provider is fundamental to provide up-to-date evidence-based practice for patient care.

PICO QUESTION

(P) In adult surgical patients presenting for thoracic surgery, **(I)** does an educational module on paravertebral block, (**C)** compared to thoracic epidural anesthesia, (**O)** increase the anesthesia providers knowledge in opiate consumption, cost, urinary retention, nausea, vomiting, hemodynamic stability, and patient satisfaction?

The purpose of this systematic review is to increase awareness and enhance the knowledge of the anesthesia provider about PVB when compared to TEA. PVB has less complications and side effects when compared to TEA.[1-23] There is less hemodynamic fluctuation and decreased opioid consumption when compared to TEA.[5,9,11,13, 14, 17-19] The PVB of the sympathetic nerve that blocks pain is known to be more complete than TEA.[3] In conclusion,

PVB shows to be more advantageous and will increase patient satisfaction with better analgesia effect in the thoracic surgical patient.

METHODOLOGY

Information Sources and Search Strategy

The search and format of the current systemic review was completed using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist.[10] Based on the PICO approach a clinical question relevant to anesthesia practice was formulated. Subsequently, a multi-database search was conducted using PubMed, Cumulative Index of Nursing and Allied Health Literature (CINAHL), and MedLine (ProQuest) to investigate content related to the clinical question. Keywords and Boolean operators included paravertebral block, thoracic epidural block, thoracotomy, hemodynamics, analgesia, opioids, cardiac surgery, cardiac thoracic surgery, continuous epidural and paravertebral block. Search parameter and filters applied included human subjects, publication date between the years of 1999-2020, English language, all sex, academic peer reviewed journals, and randomized controlled trials. A specified table defining the precise key words, topics, headings, and filters applied in each database search is displayed in Table 1.

A clinical question was created based on the PICO format: **(P)** In surgical patients presenting for thoracic surgery, **(I)** does paravertebral block (PVB), (**C)** compared to thoracic epidural anesthesia, (**O)** increase patient satisfaction, decrease opiate consumption, cost, urinary retention, nausea, vomiting, and maintain hemodynamics? The PICO question was used to guide the literature search and generated keywords, Boolean phrases, and truncation to help retrieve articles for this systematic review analysis. The total number of studies found was 515 articles.

The PubMed databased yielded 188 results, the CINHAL databased yielded 47 results, and the MedLine databased yielded 280 results. Duplicate articles were removed resulting in 123

full text articles to appraise. After review of the articles and utilizing the PRISMA tool, there were a total of 15 articles finalized for this quality improvement project. The 15 articles originated from all three databases. Eight articles were found in MedLine (ProQuest), three in CINAHL, and four in PubMed. The steps involving the selection and exclusion stages of the articles are represented in the flow diagram proposed in the PRISMA statement (Figure 1).[10]

Table 1. Database Search Table

Key Words/ Boolean Operators	Paravertebral block OR Thoracotomy OR Thoracic epidural block OR Continue paravertebral block Or Ultrasound OR Thoracic OR Paravertebral safety	Painful thoracic surgeries OR post thoracotomy analgesia OR opioid consumption OR systemic analgesia	Epidural analgesia techniques OR paravertebral analgesia technique OR Regional analgesia OR Thoracic lung function OR thoracic regional techniques	Filters Applied
CINAHL	((((paravertebral block*) OR thoracotomy*) OR thoracic epidural block*) OR postoperative pain*) OR analgesia*) OR Lobectomy)))	(painful thoracic surgery OR opioid consumption OR thoracic analgesia OR assessment pain OR systemic analgesia)	(postoperative OR perioperative OR postsurgical OR intraoperative OR "pain postoperative" OR "pain control" OR thoracic analgesic)	▪ Filters Applied: 1999-2020 (decades), Humans, Full Text, All sex, and Source Type Academic Journal. Yielded 47 results.
MEDLINE (Proquest) [1950-present]	(paravertebral block OR Thoracotomy OR Thoracic epidural block OR Postoperative	(painful thoracic surgery OR opioid consumption OR thoracic	(postoperative OR perioperative OR postsurgical OR intraoperative	▪ Filters applied: Embase only, Humans, Adults, English, 1999-2020, Humans Filter, Free Full Text, and Article

	pain OR analgesia OR lobectomy)	analgesia OR assessment pain OR systemic analgesia)	OR "pain postoperative" OR "pain control" OR thoracic analgesic)	Type RCT. Yielded 280 results.
PubMed	(“paravertebral block OR thoracotomy OR thoracic epidural block OR postoperative pain OR analgesia”)	(painful thoracic surgery OR opioid consumption OR thoracic analgesia OR assessment pain OR systemic analgesia)	(postoperative OR perioperative OR postsurgical OR intraoperative OR "pain postoperative" OR "pain control" OR thoracic analgesic)	▪ Filters applied: EMBASE ONLY (removed Medline duplicates), Randomized Controlled Trial, Humans, All sex, and Adults, from 1990-2020. Yielded 188 results.

Study Selection and Screening Method with Inclusion/Exclusion Criteria

The preliminary PICO question was utilized to inspect and select appropriate titles and abstracts of all 515 articles obtained from the database search. The investigator collected and analyzed available data in order to reduce research bias. All studies were assigned according to the PICO question. Endnote software was the preferred organization tool, which was used to remove the duplicates studies. Successively, the articles were organized where three folders were created, the “Prospective Background” folder, the “Significant” folder, and the “Irrelevant” folder. A total of 23 studies were placed into the “Prospective Background” folder.

The investigator preformed an inspection of 23 articles in the “Prospective Background” folder. The criteria were divided between inclusion and exclusion. The rigorous inclusion criteria comprised studies published in English, between 1999 to present, randomized control trials (RCT), randomized single or double blinded study, prospective RCT, and retrospective case

control study, human adults 18 year and older, male, or female, adult patients undergoing thoracic surgery, paravertebral block (PVB) and thoracic epidural block (TEB) used as a multimodal anesthetic alternative. Some articles were classified as exclusion criteria which included systematic reviews, meta-analysis, questionnaire, studies published before 1990, animal studies, improper intervention, anatomy, and patient population. For a more detailed inclusion and exclusion criteria, refer to table 2.

Table 2. Inclusion and Exclusion Criteria

Inclusion criteria	**Exclusion criteria**
Type of study: ➢ English language ➢ Full text ➢ Randomized controlled trials (RCT) ➢ Single or double-blinded study ➢ Prospective RCT ➢ Retrospective case-control study ➢ Randomized, parallel, external pilot study ➢ Publication date 1999 to present	Type of study: ➢ Non-English language ➢ Systematic reviews ➢ Meta-analysis ➢ Questionnaire ➢ Dissertations/theses ➢ Publication date before 1999 ➢ Animal studies
Population: ➢ Human ➢ Age (> 18 years of age) ➢ Male or Female	Population: ➢ Nonhuman ➢ Children (< 18 years of age)
Types of procedure: ➢ Adult thoracic surgical patient	Types of procedure: ➢ Studies other than adult thoracic surgical patient
Intervention: ➢ The studies involved patient undergoing thoracic surgery receiving PVB or TEB.	Intervention: ➢ Surgeries no relate to thoracic anatomy.
Outcomes: ➢ Better quality of analgesic control and decrease of opioid consumption. ➢ Maintain better hemodynamics especially pulmonary function values with lower risk of complications and fewer side effects. ➢ Reduce less catheterization and avoid prolong hospital stays. ➢ Increased patient satisfaction and decrease hospital cost.	Outcomes: ➢ Any outcome than did not include patients receiving PVB or TEB on patient undergoing thoracic surgery.

➢ Improve early postoperative cognitive function in the elderly. ➢ An alternative safe profile adjunct of anesthesia.	

Collection, Analysis, and Data Items

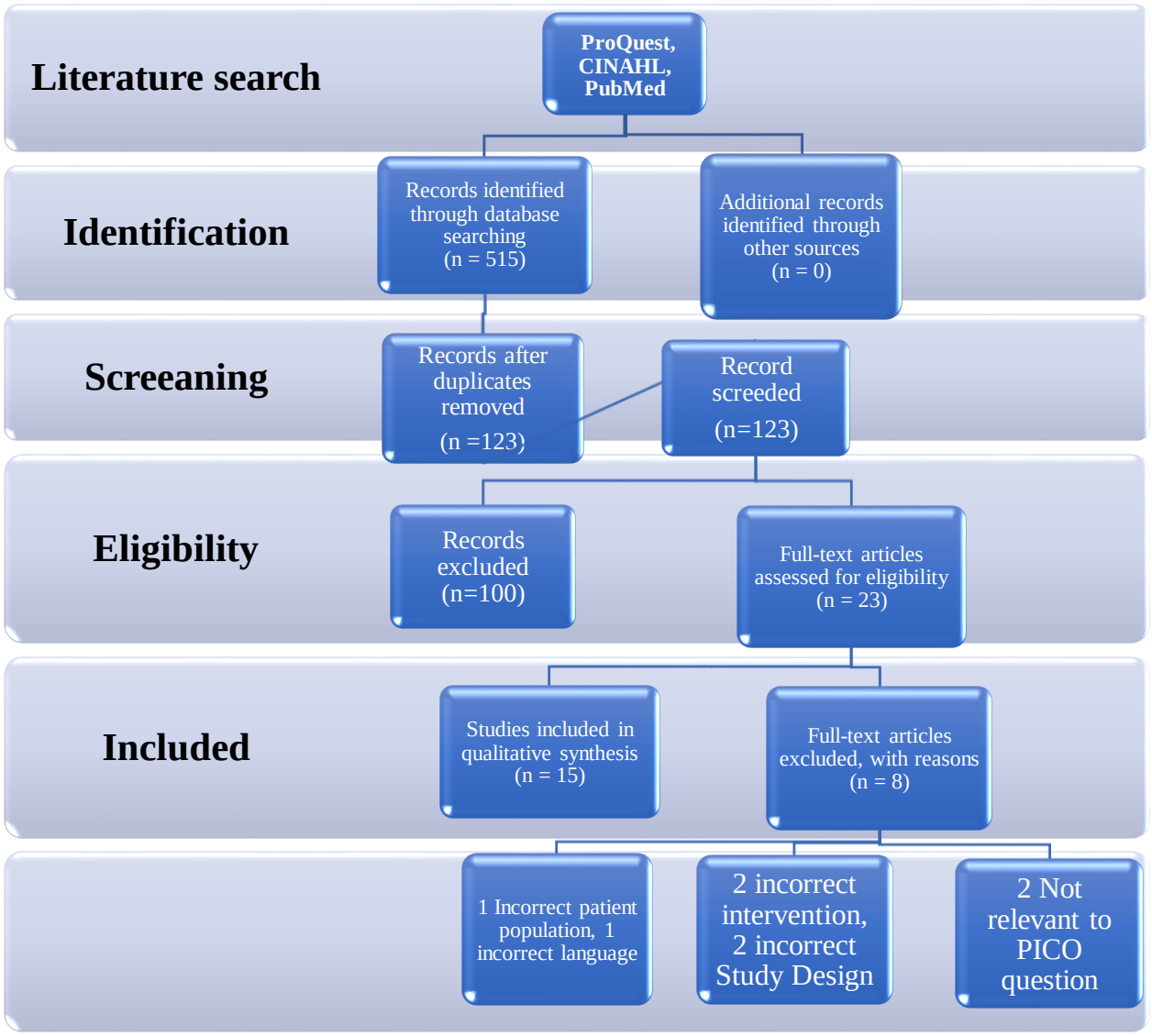
According to Dearholt et al[31], the John Hopkins Evidence-Based Practice (JHNEBP) tool is one of the best schemes to evaluate the strength and quality of research evidence. The JHNEBP has three grades in the quality rating scheme for research evidence, which include high, good, and low.[31] High quality evidence (grade A) consist in adequate sample size, consistent, generalizable, and sufficient control.[31] Good quality evidence (grade B) comprise of reasonable results with a fair conclusion, and sufficient sample size.[31] Low or major flaw evidence (grade C) involve little evidence, inconsistent results, insufficient sample size for the study design where the conclusions cannot be drawn.[31]

Additionally, JHNEBP rate the strength of research evidence on three different levels. Level I contain evidence obtained from an experimental study, randomized controlled trail (RCT), or systemic review of RCTs, with or without meta-analysis.[31] Level II is comprised of quasi-experimental study, systematic review of a combination of RCTs and quasi- experimental, or quasi-experimental studies only, with or without meta-analysis.[31] Level III included non-experimental study, systematic review of a combination of RCTs, quasi-experimental and non-experimental studies, or non-experimental studies only, with or without meta-analysis Qualitative study or systematic review with or without a meta- synthesis.[31] Level IV consisting of opinion of respected authorities or nationally recognized expert committees. Lastly, level V is based on experiential and non-research evidence.[31]

The John Hopkins' research appraisal tool was utilized methodically to evaluate the selected studies. The investigator undertook the data collected and organized the selected studies

in a table. Each study was assigned a John Hopkins's rating based on critical appraisal of multiple parameters by both investigators such as: publication date, design, method, setting, sample size, sample characteristics, setting, interventions, dependent and independent variables, outcomes, measurement and data analysis, findings, results, and author's conclusions (see Table 3).

Figure 1. PRISMA Flow Diagram depicts the screening process used in this systematic review



RESULTS

Opiate Consumption

Mukherjee et al conducted a single-blinded RCT in 2010 comparing analgesia in the post-thoracotomy patient between thoracic epidural and thoracic paravertebral blocks.[6] The sample population included 60 adult patients of ASA I and II of both sexes between the ages of 20 and 65 years old. The patients were split in two groups, Group A N=30, who received TEB with 7.5 ml of 0.25% bupivacaine, and Group B n=30 who received PVB 15 ml 0.25% bupivacaine.[6] Both groups in the study received one milliliter of Fentanyl for post-operative analgesia. In the post-operative phase, mean analgesic duration validated a statistical significance P=0.001 proving PVB lasted longer in terms of analgesia duration. Group A lasted 105.83 while PVB lasted 171.66 minutes.[6] Comparing parameters of mean, median, and maximum duration of the effective duration of analgesia, group B experienced better analgesia from the immediate postoperative period than those in group A.

The study conducted by Deebis et al in 2020, also sought to establish whether there would be any differences in opiate consumption for patients that received paravertebral block compared to systemic analgesic for the management of post-thoracotomy pain.[13] This prospective randomized study divided 63 patients into either the thoracic paravertebral group (n=32) and the systemic analgesia group (n=31). While the primary variable under consideration was the effectiveness of pain management, the authors also investigated opiate consumption in the two groups as well as pulmonary function.[13] Pain effectiveness was assessed using the visual analog scale while morphine consumption was assessed after every 24 hours for 3 days.[13] Continuous variables were compared using t-test or Mann–Whitney test if not normally distributed, and categorical variables were compared using the chi2 test or Fischer Exact test if

the frequency 18 of the events is less than 5. The specificity of opiate consumption, authors reported that there was a significant reduction in the use of morphine in the thoracic paravertebral group.

