Spring 5-4-2025

Development of Clinical Practice Guidelines for Incorporating Paravertebral Blockade for Thoracic Surgery Adult Patients

India Hutchison
india.hutchison1@gmail.com

Spring 5-4-2025

Development of Clinical Practice Guidelines for Incorporating Paravertebral Blockade for Thoracic Surgery Adult Patients

India Hutchison

Final Scholarly Project: Development of Clinical Practice Guidelines for Incorporating Paravertebral Blockade for Thoracic Surgery Adult Patients

India Hutchison, BSN, RN, CCRN

Department of Nursing, Otterbein University

In Partial Fulfillment of the Requirements for the Degree

Doctor of Nursing Practice

2024

DNP Final Scholarly Project Team:

Ruth Chavez, DNP, FNP

Approved by: Dr. Ruth Chavez DNP, CNP

Dannielle Winch, DNP, CRNA

Amy Bishop, DNP, AGCNS

Author Note

We have no conflicts of interest to disclose.

Correspondence concerning this article should be addressed to Otterbein Project Team Leader, 1 South Grove Street, Westerville, OH 43081. rchavez@otterbein.edu

Abstract

Thoracic surgery is considered one of the most painful surgical procedures due to its severity and the duration of the procedure. Pain is detrimental to the patient experience, and poor patient satisfaction results in revenue loss for hospitals. Maintaining adequate pain control after surgery is crucial in preventing pulmonary complications such as atelectasis and respiratory failure that prolong patient recovery. It is the responsibility of the anesthesia provider to ensure adequate pain control throughout the perioperative experience. Although current evidence-based data shows that regional anesthesia provides superior thoracic postoperative pain control, the current practice continues to be the utilization of intravenous and oral opioids alone. This project aims to provide evidence-based guidelines to incorporate regional anesthesia for postoperative pain management in adult patients undergoing unilateral thoracic surgery. Paravertebral blockade (PVB) is the recommended regional anesthesia technique based on the quality of pain control coupled with the low rate of postoperative complications. Regional anesthesia is widely considered the gold standard of pain management following thoracic surgery and should be implemented as part of a thoracic Enhanced Recovery After Surgery (ERAS) protocol. Providers and nurses will be educated regarding PVB ultrasound-guided technique and proper documentation, respectively. Guidelines for incorporating PVB into thoracic ERAS protocols have been established and will be recommended to the hospital for review and discussion of potential implementation. The intent is for the guidelines to be utilized for all thoracic surgeries to ensure adequate postoperative pain control while minimizing associated complications, length of stay, and hospital costs.

Key words: thoracic, pain, postoperative, regional, anesthesia, paravertebral, block, ultrasound.

Development of Clinical Practice Guidelines for Incorporating Paravertebral Blockade for Thoracic Surgery Adult Patients

Introduction

Thoracic surgery is often considered one of the most painful surgical procedures due to its severity and duration (Yaksi et al., 2021). Chronic pain after thoracotomy surgery is very common and, if inadequately acutely managed, may last for several years (Ding et al., 2014). Although regional anesthesia is widely considered the gold standard of pain management following thoracic surgery, there is currently no definitive evidence to support thoracic epidural anesthesia (TEA) over paravertebral blockade (PVB) (Liang et al., 2021). While TEA is traditionally used more often, PVB is becoming increasingly popular due to its relatively lower rate of complications (Rajarajan, 2019). Batchelor et al. state,

> ...PVBs are more effective at reducing respiratory complications than TEA and after the first few hours provide equivalent analgesia. PVB reduces the risks of developing minor complications (postoperative nausea and vomiting, pruritus, hypotension and urinary retention) compared to TEA, with no difference in acute pain, and 30-day mortality. (2019, p. 102)

By incorporating PVB into the routine postoperative pain management care plan, anesthesia providers can enhance the patient experience and improve outcomes. The Johns Hopkins Evidence-Based Practice Nursing Model (JHEBP) was utilized to facilitate project planning, implementation, and distribution throughout the target hospital system. PVB will be implemented on all unilateral thoracic surgery patients willing to participate in the project, following provider education and competency checks. Several metrics, including pain scores and total opioid usage, will be compared with the hospital's current method of postoperative pain

control. The implementation process will be continuously reviewed and evaluated, and changes will be made accordingly.

Background

An urban level-one trauma center in the Midwest has lower patient satisfaction ratings compared to similar facilities which is demonstrated in the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) surveys (Medicare, 2023). The hospital stakeholders and policy makers are looking to improve the patient experience. Post-operative pain management is an opportunity for improvement for many hospital systems. The pain associated with thoracic surgery is persistent and severe. Improving postoperative thoracic pain management could lead to an improved patient experience.

Thoracic surgical pain can originate from nociceptive and neuropathic mechanisms which may arise from both somatic and visceral afferents (Mesbah et al., 2016). Nociceptive somatic afferent signals are largely generated by the intercostal nerves after skin incision, rib retraction, muscle splitting, injury to parietal pleura, and chest drain or tube insertion (Mesbah et al., 2016). Visceral pain stimulation may arise as a result of injury to the bronchi, visceral pleura, and pericardium (Mesbah et al., 2016). The neuropathic component results from damage to intercostal nerves or other nerves during the surgery (Wojtyś et al., 2019). The incision may span multiple dermatomes in certain approaches (Mesbah et al., 2016). Pain levels resulting from this magnitude of insult may not significantly decrease during hospital stay or even for the first month after surgery, which can lead to the development of chronic pain syndromes (Yaksi et al., 2021). The multifactorial nature of thoracotomy pain precludes the use of any single analgesic approach to block all pain afferents, necessitating a multimodal approach that targets multiple sites in the pain conduction pathway (Mesbah et al., 2016).

Up to 57% of patients experience chronic pain following thoracic surgery, with 10% suffering life-altering or debilitating pain (Gupta et al., 2020). The most common complications of poor pain control after thoracic surgery are respiratory in nature (Gupta et al., 2020). Poor pain control inhibits the patient's ability to breathe deeply, cough, and ambulate, often resulting in the development of atelectasis and pneumonia (Mesbah et al., 2016). Pain can also increase the incidence of hypoxemia and hypercapnia, as well as increase myocardial oxygen consumption and the risk of arrhythmias and myocardial ischemia (Liang et al., 2020). Adequate pain management following thoracic surgery has been shown to decrease postoperative complications, particularly cardiopulmonary complications, as well as decrease the overall length of stay (Kodia et al., 2021).

Thoracic surgery patients are at higher risk for prolonged opioid use due to increased persistent pain (Brescia et al., 2019). Furthermore, the use of systemic opioids suppress the central nervous system, respiration, and cough reflexes which hinder recovery (Mahmoudi et al., 2021). In order to minimize respiratory complications as well as new persistent opioid use, the use of opioids should be limited in the postoperative period. Limiting the use of opioid pain medication administration necessitates additional pain management techniques to adequately control pain.

Regional anesthesia does not suppress the central nervous system (CNS) and is comparatively easy to perform (Mahmoudi et al., 2021). Regional anesthesia can be accurately and safely placed by trained and licensed professionals by use of anatomic landmarks, ultrasound, or fluoroscopy (Mahmoudi et al., 2021). It can provide segmental anesthesia to the desired dermatomal level without causing systemic effects (Mahmoudi et al., 2021). Although

epidural analgesia has been traditionally used, unilateral neuraxial blocks, such as intercostal or paravertebral blockades, have been shown to have lower complication rates (Kodia et al., 2021).

For many years, TEA was considered to be the gold standard of pain management following thoracic surgery (Gupta et al., 2020). Epidural anesthesia provides pain relief by diffusing local anesthetic (LA) across the dura to act on nerve roots and the spinal cord through the intervertebral foramina, disrupting pain pathways to the brain (Hernandez & Singh, 2022). While TEA is a great alternative to intravenous pain medication alone, TEA is associated with a high incidence of complications such as hypotension, urinary retention, and muscle weakness (Wojtyś et al., 2019). Additionally, epidural anesthesia is contraindicated in patients who are therapeutically anticoagulated, those with bacteremia, severe aortic stenosis, increased intracranial pressure, and anatomic spine deformities (Hernandez & Singh, 2022). Therefore, a significant number of patients are unable to receive this type of treatment. Given the heightened potential for complications in this high risk population, it is essential that providers adapt practices to newer and safer techniques to aid in patient pain control for all patient populations.

PVB is an injection of LA into the space immediately lateral to where a spinal nerve emerges from the intervertebral foramina (Batra et al., 2011). PVB can be performed unilaterally and can be localized across a single dermatome, meaning that PVBs have several advantages over epidurals (Gupta et al., 2020). Due to the smaller distribution of anesthetic, there is a decreased risk of contralateral sympathectomy, thereby minimizing hypotension and resulting in better blood pressure maintenance (D'Ercole et al., 2018). There is also less risk of systemic anesthetic toxicity associated with PVB, even with relatively large dosages (D'Ercole et al., 2018). PVBs can even be performed as a single-shot injection postoperatively in case of failed

epidurals due to a decreased risk of hematoma. Evidence suggests that pain relief of a PVB is equal to conventional TEA (Gupta et al., 2020).

Significance to the Profession

Postoperative pain is an unavoidable part of the perioperative experience as more than half of surgical patients report insufficient postoperative pain relief (Horn & Kramer, 2022). When pain is adequately controlled, there is a reduced incidence of adverse physiologic and psychological effects that can be detrimental to overall patient well-being (Horn & Kramer, 2022). Adequate postoperative pain control is essential in facilitating a patient's recovery and helps ensure a timely return to normal daily function.

Although only recently incorporated into common practice, Enhanced Recovery After Surgery (ERAS) protocols have helped to significantly enhance patient experience. ERAS protocols result in improved pain control, decreased complications, reduced recovery time, decreased overall length of stay, and improved perioperative morbidity and mortality (Tippireddy & Ghatol, 2023). ERAS protocols are standardized multimodal guidelines derived from evidence-based research to improve recovery and can be applied at every stage of the perioperative experience.

The anesthesia provider makes intraoperative choices that can have profound and lasting effects on postoperative recovery. By preemptively managing operative side effects, postoperative opioid use can be minimized while still achieving adequate pain management, and postoperative nausea and vomiting (PONV) can be prevented (Tippireddy & Ghatol, 2023). The most effective of these types of interventions for a specific procedure may be incorporated into ERAS guidelines. The implementation of standardized ERAS protocols can facilitate uniformity of patient care and ensure evidence-based guidelines are being followed consistently. While

there are many facets of ERAS protocols, pain control is one crucial aspect. Incorporating regional anesthesia into a thoracic surgery ERAS protocol would facilitate patient recovery by diminishing the deleterious effects of excessive opioid use, such as reduced pulmonary function and delayed mobilization after surgery (Horn & Kramer, 2022). Additionally, regional anesthesia helps reduce the surgically induced stress response and pain that can lead to immunosuppression and persistent chronic pain can be minimized (Horn & Kramer, 2023). The anesthesia team can significantly improve patient satisfaction by advocating for incorporating the use of regional anesthesia into a thoracic surgery ERAS protocol.

PICOT

Postoperative pain control is an opportunity for improvement amongst most anesthesia providers. Thoracic surgery is an extremely painful procedure that requires a multimodal approach to pain management for optimal outcomes and prevention of complications. In order to determine the most effective postoperative pain management method after thoracic surgery, the following PICOT question was formulated: in patients that undergo unilateral thoracotomy surgery (P), how does PVB (I) compared to traditional methods (C) affect pain control and the occurrence of urinary retention, hypotension, respiratory complications, and opioid administration (O) during a 72-hour postoperative period following thoracic surgery (T)?