Richardson et al in 1999[2] conducted a prospective randomized comparison study, the authors sought to compare patients that were receiving epidural versus patients that received paravertebral bupivacaine.[2] In both sets of patients, controlled morphine was administered. The group that received paravertebral block consisted of 49 patients while the epidural group were 46 patients. Patients were aged between 17 and 80 years old. Data analysis involved the use of the SPSS statistical package.[2] Two-tailed independent t-test was used as the main statistical test, two determined if significant differences existed between the group that received the epidural vs. the group that received the paravertebral block. In addition to morphine intake, the study also investigated effectiveness for pain management.[2] For morphine use, the researchers found out that morphine use was higher in the group where the epidural was administered with a mean use of 105.8 mgs.[2] In contrast, the mean usage of morphine in the group that received the paravertebral block was 85.5mgs. Postoperative mean peak expiratory flow (PEFR) was used as measurement of preoperative control value, the lowest postoperative PEFR as a fraction of the preoperative control was 0.73 in the paravertebral group while in the epidural group was 0.54, $P<0.04$.[2] The authors concluded that the administration of the paravertebral block was far superior when compared to epidural administration especially in regard to pain management, morphine usage, and pulmonary function.[2]

Side Effects: Urinary Retention, Nausea, and Vomiting

A retrospective case-control study by Yoshikane et al studied 56 patients who endured a thoracotomy with PVB between March 2013 and March 2014.[11] A second controlled group who

also endured a thoracotomy, however, received EDA, between April 2011 to February 2013 were also collected. Pain control and side effect results were statistically analyzed. Thoracotomy was divided into three subtypes: lobectomy with mediastinal lymph node dissection, lobectomy without mediastinal lymph node dissection, and all the others.[11] The sample was selected from Shizouka Cancer Center Hospital for both groups. Numeric Rating Scale scores on postoperative day two were gathered and did not significantly differ in the groups, PVB group (3.25 ± 1.80) and the EDA group (3.56 ± 2.05) ($p = 0.334$).[11] In terms of side effects, however, urinary retention showed a significant difference between the two groups, favoring PVB that occurred less frequently $P=0.03$. The results validated that PVB was not less effective than the EDA group in post-thoracotomy pain control.[11] Side effects of urinary retention were significant in the EDA group, ten patients in the EDA group failed a voiding trial requiring reinsertion of a urinary catheter, no patient in the PVB group had this problem ($P= 0.03$).[11] The study concludes that PVB is as effective as EDA in post-thoracotomy pain nevertheless, PVB reduced the frequency of urinary retention.

A prospective randomized single control study that also investigates urinary retention based on the type of post-anesthesia pain management for patients that undergo thoracotomy was undertaken by Sherbinny et al in 2014.[28] In this study, the authors recruited 60 patients to either the TEA group or the TPVA group. All patients were ASA I through ASA III. Each of the two groups had 25 participants drawn from both sexes and all greater than 18 years old. For statistical analysis, SPSS version 16 was used. Numbers and percentages were used to represent the quantitative data. Unpaired student t-test and the ANOVA test were used in the statistical analysis of the quantitative data. There was lower nausea, vomiting, itching, and no urine retention in the TPVA group.[28] For urinary retention, the authors found out that 16.6% of the

subjects in the TEA group presented with urinary retention. In contrast, no patient in the TPVA group presented with urinary retention (P=0.01).[28]

Hemodynamic Stability

Casati et al conducted a prospective RCT of forty-two ASA physical status II-III patients undergoing lung resection surgery that received EPI or PVB and hemodynamic effects were recorded.[5] The sample size of forty-two patients were divided into twenty-one of EPI and twenty-one PVB in a hospital setting. There were no reported differences between the two groups in age, weight, height, gender distribution, and ASA physical status. The research showed that 19% of patients in group EPI showed a markedly decrease in systolic arterial pressure greater than 30% of baseline as compared to those in the group of PVB that showed none, 0% resulting in P=0.04.[5] The study showed that patients in the group that received EPI had a higher incidence of clinically significant hypotension when compared to the group who received PVB. The findings are related to the more peripheral and unilateral block with less extended involvement of sympathetic blockade can reduce the risk of hemodynamic instability as compared to epidural anesthesia and clinically more advantageous when managing a patient undergoing thoracotomy surgery.[5]

A similar study that looked at hemodynamics conducted by Okajima et al in 2015 studied 90 patients scheduled for VATS that were broken up into two groups.[18] Group P (n=36) received USG-PVB, and group E (n=33) received TEB and variables including blood pressure as side effects were recorded.[18] The study took place at Nishi-Kobe Medical Center in Kobe, Japan in a year timeframe. The 90 patients varied between ages 18-75 years with ASA I-III and were randomly assigned into the two groups. The study concluded that side effects of hypotension occurred significantly more frequently in group E (P= 0.0169) while there was no statistical

difference in group P (n=1/36).[18] Even though both groups showed similar pain-relieving effects, USG-PVB, P group, resulted in a lower incidence of postoperative hypotension.[18]

In 2016, a study undertaken by Biswas et al. provides support for the use of paravertebral block as opposed to the administration of epidural for post-thoracotomy pain relief based on hemodynamic effects.[27] This double-blind randomized controlled trial recruited a total of 60 patients. Thirty of the patients, Group E, received epidural pain relief while the other half, Group P, received a paravertebral block. The collected data was analyzed using SPSS. Specific statistical tests that were carried out included mean, median, standard deviation, paired and unpaired T-test, Chi-square test, Mann Whitney U-test, Wilcoxon rank-sum test, *P*-value < 0.05. In addition to investigating the hemodynamic effects of the two pain relief methods, Biswas et al also investigated nausea and vomiting as well as patient satisfaction in terms of pain relief.[27] On the main variable, hemodynamics, Biswas et al found that clinically significant hypotension was reported in 23.3% of the patients in the epidural group only with a $P<0.05$. None of the patients that were in Group P experienced hypotension.[27] In terms of nausea and vomiting, six patients in group P experienced nausea and vomiting when compared to the four that experienced nausea and vomiting in the TEB group. However, the difference was not statistically significant with $P>0.05$.[27]

Haihui et al in 2019[3] assessed the cognitive function of patients undergoing elective lobectomy. The sample was randomized in three different groups as a mechanism of investigating the hemodynamic effects.[3] The first group, GA, received general anesthesia. The second group, PG, received paravertebral block. The final group, EG, received an epidural with general anesthesia. Each of the groups consisted of forty elderly population of ages 65-81 years old.[3] All patients in the group were assessed for cognitive function one day before the surgery

and seven days following the surgical procedure. Statistical analysis was done using the SPSS software. The specific tests that were undertaken included the using X 2 test, with p values. Among the findings, reports include that the general anesthesia group reported significantly increased mean arterial pressure and heart rate. On the other hand, the group that received the epidural experienced hypotension and diminished heart rate. The group that received paravertebral block did not have a significant change in hemodynamics.[3] In terms of how this translated to post-operative cognitive decline, Haihui et al pointed out that in the GA group, 18% of the participants depicted cognitive decline. Seven-point seven percent of patients in the PG group and 12.8% of patients in the EG group ($P<0.05$) experienced a post-operative decline. The authors concluded that paravertebral block is more effective in managing post-surgical pain.[3]

Hemodynamic stability affected by post-operative pain management in the MIDCAB surgery patient was studied by Dhole et al in 2001.[29] In this prospective randomized study, 41 patients both male and female were included either in the TEA group (n=21) and the PVB group (n=20). The hemodynamic aspects that were investigated included mean arterial pressure, central venous pressure, respiratory rate, and systemic vascular resistance.[29] A two-lead electrocardiogram with ST-segment monitoring, arterial blood pressure, and pulmonary artery pressure were used in monitoring and measuring the hemodynamic elements. The data were analyzed using t-test, Pearson chi-square test, and Fisher's exact through the use of the SPSS statistical analysis tool. The study reported that hemodynamic stability was comparable in both groups. However, a significant increase in the cardiac index for the TEA group at the fourth and the sixth hour. Besides, systemic vascular resistance was also lower in the TEA group as compared to the PVB group. The respiratory rate had significantly lower rates in the PVB sample at eight, ten, and twelve hours.[29] Chest physiotherapy postoperatively was better in the PVB

group in the early phase. The study showed less hypotension resulting from the sympathetic block with PVB, none of the patients in the PVB group had hypotension thus favoring PVB as effective as TEA with less risk of hemodynamic instability and complications of an epidural hematoma.

Patient Satisfaction

Kosinski et al, in 2016, studied 51 patients in an RCT comparing continuous epidural block and continuous paravertebral block in postoperative analgesia after VATS surgery lobectomy in patients with cancer at The Oncology Center in Gliwice.[9] The sample population included 81patients, however, 51 completed the final analysis. The patients were of adult population ranging between 18-85 years old of both genders, ASA I and ASA III.[9] Group PVB (n=26) and group TEB (n=25). The dependent variable measured was Static and dynamic pain scores at 24 hours, 36 hours, and 48hrs post-operatively.[9] Also, postoperative morphine usage was also collected. There was no difference regarding morphine usage between the groups, however, static and dynamic pain scores at all intervals including 24, 36, and 48 hours postoperatively were significantly lower in the PVB group ($P<0.05$).[9]

In 2018, Yeung et al conducted a randomized control study to investigate the effectiveness of thoracic epidural and paravertebral blockade for perioperative pain during thoracotomy in the reduction of chronic post-thoracotomy pain.[1] There were 194 total adult patients eligible, all greater than 65 years old, and male gender. However, 69 consented, thirty-five allocated for PVB, and thirty-four allocated TEB in a hospital setting. Scales used in the study were Visual Analogue Scales, Brief Pain Inventory, Neuropathic Pain Scale, generic health-related quality of life, Hospital Anxiety and Depression Scale. The dependent variables measured were pain scores on days 1-3, acute complications, mortality, length of stay, three

months post-randomization follow-up by questionnaire, and the same assessment at six months. The level of pain at the three days post-surgery appeared similar in both groups.[1] At the six-month post-surgery VAS pain score survey, the number of patients indicating at least a moderate level of average pain was lower with PVB when compared to TEB.[1]

A prospective RCT by Mehta et al was conducted in 2020 comparing continuous thoracic epidural and paravertebral block for postoperative analgesia after robotic robotic-assisted coronary artery bypass grafting.[7] The groups were divided into TEA Group A (n=19) and PVB Group B (n=17). All the patients were premedicated with oral lorazepam, morphine sulphate and glycopyrrolate preoperatively. Hemodynamic data including heart rate (HR), mean arterial pressure (MAP), central venous pressure (CVP), and cardiac index (CI) were compared. Partial pressure of oxygen (PaO2), Partial Pressure of Carbon Dioxide (PaCO2), pulmonary function test (PFT) and postoperative pain by VAS scores were also completed. In total, there were 36 patients, the sample population was of adult age between age range 25 and 65 years old in a hospital setting. VAS scores were collected at 12 and 24 hours after the surgery. Acid-base blood analysis were done one hour after extubating, and pulmonary function tests two hours after chest tubes were removed. The mean values of the two groups of data are gathered and analyzed using a two-tailed student t-test, and a *P-value* <0.05 was considered significant.[7] The PVB group showed better pulmonary function test, acid-base blood gas analysis, and overall better outcomes.[7]

A randomized controlled trial was undertaken by Malgozrata et al in 2019 that also investigated patient satisfaction with pain management.[8] This study randomized 60 patients using simple randomization into two groups: TEA (N=30) and PVB (n=30). The TEA group received thoracic epidural analgesia while the PVB group received the paravertebral block. The

requirement for recruitment included being older than 18 years of age. To assess patient satisfaction with pain management, a scale of one through ten was used, one indicating low satisfaction with the method used and ten indicating more satisfaction with the adopted method. T-test for dependent groups and Mann-Whitney U test were used in statistical analysis. In the PVB group, complications were observed in four persons, 13.3%, while in the TEA group complications detected in seven patients, 23.3%.[8] Complications in the PVB group involved leaking of regional anesthesia, catheter migration, and retention of secretion of respiratory tract. Complications in the TEA group included retention of secretion of respiratory tract, paroxysmal atrial fibrillation, and one patient that became paraplegic involving all segments from T4 below. Complication of paraplegia was resolved four hours after spinal catheter was removed.[8]
The author found that PVB is equivocal to TEA in postoperative pain management, however, complications were higher in the TEA group.[8]

DISCUSSION

Summary of evidence

Mukherjee et al reported that patients undergoing PVB are more likely to experience better analgesia after the immediate postoperative period when PVB includes 15ml of 0.25% Bupivacaine and 1ml of Fentanyl.[6] The duration of analgesia in PVB was reported to last longer by 65.83 minutes longer than TEA with 7.5ml of 0.25% Bupivacaine.[6] When comparing differences in the consumption of opiates between patients, it was found that the usage of morphine was significantly less amongst patients of the thoracic paravertebral group compared to the TEA group after a post-thoracotomy surgery.[2,4] This indicates higher effectiveness of paravertebral block for pain management. Richardson et al (1999) compared paravertebral Bupivacaine with TEA and found that PVB can reduce the use of morphine by 20.3ml when

compared to TEA.[2] Paravertebral block helped to improve postoperative mean peak expiratory flow (PEFR) by 0.19 compared to TEB. This indicated a better opportunity for pain management when using PVB.[2]

Thus, opiates and their effectiveness in managing pain among patients undergoing thoracic surgery, the usage of PVB showed a longer duration of the effect of analgesia. The studies also showed a reduction in the need for administering morphine, which indicates fewer symptoms of opiate side effects. PVB also improved pulmonary function and thereby improved the effectiveness of pain management.[2] It was also noted that administration of one milliliter of fentanyl further helped to improve the analgesic duration.[6] It is essential that the experience of pain can be effectively measured and comparable, VAS was used in nice of the studies.[5,6,7,8,9,10,18,27,28,]

While assessing the side effects of vomiting, nausea, and urinary retention, effects were significantly lower for the PVB group when compared to TEA among the thoracic surgical patient.[11,28] While the TEA group showed a higher rate of side effects like urinary retention that required a urinary catheter, the PVB group patients did not experience this complication at the same rate. In 2017 Yoshikane et al found that PVB and TEA were comparable in post-thoracotomy pain control, however, the risks of side effects were lower in PVB.[11] Sherbinny et al in 2014 also found that side effects of urinary retention had 0% risk in the PVB group, while 16.6% of the patients in the TEA group developed urinary retention.[28] Both articles support that urinary retention is less likely to occur with PVB in adult thoracic surgical patients.[11,28] Research indicates that patients with PVB have lower risks of side effects like vomiting, nausea, and itching. PVB almost eliminated the risks of urinary retention and the need to insert urinary catheters when compared with TEA.

In comparing PVB and TEA hemodynamic effects for patients undergoing lung resection surgery, it was found that patients who received TEA showed higher risks of hypotension than those who received PVB.[3,5,18,27,29] Hemodynamic stability in the case of PVB can be linked to a better unilateral and peripheral block that is caused by the sympathetic blockade to be less involved and thereby reducing risks of hemodynamic instabilities.[5] PVB is more effective and clinically advantageous than epidural anesthesia post-thoracotomy surgery.[5] When comparing TEA with PVB for patients between 18-75 years, it was found that adverse reactions like hypotension were more frequent in cases of TEA.[3,5,18,27,29] Even when both TEA and PVB can show similar pain relief effects, PVB has significantly fewer hypotension incidents in the postoperative period.

The higher risks of hypotension associated with TEA administration were also supported by Biswas et al in 2016, the study indicated a 23.3% higher risk in TEA when compared to PVB.[27] None of the patients receiving PVB experienced hypotension, meaning 100% in the PVB group remained normotensive.[27] Haihui et al in 2019 compared the cognitive function of patients who underwent elective lobectomy, the study revealed that the mean heart rate and arterial pressure showed no difference in the group that PVB was administered.[3] However, patients who received TEA or GA experienced a low heart rate and hypotension, while patients who were administered PVB did not have hemodynamic changes.[3] This indicates that the paravertebral block has the lowest or eliminates hemodynamic risks like hypotension or bradycardia in the PVB group.

When comparing hemodynamic factors like systemic vascular resistance, respiratory rate, central venous pressure, and mean arterial pressure, PVB indicated a lower respiratory rate at 8, 10, and 12 hours.[29] It indicated a better postoperative outcome for chest physiotherapy at early

stages and lower hypotension risks due to sympathetic block compared with TEA. Dhole et al in 2001 supported the evidence that PVB was associated with a much lesser risk of clinical complications like epidural hematoma and hemodynamic instability.[29] Therefore, in terms of hemodynamic stability, PVB reduces hemodynamic risks that can mitigate hypotension changes after surgery. It reduces the risks of side effects, prevents risks of cognitive decline, and a better respiratory rate when compared to TEA. This shows PVB to be more helpful and practical as a post-surgical procedure than TEA as it can help prevent clinical complications and support patients' ability towards self-care.

For cancer patients undergoing VATS surgery for lobectomy, PVB was found to significantly reduce both static and dynamic pain scores after 24, 36, and 48 hours of the postoperative stage. Even though the difference in usage of morphine between PVB and TEB was insignificant in this particular study, the lower pain scores indicated that patients showed better response to PVB than TEB in terms of their experience of pain and, therefore, the satisfaction from the medical procedure.[2] When focusing specifically on chronic post-thoracotomy pain during the peri-operative period for thoracotomy, PVB had a lower incidence of moderate to average pain among patients.[28] This was mostly in the 3 days post-surgery. PVB also helped reduce the length of stay for patients, lower risks of acute complications and mortality, significantly improving patients' experience and satisfaction from the procedure.[28] Several scales were used in the study VAS, neuropathic pain scale, brief pain inventory, hospital anxiety, depression scale, and health-related quality of life.[28] The scales helped not only to measure experiences of pain but the overall experience of patients and therefore the level of satisfaction was greater in the PVB group.[28]

For medical procedures like robotic-assisted coronary artery bypass grafting, PVB showed a better performance in acid-base blood gas analysis and pulmonary function test than TEA.[18] PVB group showed a better outcome with optimal HR, CVP, MAP, and CI.[18] Patients who underwent PVB also showed a healthier score of PaCO2 and PO2 along with a healthier pulmonary function as indicated by the PFTs. When assessing patients' satisfaction with pain management, PVB supported better satisfaction among patients compared to TEA. The lower patient satisfaction with TEA was mainly due to complications like respiratory tract secretion, respiratory retention, catheter migration, and leaking of regional anesthesia.[8,18] Additional complications like paroxysmal atrial fibrillation and risks of paraplegia significantly influenced patient satisfaction in the group of TEA.[8] Since PVB had lower risks of these complications (13.3%) than TEA (23.3%), a better response was elicited from PVB regarding patients' experience and satisfaction. While on the other hand, for TEA, the complications led to poor satisfaction outcomes.[8] Even though both TEA and PVB were equivocal for postoperative pain management, the evidence points out that PVB results in better satisfaction among patients than TEA.

The studies in this review conclude that PVB was associated with a lower side effect profile as it leads to less urinary retention, vomiting, nausea, and hypotension in the postoperative period. By administering PVB with multimodal analgesics can help to prevent pain profusion for thoracic surgical patients. This can also give an alternative approach for analgesic administrations for patients who experience contradictions with TEA. Overall, it can be that PVB shows to have better opiate effectiveness, reduce risks of side effects, improved hemodynamic stability, and better patient satisfaction when compared to TEA. PVB improved the duration and effectiveness of analgesia. It also reduces the dependency on opiates and improves pain

management outcomes. Side effects such as vomiting, nausea, and urinary retention can be considerably reduced or even eliminated through the administration of PVB. PVB also shows to have fewer effects of hemodynamic instability like hypotension. PVB prevents sympathetic blockage and prevents cognitive decline, unlike epidural anesthesia. Most importantly, PVB showed better outcomes in terms of patient satisfaction through a better patient experience, lower risks of complications, and better outcomes from pain management interventions.

Limitations and gaps

The investigators do acknowledge the evidence quality in this systematic review has multiple limitations. The study has a limited number of studies (n=15), and the selection of articles can represent a selection bias to favor conclusions that PVB has an advantage over TEA. The analyst selection of articles could represent a desired outcome and exclusion of such articles that were contradicted to such results. This increases the risks of bias and limits critical comparison between the two comparable groups.

Since the research entirely depends on the data analyzed and reported by other authors, the research analyst's accuracy and validity are dependent on the original research from which secondary data is collected. Therefore, this research is exposed to the pre-existing biases of the original authors. There is a risk of inaccuracies of data reported by the authors, making the research outcomes inaccurate. Since the articles selected for the analysis have been taken from a wide range of time like, Richardson et al (1999) there is a risk that some of the information and knowledge posited by the authors to be out of date and old.[2] As a result, Cole & Trinh (2017) state that those outcomes might not be well aligned with the current standards of medical research and medical literature.[16] The sample selected for the secondary data generation was limited and small as only 15 articles were chosen to be analyzed with no limiting period.

Since ETA has been the gold standard, anesthesia providers need education and knowledge about PVB, to compare PVB and TEA benefits. Since there are gaps in the knowledge about PVB among anesthesia providers, the research does not include a core segment on the anesthesiologist's understanding of the effectiveness of PVB in terms of hemodynamic stability, opiate consumption, and side effects of both PVB and TEA.

This study does not discuss the side effects that PVB has, such as paralysis of the phrenic nerve and respiratory system due to accidental injection of PVB into epidural, subdural, and subarachnoid space.[17] Other risks such as a loss of function in the vital brain stem leading to coma, seizure, or impaired consciousness and Horner syndrome are also not discussed.[17] This dramatically limits the conclusion of the comparison that PVB is better than TEA in terms of risks of side effects.

Recommendations for future research

Further research can be done on the application of PVB beyond thoracic surgery. This will highlight the application of PVB beyond one procedure and strengthen the procedure's advocacy in comparison to TEA. Extending the study from beyond pain management, like patients with multiple fractured ribs to improve respiratory parameters and arterial blood gas. Research can be extended on patients undergoing breast surgery and reducing recovery time compared to other anesthesia administrations. PVB can be used for patients who undergo renal surgery and cholecystectomy for pain relief. Research should be done on how PVB can reduce pain in renal surgery patients than the epidural infusion.

Further research should be done on the side effects of PVB, like the risks and complications involved with accidental location injections. Accidental injection can lead to serious medical complications and adverse health for patients, thus causing poor experience. It is

vital to research appropriate needle manipulation, which can prevent complications due to accidental injections. This can include studies on lateral and medial orientation limitations and caudal needle redirection instead of cephalad needle redirection. This can help to increase the safety margin while administering PVB. Future studies could also explore the financial effectiveness of introducing PVB versus ETA, this can also help increase investors' interest in promoting a change in practice favoring PVB administration.

CONCLUSION

In conclusion, 15 journal articles were critically reviewed to create a summary of the evidence, which showed that the usage of PVB was better towards pain management than TEA for patients who underwent thoracic surgery. It showed that PVB optimized the use of opiates and the duration of analgesics after surgery. PVB significantly reduced side effects and risks of complications in the post-surgery stage, prevented hemodynamic risks like hypotension, and improved hemodynamic performance and safety. As a result of the positive outcomes from PVB instead of TEA, there were fewer risks of adverse reactions and better chances of faster recovery and hospital discharge. This significantly helped to improve the satisfaction and experience of patients compared to the administration of TEA. However, it is also essential to consider the study's limitations and the future scope related to PVB research to draw a comprehensive conclusion and comparison between PVB and TEA.

IMPLEMENTATION

The goal of this Quality Improvement (QI) education is to increase awareness and enhance the knowledge of the anesthesia provider about paravertebral blocks in the Adult Thoracic Surgical Patient. The anesthesia provider will be educated on knowledge material of identifying knowledge gaps, reducing side effects, risks of complications, prevention of

hemodynamic risks, and increasing patient satisfaction with better analgesia effects. To successfully achieve the goal of this quality improvement project, a series of actions will be conducted that involves a specific group of anesthesia providers willing to participate in the QI education. The study outcomes and knowledge assessment in the anesthesia provider will be discussed in the different sections of the methodology**.**

Setting and Participants

The setting took place at Broward Health Medical Center in Fort Lauderdale, Florida. The center is Broward County's largest medical center. The hospital is a 716-bed hospital with 3100 medical professionals and more than 800 being physicians. Broad spectrum of patient population seek care at Broward Medical Center including but not limited to cardiac, cancer, neurology, orthopedic, trauma, bariatric, and pediatric. Broward Health Medical Center organizational website states in 2020 they had 11,834 inpatient surgeries and 13,714 outpatient surgeries.

The population targeted for the Quality Improvement (QI) education consisted of Anesthesia providers administering anesthesia in Broward Health Medical Center. Participants are employed by Healthcare Performance Anesco who provide anesthesia and pain management services to hospital and surgery centers. The applicants were emailed an invitation to partake in the project. The participants were contacted and recruited through the Anesthesia Department for Anesco email list making participation completely voluntary. The recruited participants were provided a survey link with the educational intervention, a pre-test questionnaire, a voice over PowerPoint educational presentation online module, and a post-test questionnaire. All participants were asked to provide feedback regarding their experiences with the educational

program and no compensation was provided. The anticipated sample size will be between 5-10 participants.

Description of Approach and Project Procedures

The primary methodology of the proposed QI educational intervention project is to inform and educate anesthesia providers of the empirical evidence on the benefits of paravertebral block Vs epidural thoracic anesthesia in the adult thoracic surgical patient. Increasing knowledge of PVB will allow anesthesia providers to feel more confident on making appropriate decisions to use PVB versus ETA and ultimately improving patient outcomes and increasing patient satisfaction. A survey will be distributed to CRNAs and anesthesiologist working in the Anesthesia Department at Broward Health Medical Center. Students were not included in the study.

The survey will be broken up into three phases. The first phase will be a pre-assessment survey of the anesthesia provider on basic knowledge of PVB and ETA. After statistical facts such as demographic data obtained, a pre-questionnaire assessment test was presented, followed by a voiceover PowerPoint. The data that is collected in the pre assessment survey were compared to evaluate the impact of the voiceover PowerPoint presentation. The second phase is the voiceover PowerPoint education that included an online educational presentation with a total of fifteen slides. The education presentation included several studies with evidence-based research to relate statistical measures of the education provided.[1-15] A post questionnaire will be asked at the end of the presentation to assess knowledge attained in the presentation.

Protection of Human Subjects

Health and Human Services (HHS) mandate the protection of human rights. The Office for Human Research Protections (OHRP) provides leadership in the protection of human rights,

welfare, and wellbeing of subjects. To abide with the regulations, unique code identifiers for the participants were used to complete the pre and post intervention surveys. For this study, the elected applicants were anesthesia providers employed by the Anesthesia Department at Broward Health Medical Center. If the anesthesia providers agree to participate, consent will occur when the participant click on the link provided via an email, which will prompt the participants to complete the three-phase survey. There will be no penalties if any participant decides to withdraw from the QI project. There are no perceived risks to the study as it only requires the time spent by each anesthesia provider participanting in the educational intervention. A unique code identifier was done via FIU Qualtrics Survey, allowing the participants to remain unidentified and securing the data. The data was protected by a laptop password and FIU Qualtrics Software.

Data Collection

For the study, the primary instruments to be used will include a pre-assessment and post-assessment testing application to determine the effects of the QI educational module. Both tests will be conducted using FIU web-based survey tool Qualtrics, which will determine if participants have an understanding and awareness of PVB vs TEA and confidence in performing PVB in the adult thoracic surgical patient. The survey involved fifteen questions assessing concentrating on knowledge and practice utilizing Qualtrics. Using Qualtrics will gauge the pretest survey knowledge and interest in the educational PowerPoint presentation. The posttest survey will measure if the participants have gained knowledge from the intervention. The instrument reliability and validity will be measured depending on the intervention and the effectiveness for the providers. The data that is gathered will be confidential and no subject identifiers will be recorded during any phase of the study.

Data Management and Analysis Plan

The co-investigator for the project will be the DNP student responsible for obtaining the members of the Anesthesia Department for Anasco at Broward General Hospital via email list. The investigator will conduct the pre and post assessment survey and Zoom voiceover PowerPoint educational module. The investigator will conduct an analysis of each question, evaluate the responses provided on the pre-test and post-test and conduct a comparative analysis. No personal identifiers will be requested, used, or recorded to assure confidentiality. The results will be based solely on the pre and posttest survey questions. Through statistical analysis, study results will be compared and analyzed for patterns to determine the efficacy of the educational intervention and how it affects actions of the anesthesia provider. The co-investigator will store the data collected in a password-protected laptop computer.