Problem Statement

Despite improved understanding of the physiologic mechanism of pain, postoperative pain management remains an opportunity for improvement for anesthesia providers. In postsurgical thoracotomy patients, postoperative pain management is crucial in preventing pulmonary complications such as atelectasis and respiratory failure related to the inability to adequately clear secretions due to pain (Mesbah et al., 2016). The occurrence of postoperative

complications and inadequate pain control can result in prolonged length of stay, development of chronic pain syndromes, and even patient morbidity and mortality.

Poor pain control can have deleterious effects on patient outcomes. Uncontrolled pain can result in atelectasis, pH abnormalities, respiratory distress, and prolonged hospitalization (Mesbah et al., 2016). Adequate pain management following thoracic surgery has been shown to decrease postoperative complications, particularly cardiopulmonary complications, as well as decrease the overall length of stay (Kodia et al., 2021).

While pain associated with surgery is virtually unavoidable, the preferred method of managing postoperative pain is complex. There is a very small margin of error for providers to adequately treat acute complex thoracic surgical pain (Collier, 2018). While opioids are effective in disrupting the pain signal to the brain, there are also many dangerous side effects (Collier, 2018). Thoracic surgery patients are at higher risk for prolonged opioid use due to persistent pain (Brescia et al., 2019). Furthermore, the use of systemic opioids suppress the central nervous system, respiration, and cough reflexes which hinder recovery and should therefore be minimalized in the postoperative setting (Mahmoudi et al., 2021).

Despite continual demonstration of the need for a multimodal approach to postoperative pain control, many hospital systems and physicians have yet to begin incorporating neuraxial analgesia into standard practice for postoperative pain control. Regional anesthesia has been shown to reduce the risk of persistent postoperative pain and is associated with fewer side effects than opioid use alone (Wong et al., 2019). Incorporating unilateral regional anesthesia into a standardized postoperative ERAS protocol would lead to lower postoperative complication rates, reduced length of stay, and overall improved patient outcomes (Gupta el al., 2020).

ERAS protocols incorporate evidence-based practices into every stage of the perioperative experience with the goal of achieving optimal patient outcomes in the most efficient manner (Kodia et al., 2021). While most hospitals have utilized generalized ERAS protocols, very few have adopted thoracic surgery specific recovery guidelines, especially concerning pain management. Developing an ERAS protocol specific to thoracic surgery pain management would help to streamline patient recovery and lead to improved patient outcomes. Standardized thoracic ERAS protocols, including the use of unilateral regional anesthesia, should be developed and implemented hospital wide.

Project Objectives

This scholarly project aims to provide evidence-based guidelines for incorporating PVB into thoracic surgery ERAS protocols for postoperative pain management for adult patients undergoing unilateral thoracic surgery. Many hospital systems do not have standardized postoperative pain management methodology incorporated into current practice for post-thoracotomy patients. While evidence suggests neuraxial anesthesia does provide superior analgesia to intravenous (IV) medication alone, the method for neuraxial anesthesia delivery is less clearly defined (Mesbah et al., 2016). The intent is for the guidelines to be utilized for all thoracic surgeries to ensure adequate postoperative pain control while minimizing associated complications, length of stay, and hospital costs. The successful implementation of the guidelines will require collaboration between multiple disciplines, including physicians, pharmacists, and nursing staff. To accomplish the goal of improving postoperative pain management in post-thoracotomy adult patients, the following objectives have been defined:

- Develop evidence-based guidelines for incorporating PVB into routine postoperative pain management for adult patients undergoing unilateral thoracic surgery.

- Develop a comprehensive plan to implement guidelines on a multi-disciplinary level to incorporate PVB into hospital thoracic ERAS protocols.
- Develop a comprehensive plan to monitor and measure supplemental opioid use, vital signs, and rate of complications such as hypotension, symptoms of respiratory distress, and urinary retention.
- Develop a continuous quality improvement process to adjust guidelines as needed if compliance is low.

Literature Synthesis & Analysis

Literature Review

Two databases were searched to ensure the most diverse results were obtained. The databases searched were PubMed and EBSCOhost. The databases were chosen for their accessibility and large resource libraries. Otterbein University provides free access for students to the EBSCOhost library. Both databases provide links to full articles through third-party websites if unavailable through the original database.

The first database searched was PubMed. Boolean operators were used, ensuring that results were relevant and applicable to the stated PICOT intervention. The phrases searched were “paravertebral block” and “thoracic epidural,” connected by the Boolean operator “and.” This search yielded 101 results. The search was then narrowed using the filter “publication date: within five years” to ensure the research was current. Of the 101 articles, 53 were published within the last five years. The search was further pared using the “free full text” filter to facilitate the accessibility of the articles. Only 37 results remained. A Rapid Critical Analysis (RCA) was performed to determine relevance based on the abstract. Four of the most pertinent articles were identified for use in evaluating the usage of PVB vs. traditional thoracic epidurals.

Similar to the previous search, the phrases “paravertebral block” and “thoracic epidural” were searched in the EBSCOhost database, using the Boolean operator “and” to confirm that articles were relevant to the intervention question. These search terms yielded 2,070 results. The filter “last five years” was applied, narrowing the resulting articles to 1,314. Additional filters were applied, including “available online,” “peer-reviewed journals,” and “full text.”

Surprisingly, 1,108 articles remained after all three filters were applied. In an attempt to restrict results to a reasonable number to be analyzed, additional terms were included, retaining the same four filters as the original search. The added terms to be included by the boolean operator “and” were “thoracotomy” and “unilateral.” The combination of these terms and filters yielded a more manageable 134 results. The results were then sorted according to relevance, and an RCA of the article abstracts was performed. Two articles were found to be relevant to the desired patient population. A second search was then conducted using similar phrases: paravertebral, thoracic epidural, and thoracotomy. However, for this search, the addition of the Boolean operator “not” was used to exclude results for “serratus” and “erector” to filter out results for other types of nerve blockades that could be included in the studies. The same four filters were applied to these phrases and yielded 473 relevant studies. After RCA of the first two pages of results, four additional articles were identified for further analysis in evaluating the efficacy of PVB use in post-op thoracotomy patients.

While using both PubMed and EBSCOhost databases yielded a vast array of articles from varying sources, the libraries often linked to full-text articles on other websites that were behind paywalls or required subscriptions. This obstacle was perhaps the most significant limitation of the search on either database. PubMed offered the option to filter out pay-access articles, which resulted in fewer articles, but guaranteed that the articles listed were accessible. EBSCOhost

provided the option only to include articles with full text, most of which were free access through the library subscription; however, this was not always the case. Ultimately, ten articles were selected from either library based on relevance to the intervention question.

Literature Synthesis and Analysis

Comparing TEA and PVB

TEA is often called the "gold standard" of pain management following thoracic surgery (Liang et al., 2021). However, recent studies suggest that, for unilateral instances, PVB is equally as effective in managing postoperative pain. To test this theory, Tamura et al. (2017) conducted a randomized controlled trial to compare the analgesic efficacy of PVB versus TEA using ropivacaine for post-thoracotomy pain relief in adults. The study found that mean visual analog scale (VAS) scores were lower in the TEA group at two hours post-surgery. However, the two-hour mark was the only point at which the pain scores were statistically significant throughout the study. This evidence ultimately supports the near equivalence of the two pain control methodologies. The occurrence of complications was not evaluated in this study.

Similarly, Liang et al. (2021) systematically reviewed five additional randomized-controlled trials and compared pain scores using the visual analog scale during different stages of the initial post-op period. The research team found that while average pain scores within the first six hours of surgery were statistically lower with TEA, scores quickly equilibrated with PVB after the six-hour mark. These studies suggest that while immediate pain control with TEA may be marginally better than PVB, those effects are transient and ultimately insignificant (LIan et al., 2021).

Another single randomized-controlled trial was conducted at Pomeranian Medical University in Szczecin, Poland, which studied 60 adult patients undergoing thoracotomy surgery

(Wojtyś et al., 2019). This study aimed to compare the effectiveness of PVB versus TEA, focusing on assessing postoperative pain management quality. Wojtyś et al. (2019) used various evaluation methods, including the Numeric Pain Scale, VAS, and the Clinical Quality Indicators in Postoperative Pain Management Scale. The study concluded that no statistically significant difference could be appreciated between PVB and TEA (Wojtyś et al., 2019). This conclusion was also supported by a retroactive case/cohort study conducted by Zengin and Alagoz (2021) using the VAS to evaluate pain control in 106 patients in Turkey.

On a larger scale, a systematic review conducted by D'Ercole et al. (2018) that reviewed 95 related articles concluded that there was "non-inferiority" of PVB compared with TEA for postoperative analgesia. The study concluded that there was near equivalence in analgesic efficacy between the two methodologies (D'Ercole et al., 2018). These results reinforce the conclusions previously made by a meta-analysis conducted by Ding et al. (2014). Ding et al. (2014) included 18 studies in their research and again concluded that there was no statistically significant difference in pain control efficacy between the two techniques.

Occurrence of Complications

While most studies agree on the functional equivalence of PVB versus TEA for postoperative analgesia, the most significant difference between the methods is the rate of complications. LAs produced pain relief by binding to specific sites in voltage-gated sodium channels and blocking the sodium current, thereby reducing the neuronal excitability of central nervous tissue (Flood et al., 2022). The transmission of nerve impulses is prevented by inhibiting the passage of sodium ions through ion-selective sodium channels in nerve membranes (Flood et al., 2022). In the case of TEA, the blockage of nerve impulses also results in contralateral blockade of the sympathetic nervous system output, which can lead to vasodilation and

undesirable complications such as hypotension and bradycardia (D'Ercole et al., 2019). With PVB, no contralateral sympathetic blockade occurs and, therefore, it is associated with fewer complications (Rajarajan, 2019).

In a meta-analysis conducted by Ding et al. (2014), PVB demonstrated significantly lower rates of urinary retention, nausea and vomiting (N/V), hypotension, and failed block. Liang et al. (2021) performed a systematic review that reinforced these results and concluded that the occurrence of hypotension was significantly higher in TEA recipients. Furthermore, Zengin and Alagoz (2021) studied 106 patients over 65 in Turkey and found that average mean arterial pressure (MAP) was significantly lower in those that received TEA, which may suggest a higher occurrence of hypotension.

In contrast, a study took place between 2008 and 2012 evaluating1619 patients who received thoracotomy surgery which examined the occurrence of complications following pain management with either PVB or TEA (Blackshaw et al., 2018). The study included instances of in-hospital death, intensive care readmission, increased length of stay, respiratory complications, and any other reported complication (Blackshow et al., 2018). Researchers found that while there were lower complication rates and shorter hospital stays within the PVB group, the differences were not statistically significant.

Placement Technique

Outside the type of regional anesthesia, the placement technique of the block may have a significant effect on the efficacy of pain relief. A systematic review by Cadavid-Puentes et al. (2020) analyzed 38 studies regarding the placement method and efficacy of PVB and comparative rates of failed blocks. The study team concluded that placement via direct visualization by the surgeon produced the most variable outcomes, with ultrasound-guided

technique yielding the most consistent block coverage and decreased adjunct opioid use than anatomic-guided placement (Cadavid-Puentes et al., 2020). While the review did not identify an objectively superior method, consistent results are paramount to clinical practice. A systematic review conducted by D'Ercole et al. (2018) also recommends using an ultrasound-guided PVB placement over other placement techniques, with added nerve stimulation to reduce block failure rates to less than six percent.

Medication Selection and Dosage

The standard medications and dosages of LAs vary widely between institutions. The systematic review conducted by D'Ercole et al. (2018) concluded that higher dose LA regimens are predictive of lower pain scores for up to 48 hours after surgery and can decrease postoperative pain by up to 50%. D'Ercole et al. (2018) specify that the average volume dosage for single-shot PVB is approximately two milliliters per desired dermatome, with associated improved efficacy with longitudinal LA spread along the vertebral column. The study suggests using 0.3% ropivacaine or 0.25% bupivacaine due to their increased duration of action (D'Ercole et al., 2018). Tamura et al. (2017) used five milliliters of 0.375% ropivacaine, while Wojtyś et al. (2019) opted for 15 milliliters of 0.5% bupivacaine. Furthermore, adding adjuvants such as opioids to the block increases pain control efficacy (D'Ercole et al., 2018). D'Ercole et al. (2018) list buprenorphine, clonidine, dexamethasone, magnesium, and dexmedetomidine as other acceptable adjuvants to decrease pain.

Other Considerations

While many studies aimed to evaluate the short-term pain management efficacy of PVB versus TEA, a quasi-experimental study that took place at St. Bartholomew's Hospital in London aimed to analyze the impact on the occurrence of persistent postsurgical pain (PPP) following

thoracic surgery (Wong et al., 2019). The study analyzed 82 patients using various pain scales across multiple years. It concluded that while there was a very high rate of PPP following thoracic surgery, there was no statistical difference between those treated with either PVB or TEA. The study showed PPP was correlated more with young age, poor acute pain management, and increased duration of surgery (Wong et al., 2019). The results suggest long-term analgesic equivalence of the two methodologies.

Another consideration for choosing pain control techniques is the patient's age. While all the included studies evaluated an adult population, Zengin and Alagoz (2021) specifically considered the adult over 65. As previously discussed, TEA results in a sympathetic blockade that leads to a reduction in heart rate, respiratory rate, and mean arterial pressure. As the body ages, catecholamine receptors become increasingly more desensitized and are often not able to elicit the intended response of vasoconstriction or increased heart rate to compensate for decreased fluid volume, placing them at higher risk for hypotension (Elisha et al., 2023). Zengin and Alagoz (2021) conducted a retroactive case/cohort study and found that MAP values were significantly lower in the TEA group, but patients remained hemodynamically stable. The team concluded that both forms of pain management were safe for use in the older adult and should be considered on a case-by-case basis for implementation.

Lastly, there are numerous contraindications for TEA and PVB. Difficult anatomic conditions, active infection at the insertion site, coagulopathies, and clotting disorders are contraindications for TEA (Wojtyś et al., 2019). PVB is also contraindicated in difficult anatomic conditions and cases of active injection site infection; however, blood clotting disturbances and coagulopathies are not a contraindication to PVB, which could allow

opportunities for those with clotting disorders, certain autoimmune diseases, and implanted devices that require anticoagulation to receive regional anesthesia (Wojtyś et al., 2019).

Summary of Literature

The literature suggests that PVB and TEA exhibit similar levels of pain relief in the immediate postoperative period. However, PVB appears to have a lower incidence of complications, making it a desirable option for pain management. Placement technique, type of LA and dosage utilized, patient age, presence of contraindications, and potential for persistent pain syndromes are important factors to consider. In light of these findings, PVB presents a viable and potentially advantageous alternative to traditional TEA for post-thoracotomy pain management, offering comparable pain relief with fewer associated complications. Further research and clinical trials are needed to provide additional insights and definitively conclude the superior approach for pain control in thoracic surgery patients.

Evidence-Based Practice Framework

Applying an evidence-based framework to a QI project facilitates the translation of abstract knowledge and data into clinical practice. The JHEPB model is a 19-step clinical decision-making and problem-solving strategy aimed to quickly improve clinical practice standards by ensuring the incorporation of current evidence-based data and improving interprofessional collaboration and care coordination (Dang et al., 2022). Permission to use the JHEBP model was obtained from the Johns Hopkins Nursing Center for Evidence-Based Practice and is provided in Appendix B.

The JHEBP model provides guidance throughout all stages of project planning, including development, analysis of literature review, and implementation. The JHEBP model describes three important steps in developing best practice guidelines: practice question, evidence, and

translation (PET) (Dang et al., 2022). Figure 1 depicts the flow of information throughout the model and visually represents the importance of reflection, evaluation, and revision throughout the QI process. Information gathered from these three progressions is then incorporated into clinical recommendations, ultimately improving practice. The structured and detailed design of the model starting from identifying a clinical issue through reflection and revision makes the JHEBP model ideal for this QI project. Based on the model, a clinical problem was identified and translated into a problem statement to be addressed.

Feasibility, Fit, and Acceptability

The proposed implementation process is very feasible within the acute care hospital setting. The providers will be given the required training and equipment to successfully fully implement the initiative. Incorporating PVB into the postoperative pain management regimen is very low risk as there are few negative side effects of PVB (D'Ercole, 2018). Current literature demonstrates that PVB is associated with fewer instances of urinary retention, fewer instances of hypotension, and overall shorter lengths of stay and is, therefore, lower risk than the use of TEA in most patient populations (Ding et al., 2014). The opportunity to lower the instance of complications, improve patient satisfaction, and reduce hospital costs should result in project acceptance and compliance by all involved parties.

Methods and Design

Practice Question and Project Planning

The first step of the PET process within the JHEBP model concerns project planning, mainly identifying a clinical issue and creating an evidence-based practice question (Dang et al., 2022). With the assembled project team, the issue of postoperative thoracic surgery pain was identified as an area for improvement for anesthesia providers. In order to address this issue, the

team developed the JHEBP model practice question. The development resulted in the PICOT question: In patients that undergo unilateral thoracotomy surgery (P), how does paravertebral blockade (I) vs. traditional methods (C) affect analgesic efficacy and the occurrence of urinary retention, hypotension, respiratory complications, and opioid administration(O) during the postoperative hospital stay (T)?

The last part of the JHEBP planning phase includes identifying stakeholders (Dang et al., 2022). Key stakeholders for the project include the anesthesia providers, thoracic surgeons, PACU nursing staff, the hospital finance department, pharmacists, and the patients. It is important to note that each stakeholder holds a different interest within the project. The stakeholders have the ability to both progress and impede the project initiative and therefore strategies for stakeholder engagement should be considered (Dang et al., 2022).

Evidence

The JHEBP model emphasizes thorough research and analysis and synthesis of current research to direct the development of evidence-based recommendations (Dang et al., 2022). A literature review was conducted to accumulate current evidence-based data relevant to the optimization of postoperative pain control in adult post-thoracotomy patients. The literature was evaluated and appraised to ensure that the highest quality evidence was used to support the project initiative. The most current and highest quality evidence supports the incorporation of regional or neuraxial anesthesia into the post-thoracotomy pain management plan with extremely comparable pain control efficacy. After synthesizing the collection of data from the literature, it was concluded that the PVB technique is associated with adequate pain control and fewer complications, and should be implemented for appropriate patients following thoracic surgery. The synthesis of literature and evidence was discussed more in-depth within the “Literature

Review" and “Synthesis of Evidence” sections of this project. A copy of the literature synthesis table is included in Appendix C.

Translation

The final steps of the JHNEBP model involve translating data into practice. The literature is used to operationalize data and create a strategic action plan to implement improved practice standards (Dang et al., 2022). Evidence regarding the efficacy of incorporating regional anesthesia into post-thoracotomy pain management standards was evaluated for relevance, validity, and clinical applicability. After thorough data analysis and synthesis, the practice setting-specific recommendation of PVB was created. An action plan for the implementation of PVB was then created and will be discussed in detail within the “Implementation” section of this paper.

The JHENP model incorporates reflection into every stage of project development, but is specifically outlined within the final translation process (Dang et al., 2022). Following the implementation of the action plan, the process and outcomes will be continuously evaluated to determine the need for revisions or project improvements. Once the implementation and outcome analysis phases are complete findings and results will be reported to the appropriate stakeholders for review and ultimately disseminated publicly.

Implementation

Patients undergoing thoracic surgery represent an opportunity for improvement as a population that experiences high levels of pain and are at risk for serious postoperative complications (Mesbah et al., 2016). Currently, the hospital lacks up-to-date postoperative pain management guidelines for this specific surgical population. The goal of this project is to provide

evidence-based guidelines for integrating PVB into the postoperative pain management plan and ERAS protocols for post-thoracic surgery patients.

Planning

After identifying the improvement opportunity, the project team performed a literature review and analysis. The review of literature indicated a significant improvement in patient satisfaction and outcomes with the incorporation of regional anesthesia into ERAS protocols for thoracic surgery patients. In 2019, Batchelor et al. published an ERAS protocol for thoracic surgery in the European Journal of Cardiothoracic Surgery, which is provided in Appendix D. The project team prioritized anesthesia-related improvement opportunities and focused on the incorporation of regional anesthesia into perioperative thoracic surgery pain management.

Stakeholders

The implementation of a QI project significantly impacts the stakeholders at the participating hospital. Hospital administrators, operating room staff, anesthesia providers, and thoracic surgeons are all affected by the study. The most significant beneficiary of the success of the project will be the patients, who will experience less perioperative pain, a shorter length of stay related to reduced postoperative complications, and a lower out-of-pocket healthcare cost. The participating hospital will also benefit from reduced costs related to lowered pharmaceutical and equipment costs as a result of fewer postoperative complications and adjunct pain medication requirements, increased patient turnover, and improved patient satisfaction scores.

Project Team Assembly and Education

Project champions will be selected on a volunteer basis to help provide support and answer questions for other staff members. The project leader will facilitate a presentation to the anesthesia and surgical departments of the participating hospital outlining the benefits and

rationale of incorporating regional anesthesia into thoracic perioperative pain management regimens. The presentation will include evidence-based recommendations regarding required supplies and equipment, ultrasound guided placement technique, LA selection and dosage, and postoperative care. The project leader will also present separately to nursing and support staff regarding the postoperative care and accurate documentation for patients who have received PVB, as well as answer staff questions.

The provider presentation meeting will be used to assess the anesthesia providers' previous experience and self-reported comfort level with PVB, with special consideration for ultrasound guided placement technique. For those anesthesia providers who are unfamiliar with the placement, project champions will provide hands-on check-offs to ensure proper technique is used. Providers will be able to identify specific anatomical markers, including the spinal transverse process, costotransverse ligament, and the paravertebral space. Providers will also be able to verbalize that the widening of the paravertebral space and anterior displacement of the pleura confirm proper PVB placement.

Population

Following the presentations and project team assembly, the action phase will begin. The target patient population for inclusion in the QI project includes adults between the ages of 18-65 that undergo unilateral thoracic surgery. Exclusion factors include patients outside the specified age range, patients requiring bilateral thoracic surgery, patients with confounding comorbidities such as active infection or severe cardiac disease, patients with allergies to LAs, and patients with preventative anatomical conditions such as spinal column injuries or implanted hardware.

Implementation Plan

During the four-month implementation phase, all patients that meet the inclusion criteria will undergo PVB during the perioperative period. To facilitate direct comparison, data will be collected from the charts of participating patients that receive PVB, and will be compared to previous patients' charts that received the hospital's previous standard of care of IV and oral analgesics. All regional anesthesia will be administered by an anesthesia provider (including anesthesiologists, anesthesia residents, CRNAs, and SRNAs) utilizing ultrasound guidance.

Data Collection

Data will be collected from the electronic medical record (EMR). During the 72 hours following surgery, vital signs, pain scores using the Numeric Rating Scale (NRS), total opioid utilization, time to the first request for breakthrough pain medication will be noted. Any documented occurrence of urinary retention, hypotension, or respiratory compromise will also be noted. Urinary retention will be defined as no void within eight hours with a bladder scan reading greater than 300 mL, or a post-void residual of greater than 100 mL. Instances of hypotension will be defined as blood pressure recordings with a mean arterial pressure below 65 mmHg or systolic pressure less than 90 mmHg. Symptoms of respiratory compromise will include a pulse oximeter reading of less than 92%, increasing oxygen requirements to maintain oxygen saturation, an arterial partial pressure of oxygen (PaO_2) less than 60 mmHg, partial pressure of carbon dioxide ($PaCO_2$) greater than 45 mmHg, an increased lactate unrelated to hypovolemia or anemia, and new onset of pulmonary congestion or atelectasis as seen on radiologic imaging.