IMPLEMENTATION RESULTS

Pre/Post-Test Demographics

The pre/post-test demographics are shown in Table 4, shown below

Table 4. Pre/Post-Test Participant Demographics

Demographic	n (%)
Total Participants	7 (100%)
Gender	
Male	5 (25%)
Female	2 (75%)
Age	
<18	0 (0%)
18-29	3 (42.85%)
30-49	3 (42.85%)
>50	1 (%)
Ethnicity	
White	6 (87.5%)
Black or African American	1 (12.5%)
America Indian or Alaska Native	0 (0%)
Asian	0 (0%)
Native Hawaiian or Pacific Islander	0 (0%)
Other	1 (12.5%)
Position/Title	
CRNA	7 (100%)
MD/DO	0 (0%)
Years of Experience	
Less than 1 year	1 (20%)
1 to 5 years	2 (40%)
6 to 10 years	0 (0%)
More than 10 years	2 (40%)

There were 7 participants in the pretest and posttest demographics. The majority of the participants were male (n=5, 71.5%) female (n=2, 28.5%). There were also a range of ethnicities represented: Black or African American (n=1,12.5%), and Hispanic or white (n=6, 87.5%). The age ranges represented were from <18 through >50 years old. The most represented age groups were the 18-29 (n=3,42.85%) and the 30-49 (n=3,42.85%), followed by the group >50 years old with (n=1, 14.2%). Information was obtained regarding the participant's role at the clinic. Most of the participants were CRNAs (n=7, 100%) instead MD Anesthesiologists (n=0, 0%). The

participants were questioned about the length of time practicing, finding that the practice period ranged: less than one year (n=0, 0%), 1 to 5 years (n=3, 42.8%), 6-10 (n=3, 42.8%), and more than 10 years (n=1, 14.4%). The participants consisted of DNP-prepared CRNAs (n=7, 100%)

Pre-Test General Knowledge of Thoracic Surgery

The pre-test concluded that (n=3; 42.86%) of the participants considered thoracic surgery the most painful surgery. The majority of the participants (n=6; 85.71%) agree that TEA causes hemodynamic instability. More than one-third (n=6) know that the Gold standard of care in preventing pain in the adult thoracic surgical patient is TEA. Only (n=2, 28.57%) recommended PVB undergoing thoracic surgery.

Pre-Test Knowledge of PVB Vs TEA in the Adult Thoracic Surgical Patient

The pre-test contained information regarding knowledge of PVB and TEA. Most of the participants had basic knowledge that PVB involves administration of local anesthetic (n=6;85.71). Most of the participants (n=5; 71.43%) knew that PVB is superior to TEA when comparing opiate consumption and pulmonary function tests. When asked if urinary retention occurs more frequently in TEA Vs PVB, (n=5,71.43%) answered correctly by selecting yes. In the pre-test (n=4;57.14%) were able to identify that all options listed including diastolic blood pressure, MAP, and SVR are affected in the patient receiving TEA. Some participants (n=4;57.14%) concluded the TEA group has more post-operative nausea and vomiting. See Table 5 for the results as listed above.

Table 5. Differences in Pre-and Post-Test Knowledge

Questions (n)= participants	**Pre- test correct**	**Post- test correct**	**Difference Pretest/ posttest correct**
1. What surgery is considered to be the *MOST* painful surgical procedure?	(3) 42.86%	(5)71.43%	↑ 28.57%
2. Currently, what is the Gold standard of care in preventing pain in the adult thoracic surgical patient?	(6) 85.71%	(6)85.71%	0%
3.Paravertebral Block technique involves administering local anesthetic?	(6) 85.71%	(5)71.43%	↓ 14.28%
4.Hemodynamic instability are mostly affected under what method of anesthesia?	(6) 85.71%	100 %	↑ 14.29 %
5.What hemodynamics are affected by Thoracic Epidural Anesthesia?	(4) 57.14%	(5) 71.43%	↑ 14.29 %
6.Urinary Retention occurs more frequently in which type of block?	(5)71.43%	(5) 71.43%	0%
7.When comparing Paravertebral Block Vs Thoracic Epidural Anesthesia, what side effects are less or even eliminated with Paravertebral Block?	(4) 57.14%	(5) 71.43%	↑ 14.29 %
8. During a cardiothoracic surgery, *pulmonary function test* (FEV_1, FVC, PEFR, MVV) is markedly superior in the _____ group when compared to _____ group in the post thoracic surgical patient.	(4) 57.14%	(5) 71.43%	↑ 14.29 %
9.Which of the following thoracic block causes the *MOST* post-operative nausea and vomiting?	(4) 57.14%	(6) 85.71%	↑ 28.57%
10. Which statement is *True* regarding opiate consumption?	(2) 42.86%	(5) 71.43%	↑ 28.57%
11.What statement is *TRUE* regarding outweighs the benefits of Thoracic Epidural Block and Paravertebral Block?	(5) 71.43%	(5) 71.43%	0 %
12. Complication of Epidural Block compared to Paravertebral Block include?	(3) 42.86%	(5) 71.43%	↑ 28.57%
13. What statement is *TRUE* regarding opiate consumption between Paravertebral Block and Thoracic Epidural Block?	(5) 71.43%	(7) 100%	↑ 28.57%
14. How does Paravertebral Block and Thoracic Epidural Block differ?	(5) 71.43%	(7) 100%	↑ 28.57%
15. How likely do you recommend Paravertebral Block in patients undergoing thoracic surgery?	(2) 28.57%	(4) 57.14%	↑ 28.57%

Post-Test General Knowledge of Thoracic Surgery

In the posttest most participants (n=5;71.43%) understood that thoracic surgery is considered the most painful surgical procedure, an increase of 28.57%. The same number of participants (n=6; 86.71%) answered that TEA is the gold standard of care in preventing pain in the adult thoracic surgical patient in the pre and posttest; making the investigator believe either

the material was not covered in the module or a personal choice. The post-test results showed that 71.43% (n=5) answered correctly that PVB involves administration of local anesthetic. However, in the pre-test 85.71% (n=6) participants answered correctly, showing a decline of 14.28%. That was the only question in the survey that showed a knowledge deficit after completing the educational module.

Post-Test Knowledge of PVB Vs TEA in the Adult Thoracic Surgical Patient

After the educational module, all participants (n=7;100%) learned that hemodynamic instability is mostly affected under TEA when compared to PVB. This category includes diastolic blood pressure, MAP, SVR and pulmonary function tests. Complications with TEA Vs PVB were correctly identified by 71.34% in the posttest, an improvement of 28.57% from the pretest. Following the presentation, the participants identified that side effects of post-operative nausea and vomiting were greater in the PVB group. All participants acknowledged that opiate consumption favored the PVB group when compared to TEA with decreased consumption.

Summary

After the educational voiceover PowerPoint presentation, the participant's scores improved on the post-test assessment from the baseline pre-test scores except for one question that involved describing that PVB technique involved instilling local anesthesia. In this particular survey question, there was a drop of 14.28% that answered incorrect. A significant result from the pretest and posttest noted that 47% (n=7) of the questions showed an increase of 28.57% of knowledge improvement. There were 3 survey questions that were unchanged from pretest and posttest. Overall, the knowledge of the participants did improve after watching the educational module.

IMPLEMENTATION DISCUSSION

Limitations

Limitations of the study include a small sample size. The survey was emailed to the members of the Anesthesia Department for Anesco at Broward General Hospital. From the list obtained, 46 emails were sent and only 7 people completed the study. The survey link, which included a pre-test, a narrated PowerPoint presentation, and a post-test, was available online for two weeks; extending the time frame may have generated more replies. The email with the request to participate in the study was sent multiple times during the two weeks; and even though follow up emails might generate more responses, in this case the lack of time and participation contributed to only 7 responses. Due to COVID-19, the project was executed online, thus, minimizing person to person participation and interaction with the anesthesia providers. Therefore, different delivery methods and settings that serve different personalities were unable to be utilized.

Future Implications for Anesthesia Practice

The goal of this project is to increase awareness and enhance the knowledge of the anesthesia provider about paravertebral blocks in the adult thoracic surgical patient to, reduce side effects, risks of complications, prevent hemodynamic instability, and increase patient satisfaction with better analgesia effects. This quality improvement project demonstrates a positive outcome and an effective quality in the use of PVB in the adult thoracic surgical patient supported with evidence-based practice. Patient outcomes are optimized when healthcare anesthesia providers' knowledge is increased. This allows the provider to enhance skills of PVB into the anesthesia providers practice, increase their knowledge and build confidence in the

implementation of PVB for thoracic surgical cases. Expanding knowledge ultimately benefits both provider, patient, increasing patient satisfaction and quality of care.

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Appendix

Appendix A: Literature Review

Table 3. Studies Included in the Appraisal

Citation	Design/Method	Sample/Setting	Major Variables Studied and Their Definitions	Measurement And Data Analysis	Findings	Results	Conclusions	Appraisal: Worth to Practice/Level
Author, Year, Title PLACE IN AMA Casati A, Alessandrini P, Nuzzi M, et al. A prospective, randomized, blinded comparison between continuous thoracic paravertebral and epidural infusion of 0.2% ropivacaine after lung resection surgery. *European Journal of Anaesthesiology*. 23(12):999-1004. doi:10.1017/S0265021506001104	Indicate design and briefly describe what was done in the study RCT of Forty-two ASA physical status II–III patients undergoing lung resection surgery were randomly allocated to receive postthoracotomy analgesia with either a thoracic epidural (group EPI, *n* = 21) or paravertebral (group PVB, *n* = 21) infusion of 0.2% ropivacaine (infusion rate: 5–10 mL h^{-1}). Degree of pain at rest and during coughing, hemodynamic variables and blood gas analysis were recorded every 12h for the first 48 h.[1]	Number, characteristics, attrition rate, & why Where was the study conducted, how many participants? What was the setting? The sample size was 42 thoracic epidural (group EPI, *n* = 21) and paravertebral (group PVB, *n* = 21) undergoing elective lung resection in a hospital setting. No differences were reported between the two groups in age (60 (32–77) in group EPI vs. 65 (52–75) in group PVB), weight (69 (45–95) in group EPI vs. 75 (56–100) in group PVB), height (170 (155–180) in group EPI vs. 175 (155–183) in group PVB), gender distribution (15 males and 6 females in group EPI vs. 18 males and 3 females in group PVB), and ASA physical status (16 ASA II and 5 ASA III in group EPI vs. 17 ASA II and 4 ASA III in group PVB).[1]	Independent variables (e.g., IV=1 IV2=) Dependent variable (e.g., DV =). Independent variable: EPI Vs PVB in the lung resection surgical patient Dependent variable: DV1 Pain scores by visual analogue scale (VAS) where 0 represented no pain and 10 the worst imaginable pain DV2 rescue analgesia use to keep VAS <4 DV3 blood pressure DV4 heart rate DV5 blood gas analysis DV6 patient satisfaction by using VAS where 0 means totally unsatisfied and 10 completely satisfied.[1]	What scales were used to measure the outcome variables? (name of scale, level of scale, e.g , nominal, ordinal, etc., How was reliability info reported (e.g., Cronbach's alpha)? Statistical analysis was performed using the program Systat 7.0 (SPSS Inc., Chicago, IL, USA). The population for the statistical analysis was based on an intention-to-treat analysis. Continuous variables were analyzed using the *U*-test. Changes over time were also assessed using a two-way non-parametric analysis of variance for repeated measures. The Fisher's and Sheffe's tests were also used for *post hoc*analysis. Categorical variables were analysed using the contingency table analysis and the Fisher's exact test.Results are presented as median (range) or number (percentage). A *P*-value ≤5% was considered as significant.[1]	Statistical findings or qualitative findings (i.e., for every statistical test you have in the data analysis column, you should have a finding) No differences in the degree of pain measured both at rest and during coughing were reported between the two groups. Total volume of 0.2% ropivacaine infused during the 48-h observation period was 288 (144–348) mL in group EPI and 312 (96–456) mL in group PVB (*P* = 0.46). Rescue morphine analgesia was required in four patients of group EPI (19%) and five patients of group PVB (23%) (*P* = 0.99). Patients of group EPI showed a more marked percentage reduction of SAP as compared to those of group PVB (Fig. 2), while clinically relevant hypotension, defined as a decrease of SAP >30% of baseline, was observed in four patients of group EPI (19%) and none of group PVB (0%) (*P* = 0.04). No severe complications occurred in either group, and hospital stay was 9 (5–25) days in group EPI and 8 (5–14) days in group PVB (*P* = 0.49). Patient satisfaction with the quality of pain relief was similarly good in the two groups.	Results of the studies Patients in group EPI showed a more marked reduction of SAP from baseline during the study period with a higher incidence of clinically relevant hypotension as compared to patients receiving continuous paravertebral block. This finding is reasonably related to the more peripheral and unilateral block with a less extended involvement of sympathetic blockade as compared to epidural anesthesia and may represent a clinically relevant advantage when managing post-thoracotomy analgesia on the surgical ward.	The authors conclusions Continuous thoracic paravertebral analgesia is as effective as epidural blockade in controlling post-thoracotomy pain but is associated with less hemodynamic effects.	*****Strengths & limitations of the study *****Risk or harm if the study interventions or findings implemented *****Feasibility of use in practice *****Remember: level of evidence = strength of evidence & confidence to act e.g., L-III. Strength: Level II, RCT adequate monitoring that adds value to conclusions, objective findings with vital signs and scales. Limitations: Short follow up period Risk of harm: Reduced morbidity reported with PVB and avoidance of spinal hematoma in patients taking anticoagulant or antiplatelet therapy Feasibility of use: adequate, since assessment tools are scales and objective data can be pulled from the chart.
Mukherjee M, Goswami A, Gupta SD, Sarbapalli D, Pal R, Kar S. Analgesia in	Single-blinded RCT of 60 adult patients: Group A n=30, who received TEB with	60 adult patients of both sex (ASA I and II): Group A n=30, Group B n=30; adult patient of both sex, equal distribution of sexes; adult population of age	Independent variable: IV1 Group A (TEB) administration vs Group B (PVB) in the thoracic	Statistical analysis was performed with a commercially available software package (Graph Pad	Comparison of clinical variables between two groups demonstrated in the perioperative phase, group A and group B demonstrated no	Group A (TEB) and Group B (PVB), there were no incidents of adverse effects or complicatio	We observed longer duration of analgesia with PVB compared to TEB. Patient receiving PVB for postoperative analgesia experienced better analgesia than those	Strength: Level I, RCT. PVB is an effective alternative to TEB in a resource-poor set up