Reflection and Revision

Adjustments will be made to the QI initiative based on collected data and feedback from project stakeholders. The project leader will hold monthly department meetings with the project team for discussion of the current patient outcomes and satisfaction, as well as any perceived limitations or barriers to the QI initiative. Potential barriers include disruption of workflow, surgeon pushback, and inaccurate charting. If barriers are identified, a forum for proposed solutions will be held and the project will be adjusted accordingly to align with specific departmental priorities and ensure the initiative continues to be implemented to its full extent.

Project Timeline

Following the project team identification, the educational presentations will be created. This phase of the project is projected to take approximately two weeks. The initial project presentations will take place at various times over one week to accommodate the majority of department member's schedules. Providers will be able to choose between a Monday, Wednesday, or Friday presentation. The Monday presentation will take place at 1200, the Wednesday presentation at 1930, and the Friday presentation at 0730. Following presentations, superusers will be chosen on a volunteer basis to assist in competency check-offs for providers who are unfamiliar with the technique. The check-off will include identifying the transverse processes, superior costo-transverse ligament, intertransverse ligaments, paravertebral space, and pleura using the parasagittal or transverse approach. The providers will be able to articulate that accurate needle positioning is confirmed with anterior displacement of the pleura and widening of the paravertebral space are visualized with ultrasound. The educational presentations for nursing staff will take place the week after the provider presentations and will follow the same

schedule, but will only last half an hour each. All presentation meetings and checkoffs should take place over two weeks.

Following the education phase, the active implementation process will begin and continue over four months, with a goal of including 80 patients in the study. During this time, all patients that meet inclusion criteria will undergo perioperative PVB. During these four months, monthly review meetings will be held to discuss project strengths, perceived barriers, and needed revisions. These meetings will occur during the last week of each month and follow the same schedule as the initial project presentations. If major limitations are identified (such as significant workflow disruptions or inaccurate charting), an additional month of implementation may be applied to evaluate the success of revision practices. The final month of the project will be data collection and data analysis. The total length of the QI initiative will be approximately six months.

Draft Budget Plan

The proposed budget for this scholarly project takes into consideration provider time commitments, required equipment, and medication costs. The estimated number of supplies needed was based upon the anticipated number of procedures performed. Approximately five unilateral thoracic surgeries are completed at the facility each week, resulting in an estimated total of 80 surgeries during the four month implementation phase. Based on the average hourly income per provider and anticipated supply costs for 80 procedures, the estimated budget for potential future use by the prospective project site is approximately $23,000.

Compensation for Time

The largest budget allotment is for provider time. The project presentation meetings will ideally be attended by all staff anesthesiologists, CRNAs, and thoracic surgeons, and last

approximately one hour. The hospital currently employs approximately 25 anesthesiologists, 45 CRNAs, and four thoracic surgeons. An itemized breakdown of estimated average salaries for required participants is available in Appendix F. Using the average hourly rate for each provider in Ohio, the total estimated cost of provider time is $10,200 (Ziprecruiter, 2023a,v2023b, 2023d). Monthly check-in meetings will be attended by the six appointed project champions, requiring an estimated additional $3,960 of compensation (Ziprecruiter, 2023a).

Approximately 45 nurses will be involved in the aftercare of the patients and will also be required to attend a presentation to ensure accurate data collection. These meetings will last approximately 30 minutes. The estimated cost of the nurse education presentations is $790 (Ziprecruiter, 2023c). Lastly, the project team lead will attend all presentations and monthly meetings, as well as perform all data collection and dissemination. The expected time required from the project lead is approximately 40 hours. The estimated cost of the project lead compensation based on average hourly wage is $1,400 (Ziprecruiter, 2023c).

Equipment Costs

The required equipment is based on the estimated number of PVBs and TEAs to be performed. The cost of two 25-count boxes of Stimuplex Echogenic needles is $1776 (MFIMedical, 2023). Five boxes of ten-count epidural kits is $1083 (MedEx Supply, 2023). Five boxes of fifty-count sterile gloves in various sizes is approximately $140 (McKesson, 2023a). The price for four boxes of 25-count chlorhexidine prep sticks is $214 (VitalityMedical, 2023). One box of 100-count 25 gauge one inch needles is $8 (McKesson, 2023b). One box of 100-count five mL syringes is $17 (McKesson, 2023c). One box of 100-count three mL syringes is $11 (McKesson, 2023c). Approximately ten bottles of ultrasound gel will be needed, and would cost $65 (Amazon, n.d.).

If the hospital desires to have a dedicated ultrasound machine for the project, a Butterfly IQ+ probe is $2,699, plus $199 for one year of membership (Butterfly Network, 2023). The probe is compatible with any apple iPad, which can be purchased for $279 (Walmart, 2023). As this additional cost is optional, the price of the dedicated ultrasound machine was not included in the estimated project budget plan.

Medication Costs

Lastly, the estimated cost of LA is variable depending on the amount used per LA administration. The total amount needed has been estimated based on the number of blocks anticipated. The current price for 2 boxes of 25-count 50 mL 1% lidocaine is $188 (Pfizer, 2023). The purchase of 120 30 mL vials of 0.5% ropivacaine costs $2640 (McGuff Medical Products, 2023). Eighty vials of 100 mcg of fentanyl is $52 (Waberski et al., 2022).

Outcome Analysis Plan

Data Collection

Following the implementation phase, the final one-month period of the project will be used for data analysis. The information will be retrospectively obtained from the electronic medical record (EMR). Data points will be collected from the charts of all thoracic surgery patients who received PVB during the four-month implementation phase, and from all thoracic surgery patients who received traditional pain relief methods during the four months prior to the implementation phase. The data points that will be collected are:

1. Numeric pain scores
2. Time until the first request for adjunct pain medication
3. Total narcotic utilization

4. Occurrence of complications and adverse events (including hypotension, urinary retention, and respiratory compromise as previously defined)

Data obtained from both groups will be placed into a secured Microsoft Excel file and analyzed using comparative analytics. The goal is to compare and contrast the overall effectiveness of pain control with the occurrence of adverse events and complications.

Data Analysis

Comparing specific analogous data points from pre- and post-intervention will determine the effectiveness and feasibility of implementing PVB in the perioperative thoracic surgery setting. Directly comparing pain scores, adjunct pain medication and narcotic utilization will help to determine the pain control efficacy of PVB compared to traditional methods. Incidence rates of complications and length of stay will be directly compared. However, additional evaluation and data collection over a longer period of time may be required to determine the true effect on long-term patient outcomes, such as the development of persistent pain syndromes.

Outcomes

Implementing perioperative PVB for postoperative thoracic surgery pain control will ideally reduce opioid utilization, minimize respiratory complications, and reduce instances of hypotension, and urinary retention. Reducing pain and adverse events will improve patient satisfaction and lower hospital costs. In the event that data analysis shows no statistical difference between the two pain control methodologies or an increase in adverse events, an extensive project review will take place. The project objectives and assessment methods will be re-evaluated, and a second in-depth review of the current literature will occur. Collaborative input from project leads, providers, and other stakeholders will be used to evaluate project significance and re-strategize the implementation process if necessary.

Barriers, Limitations, and Future Directions

Barriers to successful project implementation include significant provider workflow disruptions, patient cooperation, and inaccurate charting. PVB is a technically challenging block and, therefore, does take time to perform. Additionally, patient cooperation can greatly affect the time required if performed preoperatively. Significant added procedure time may prove prohibitory for some providers. The project design attempts to minimize possible barriers; however, total mitigation is unlikely.

This project explicitly targets four main outcome objectives to evaluate the pain control efficacy and occurrence of complications related to PVB after thoracic surgery. Variations between local anesthetic doses, provider skill level, and the complexity of surgery may affect these outcomes. Future projects may consider evaluating the effect of different local anesthetic usage and adjunct combinations as well as aggregating procedure-specific data. Other outcomes that may be valuable for future project investigation include the time to first ambulation following surgery, the occurrence of a failed block, and the overall length of hospital stay.

Unexpected obstacles or limitations encountered during the implementation process will be discussed during monthly meetings with the project team, providers, and stakeholders. All project stakeholders will be able and encouraged to attend the monthly review meeting to raise personal concerns or identify perceived barriers. The meetings will also include strategizing possible solutions to implement if issues occur.

Conclusion

Postoperative thoracotomy pain is challenging to manage and can be detrimental to patient health. Routine administration of PVB for unilateral thoracotomies could result in lower instances of postoperative hypotension, urinary retention, and respiratory complications. The

data collected will be used to support incorporating PVB into thoracic surgery ERAS protocols for unilateral thoracic surgery. All encountered barriers to project implementation will be addressed, and changes will be made accordingly to ensure improved compliance. Standardized postoperative pain management in thoracic surgery will help to minimize complications, hospital costs, and ultimately improve patient outcomes and satisfaction.

References

Amazon. (n.d.). *Parker Laboratories Aquasonic Ultrasound Gel .25 Liter Bottle*. Retrieved September 11, 2023, from https://www.amazon.com/Parker-Laboratories-Aquasonic-Ultrasound-Bottle/dp/B000ERJDX4/ref=asc_df_B000ERJDX4/?tag=hyprod-20&linkCode=df0&hvadid=642170619269&hvpos=&hvnetw=g&hvrand=12123320958054700164&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9014961&hvtargid=pla-565059465521&psc=1&gclid=Cj0KCQjwmICoBhDxARIsABXkXlKeLESV3N3-wCCGzIxHSxno_RZpp2pGwEA7CDL6bAToyhwS1TE0YEAaAt1HEALw_wcB

Batchelor, T. J. P., Rasburn, N. J., Abdelnour-Berchtold, E., Brunelli, A., Cerfolio, R. J., Gonzalez, M., Ljungqvist, O., Petersen, R. H., Popescu, W. M., Slinger, P. D., & Naidu, B. (2019). Guidelines for enhanced recovery after lung surgery: recommendations of the Enhanced Recovery After Surgery (ERAS®) Society and the European Society of Thoracic Surgeons (ESTS). *European journal of cardio-thoracic surgery : official journal of the European Association for Cardio-thoracic Surgery, 55*(1), 91–115.

Batra, R. K., Krishnan, K., & Agarwal, A. (2011). Paravertebral block. *Journal of anaesthesiology, clinical pharmacology, 27*(1), 5–11.

Blackshaw, W. J., Bhawnani, A., Pennefather, S. H., Al-Rawi, O., Agarwal, S. & Shaw, M. (2018). Propensity score-matched outcomes after thoracic epidural or paravertebral analgesia for thoracotomy. *Anaesthesia*, 73, 444-449. https://doi.org/10.1111/anae.14205

Brescia, A.A., Harrington, C.A., Mazurek, A.A., Ward, S.T., Lee, J.S., Hu, H.M., Brummett, C.M., Waljee, J.F., Lagisetty, P.A., & Lagisetty, K.H. (2019). Factors associated with new persistent opioid usage after lung resection. *The Society of Thoracic Surgeons 2019*(107):363-368. https://doi.org/10.1016/j.athoracsur.2018.08.057

Butterfly Network, (2023). *Choose a Butterfly Solution*. Retrieved September 11, 2023, from https://store.butterflynetwork.com/us/en/offer/

Cadavid-Puentes, A.M., Cases-Arroyave, F.D., Palacio-Montoya, L.M., & Valencia-Gallon, E. (2020). Efficacy of paravertebral block techniques in thoracic surgery: Systematic literature review. *Colombian Journal of Anesthesiology, 48*(1), 20-29. DOI: 10.1097/CJ9.0000000000000151

Collier, R. (2018). A short history of pain management. *Canadian Medical Association Journal 190*(1), 26–27. https://doi.org/10.1503/cmaj.109-5523

Dang, D., Dearholt, S., Bissett, K., Ascenzi, J., & Whalen, M. (2022). *Johns Hopkins evidence-based practice for nurses and healthcare professionals: Model and guidelines.* 4th ed. Sigma Theta Tau International

D'Ercole, F., Arora, H., & Kumar, P. A. (2018). Paravertebral block for thoracic surgery. *Journal of Cardiothoracic and Vascular Anesthesia 32*(2), 915-927. https://doi.org/10.1053/j.jvca.2017.10.003.

Ding, X., Jin, S., Niu, X., Ren, H., Fu, S., & Li, Q. (2014). A comparison of the analgesia efficacy and side effects of paravertebral compared with epidural blockade for thoracotomy: An updated meta-analysis. *Plos one, 9*(5) 96233. DOI:10.1371/journal.pone.0096233.g001

Elisha, S., Heiner, J.S., & Nagelhout, J.J. (2023). *Nurse anesthesia* (7th ed.). Elsevier.

Finkelman, A. (2022). *Quality improvement: A guide for integration in nursing* (2nd ed.). Jones & Bartlett Learning.

Flood, P., Rathmell, J.P., & Shafer, S. (2022). *Stoelting's pharmacology & physiology in anesthetic practice* (6th ed.).Wolters Kluwer.

Gupta, R., Van de Ven, T., & Pyati, S. (2020). Post-thoracotomy pain: Current strategies for prevention and treatment. *Drugs 2020*(80): 1677-1684. https://doi.org/10.1007/s40265-020-01390-0

Hernandez, A.N., & Singh, P. (2022). *Epidural anesthesia*. StatPearls. StatPearls Publishing. Retrieved from: https://www.ncbi.nlm.nih.gov/books/NBK542219/

Horn, R., & Kramer, J. (2022). *Postoperative Pain Control.* StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK544298/

Kodia, K., Stephens-McDonnough, J. A., Alnajar, A., Villamizar, N. R., & Nguyen, D. M. (2021). Implementation of an enhanced recovery after thoracic surgery care pathway for thoracotomy patients-achieving better pain control with less (schedule II) opioid utilization. *Journal of thoracic disease*, *13*(7), 3948–3959. https://doi.org/10.21037/jtd-21-552

Liang, X. L., An, R., Chen, Q., & Liu, H. L. (2021). The analgesic effects of thoracic paravertebral block versus thoracic epidural anesthesia after thoracoscopic surgery: a meta-analysis. *Journal of Pain Research*, 14, 815–825. https://doi.org/10.2147/JPR.S299595

Mahmoudi, K., Rashidi, M., Soltani, F., Savaie, M., Hedayati, E., & Rashidi, P. (2021). Comparison of the intercostal nerve block with ropivacaine and ropivacaine-dexmedetomidine for postoperative pain control in patients undergoing thoracotomy: A randomized clinical trial. *Anesthesiology and Pain Medicine 11*(6) e118667. DOI: 10.5812/aapm.118667

McGuff Medical Products. (2023). *Ropivacaine HCL, 0.5% (5mg/mL), SDV 30mL*. Retrieved September 11, 2023, from https://www.mcguffmedical.com/ropivacaine-hcl-05-5mgml-sdv-30ml-2

McKesson. (2023a). *McKesson Exam Glove Confiderm STR Large Sterile Pair Nitrile Standard Cuff Length Textured Fingertips Blue Not Chemo Approved, 50 EA/BX.* Retrieved September 10, 2023, from https://www.bettymills.com/exam-glove-confiderm-str-large-sterile-pair-nitrile-standard-cuff-length-textured-fingertips-blue-not-chemo-approved-50-ea-bx-14-6nstr6?gclid=Cj0KCQjwmICoBhDxARIsABXkXlKrkEgFuNSQ-KT78s1XWjv_GrgjewIJogB89j8kBZNf6dz-m0HPOScaAq0jEALw_wcB

McKesson. (2023b). *McKesson Hypodermic Needle Without Safety 25 Gauge 1 Inch Length, 100/BX.* Retrieved on September 11, 2023, from https://www.bettymills.com/hypodermic-needle-without-safety-25-gauge-1-inch-length-100-bx-16-n251

McKesson. (2023c). *General Purpose Syringe 5 mL Blister Pack Luer Lock Tip Without Safety, 100/BX*. Retrieved on September 11, 2023, from https://www.bettymills.com/general-purpose-syringe-5-ml-blister-pack-luer-lock-tip-without-safety-100-bx-16-s5c?gclid=Cj0KCQjwmICoBhDxARIsABXkXlIiukJ3TgCkLPKsPhe7Q0hez_nggz350q0-V3b6nkQf1XN4p5WzOj4aAsBSEALw_wcB

MedEx Supply. (2023). *Portex 4950 Continuous Epidural Mini-Pack Tray, 16G x 3 1/8" Tuohy Needle, 10/cs.* Retrieved on September 10, 2023, from https://medexsupply.com/portex-4950-continuous-epidural-mini-pack-tray-16g-x-3-1-8-tuohy-needle-10-cs/?sku=SMD-4950-16&gclid=Cj0KCQjwmICoBhDxARIsABXkXlLFaCSSA-S4HqH6F_nkiN8ajbMURNnaRGE9fF0NWvRVJ5hivNDqRnEaAmD_EALw_wcB

Medicare. (2023). *Overall hospital quality star ratings*. U.S. Centers for Medicare and Medicaid Services. Retrieved September 4, 2023, from https://www.medicare.gov/care-compare/details/hospital/360017?city=Columbus&state=OH&zipcode=

Mesbah, A., Yeung, J., & Gao, F. (2016). Pain after thoracotomy. *British Journal of Anesthesia Education 16*(1): 1-7. DOI: 10.1093/bjaceaccp/mkv005

MFIMedical. (2023). *B. Braun Stimuplex Ultra 360 Insulated Echogenic Needles*. Retrieved on September 10, 2023, from https://mfimedical.com/products/b-braun-stimuplex-ultra-360-insulated-echogenic-needle?variant=32327110164557

Pfizer. (2023). *Lidocaine (Xylocaine) Multiple-dose Plastic Flip-top 50mL Vial, 1%HCL, 20mg/mL*. Retrieved September 11, 2023, from https://www.buyemp.com/product/4276-02?selectedItem=4276-02&selectedUnit=BOX&gclid=Cj0KCQjwmICoBhDxARIsABXkXlKvsA1zrC5nAkaqm2gNa_YQJkXhn6KTs4KAn8_NjulhJn35qtTkNr0aAj3hEALw_wcB

Rajarajan, P. (2019). Clinical outcome of pain management in paravertebral block and continuous intercostal nerve block for post-thoracotomy pain. *International Archives of Integrated Medicine 6*(3): 99-104.

Santonastaso, D.P., de Chiara, A., Rispoli, M., Musetti, G., & Agnoletti, V. (2018). Real-time view of anesthetic solution spread during an ultrasound-guided thoracic paravertebral block. *Tumori Journal, 104*, NP50 - NP52. DOI:10.1177/0300891618763212

Tamura, T., Mori, S., Mori, A., Ando, M., Yokota, S., Shibata, Y., & Nishiwaki, K. (2017). A randomized controlled trial comparing paravertebral block via the surgical field with thoracic epidural block using ropivacaine for post-thoracotomy pain relief. *Journal of Anesthesia,* 31*(*2), 263–270. https://doi.org/10.1007/s00540-017-2307-5

Tippireddy, S., & Ghatol, D. (2023). *Anesthetic management for enhanced recovery after major surgery (ERAS).* StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK574567/

Vitality Medical. (2023). *Chloraprep*. Retrieved September 11, 2023, from https://www.vitalitymedical.com/chloraprep.html?gclid=Cj0KCQjwmICoBhDxARIsABXkXlLBITXVdXg37xV6Kr7GUvPnTWeq_BFoiIGHYDYS3Ye89ve89g94Gv0aAvmUEALw_wcB

Waberski, A. T., Cronin, J., Hammer, B., Braffett, B. H., & Heitmiller, E. (2022). What a waste: Perioperative fentanyl wastage at a pediatric hospital. *The Journal of Pediatric Pharmacology and Therapeutics : JPPT : The Official Journal of PPAG, 27*(2), 120–122. https://doi.org/10.5863/1551-6776-27.2.120

Walmart. (2023). *Apple 10.2-inch iPad Wi-Fi 64GB - Silver (9th Generation)*. Retrieved September 11, 2023, from https://www.walmart.com/ip/2021-Apple-10-2-inch-iPad-Wi-Fi-64GB-Silver-9th-Generation/674982024?wmlspartner=wlpa&selectedSellerId=0

Wojtyś, M. E., Wąsikowski, J., Wójcik, N., Wójcik, J., Wasilewski, P., Lisowski, P., & Grodzki, T. (2019). 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*, 14(1), 78. https://doi.org/10.1186/s13019-019-0901-3

Wong, J., Cooper, J., Thomas, R., Langford, R., & Anwar, S. (2019). Persistent postsurgical pain following thoracotomy: a comparison of thoracic epidural and paravertebral blockade as preventive analgesia. *Pain Medicine, 20*(9), 1796–1802. DOI: 10.1093/pm/pny293

Yaksi, O., Ozel, A., Yaksi, E., & Kilicgun, A. (2021). Postoperative complications and its relationship with the severity of postoperative pain in patients undergoing thoracic surgery. *Experimental Biomedical Research, 4*(2), 107–112. https://doi.org/10.30714/j-ebr.2021267973

Zengin, M., & Alagoz, A. (2021). Comparison of thoracic epidural analgesia and thoracic paravertebral block applications in the treatment of acute pain after thoracotomy in geriatric patients. *Cureus, 13*(10), 18982. DOI: 10.7759/cureus.

ZipRecruiter. (2023a). *Anesthesiologist Salary in Ohio*. Retrieved September 10, 2023, from https://www.ziprecruiter.com/Salaries/Anesthesiologist-Salary--in-Ohio

ZipRecruiter. (2023b). *CRNA Salary in Ohio*. Retrieved September 10, 2023, from https://www.ziprecruiter.com/Salaries/CRNA-Salary--in-Ohio

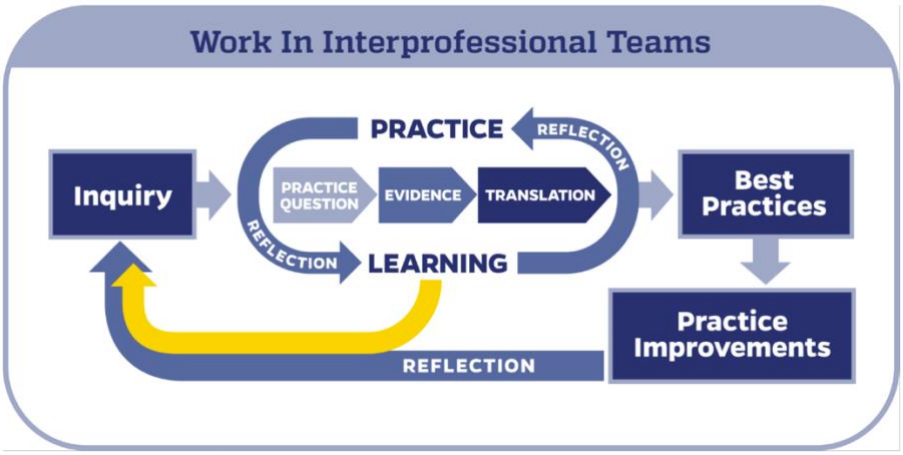
ZipRecruiter. (2023c). *RN Salary in Ohio*. Retrieved September 10, 2023, from https://www.ziprecruiter.com/Salaries/Entry-Level-RN-Salary--in-Ohio

ZipRecruiter. (2023d). *Thoracic Surgeon Salary in Ohio*. Retrieved September 10, 2023, from https://www.ziprecruiter.com/Salaries/Thoracic-Surgeon-Salary--in-Ohio

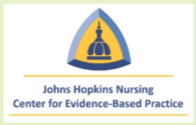
Appendix A

Figure 1

The Johns Hopkins Evidence-Based Practice Model for Nursing and Healthcare Professional



Appendix B



Thank you for your submission.
We are happy to give you permission to use the Johns Hopkins Evidence-Based Practice model and tools to adhere to our legal terms noted below.
No further permission for use is necessary.