post-thoracotomy patients: Comparison between thoracic epidural and thoracic paravertebral blocks. *Anesthesia: Essays & Researches*. 2010;4(2):75-80. doi:10.4103/0259-1162.73511	7.5 ml of 0.25% bupivacaine; Group B n=30 received PVB 15 ml of 0.25% bupivacaine. Both groups received 1 ml of fentanyl for postoperative analgesia.	range between 20 and 65 years old, undergoing posterolateral thoracotomy surgery. Conducted at operating room at Institute of Postgraduate Medical Education and Research, Kolkata.	surgical patient. Dependent variable: DP 1 Mean systolic blood pressure (SBP) and diastolic blood pressure (DBP). DP2 Mean arterial pressure (MAP). DP3 Mean heart rate (HR). DP4 Mean *P*. DP5 Mean analgesia duration.	InStat "version 3"). Data was entered in an MS Excel spreadsheet involving transcription, preliminary data inspection, content analysis, and interpretation. Parameters to compare groups were demographic characteristics, duration of analgesia, hemodynamic factors.	significant differences in hemodynamic values statistical significant ; mean SBP (t=1.606, P=0.1161), mean DBP (t=0.5074, P=0.6138), MAP (t=2.721, P=0.0086), and mean P per minute (t=3.197, P=0.0023). However; in the postoperative phase, mean analgesic duration validate a statistical significance (t= 4.284, P=0.001) proven PVB lasted longer in term of analgesic duration.	ns such as urinary retention, nausea and vomiting, coughing or pleural puncture. No significance in pre-induction hemodynamic parameters (HR, SBP, DBP and MAP). Hemodynamics profiles were taken at the end as an indirect indicator of postoperative pain. No significant difference in mean SBP and mean DBP; however, there was a statistically significant difference in MAP and mean *P*. Comparing parameters of mean, median, and maximum duration of the effective duration of analgesia, group B experienced better analgesia from the immediate postoperative period than those in group A.	receiving TEB from immediate postoperative period that lasted longer.	in the developing countries. Limitation: There are several limitations. For example, missing a pain score system, and not determining the level of depth of the thoracic block. Risk of harm: Risk of harm was minimal because ASA I and II patients were selected. Unable to time when the patient was feeling pain and missing pulmonary function test and blood gas analysis to detect any postoperative complication. Feasible use in practice: The study demonstrated that PVB is feasible and provides a longer duration of anesthesia for patients undergoing posterolateral thoracotomy surgery.
Kosiński S, Fryźlewicz Kosiński S, Fryźlewicz E, Wiłkojć M, Ćmiel A, Zieliński M. Comparison of continuous epidural block and continuous paravertebral block in postoperative analgaesia after video-assisted thoracoscopic surgery lobectomy: a randomised, non-inferiority trial. *Anaesthesiology Intensive Therapy*. 2016;48(5):280-287. doi:10.5603/AIT.2016.0059	RCT of 51 patients: Group PVB (n=26) and group TEA (n=25), both groups received a continuous infusion of 0.25% bupivacaine with epinephrine, IV ketoprofen and paracetamol. In both groups, local anesthetics were determined to achieve at least 4 segments spread; postoperative static, dynamic visual analogue pain scores, and patient	Enrollment/randomization n=83 patients, 51 patients involved in the final analysis, patient of both genders (ASA I and III): Group PVB (n=26) and group TEB (n=25); adult population of age range between 18-85 years old undergoing VATs lobectomy due to cancer. Conducted and approved by the Bioethical Committed at the Oncology Center in Gliwice.	Independent variable: IV1 TEA administration vs PVB in the thoracic surgical patient undergoing VATs lobectomy due to cancer. Dependent variable: DV1 Static and dynamic pain scores at 24hrs, 36hrs and 48hrs (P< 0.05) postoperative. DV2 Postoperative morphine usage. DV3 Failure to perform block. DV3 Complication and side effects (urinary retention, hypotension).	Statistical data analysis was performed using STATISTICA 10 software (StatSoft, Inc.) Both groups were compared using Student's t-test and the Mann-Whitney U test. The changes in pain severity was analysed using the general linear model (GLM). The method of non-inferiority or equivalence according to the CONSORT recommendations measures the first-line end-point of pain intensity.	The comparative analysis of pain sensations demonstrated differences in both groups. In the measurement of 24hrs, both groups at rest and coughing PVB was P=001 and TEA was P=0.023; and in static pain at 36hrs and 48hrs PVB was P=0.025 and TEA was P=0.026. Moreover the U test showed a significant difference in pain on coughing at 48hrs (P=0.045) for both groups. Regarding postoperative morphine dosage, the mean dose was 0.4mg h^{-1} on day 0, 0.37mg h^{-1} on day1, 0.21 mg h^{-1} on day 2, and 0.14 mg h^{-1} on day 3.	The incident of failure rate was higher in TEB compared to PVB. None of the groups developed severe anesthesia complications, but side effects (hypotension and urinary retention) were found more frequent in the TEA group (P <0.05). There was no different regarding postoperative morphine usage. Static and dynamic pain scores at 24, 36	PVB is equally effective as TEB in providing analgesic techniques in patients undergoing VATS lobectomy. However, PVB has a better safety profile than TEB.	Strength: Level I, RCT. Study conducted in the ICU, intensity of the pain is routinely assessed every 1-4 hours. Limitations: Study design does not include the intraoperative assessment of blood loss or regimen of intraoperative fluid therapy, which can result in the evaluation of incidents of hypotension. Additionally, the sedation was not evaluated

	controlled morphine					and 48 postoperative hours were significantly lower in PVB group (P <0.05).		overlooking the possible toxicity of local anesthetics. Pain assessments were difficult in older patients. The preferred pain assessment was Wong-Baker faces, which could lead to some miscalculation. Considering the comparable mean ages of patients, the errors, if any, were probably equally distributed. Risk or harm: No risk of harm is associated with the study's intervention if they were to be reproduced. Feasibility of use in practice: This study demonstrated that PVB is a feasible and safe for continuous paravertebral block in postoperative analgesia after video-assisted thoracoscopic surgery (VATs) lobectomy
Okajima H, Tanaka O, Ushio M, Higuchi Y, Nagai Y, Iijima K, Horikawa Y, Ijichi K. Ultrasound-guided continuous thoracic paravertebral block provides comparable analgesia and fewer episodes of hypotension than continuous epidural block after lung surgery. *Journal of Anesthesia*. 2015;29(3):373-378. doi: 10.1007/s00540-014-1947-y.	We examined 90 consecutive patients scheduled for video-assisted thoracic surgery (VATS). Group P received USG-PVB and group E received TEB. In both groups, all blocks (four blocks in USG-PVB and one block in TEB) and one catheter insertion were performed preoperatively. Continuous postoperative infusion (0.1 % ropivacaine	90 consecutive patients (age: 18–75 years) with ASA physical status I–III scheduled for VATS with an axillary skin incision of 6–8 cm at Nishi-Kobe Medical Center in Kobe, Japan, between August 2008 and October 2009. The patients were assigned randomly into two groups using the sealed enve- lope technique. Group P received USG-PVB n=36 and group E received TEB n=33.	Independent variable: IV1 is USG-PVB versus IV2 TEB Dependent variable: DV1 Verbal rating scale for pain at rest (VRS; 0 = none, 10 = maximum pain). DV2 blood pressure. DV3 Postoperative nausea and vomiting. D V4 Pruritus. DV5 Postoperative lung complications.	The data was analyzed using Stat-view 5.0 (SAS Institute Inc., Cary, NC). All quantitative parametric values are presented as mean ± SD, while the other non-parametric values are presented as median (interquartile range). Independent Student's *t*-test, Mann–Whitney *U* test, chi-square test, and Fisher's exact test were used as appropriate. The null hypothesis was rejected when P was less than 0.05, (P =0.02).	In total, 36 patients in group P and 33 patients in group E completed this study and were examined. The frequencies of taking supplemental analgesics were similar in the two groups. There were no significant differences in VRS between group P and group E at any time. Side effects of hypotension occurred significantly more frequently in group E (P = 0.0169), while no statistically significant differences were noted with respect to PONV and pruritus. Hypotension occurred significantly more frequently in TEB(n=7/33)than	USG-PVB was shown to have a similar pain-relieving effect to TEB, with a lower incidence of post-operative hypotension. In PVB, a larger amount of ropivacaine was used than in TEB both intra- and postoperatively, while the incidence of hypotension and hemodynamic changes decreased as a result of unilateral sympathetic blockage.	USG-PVB provided similar postoperative analgesia to TEB for patients undergoing VATS. PVB had better advantages in terms of the maintenance of hemodynamics and the prevention of hypotension. Both blocks with the same concentration of Ropivicaine and Fentanyl can provide adequate postoperative analgesia for VATS.	Strength: Level II, RCT. All patients received standardized general anesthesia with standard monitoring. Limitations: Intraoperative fentanyl consumption decided by an anesthesiologist might have influenced the postoperative course which was not accounted for. Risk of harm: None Feasibility of use: PVB combined with

	plus fentanyl at 0.4 mg/day) was undertaken for 36 h in both groups. The recorded data included the verbal rating scale (VRS) for pain, blood pressure, side effects, complications for 2 days, and overall satisfaction score.[5]				in PVB(n=1/36)(P=0.02);on the other hand, the incidences of PONV and pruritus, as well as overall satisfaction score, were similar. There were no complications in both groups; however, the catheters migrated intrathoracically in four patients in PVB.			fentanyl caused a high incidence of PONV, similarly to TEB, so further trials are required to search for an adequate dosage and further investigation
Yeung J, Middleton L, Tryposkiadis K, et al. Randomised controlled trial to investigate the effectiveness of thoracic epidural and paravertebral blockade in reducing chronic post-thoracotomy pain (TOPIC): a pilot study to assess feasibility of a large multicentre trial. *BMJ OPEN*. 9(7). doi:10.1136/bmjopen-2018-023679	A randomized, parallel, external pilot study was conducted to assess whether a large randomized trial of thoracic epidural block (TEB) versus paravertebral block (PVB) for perioperative pain during thoracotomy reduces chronic post-thoracotomy pain (CPTP).	Two adults thoracic centres in the UK including Heartlands Hospital, Birmingham and University Hospital South Manchester (Wythenshawe, England). 194 total patients eligible, n=125 not randomized, n=69 consented and randomized, 35 allocated PVB, 34 allocated TEB; adult population greater than 65 years old, male gender, mean age of 66 years old; undergoing thoracic surgery in hospital setting.	Independent variable: TEB vs PVB in the thoracic surgical patient. Dependent variable: DV1 Pain scores on days 1-3. DV2 Acute complications DV3 Mortality. DV4 Length of stay. DV5 3 month post-randomization follow up by postal questionnaire. DV6 Same assessments at 6 months.	A study team collected all the data, patient outcome data were collected by a research team blinded to the group. Scales used at 3 month and 6 month questionnaire were Visual Analogue Scales (VAS), Brief Pain Inventory (BPI), Neuropathic Pain Scale (NPS), generic health-related quality of life (EQ,-5D-5L), Hospital Anxiety and Depression Scale	Levels of pain in the 3 days post-surgery appeared similar in both groups. However, the number of patients indicating at least a moderate level of average chest pain was lower with PVB when compared TEB at 6 months VAS pain scores were with PVB compared to TEB at 6 months. Short term outcomes like minor complications and analgesic efficacy points to PVB being at least as effective as TEB.	The number of participants indicating at least moderate level of chest pain at 6 months was lower with PVB but with high levels of uncertainty.	A large, multicenter randomized controlled trial of PVB versus TEB is feasible with high fidelity, pain scores were lower in the PVB group when compared to TEB, but a much larger trial is required to confirm the reliability.	Strength: Level I, RCT adequate monitoring that adds value to conclusions. Limitations: Small study. Risk of harm: No concerns were expressed by the independent Oversight Committee who met twice during recruitment period to review study progress and safety data. Feasibility of use: Adequate, since assessment tools are scales and objective data can be pulled from the chart and reimplemented.
Yoshikane Yamauchi, Mitsuhiro Isaka, Kamon Ando, et al. Continuous paravertebral block using a thoracoscopic catheter-insertion technique for postoperative pain after thoracotomy: a retrospective case-control study. *Journal of Cardiothoracic Surgery*. 2017;12:1-6. doi:10.1186/s13019-017-0566-8	Retrospective case-control study of 56 patients. Patients who underwent thoracotomy with thoracic PVB between March 2013 and March 2014 were examined retrospectively. Prior to creating the thoracotomy incision, a catheter for PVB was inserted percutaneously into the paravertebral space under	Matching criteria were sex, age, and type of surgery. The criterion of age was divided into five groups: ≤49, 50–59, 60–69, 70–79, and 80–89 years. The types of surgery were divided into three groups: lobectomy with mediastinal lymph node dissection, lobectomy without mediastinal lymph node dissection, and all others. The control group was selected by a person not otherwise associated with the study with no other information about the patients. When there were more than three	Independent variable: IV1 PVB and IV2 is EDA Dependent variable: DV1 Pain score. DV2 Rescue analgesia. DV3 Amount of fentanyl 2 ug/kg or ropivacaine 0.2% used intraoperatively.	All relevant patient data were recorded before and after surgery, and patients were followed until hospital discharge. The following data was assessed: pain score 48 h after surgery, requirement for intravenous rescue analgesia, the required duration of regional anesthesia, and the amount of fentanyl or ropivacaine administered during the perioperative	Thoracic PVB was performed in 56 patients during this period, and 112 patients were selected as matched controls. Numeric Rating Scale scores on postoperative day 2 did not differ significantly between the PVB group (3.25 ± 1.80) and the EDA group (3.56 ± 2.05) (p = 0.334). In terms of side effects, urinary retention occurred less frequently in thoracic PVB patients (P = 0.03).	Results demonstrate that thoracic PVB was not inferior to EDA in controlling post-thoracotomy pain and 10 EDA patients (8.9%) failed a voiding trial, which required reinsertion of the urinary catheter until voiding was successful. No patient in the PVB group had this	Thoracic PVB reduced the frequency of urinary retention and was at least as effective as EDA for the postoperative pain control after thoracotomy with lung resection.	Strength: Level III, Retrospective case-control study Limitations: The limitations of this study—sampling bias, selection bias, and recall bias—are usually present in a retrospective case control study. Regarding sampling bias, there were significant differences in the frequency of