You may not modify the model or the tools without written approval from Johns Hopkins.
All references to source forms should include "© 2022 Johns Hopkins Health System/Johns Hopkins School of Nursing."
The tools may not be used for commercial purposes without special permission.
If interested in commercial use or discussing changes to the tool, please email ijhn@jhmi.edu.

Available Downloads:

2022 JHEBP Tools- English version

2022 JHEBP Tools- Spanish version

2022 JHEBP Tools- Chinese version

2022 JHEBP Tools- Portuguese version

Would you like to join us? *Group rates are available, email ijhn@jhmi.edu to inquire.*

EBP Boot Camp: We are offering a 5-day intensive Boot Camp where you will learn and master the entire EBP process from beginning to end. Take advantage of our retreat-type setting to focus on your project, collaborate with peers, and get expertise and assistance from our faculty. *COMING in 2024!*

EBP Skill Build: This 3-day virtual workshop gives you a front-row seat to our EBP training and provides every participant with the guidance and support they need to get their EBP projects started.

Appendix C

Appendix A: Evidence Review Worksheet Assignment C								
APA Citation: Blackshaw, W. J., Bhawnani, A., Pennefather, S. H., Al-Rawi, O., Agarwal, S. & Shaw, M. (2018). Propensity score-matched outcomes after thoracic epidural or paravertebral analgesia for thoracotomy. *Anaesthesia*, 73, 444-449. https://doi.org/10.1111/anae.14205								
Conceptual Framework or Model	***Design or Method***	***Sample & Setting***	***Major Variables Studied & their Definitions, if any***	***Outcome Measurement(s)***	***Data Analysis***	***Findings***	***Level of Evidence***	***Quality of Evidence: Critical Worth to Practice***
Theoretical basis for the study: Not explicitly stated.	Retroactive Cohort/ Case -Control study	**Number of Characteristics:** 1619 total pts 828 received TEA and 791 received PVB. 324 from each group were used in final analysis after propensity matching. **Exclusion Criteria:** None stated. **Attrition:** N/A **Setting:** Adult acute care pts receiving open lung resection via thoracotomy between 1/2008-12/2012	**Independent variables:** **IV1=** Post-thoracotomy pain management technique: either treatment with thoracic epidural or paravertebral blockade. **Dependent variables:** Instance of postoperative complications and length of stay.	**Scale(s) used:** instance of: - in-hospital death - intensive care readmission - length of hospital stay - respiratory complications - any other complication **Reliability information (*alphas*, if any):** N/A	**Statistical tests, if any:** unmatched: Wilcoxon rank sum tests and chi-squared test matched: McNemar and signed rank tests Kaplan-Meier estimates for post op discharge **Qualitative analysis, if any:** N/A	**Statistical findings, if any:** Total number of complications in epidural group: 201 (24%) Total number of complications in paravertebral group: 163 (21%) p = 0.08 Propensity-matched epidural group complications: 80 (25%) Propensity-matched paravertebral group: 78 (24%) p = 0.85 **Qualitative findings, if any:** N/A	IV	**Strengths:** Direct comparison of block usage in thoracotomy pts **Limitations:** -retroactive analysis -Patients were able to choose their pain control method. -Analgesic efficacy was not evaluated due to incomplete data. - small sample size **Risk or harm if implemented:** N/A **Feasibility of use in the project practice area:** Evidence for comparable complication rate of both TEA and PVB usage.

APA Citation: Cadavid-Puentes, A.M., Cases-Arroyave, F.D., Palacio-Montoya, L.M., & Valencia-Gallon, E. (2020). Efficacy of paravertebral block techniques in thoracic surgery: Systematic literature review. *Colombian Journal of Anesthesiology, 48*(1), 20-29. DOI: 10.1097/CJ9.0000000000000151								
Conceptual Framework or Model	***Design or Method***	***Sample & Setting***	***Major Variables Studied & their Definitions, if any***	***Outcome Measurement(s)***	***Data Analysis***	***Findings***	***Level of Evidence***	***Quality of Evidence: Critical Worth to Practice***
Theoretical basis for the study: Not explicitly stated.	Systematic Review	**Number of Characteristics:** 386 studies reviewed for inclusion. 38 studies included in final analysis. **Exclusion Criteria:** Repeat studies & those not published in english or spanish **Attrition:** 348 studies did not meet criteria. **Setting:** Pts over 18 undergoing open chest surgery and using PVB as a single analgesic technique or in comparison with other techniques up til 7/2018.	**Independent variables:** **IV1=** PVB technique **Dependent variables:** -Opioid consumption - incidence of complications	**Scale(s) used:** Post-operative analgesia measured by visual analog scale (VAS) -Opioid consumption equivalent to morphine **Reliability information (*alphas*, if any):** N/A	**Statistical tests, if any:** N/A **Qualitative analysis, if any:** Method not explicitly stated Evaluation subjective by 2 to 3 researchers.	**Statistical findings, if any:** N/A **Qualitative findings, if any:** In terms of postoperative analgesia, placement with direct visualization by surgeon had the most variable of pain control, with ultrasound guided having the most consistent results. Opioid consumption was more difficult to evaluate due to differing anesthetic use, however anatomic guided placement yielded less opioid use.	I	**Strengths:** -Many studies reviewed, large sample number -biases disclosed. **Limitations:** **-** lack of detailed description of PVB placement technique in analyzed studies **-** 50% of included didn't meet requirement of allocation concealment and/or staff blinding -varying methods of analysis between studies **Risk or harm if implemented:** N/A **Feasibility of use in the project practice area:** Provides evidence for most effective PVB administration route.

APA Citation: D'Ercole, F., Arora, H., & Kumar, P. A. (2018). Paravertebral block for thoracic surgery. *Journal of Cardiothoracic and Vascular Anesthesia 32*(2), 915-927. https://doi.org/10.1053/j.jvca.2017.10.003.								
Conceptual Framework or Model	***Design or Method***	***Sample & Setting***	***Major Variables Studied & their Definitions, if any***	***Outcome Measurement(s)***	***Data Analysis***	***Findings***	***Level of Evidence***	***Quality of Evidence: Critical Worth to Practice***
Theoretical basis for the study: Not explicitly stated.	Meta-analysis/Systematic Review]	**Number of Characteristics:** Not explicitly stated, however, 95 article references provided. **Exclusion Criteria:** Not explicitly stated **Attrition:** Not explicitly stated. **Setting:** Review of PRJs an RCTs from Medline, EMBASE, and Cochrane Library from Jan 1995 to Jan 2017.	**Independent variables:** **IV1=** Postoperative Pain control technique via PVB or other method **IV2:** PVB placement technique **IV3:** LA dosage and adjuncts **Dependent variables:** Post operative pain control, incidence of side effects such as hemodynamic instability, risk of pneumothorax, failed block, LAST, pulmonary complications, risk of hematoma/bleeding, and neurologic sequelae.	**Scale(s) used:** Not explicitly stated. **Reliability information (*alphas*, if any):** None listed.	**Statistical tests, if any:** Not explicitly stated. **Qualitative analysis, if any:** Not explicitly stated.	**Statistical findings, if any:** Not explicitly stated. **Qualitative findings, if any:** Analysis demonstrates "non-inferiority" of PVB compared with TEA for postop analgesia, with fewer side effects, with a need for further research into the long-term efficacy as well as the neuropathic parameter.	I	**Strengths:** - Includes a range of RCTs, with large sample size. - Considers placement technique with detailed descriptions - Considers med & dosages **Limitations:** - Does not directly compare/evaluate TEA vs PVB placement - Many sources of heterogeneity within studies. **Risk or harm if implemented:** None. **Feasibility of use in the project practice area:** More in depth evaluation of efficacy dependent on variation within PVB itself, also compared with TEA. Provides thorough background information.

APA Citation:

Ding, X., Jin, S., Niu, X., Ren, H., Fu, S., & Li, Q. (2014). A comparison of the analgesia efficacy and side effects of paravertebral compared with epidural blockade for thoracotomy: An updated meta-analysis. Plos one, 9(5) 96233. DOI: 10.1371/journal.pone.0096233.g001

Conceptual Framework or Model	***Design or Method***	***Sample & Setting***	***Major Variables Studied & their Definitions, if any***	***Outcome Measurement(s)***	***Data Analysis***	***Findings***	***Level of Evidence***	***Quality of Evidence: Critical Worth to Practice***
Theoretical basis for the study: Not explicitly stated.	Meta-analysis/Systematic Review	**Number of Characteristics:** 18 trials were included in the study. **Exclusion Criteria:** Studies not published in English, non-thoracotomy surgeries, studies regarding breast cancer and lumbar epidural **Attrition:** 0 **Setting:** 2 researchers used Pubmed, EMBASE, and Cochrane Library for RCT reports between 1/2006 and 2/2013.	**Independent variables:** **IV1=** Post thoracotomy pain management technique, either TEA or PVB. **Dependent variables:** - Postoperative pain scores - Incidence of complications including pulmonary, urinary retention, nausea and vomiting, hypotension, and failed rate of block.	**Scale(s) used:** Visual Analog Scale for pain **Reliability information (*alphas*, if any):** N/A	**Statistical tests, if any:** I squared statistic Chi-squared test. **Qualitative analysis, if any:** -Mean difference -Odds ratio -Confidence intervals	**Statistical findings, if any:** No statistically significant differences were observed in the pain control efficacy between methods. PVB demonstrated lower instances of urinary retention ($p<0.0001$), nausea and vomiting ($p=0.01$), hypotension ($p<0.00001$), and rates of failed block ($p=0.01$) **Qualitative findings, if any:** None listed.	I	**Strengths:** **-** Many studies analyzed, large sample size. **Limitations:** - 2 researchers utilized, disputes settled by 3rd researcher. - some low quality data used with high risk of bias. -No detailed description or standardization of insertion technique or medications used. **Risk or harm if implemented:** None. **Feasibility of use in the project practice area:** Most complete data set concerning the direct comparison between the pain control efficacy and complication rate of PVB vs TEA in thoracotomy patients.