	thoracoscopic guidance. A matched-pair control group was selected at a 1:2 ratio from patients who underwent thoracotomy with thoracic EDA from April 2011 to February 2013. Pain control and side effects were compared between groups and the results statistically analyzed.	matching controls for a PVB patient, we selected patients using a random number table. PVB group =56. EDP group =112. The Shizuoka Cancer Center Hospital.		period. Categorical variables were compared using Fisher's exact test and continuous variables using the Mann-Whitney test. IBM SPSS for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA) was used for all statistical evaluations. P values less than 0.05 were considered statistically significant.		problem (p = 0.03).		three factors in the backgrounds of patients: BMI, the presence of acquired heart disease, and the presence of ischemic cerebrovascular disease. Reliability of the completeness of the medical records varied, some patient data was not available. Risk of harm: None since it was a retrospective study Feasibility of use: The study can be replicated or increase level of evidence by implementing an RCT to the technique of using thoracoscopic catheter insertion technique.
Mehta Yatin, Arora Dheeraj, Sharma Krishna, Mishra Yugal, Wasir Harpreet, Trehan Naresh. Comparison of continuous thoracic epidural and paravertebral block for postoperative analgesia after robotic-assisted coronary artery bypass surgery. *Annals of Cardiac Anaesthesia*. 2008;11(2):90-95. Accessed October 20, 2020.	Prospective RCT of 36 total patients undergoing elective robotic-assisted CABG. TEA Group A (n=19) and PVB Group B (n=17) were premedicated with oral lorazepam, morphine sulphate with glycopyrrolate preoperative. Patients were anesthetized with midazolam, fentanyl, isoflurane on oxygen and air, and vecuronium bromide. Hemodynamic data including HR, MAP, CVP, and CI were compared. PaO2, PaCO2, PFT and postoperative pain by VAS scores were also compared.	36 total patients of either sex: group A (n=19) TEA; group B (n=17) PVB; adult population of age range between 25 and 65 years old; undergoing elective CABG using robotic assistance in the hospital setting	Independent variable: TEA vs PVB in the elective robotic-assisted CABG surgery. Dependent variable: DV1 Hemodynamic parameter (HR, MAP, MPAP, CVP, CI). DV2 Respiratory parameter (PaO_2, $PaCO_2$). DV3 Pulmonary function test (FEV_1, FVC, FEV_1/FVC, PEFR, MVV). DV4 Postoperative pain scores (VAS)from 12-24 hours. DV5 Rescue analgesia; DV6 Post-operative complication.	An independent observer blinded to analgesic techniques recorded the Visual analogue scale (VAS) at 12 hours and 24 hours after surgery at rest and while coughing. Acid-base analysis performed 1 hour after extubation, pulmonary function test 2 hours after chest tubes removal. Complications were documented. Data were present as ± SD. The mean values of the two groups of data were analyzed using a two-tailed Student *t* test. A *p* value <0.05 was considered significant.	Both groups (PVB and TEA) were equally comparable regarding demographic data (age, sex, height, weight, body surface area), and other parameters (surgical time, hospital stay, analgesic, muscle relaxing requirement). Hemodynamic were well maintained during the intraoperative period. PVB group demonstrated superior pulmonary function test (FEV_1, FVC, PEFR, MVV) values in the preoperative, intraoperative, and postoperative data indicating better analgesia. *P*-value >0.05. The VAS scores were slightly higher in PVB group as compared with TEA group; however, rescue analgesia requirement was more in TEA. None of the groups of patients had any complications related to insertion of the catheter in either PVB or	PVB had no difference with regards to the quality of analgesia, better pulmonary function test and blood gas analysis, safe and effective technique compared with TEA.	PVB is a safe and effective technique for postoperative analgesia after robotic-assisted CABG and is comparable to TEA with regards to quality of analgesia. In addition, it may be used safely in patients having recent anticoagulation, and it provides unilateral analgesia, which is required in CABG surgery.	Strength: Level II, prospective randomized study. All complications were noted. All data are expressed as mean ± SD. Independent observers were able to assess VAS from 12-24 hours after surgery while coughing or at rest. Limitation: Number of patients, lack of control group, relation between VAS and other parameters to explain analgesia, and learning curve associated with the surgical technique. Risk of harm: No risk or harm is anticipated from implementation of study

					TEA. After extubation blood analysis revealed comparable PaO_2 and $PaCO_2$ values in both groups. Group A (TEA) had two patients with transient numbness in the upper extremities and disappeared with stopping infusion. None of the patients in group B (PVB) has numbness or any complications.			intervention s in similar settings. Therefore, large randomized controlled trials are required. Feasibility of use: This study demonstrate s that PVB is feasible and safe for postoperativ e analgesia after robotic-assisted CABG.
Biswas S, Verma R, Bhatia VK, Chaudhary AK, Chandra G, Prakash R. Comparison between Thoracic Epidural Block and Thoracic Paravertebral Block for Post Thoracotomy Pain Relief. *Journal of Clinical & Diagnostic Research*. 2016;10(9):8-12. doi:10.7860/JCDR/2016/19159.8489	Randomized control double blind study was conducted in a tertiary care center from June 2014 to July 2015. Sixty patients belonging to age group 18-60 years of either sex, belonging to Avaya Site Administrati on (ASA) physical status II and III and within 25% of ideal weight and posted for elective anterolateral thoracotomy surgeries were studied	60 total patients (ASA II and III): n=30 Group E for Epidural; n=30 group P for paravertebral patients; adult population of age range between 18-60 years old; undergoing elective anterolateral thoracotomy in a hospital setting	Independent Variable: IV1 is Thoracic Epidural Block, IV2 is Thoracic Paravertebral Block. Dependent Variables: DV1 VAS score, DV2 four point observer ranking scale (FPORS). DV3 mean arterial pressure (MAP). DV4 hypotension. DV5 PONV.	The clinical data was collected, verified and then analyzed using SPSS (statistical program for social science version 12). Tests used were mean, median, standard deviation, paired and unpaired T-test, Chi-square test, Mann Whitney U-test, Wilcoxon rank sum test, p-value (significant < 0.05). Sample size was calculated using previous studies taking VAS score as the main parameter (mean standard deviation 1.5-2.0 cm) considering 5% margin of error and 90% power and considering a difference of 2cm as clinically significant. The total sample size was calculated as 60.	During the whole of the study period VAS score as well as mean Rational Dynamic Object-Oriented Requirements System (DOORS) score was higher in group P as compared to group E and this difference was statistically significant from 12 to 24 hours postoperatively. Clinically significant hypotension with reduction of the MAP> 30% from the baseline values occurred in seven (23.3%) patients in group E only ($p<0.05$) and this reduction was observed between 20-30 minutes after the epidural injection and was treated with 6 mg bolus of mephentermine. None of the patients in Group P had hypotension. Statistically, the event of hypotension was significantly higher in Group E as compared to Group P ($p=0.005$). Nausea/ vomiting was seen in 4 (13.3%) of Group E and 6 (20%) of Group P patients, thus showing no statistically significant difference between the two groups ($p=0.588$). No other complication or side effects were noticed in either of the groups.	Both the techniques continuous thoracic epidural block and continuous thoracic paravertebr al block were effective for post-thoracotom y pain relief; however, epidural block provides better pain relief according to this study. Hemodyna mics are significantl y affected in the TEB group. The incidence of nausea/vom iting was seen in 4 patients (13.3%) of Group E and 6 (20%) of Group P. The difference was not significant statistically ($p>0.05$). No other complicatio ns or side effects were noticed in either of the groups.	The incidence of sympatholytic complications was more in the epidural group. The effect on respiratory mechanics was equivalent. Hence, paravertebral block can be used for post thoracotomy pain relief in those patients where thoracic epidural is contraindicated.	Strength: Level I, RCT adequate monitoring that adds value to conclusions, Preoperative pulmonary function test, trend recorded Limitations: Only 24 hrs. of recorded data were observed Risk of harm is moderate, provided ASA II and III patients are selected, without contraindica tions to procedures like spinal/thorac ic wall deformity, Feasibility of use is appropriate as proven by results.
Haihui Xie, Jianping Zhou, Wei Du, et al. Impact of thoracic paravertebral block combined with general anesthesia on postoperative cognitive function and serum adiponectin levels in elderly patients undergoing	RCT of 120 elderly patients: randomized divided in three groups: n=40 general	120 total elderly patients (ASA II - III and NYHA I-II): Divided in three groups: n=40 general anesthesia (GA); n=40 TPV-GA (PG); n=40 epidural block	Independent variable: IV1 GA vs TPV-GA vs EG inthe elderly patients undergoing elective lobectomy.	Statistical analysis was performed using the program SPSS version 17.0 (IBM Corporation, Chicago, IL,	Assessing perioperative hemodynamics: group GA had a significantly increased MAP and HR; group EG had significant decrease in MAP	Cognitive function scores in the three groups decreased by different extents at T5 ($p<$	Thoracic paravertebral block or epidural block combined with general anesthesia can improve early postoperative cognitive function in the elderly patient	Strength: Level II, RCT. Total of 112 patients completed the study. Limitations: Six patients

lobectomy. *Videosurgery and Other Miniinvasive Techniques*. 2019;14(4):538-544. doi:10.5114/wiitm.2019.84742	anesthesia (GA); n=40 TPV-GA (PG); n=40 epidural block combined with general anesthesia (EG). Cognitive function in the three groups were evaluated 1 day before and 7 days after surgery. Serum levels of ADP and S-100*B protein* were evaluated before anesthesia (TO), 15 min after skin incision (T3), and 7 days after surgery (T5).	combined with general anesthesia (EG). Adult population of age 65-81 years old; undergoing elective thoracoscopic lobectomy. Conducted by the Medical Ethics Committee of Dongguan People's Hospital.	Dependent variable: DV1 Hemodynamic monitoring measurement (MAP, HR) at before anesthesia (TO), 15 min after PVB or epidural anesthesia (T1), at extubation (T2), 15 min after incision (T3), and pre-extubation (T4). DV2 Cognitive function before and after surgery (MMSE, digital symbol test, trail connection test A, word recognition test, digital breadth test). DV3 Incidence of postoperative cognitive decline7 days after surgery (POCD). DV4 Serum ADP and S-100*B protein* levels using ELISA test. [7 days after surgery (T5) to assess serum]	USA). Measurement data are expressed as mean ± standard deviation (SD). Intra-group comparison used single-factor analysis of variance or multivariate analysis of variance. Inter-group comparisons were performed using the group *t*-test, and measurement data were analyzed using X^2 test, with $p< 0.05$ considered to be statistically significant.	and significantly diminished HR; group PG had a smaller impact on MAP and HR maintaining hemodynamic stability. Cognitive function scores: not significant among the three groups, comparing data collected in 1 day before surgery and 7 days after surgery ($p< 0.05$). Inter-group comparisons in group GA were lower than in group PG and EG 7 days after surgery ($p< 0.05$). These scores were higher in group PG compared with those in EG. Incidence of postoperative cognitive decline (POCD) 7 days after surgery: 18% in group GA, 7.7% in group PG, and 12.8% in group EG ($p< 0.05$). Serum ADP levels: T3 and T5 compared to T0 all three groups decrease levels; in groups PG and EG ADP levels were higher than GA group ($p< 0.05$). PG group serum levels were higher than in group EG at T5. Serum S-100*B protein:* Increase in all three groups at T3 and T5 compared to T0 ($p< 0.05$). Groups PG and EG were lower than GA groups at T3 and T5($p< 0.05$). Group PG had lower serum levels than group EG at T5.	0.05); scores in groups PG and EG were higher than those in group GA ($p< 0.05$). The serum levels of S-100*B protein* in the three groups at T3 were higher than those at T0 ($p< 0.05$); however, serum ADP concentrations were reduce ($p< 0.05$), the serum levels S-100*B protein*, in groups PG and EG were lower than those in group GA at T3, while serum ADP levels were higher.	undergoing lobectomy. TPVB-GA demonstrated better effects, which may be related to secretion of ADP.	included in this study were lost to follow-up after surgery (group GA-1 patient, group PG-2 patient, group EG-2 patient). Two patients developed complications and were transferred to the intensive care unit (ICU) (group PG-1 patient, group EG-2 patient). Risk of harm: Risk of harm is possible with this method and may not substantiate the findings. Feasibility of use: The study demonstrates the feasibility and safety of TPV-GA or EG if it is used under the study's settings.
Ahmed Deebis, Hala Elattar, Osama Saber, Kareem Elfakharany, Nezar Elnahal. Continuous paravertebral block by intraoperative direct access versus systemic analgesia for postthoracotomy pain relief. *The Cardiothoracic Surgeon*. 2020;28(1):1-7. doi:10.1186/s43057-020-00027-y	Prospective randomized study of 63 patients for post thoracotomy pain relief by comparing (thoracic paravertebral group, *n* = 32) and systemic analgesia (systemic analgesia group, *n* = 31) undergoing elective posterolateral thoracotomy for pulmonary procedures.	Total 63 patients, (thoracic paravertebral group, *n* = 32) or systemic analgesia (systemic analgesia group, *n* = 31) (ASA physical status of II and III) and body mass index (BMI) between 25 and 35 kg/m undergoing elective posterolateral thoracotomy for pulmonary procedures in the hospital setting.	Independent variable: IV1 is TPVB and IV2 is SA (systemic analgesia group). Dependent variable: DV1 VAS scores. DV2 rescue analgesia with Morphine. DV3 Spirometric pulmonary functions. DV4 Complications. DV5 side effects mainly nausea and vomiting	The primary endpoint was pain score on visual analogue scale (VAS) at rest and on coughing measured and recorded at 1, 6, 12, 24, 36, 48 h, and 72 h postoperatively. The secondary endpoints were total morphine consumption at the end of each postoperative day and pulmonary function tests at 24, 48, and 72 h postoperatively. Complications related to the	Pain scores on visual analogue scale were significantly lower in the TPVB group at rest and on coughing throughout the study period, indicating better pain relief in the TPVB group. Postoperative morphine consumption was significantly lower in the TPVB group of patients in all the three postoperative days. In both groups, all pulmonary function tests (FVC, FEV1, and PEFR) were reduced in first postoperative day (measured 24 h postoperatively) than the preoperative	Sixty-three patients were randomized to receive a continuous infusion of lidocaine in the paravertebral catheter for 3 postoperative days (thoracic paravertebral group, *n* = 32) or systemic analgesia (systemic analgesia group, *n* = 31). All patients underwent standard posterolateral thoracotomy. There	Continuous paravertebral block by direct access to the paravertebral space using a catheter inserted by the surgeon is a simple technique, with low risk of complications, provides effective pain relief with fewer side effects, and reduces the early loss of postoperative pulmonary functions when compared to systemic analgesia.	Strength: Level I prospective RCT with adequate monitoring that adds value to conclusions. Limitations: Number of patients. Risk of harm: Minimal with exclusion criteria of 18 years or younger, emergency surgery, previous thoracotomy, drug addiction, coagulopathy Feasibility of use: adequate

				catheter, postoperative pulmonary complications, respiratory depression (defined as respiratory rate less than 8 per min), nausea and vomiting, and urinary retention were recorded. Continuous variables are presented as mean ± SD and categorical variables as number and percent. Continuous variables were compared using t test or Mann–Whitney test if not normally distributed, and categorical variables were compared using the chi2 test or Fischer's Exact test if the frequency of the events is less than 5. Differences were accepted to be significant at $p < 0.05$. Analyses were done using IBM SPSS for Windows, Version 22.0 (IBM Corp., USA).	values and continue to increase in the second and third days but not reaching the preoperative values at 72h postoperatively. All pulmonary function tests are significantly better in TPVB group in all days. No complications could be attributed to the paravertebral catheter or to lidocaine. Pulmonary complications were more in SA group but without statistical significance (P = 0.14). Side effects were significantly more in SA group (P = 0.03).	were no significant differences between both groups in age, sex, side, type, and duration of operation. Pain scores measured on visual analogue scale and morphine consumption were significantly lower in thoracic paravertebral group in all postoperative days. Spirometric pulmonary functions were not reaching the preoperative values in the third postoperative day in both groups, but restorations of pulmonary functions were superior in the paravertebral group. No complications could be attributed to the paravertebral catheter. Side effects, mainly nausea and vomiting followed by urinary retention, were significantly more in systemic analgesia group (P = 0.03). Also, pulmonary complications were more in the systemic analgesia group but not reaching statistical significance (P = 0.14).		since anesthesia practice has all capabilities
Richardson J, Sabanathan S, Jones J, Shah RD, Cheema S, Mearns AJ. A prospective, randomized comparison of preoperative and continuous balanced epidural or paravertebral bupivacaine on post-thoracotomy pain, pulmonary function and stress responses. *British Journal of Anaesthesia*. 1999;83(3):387-392. doi:10.1093/bja/83.3.387	A prospective, randomized of 95 patients: Epidural group (n=49); Paravertebral group (n=46). Patients randomly received	95 total patients; age range between 17-80 years old; undergoing elective posterolateral thoracotomy. Approved from the Ethics Committee.	Independent variable: IV1 Thoracic epidural bupivacaine vs thoracic paravertebral bupivacaine in on post-thoracotomy pain, pulmonary function and	Data were analyzed using SPSS for Windows version 7.0 and Epidemiological Information for DOS version 5.0. The assumption of normality was checked using	No significant finding in regard to age, sex, weight or type of surgery. Patients in the paravertebral (PVB) group had significantly lower VAS pain scores both at rest and on coughing (P=0.02 and 0.0001). Morphine consumption in	Significantly lower VAS scores at rest and on coughing were found in the paravertebral group and patient-controlled morphine requirements were less	We conclude that with these regimens, the paravertebral block was superior to the epidural block in terms of analgesia, pulmonary function, neuroendocrine stress responses, side effects, and postoperative respiratory morbidity.	Strength: Level II, a prospective, randomized study. Limitations: An epidural catheter could not be sited in five patients and data from the remaining

	thoracic epidural bupivacaine or thoracic paravertebral bupivacaine. All patients were premedicated with morphine 10mg using a patient-controlled analgesia machine (PCA), prochlorperazine 12.5mg IM, and 1 hour before surgery with rectal diclofenac 50mg. Both techniques were followed by continuous postoperative infusion of bupivacaine; 0.25% in the epidural group and 0.5% in the paravertebral group at rate 0.1ml kg^{-1} h^{-1}.		stress responses. Dependent variable: DP1 Visual analogue pain scores (VAS) at rest and coughing. DP2 Morphine consumption. DP3 Pulmonary function assessed by postoperative mean peak expiratory flow rate (PEFR.) DP4 Outcomes (Urinary retention, Nausea and Vomiting, Chest infection, hypotension, wound infection, myocardial infarction, arrhythmias, confusion, somnolence, cerebral accident, hospital stay, death).	the Komolgorov-Smirnov test before applying the *t* test to parametric data. The power of the study was based on the serial measurement of PEFR, the lowest numbers were expressed as a fraction of the patient's preoperative control value. Distribution of those ratios were compared using a two-tailed independent *t* test.	24hours periods was higher in the epidural group [mean 105.8(±95% confidence intervals 20.4) mg and 262(67) mg vs 85.5(30) mg and 210.7 (63.8) mg; *P*=0.008 and 0.005]. PVB groups had better pulmonary function with 0.73 (SEM 0.06) in contrast with the epidural group with 0.54 (0.05) (*P* < 0.004). Oximetric recordings were significant in the PVB group though 48hours study [96 (0.2) %] compared with the epidural group [95(0.2) %] (*P*=0.0001). The increase of both plasma cortisol and glucose concentration were less in the PVB groups (*P*=0.003 and 0.006). No neurological complications. Mean hospital stay was 6.7 (range 4-11) days for the PVB and 6.7 (range 3-16) days for the epidural group.	compared to epidural groups. Pulmonary function was better preserved in the paravertebral group who had higher oxygen saturations and less postoperative respiratory morbidity. There was a significant increase in plasma concentration of cortisol from baseline in both groups and in plasma glucose concentration in the paravertebral group. However, the areas under the plasma concentration vs time time curves for cortisol and glucose were significantly lower in the paravertebral groups. Side effects, especially nausea, vomiting, and hypotension, were troublesome only in the epidural group. There were 11 patients in the epidural group compared with 5 in the PVB group who required catheterization for retention of urine.		95 patients were analysed. Risk of harm: Three patients in each group were admitted as emergency to intensive care units (ICU) and there were seven deaths in total. Feasibility of use: The authors believe the study methods to be replicable, feasible and safe.
Małgorzata Edyta Wojtyś, Józef Wąsikowski, Norbert Wójcik, et al. Assessment of postoperative pain management and comparison of effectiveness of pain relief treatment involving paravertebral block and thoracic epidural analgesia in patients undergoing posterolateral thoracotomy. *Journal of Cardiothoracic Surgery*. 2019;14(1):1-11. doi:10.1186/s13019-019-0901-3	RCT study involves 2 groups of patients, each consisting of 30 patients each undergoing posterolateral thoracotomy. The study group involved patients anesthetized applying	The study involved two groups of patients, each consisting of 30 patients of both sexes, above 18 years of age. Patients were randomized to particular groups (simple randomization). Patients from both groups had no contraindications to application of any of the postoperative	Independent variable: IV1 is PVB vs TEA Dependent variable: DV1 is Hemodynamics. DV2 respiratory parameters. DV3 is pain with NRS (numeric rating scale) during the first 3 days after surgery.	Each group had evaluations of SpO2 every 4 hours, arterial blood pressure and pulse every 4 hours, assessment of pain (NRS) every 4 hours, Clinical Quality Indicators in Postoperative Pain Management. Values	There was no statistically significant difference in the mean values of heart activity between particular days after the surgery in PVB group, while in TEA group staistically significant increase of mean values of heart acivity has been observed between the first and the second day	No statistical significance was demonstrated between the groups in respect of hemodynamic and respiratory parameters values, the need to use additional pain	PVB and TEA are not significantly different in terms of postoperative pain management and the need to use additional pain relievers. [12]	Strength: Level I RCT. Limitations: Sample size. Risk of harm: Risk of harm is minimal, trained anesthesia providers. Feasibility of use: Adequate since anesthesia

	PVB method, while the control group involved patients anesthetized with TEA. Hemodynamic and respiratory parameters as well as severity of pain assessed using NRS (numeric rating scale) during the first 3 days after the surgery, number of days of hospitalization, and the need to use additional pain relievers were taken into account in both groups. Evaluation of postoperative pain management quality was performed applying Clinical Quality Indicators in Postoperative Pain Management.[12]	analgesia methods. Group 1 involves patients who had PVB, while group 2 involves patients who were treated with TEA. This was done in the hospital setting.[12]	DV4 length of stay. DV5 rescue analgesia .[12]	regarding current pain in NRS scale (0-10 pints). Satisfaction with the manner of postoperative pain management was assessed using the scale of 1-10 points. Collected data was subject to statistical analysis performed with the use of SPSS package (SPSS Inc., Chicago IL, USA). T-test for dependent groups and Mann-Whitney U test were used in statistical analysis. Statistical calculaions were performed applying the statistical significance of 0.05.[12]	and the first and the third day after the surgery. Statistically significant decrease in saturation in the TEA group was observed between the first and the second day after the surgery. No statistically significant differences have been observed between the groups in terms of the need to use additional pain relievers. In PVB group complications were observed in 4 persons, i.e. in 13.3% of the group, while in TEA group complications were observed in 7 persons, i.e. in 23.3%; Time of hospitalization of patients who were treated with PVB compared to TEA patients (p =0.008) of 1 day (6 days vs. 7 days) time of hospitalization of patients treated with PVB was 1 day shorter.[12]	relievers and the number of days of hospitalization. There was no statistically significant difference between the groups in respect of general assessment of pain management quality, except for the assessment of the lowest level of pain within the last 24 h of measurement. This result in TEA group was statistically significantly lower than the one in the PVB group (p = 0.019).[12]		providers are trained for both.
Sherbiny M, Serry Y, Abdelhamid A, Moneim T, et al. Comparison between Continuous Thoracic Epidural and Ultrasound Guided Continuous Thoracic Paravertebral Block on Perioperative Analgesia and Hemodynamic Stability in Patients Undergoing Thoracotomy. *Researchgate.net*.2014	Prospective, randomized, single, and clinical study. Total of 60 total patients. Group I: thoracic paravertebral analgesia (TPVA); group II: thoracic epidural analgesia (TEA). Both groups received ultrasound guided thoracic or paravertebral catheter. In both groups a bolus dose of 0.5% bupivacaine then continuous infusion of bupivacaine 0.25% intraoperative followed by postoperative continuous infusion of bupivacaine 0.25% plus	60 total patients (ASA I-III) of either sex: n=25 experimental group patients; n=25 control group patients; adult population of age range above 18 years old; undergoing elective thoracotomy.	Independent variable: IV1 TPVA vs TEA in patients undergoing thoracotomy. Dependent variable: DV1 Pain assessment measuring with VAS. DV2 Hemodynamic parameter (HR and MAP); DV3 Respiratory parameters [rate, SpO_2, arterial blood base analysis (pH, PaO_2 and $PaCo_2$) and peak expiratory flow meter]. DV4 Total bupivacaine consumption. DV5 Pain rescue analgesia consumption.	Statistical analysis was done by using SPSS version 16. Quantitative data was presented as mean ± Standard deviation. Qualitative data was presented as numbers and percentages. Quantitative data was analyzed by using unpaired student t-test. Quantitative data in the same group was analyzed by using repeated measure ANOVA tests. Qualitative data was analyzed by using Chi-square test and Z test. P – Value < 0.05 was considered statistically significant. P – Value < 0.01 was	No significant differences between groups as regarding the demographic characteristics of patients, arterial blood gases analysis, pain rescue analgesia consumption, and peak expiratory flow rate (PEFR). As regards comparing. MAP and HR was lower in the TEA group compared to TPVA group. TPVA showed lower complication as regards nausea, vomiting, and itching than TEA. There was a significant difference of 16.6% as regards urine retention in TEA group and no urinary retention in patients from TPVA group (p=0.01).	Current study showed no significant differences between both groups as regards VAS at rest, deep breathing and coughing. As regards comparing mean arterial blood pressure (MAP) between both groups, current study showed a significant lower MAP values in TEA group at 10 minutes from bolus dose injection, 20 minutes from bolus dose injection, 10 minutes after induction of	There was no statistically significant difference between TPVA and TEA in terms of efficient analgesia but TPVB showed greater hemodynamic stability than epidural analgesia in patients having thoracotomy also TPVB was associated with less side effects. We recommend that The TPVB is safe and effective and should be always considered as a TEB alternative.[13]	Strength: Level I, RCT Limitations: The possible shortcomings of our paper; the study did not include a placebo control group. VAS and other measured parameters were compared between both groups for only 24 hrs. Risk of harm: No risk or harm is associated with the study's interventions if they were to be reproduced Feasibility of use: This study demonstrates that TPVB is feasible and safe for patients undergoing

	2 mcg/ml fentanyl.			considered statistically highly significant. A sample size of at least ten patients was needed to have a power of least 80%, the two-sided ά error of 5% level, and on the basis that from our previous studies we would expect a difference in Visual analogue score at rest after 6 hrs.[13]		general anesthesia, after lateral position, after skin incision, after rib retraction and six hours postoperative compared to TPVA group. There were no significant differences as regards respiratory rate, spo2, arterial blood base analysis (pH, PaO2 and PaCo2) and peak expiratory flow meter at 1h, 12hrs and 24hrs postoperative. Also, there were no significant differences as regards. Total bupivacaine consumption in 24 hrs and Pain rescue analgesia consumption. There was lower nausea, vomiting, itching and no urine retention in TPVA group.[13]		thoracotomy surgery.
Dhole S, Mehta Y, Saxena H, Juneja Rajov, Trehan N. Comparison of continuous thoracic epidural and paravertebral blocks for postoperative analgesia after minimally invasive direct coronary artery bypass surgery. *Journal of Cardiothoracic and Vascular Anesthesia*. 2001; 15 (3): 288-292. doi: 10.1053/jcan.2011.23271	41 consenting male and female patients undergoing elective MIDCAB surgery through a left anterior minithoracotomy were included in this prospective, randomized study. [14]	Total of 41 patients. Patients were randomized either to the TEA (n=21) or the PVB (n=20) group. Patients in both groups were comparable for demographic characteristics, including age, sex, height, weight, and ejection fraction. The setting was at a hospital setting unnamed.[14]	Independent variable: IV1 TEA versus IV2 PVB group in MIDCAB surgery Dependent variable: DP1 visual analog scale (VAS) pain scores at rest at rest and while coughing on a scale of 10 (0 no pain, 10 maximum pain). DP2 Heart rate. DV3 mean arterial pressure (MAP). DV4 central venous pressure (CVP), pulmonary artery occlusion pressure. DV5 cardiac index. DV6 systemic vascular resistance. DV7	Monitoring in these patients included a continuous 2-lead electro-cardiogram with ST-segment monitoring, arterial blood pressure, pul-monary artery pressure, rectal temperature, oxygen saturation by pulse oximetry, end-tidal carbon dioxide, cardiac output and its derived parameters, arterial blood gases, urine output, and regional wall motion of the left ventricle by transesophageal echocardiography.[14] The data were analyzed using *t*-test, Pearson chi-square test,	Pain scores at rest and while coughing was similar in both groups, pain scores at rest were lower, but while coughing were higher in the PVB group; however, the differences in scores were not statistically significant at any time. Hemodynamic parameters in both groups were comparable except that CI at 4 and 6 hours was significantly higher in the TEA group than in the PVB group. Systemic vascular resistance was lower in the TEA group throughout the study period, although there was no statistical difference. Patients in the PVB group had significantly lower respiratory rates at 8 hours, 10 hours, and 12	In the present study, TEA and PVB were compared for pain relief after MIDCAB surgery. The potential risk of an epidural hematoma after puncture of epidural vessels and subsequent anticoagulation is a major concern with regards to the TEA technique. With comparable quality of analgesia compared with TEA, as assessed by VAS at rest and while coughing,	PVB has the advantages of having no risk of epidural hematoma formation in the event of MID-CAB surgery being converted to conventional CABG surgery on cardiopulmonary bypass with full heparinization. Hypotension resulting from sympathetic block is less with PVB; none of the patients in this PVB group had hypotension. Less hypotension may be an additional advantage of this technique over TEA.	Strength: Level I RCT Limitations: One limitation of PVB is that because of unilateral analgesia, it can be used only for MIDCAB surgery through an anterolateral thoracotomy and not for a mini-sternotomy. Risk of harm minimal with exclusion criteria Feasibility of use is appropriate as proven by results.