APA Citation:

Liang, X. L., An, R., Chen, Q., & Liu, H. L. (2021). The analgesic effects of thoracic paravertebral block versus thoracic epidural anesthesia after thoracoscopic surgery: a meta-analysis. *Journal of Pain Research*, 14, 815–825. https://doi.org/10.2147/JPR.S299595

Conceptual Framework or Model	***Design or Method***	***Sample & Setting***	***Major Variables Studied & their Definitions, if any***	***Outcome Measurement(s)***	***Data Analysis***	***Findings***	***Level of Evidence***	***Quality of Evidence: Critical Worth to Practice***
Theoretical basis for the study: Not explicitly stated.	Systematic Review/Meta-Analysis	**Number of Characteristics:** Across 5 RCTs, 458 thoracoscopic surgery patient cases were evaluated. **Exclusion Criteria:** RCTs with mission or incomplete data, conference proceedings without detailed study data, articles not published in english. **Attrition:** 0 **Setting:** All RCTs took place between 2015 and October 2020. Only adult cases were reviewed. PubMed, EMBASE, and Cochrane library data reviewed.	**Independent variables:** **IV1=** postoperative pain control with either TEA or PVB. **Dependent variables:** Postoperative pain, supplemental opioid use, hypotension, and PONV.	**Scale(s) used:** Numeric Rating Scale for pain Visual Analog Scale for pain Verbal Rating Scale for pain **Reliability information (*alphas*, if any):** Not listed.	**Statistical tests, if any:** Confidence Intervals Inverse variance method Standard mean difference Mantel-Haenszel method **Qualitative analysis, if any:** Not stated.	**Statistical findings, if any:** Average pain scores within the first 6 hours after surgery among those that received thoracic epidural analgesia were lower ($p < 0.0001$), with lower supplemental morphine use ($p = 0.04$). The rate of hypotension was higher in the epidural group ($p = 0.0002$). No difference in instance of PONV. **Qualitative findings, if any:** None listed.	I	**Strengths:** - Analysis of many RCTs resulting in larger sample size. **Limitations:** - Only 5 RCTs included. - many sources of heterogeneity within data - some degree of selection bias **Risk or harm if implemented:** None. **Feasibility of use in the project practice area:** Further evidence of the comparable pain management efficacy of PVB vs TEA.

APA Citation:
Rajarajan, P. (2019). Clinical outcome of pain management in paravertebral block and continuous intercostal nerve block for post-thoracotomy pain. *International Archives of Integrated Medicine 6*(3): 99-104.

Conceptual Framework or Model	***Design or Method***	***Sample & Setting***	***Major Variables Studied & their Definitions, if any***	***Outcome Measurement(s)***	***Data Analysis***	***Findings***	***Level of Evidence***	***Quality of Evidence: Critical Worth to Practice***
Theoretical basis for the study: Not explicitly stated.	Single Randomized Controlled Trial	**Number of Characteristics:** 50 adult pts, 25 received PVB and 25 INB **Exclusion Criteria:** lack of patient consent, inability to comprehend pain scale, localized or systemic sepsis, contraindications to regional technique, need for additional incision, coagulopathy or metabolic disease. **Attrition:** 0 **Setting:** Adult acute care patients undergoing elective posterolateral thoracotomy at Government Mohan Kumaramangalam Medical College Hospital between 2016 and 2017.	**Independent variables:** **IV1=** Postoperative pain management technique, using either PVB or intercostal nerve block. **Dependent variables:** - Postoperative pain scores - opioid consumption - pulmonary function - incidence of complications.	**Scale(s) used:** Visual Analog Scale **Reliability information (*alphas*, if any):** N/A	**Statistical tests, if any:** Not explicitly stated. **Qualitative analysis, if any:** Not explicitly stated.	**Statistical findings, if any:** Both techniques are effective at relieving postoperative pain, with statistically significant lower pain scores with PVB vs INB. **Qualitative findings, if any:** Not stated.	II	**Strengths:** - Randomized trial - Medications and dosages listed - placement technique described. **Limitations:** - Small sample size - Not double blind - No statistical analysis listed - Only information reported from 48 hours after surgery - conditions of surgery not well standardized. **Risk or harm if implemented:** None. **Feasibility of use in the project practice area:** Provides information regarding the incidence of complications following PVB.

APA Citation:

Tamura, T., Mori, S., Mori, A., Ando, M., Yokota, S., Shibata, Y., & Nishiwaki, K. (2017). A randomized controlled trial comparing paravertebral block via the surgical field with thoracic epidural block using ropivacaine for post-thoracotomy pain relief. *Journal of Anesthesia*, 31*(*2), 263–270. https://doi.org/10.1007/s00540-017-2307-5

Conceptual Framework or Model	***Design or Method***	***Sample & Setting***	***Major Variables Studied & their Definitions, if any***	***Outcome Measurement(s)***	***Data Analysis***	***Findings***	***Level of Evidence***	***Quality of Evidence: Critical Worth to Practice***
Theoretical basis for the study: Not explicitly stated.	Single Randomized Controlled trial	**Number of Characteristics:** 80 initially enrolled, 72 used in final analysis. 32 patients received PVB, 32 received TEA. **Exclusion Criteria:** combined resection of parietal pleura, coagulation disorder, thrombocytopenia, anticoagulation therapy, and heart failure. **Attrition:** 8 **Setting:** Adults 20-80 with lung CA and ASA status of 1 or 2 electively scheduled for lobectomy via thoracotomy at the Japanese Red Cross Nagoya Daiichi Hospital between 3/2013 and 10/2014.	**Independent variables:** **IV1=** Postoperative pain control with either epidural block or PVB. **Dependent variables:** Postoperative pain control	**Scale(s) used:** Visual Analog scale **Reliability information (*alphas*, if any):** N/A	**Statistical tests, if any:** Turkey-Kramer test Pearson chi-squared test Wilcoxon rank-sum test **Qualitative analysis, if any:** T-Test	**Statistical findings, if any:** After two hours, all mean VAS scores were lower in the epidural group & the time to supplemental analgesic dose being approximately twice as long in the epidural group ($p < 0.01$). **Qualitative findings, if any:** N/A	II	**Strengths:** -Detailed description of insertion technique and med dosage. - highly controlled and standardized surgical conditions - Postop pain evaluation by "blinded" anesthesiologist **Limitations:** -Small sample size - Addition of opioids to local anesthetic solution not utilized. **Risk or harm if implemented:** None **Feasibility of use in the project practice area:** Although the results of the study are in conflict with expected outcomes, it still provides valuable information in post thoracotomy pain management.

APA Citation:

Wojtyś, M. E., Wąsikowski, J., Wójcik, N., Wójcik, J., Wasilewski, P., Lisowski, P., & Grodzki, T. (2019). 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,* 14(1), 78. https://doi.org/10.1186/s13019-019-0901-3

Conceptual Framework or Model	***Design or Method***	***Sample & Setting***	***Major Variables Studied & their Definitions, if any***	***Outcome Measurement(s)***	***Data Analysis***	***Findings***	***Level of Evidence***	***Quality of Evidence: Critical Worth to Practice***
Theoretical basis for the study: Not explicitly stated	Single Randomized Controlled Trial	**Number of Characteristics:** 60 adult patients, 30 PVB, 30 TEA **Exclusion Criteria:** - failure to obtain pt consent, clotting disturbances preventing region analgesia, infection in planned insertion area, spinal column deformation, difficulty with pain assessment, T4 tumors resulting in continuous pain. **Attrition:** 0 **Setting:** Adult acute care pts undergoing thoracotomy at Pomeranian Medical University in Szczecin, Poland.	**Independent variables:** **IV1=** Postoperative pain control with either TEA or PVB. **Dependent variables:** Postoperative pain control and quality.	**Scale(s) used:** -Numeric Pain Rating scale -Clinical Quality Indicators in Postoperative Pain Management Scale -Visual Analog Scale **Reliability information (*alphas*, if any):** N/A	**Statistical tests, if any:** T-Test Mann-Whitney U Test **Qualitative analysis, if any:** N/A	**Statistical findings, if any:** Mean pain relief score difference: p = 0.2 Difference in additional pain relief requirements: p = 0.07. Number of days of hospitalization: p = 0.15. No real statistical difference appreciated between the two methods. **Qualitative findings, if any:** N/A	II	**Strengths:** -Randomized - Detailed description of administration technique and dosage **Limitations:** - Small sample size - Cannot be double blind **Risk or harm if implemented:** N/A **Feasibility of use in the project practice area:** Effective direct comparison of pain management techniques under experimental conditions.

APA Citation: Wong, J., Cooper, J., Thomas, R., Langford, R., & Anwar, S. (2019). Persistent postsurgical pain following thoracotomy: a comparison of thoracic epidural and paravertebral blockade as preventive analgesia. *Pain Medicine, 20*(9), 1796–1802. DOI: 10.1093/pm/pny293								
Conceptual Framework or Model	***Design or Method***	***Sample & Setting***	***Major Variables Studied & their Definitions, if any***	***Outcome Measurement(s)***	***Data Analysis***	***Findings***	***Level of Evidence***	***Quality of Evidence: Critical Worth to Practice***
Theoretical basis for the study: Not explicitly stated.	Quasi experimental study	**Number of Characteristics:** 117 pts underwent thoracotomy. 113 had notes available. 82 pts in final analysis: 36 had TEB, 46 had PVB **Exclusion Criteria:** Previous thoracotomy, repeat incision before follow-up, death, failure to respond to telephone, failure of regional anesthesia. **Attrition:** 31 **Setting:** Adult lung cancer pts undergoing first time thoracotomy at Bartholomew's Hospital in London, England over a 1 year period.	**Independent variables:** **IV1=** Postoperative pain control with either TEB or PVB. **Dependent variables:** Occurrence of PPP and quality of life after surgery.	**Scale(s) used:** -Numeric Rating Scale for pain -Leeds Assessment of Neuropathic Symptoms and Signs -EuroQol-5 dimension tool to evaluate persistent postoperative pain **Reliability information (*alphas*, if any):** N/A	**Statistical tests, if any:** Student T-test Mann-Whitney U Test Chi-squared test logistic regression **Qualitative analysis, if any:** None stated.	**Statistical findings, if any:** PPP occurred in 21 (58.3%) of TEB patients and 28 (60.9%) of PVB patients. ($p = 0.82$).There was no statistically significant difference in the occurrence of PPP between the PVB or TEB intervention groups. The presence of PPP was associated with young age, poor acute pain management, and increased duration of surgery. **Qualitative findings, if any:** N/A	III	**Strengths:** - Takes long term pain management into consideration - uses adjunct opioids in LA solution **Limitations:** - Convenience sampling without randomization - choice in intervention made by surgeon based on perceived difficulty/recovery time. - only studied movement provoked pain following 3 coughs **Risk or harm if implemented:** None **Feasibility of use in the project practice area:** Provides data beyond immediate postoperative period

APA Citation:
Zengin, M., & Alagoz, A. (2021). Comparison of thoracic epidural analgesia and thoracic paravertebral block applications in the treatment of acute pain after thoracotomy in geriatric patients. *Cureus*, *13*(10), 18982. DOI: 10.7759/cureus.

Conceptual Framework or Model	***Design or Method***	***Sample & Setting***	***Major Variables Studied & their Definitions, if any***	***Outcome Measurement(s)***	***Data Analysis***	***Findings***	***Level of Evidence***	***Quality of Evidence: Critical Worth to Practice***
Theoretical basis for the study: Not explicitly stated.	Retroactive Cohort/Case-Control study	**Number of Characteristics:** 349 pts over 65 underwent thoracotomy. 106 included in the final analysis. **Exclusion Criteria: -** underwent other analgesic method -under 65 -emergency surgery -chronic pain before surgery - Hx of opioid abuse **Attrition:** 0 **Setting:** Pts over 65 undergoing thoracotomy surgery at Ankara KeciorenTraining and Research hospital	**Independent variables:** **IV1=** postoperative pain management intervention (either TEA or PVB) **Dependent variables:** - postoperative pain levels - additional analgesia requirements - incidence of side effects	**Scale(s) used:** Visual analog scale (Pain) **Reliability information (*alphas*, if any):** N/A	**Statistical tests, if any:** Kolmogorov Smirnov test, Levene test t-test Mann-Whitney U test Pearson's chi-squared Fisher's exact test **Qualitative analysis, if any:** N/A	**Statistical findings, if any:** While there was not statistically significant difference found between analgesic efficacy, MAP, HR, and RR in the TEA group were statistically significantly lower than PVB group with no significant change in SpO2. Lower incidence of side effects in PVB, but not statistically significant. Use of additional analgesics lower in TEA vs PVB. **Qualitative findings, if any:** N/A	IV	**Strengths:** -Detailed description of administration technique and medication dosage. - Thorough evaluation of side effects **Limitations:** -retrospective study conducted at one hospital, small sample number -PVB not performed with US guidance -Pain scores only recorded in first 24 hours post-op **Risk or harm if implemented:** N/A **Feasibility of use in the project practice area:** Focuses on use of PVB specifically in the elderly. which many other studies exclude. Many surgical pts are over the age of 65 and therefore is useful to the overall project.