			respiratory rate. DV8 paO2. DV9 PCO2. DV10 complications [14]	and Fisher's exact test wherever applicable. Statistical analysis software (SPSS 7.0) was used to perform these tests.[14]	hours. PaCO2 and PaO2 were comparable in both groups. Compliance to chest physiotherapy in the early postoperative period was better in the PVB group, but at the end of the study was similar in both groups. At no point was there a statistically significant difference between the 2 groups. Requirement of additional analgesics was similar in both groups.[14]	and no serious potential complications associated with PVB in this study, PVB may be the superior technique for pain relief after MIDCAB surgery. There was no significant difference in supplemental analgesic requirement between the 2 groups. The respiratory rate was significantly lower at 8, 10, and 12 hours in the PVB group, which may indicate more effective analgesia.[14]		
Grider JS, Mullet TW, Saha SP, Harned ME, Sloan PA. A Randomized, Double-Blind Trial Comparing Continuous Thoracic Epidural Bupivacaine With and Without Opioid in Contrast to a Continuous Paravertebral Infusion of Bupivacaine for Post-thoracotomy Pain. *Journal of Cardiothoracic and Vascular Anesthesia*. 2012;26(1):83-89. doi:10.1053/j.jvca.2011.09.003	A prospective, randomized, double-blind clinical trial of 75 patient (ASA physical status I- III): epidural bupivacaine + opioid (EB + O, n=25); epidural bupivacaine alone (EB, n=25); paravertebral catheter with bupivacaine (paravertebral block [PB], n=25). All patients received bupivacaine 0.25% via epidural or paravertebral route; at a teaching hospital.	75 adult patients at a tertiary teaching hospital; approve by the institutional review board; epidural bupivacaine + opioid [(EB + O) n=25]; epidural bupivacaine alone [(EB) n=25]; paravertebral catheter with bupivacaine [(PB), n=25]; adult population from 46-75 years old; undergoing elective anterolateral thoracotomy surgery for lung cancer.	Independent variable: epidural bupivacaine + opioid vs epidural bupivacaine alone vs paravertebral catheter with bupivacaine in patient undergoing elective anterolateral thoracotomy surgery. Dependent variable: DV1 VAS pain scores. DV2 Incentive Spirometry (IS). DV3 Respiratory distress. DV4 Reintubation. DV5 Catheter malposition or dislodgement. DV6 Hypotension requirement reduction of local anesthetics.	All statistical analysis was performed using Sigma Stat (Aspire Software International, Ashburn, VA). Visual Analogue Scales (VAS) results were analyzed using the Mann-Whitney *U* nonparametric test, expressed as mean values with standard deviation. Incentive spirometry values as a measure of postoperative pulmonary function were compared using the Student *t* test and were simply expressed as the ability to achieve a vital capacity of >2 L.	There was no difference in mean ± standard error VAS pain scores between the paravertebral (PB, 3.3± 0.5) and EB (3.1 ± 0.5) local anesthetic groups; however, the EB + O group provided superior analgesia (2.6 ± 0.4, p <0.05) compared with groups receiving local anesthetic alone.	Analgesia on all postoperative days was superior in the thoracic epidural group receiving bupivacaine plus hydromorphone. Analgesia was similar in the epidural and continuous paravertebral groups receiving bupivacaine alone. No significant improvement was noted by combining the continuous infusion of bupivacaine via the paravertebral and epidural routes. Incentive spirometry goals were best achieved in the epidural bupivacaine and hydromorphone group and equal in the group receiving bupivacaine alone.	The current study provided data that fill gaps in the current literature in 3 important areas. First, this study found that thoracic epidural analgesia (TEA) with bupivacaine and a hydrophilic opioid, hydromorphone, may pro- vide enhanced analgesia over TEA or continuous paravertebral infusion (CPI) with bupivacaine alone. Second, in the bupivacaine alone group, the increased basal rates required to achieve analgesia resulted in hypotension more frequently than in the bupivacaine/hydromorphone combination group, underscoring the benefit of the synergistic activity. Finally, in agreement with previous retrospective studies, the current data suggest that CPI of local anesthetic appears to provide acceptable analgesia for post thoracotomy pain.	Strength: Level I, RCT adequate monitoring that adds value to conclusions. Limitations: Reintubation and sedation preventing the evaluation of VAS or IS, catheter malposition or dislodgement. Limitations of the current study included the relatively small numbers of subjects in each group and the number of data points absent because of the inability to obtain VAS and IS on patients requiring ventilator support. Additionally, the in- creased basal rate required in the bupivacaine-alone group may have contributed

								to the incidence of hypotension in that group Risk of harm: No risk or harm is associated with the study's interventions if they were to be reproduced. Feasibility of use: The study demonstrates the feasibility and safety of epidural bupivacaine + opioid, epidural bupivacaine alone, and paravertebral catheter with bupivacaine in patient undergoing elective anterolateral thoracotomy surgery if used under the study's settings.

Appendix B

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Office of Research Integrity
Research Compliance, MARC 414

MEMORANDUM

To:	Dr. Yasmine Campbell
CC:	Daniel Orozco
From:	Elizabeth Juhasz, Ph.D., IRB Coordinator
Date:	April 2, 2021
Protocol Title:	**"Paravertebral Block for the Adult Thoracic Surgical Patient: A Quality Improvement Project"**

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-21-0111	**IRB Exemption Date:**	04/02/21
TOPAZ Reference #:	110235		

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.

Institutional Review Board - Human Research Protections

Broward Health Medical Center
Broward Health Coral Springs
Broward Health Imperial Point
Broward Health North

Salah Foundation Children's Hospital
Broward Health Weston
Community Health Services
Broward Health Physician Group

DATE: 04/26/2021

TO: Daniel Orozco, BSN, RN, CCRN

FROM: Broward Health Institutional Review Board

RECORD NUMBER: 2021-054

STUDY TITLE: Paravertebral Block for the Adult Thoracic Surgical Patient: A Quality Improvement Project

RE: NOT HUMAN SUBJECT RESEARCH DETERMINATION

Dear Daniel Orozco, BSN, RN, CCRN:

This is to advise you that your project, "Paravertebral Block for the Adult Thoracic Surgical Patient: A Quality Improvement Project " was reviewed on behalf of the Broward Health Institutional Review Board and was declared "not research involving human subjects" based on the definitions provided in the U.S. Department of Health and Human Services Code of Federal Regulations found at 45 CFR 46.102.

Please note, this determination does not absolve the Principal Investigator from complying with other federal, state, or local laws or institutional policies and procedures that may be applicable in the conduct of this project.
This determination applies to your project in the form and content as submitted to the IRB for review. Any variations or modifications to this project involving the participation of human subjects must be approved by the IRB prior to implementing such changes. Please maintain a copy of this determination for your records.

Thank you for submitting your project to the IRB for consideration.

The Broward Health Institutional Review Board – FWA00001248 operates in accordance with the Office of Human Research Protections and U.S. Food and Drug Administration (FDA) regulations. The Broward Health Institutional Review Board complies with the ICH guidelines on Good Clinical Practice (GCP) where they are compatible with the FDA and HHS regulations.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Broward Health IRB's records.

Appendix C

Proposed Method for Data Collection Pretest and Posttest Questionnaire

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Pretest and Posttest Questionnaire:

Paravertebral Block

INTRODUCTION

The primary aim of this QI project is to improve the knowledge of anesthesiologists about Paravertebral block (PVB) versus Thoracic Epidural Block (TEB) in adult thoracic surgical patients. Please answer the following questions below to the best of your ability. The questions are either in multiple-choice or true/false format. These questions are meant to measure knowledge, attitude, and confidence in the anesthesia provider regarding Paravertebral 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:** Associates__ Bachelors__ Masters__ DNP__ PhD__ MD__
6. **How many years have you been administering anesthesia?**

   <1 year ____ 1-3 years ____ 3-5 ____ 5-10 years ___ >10 years___
7. **Do you currently practice in the State of Florida?** Yes ___ No___
8. How many Paravertebral block (PVB) do you perform on a weekly basis?

   None 1 2 3 More than 3

9. How many thoracic epidural anesthesia (TEA) do you perform on a weekly basis?

   None 1 2 3 More than 3

10. What is your first analgesic technique for a thoracic surgery patient if you were going to utilize neuraxial anesthesia?

    a. Thoracic Epidural Block

    b. Paravertebral Block

11. How confident do you feel performing Paravertebral Block?

    Not confident at all ___Somewhat confident____ Confident ___ Very Confident___

QUESTIONNAIRE:

1. **What surgery is considered to be the *MOST* painful surgical procedure?**

    a. Spinal surgery

    b. Thoracic surgery

    c. Abdominal surgery

    d. Orthopedic surgery

2. **Currently, what is the Gold standard of care in preventing pain in the adult thoracic surgical patient?**

    a. Epidural

    b. Paravertebral

    c. Erector Spinae Plane Block

    d. Pectoralis Block

3. **Paravertebral Block technique involves administering local anesthetic?**

    a. Adjacent to the thoracic vertebra

    b. Into the epidural space

    c. Distant to the thoracic vertebra

    d. Into the spinal canal

4. **Hemodynamic instability are mostly affected under what method of anesthesia?**
    a. Epidural Block
    b. Paravertebral Block
    c. Erector Spinae Plane Block
    d. Pectoralis Block
5. **What hemodynamics are affected by Thoracic Epidural Anesthesia?**
    a. Diastolic Blood Pressure
    b. Mean Arterial Pressure
    c. Systemic Vascular Resistance
    d. All the above
6. **Urinary Retention occurs more frequently in which type of block?**
    a. Thoracic Epidural Block
    b. Paravertebral Block
    c. Erector Spinae Plane Block
    d. Pectoralis Block
7. **When comparing Paravertebral Block Vs Thoracic Epidural Anesthesia, what side effects are less or even eliminated with Paravertebral Block?**
    a. Vomiting
    b. Nausea
    c. Urinary retention
    d. All the above
8. **During a cardiothoracic surgery, *pulmonary function test*** (FEV_1, FVC, PEFR, MVV) **is markedly superior in the _____ group when compared to _____ group in the post thoracic surgical patient.**
    a. Paravertebral Block; Epidural Block
    b. Epidural Block; Paravertebral Block
    c. Erector Spinae Plane Block, Epidural Block
    d. Paravertebral Block; Pectoralis Block

9. **Which of the following thoracic block causes the *MOST* post-operative nausea and vomiting?**
    a. Epidural Block
    b. Paravertebral Block
    c. Erector Spinae Plane Block
    d. Pectoralis Block
    e. Serratus Block

10. **Which statement is *True* regarding opiate consumption:**
    a. ETA requires more opiate use than PVB to equally manage pain
    b. Opiate use is less in the PVB group compared to ETA
    c. PVB requires more opiate use than ETA to equally manage pain
    d. Opiate use is less in the ETA group compared to PVB
    e. Opiate use in PVB and ETA are similar, and analgesia is comparable

11. **What statement is *TRUE* regarding outweighs the benefits of Thoracic Epidural Block and Paravertebral Block?**
    a. Thoracic Epidural Block is contraindicated with antiplatelet treatment.
    b. Thoracic Epidural Block is contraindicated with therapeutic anticoagulation
    c. Thoracic Epidural Block is contraindicated with hemostatic disorders or coagulopathies.
    d. Paravertebral Block is an alternative when Thoracic Epidural Block is contraindicated.
    e. All the above.

12. **Complication of Epidural Block compared to Paravertebral Block include?**
    a. Retention of secretion of respiratory tract
    b. Paroxysmal atrial fibrillation
    c. Catheter migration
    d. Retention of secretion of respiratory tract, paroxysmal atrial fibrillation, and paraplegic involving all segments from T4 below.

13. What statement is *TRUE* regarding opiate consumption between Paravertebral Block and Thoracic Epidural Block?

a. Administration of the paravertebral block was superior when compared to epidural administration in regard pain management, morphine usage, and pulmonary function

b. Administration of the paravertebral block was inferior when compared to epidural administration regarding pain management, morphine usage, and pulmonary function

c. There were no different between Paravertebral Block and Thoracic Epidural Block

d. None of the statements are true.

14. How does Paravertebral Block and Thoracic Epidural Block differ?

a. Paravertebral Block is found to cause less postoperative pain, nausea, vomiting and more patient satisfaction.

b. Paravertebral Block and Thoracic Epidural Block have the same postoperative pain, nausea, vomiting and patient satisfaction.

c. Thoracic Epidural is found to cause less postoperative pain, nausea, vomiting and more patient satisfaction.

15. How likely do you recommend Paravertebral Block in patients undergoing thoracic surgery?

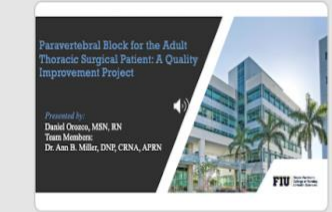
a. Most likely

b. Somewhat likely

c. Somewhat unlikely

d. Most unlikely

Appendix D



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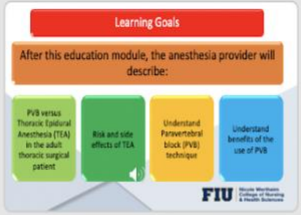

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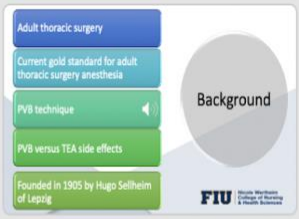

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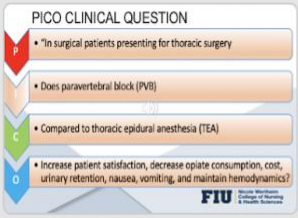

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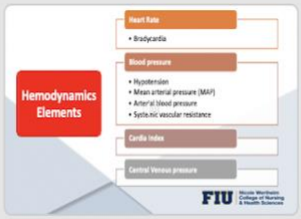

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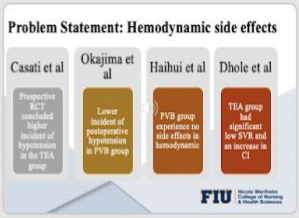

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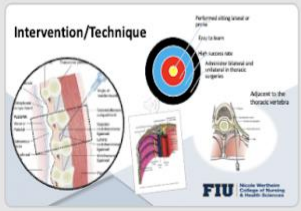

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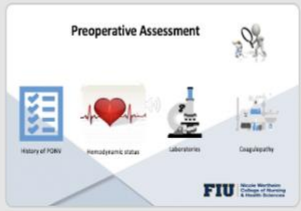

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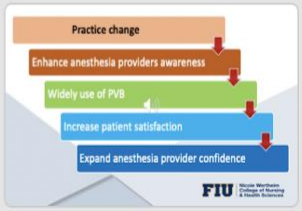

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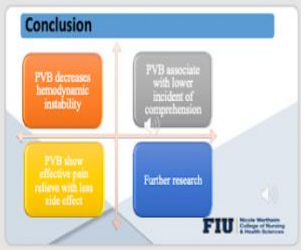

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