Appendix D

Table 1: Guidelines for enhanced recovery after lung surgery: recommendations of the ERAS Society and the ESTS

Recommendations	Evidence level	Recommendation grade
Preoperative phase		
Preadmission information, education and counselling		
Patients should routinely receive dedicated preoperative counselling	Low	Strong
Perioperative nutrition		
Patients should be screened preoperatively for nutritional status and weight loss	High	Strong
Oral nutritional supplements should be given to malnourished patients	Moderate	Strong
Immune-enhancing nutrition may have a role in the malnourished patient postoperatively	Low	Weak
Smoking cessation		
Smoking should be stopped at least 4 weeks before surgery	High	Strong
Alcohol dependency management		
Alcohol consumption (in alcohol abusers) should be avoided for at least 4 weeks before surgery	Moderate	Strong
Anaemia management		
Anaemia should be identified, investigated and corrected preoperatively	High	Strong
Pulmonary rehabilitation and prehabilitation		
Prehabilitation should be considered for patients with borderline lung function or exercise capacity	Low	Strong
Admission		
Preoperative fasting and carbohydrate treatment		
Clear fluids should be allowed up until 2 h before the induction of anaesthesia and solids until 6 h before induction of anaesthesia	High	Strong
Oral carbohydrate loading reduces postoperative insulin resistance and should be used routinely	Low	Strong
Preanaesthetic medication		
Routine administration of sedatives to reduce anxiety preoperatively should be avoided	Moderate	Strong
Perioperative phase		
Venous thromboembolism prophylaxis		
Patients undergoing major lung resection should be treated with pharmacological and mechanical VTE prophylaxis	Moderate	Strong
Patients at high risk of VTE may be considered for extended prophylaxis with LMWH for up to 4 weeks	Low	Weak
Antibiotic prophylaxis and skin preparation		
Routine intravenous antibiotics should be administered within 60 min of, but prior to, the skin incision	High	Strong
Hair clipping is recommended if hair removal is required	High	Strong
Chlorhexidine–alcohol is preferred to povidone-iodine solution for skin preparation	High	Strong
Preventing intraoperative hypothermia		
Maintenance of normothermia with convective active warming devices should be used perioperatively	High	Strong
Continuous measurement of core temperature for efficacy and compliance is recommended	High	Strong
Standard anaesthetic protocol		
Lung-protective strategies should be used during one-lung ventilation	Moderate	Strong
A combination of regional and general anaesthetic techniques should be used	Low	Strong
Short-acting volatile or intravenous anaesthetics, or their combination, are equivalent choices	Low	Strong
PONV control		
Non-pharmacological measures to decrease the baseline risk of PONV should be used in all patients	High	Strong
A multimodal pharmacological approach for PONV prophylaxis is indicated in patients at moderate risk or high risk	Moderate	Strong
Regional anaesthesia and pain relief		
Regional anaesthesia is recommended with the aim of reducing postoperative opioid use. Paravertebral blockade provides equivalent analgesia to epidural anaesthesia	High	Strong
A combination of acetaminophen and NSAIDs should be administered regularly to all patients unless contraindications exist	High	Strong
Ketamine should be considered for patients with pre-existing chronic pain	Moderate	Strong
Dexamethasone may be administered to prevent PONV and reduce pain	Low	Strong
Perioperative fluid management		
Very restrictive or liberal fluid regimes should be avoided in favour of euvolemia	Moderate	Strong
Balanced crystalloids are the intravenous fluid of choice and are preferred to 0.9% saline	High	Strong
Intravenous fluids should be discontinued as soon as possible and replaced with oral fluids and diet	Moderate	Strong
Atrial fibrillation prevention		
Patients taking β-blockers preoperatively should continue to take them in the postoperative period	High	Strong
Magnesium supplementation may be considered in magnesium deplete patients	Low	Weak
It is reasonable to administer diltiazem preoperatively or amiodarone postoperatively for patients at risk	Moderate	Weak
Surgical technique: thoracotomy		
If a thoracotomy is required, a muscle-sparing technique should be performed	Moderate	Strong

Contin

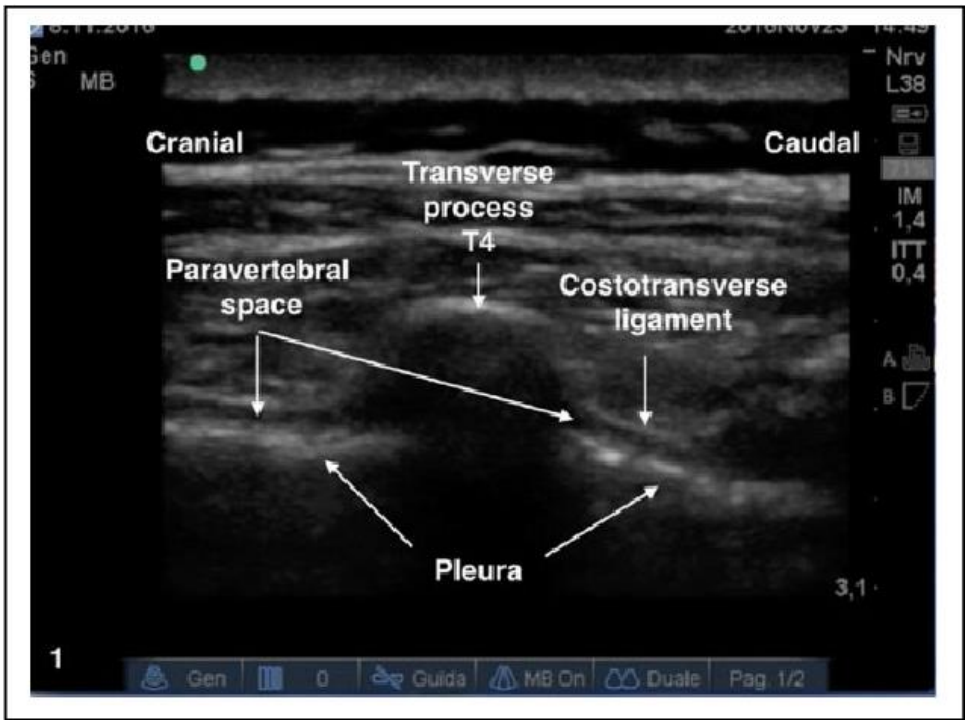
Table 1: Continued

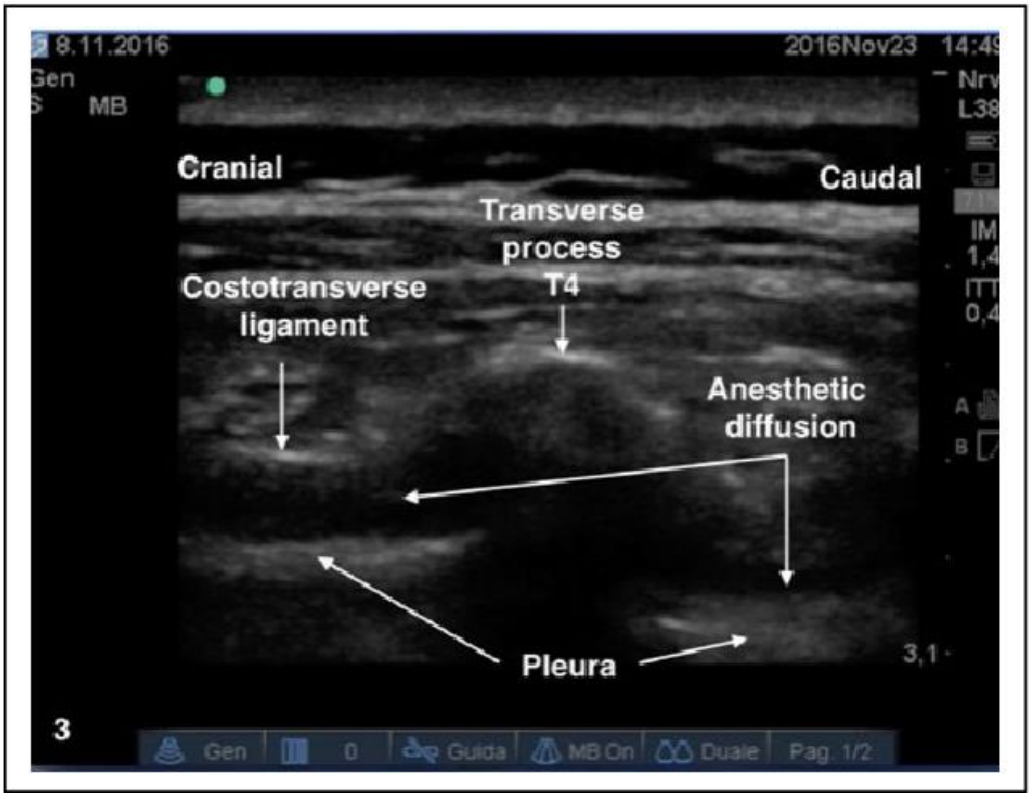
Recommendations	Evidence level	Recommendation grade
Intercostal muscle- and nerve-sparing techniques are recommended	Moderate	Strong
Reapproximation of the ribs during thoracotomy closure should spare the inferior intercostal nerve	Moderate	Strong
Surgical technique: minimally invasive surgery		
A VATS approach for lung resection is recommended for early-stage lung cancer	High	Strong
Postoperative phase		
Chest drain management		
The routine application of external suction should be avoided	Low	Strong
Digital drainage systems reduce variability in decision-making and should be used	Low	Strong
Chest tubes should be removed even if the daily serous effusion is of high volume (up to 450 ml/24 h)	Moderate	Strong
A single tube should be used instead of 2 after anatomical lung resection	Moderate	Strong
Urinary drainage		
In patients with normal preoperative renal function, a transurethral catheter should not be routinely placed for the sole purpose of monitoring urine output	Moderate	Strong
It is reasonable to place a transurethral catheter in patients with thoracic epidural anaesthesia	Low	Strong
Early mobilization and adjuncts to physiotherapy		
Patients should be mobilized within 24 h of surgery	Low	Strong
Prophylactic minitracheostomy use may be considered in certain high-risk patients	Low	Weak

ERAS: Enhanced Recovery After Surgery; ESTS: European Society of Thoracic Surgeons; LMWH: low-molecular-weight heparin; NSAID: non-steroidal anti-inflammatory drugs; PONV: postoperative nausea and vomiting; VATS: video-assisted thoracoscopic surgery; VTE: venous thromboembolism.

(Batchelor et al., 2019).

Appendix E


Cranial
Caudal
Transverse process T4
Paravertebral space
Costotransverse ligament
Pleura
1


8.11.2016
2016Nov23
Cranial
Caudal
Transverse process T4
Costotransverse ligament
Anesthetic diffusion
Pleura
3

Appendix F

Provider Type	Estimated Number of Provider Type at Facility	Estimated Hourly Wage	Hours of Required Participation	Calculated Project Cost for Provider
CRNA	45	$110	1	$4,950
Anesthesiologist	25	$181	1	$4,525
Thoracic Surgeon	4	$145	1	$725
Nurse	45	$35	0.5	$787
Project Champions	6	$110	6	$3,960
Project Lead	1	$35	40	$1,400

(Zip Recruiter, 2023a, 2023b, 2023c, 2023d)