Open Access Publish Free

http://jept.ir
doi:10.34172/jept.1767

Journal of Emergency Practice and Trauma
J Emerg Pract Trauma 2025;11(1):33-38

Original Article

# Intercostal Nerve Block in Supine Position for Urgent Tube Thoracostomy in Trauma Patients: A Randomized-Controlled Study

**Esmail Abdorrahim-Kashi[1], Mehdi Rajabi[2], Sajjad Zarrati[3], Akram Yazdani[4], Nushin Moussavi[5*]**

[1]Surgery Department, Kashan University of Medical Sciences, Kashan, Iran
[2]Anesthesia Department, Kashan University of Medical Sciences, Kashan, Iran
[3]General Surgery Department, Kashan University of Medical Sciences, Kashan, Iran
[4]Department of Biostatistics and Epidemiology, Faculty of Health, Autoimmune Diseases Research Center, Kashan University of Medical Sciences, Kashan, Iran
[5]Surgery Department, Trauma Research Center, Kashan University of Medical Sciences, Kashan, Iran

**Received:** August 13, 2025
**Accepted:** October 8, 2025
**ePublished:** June 6, 2026

***Corresponding author:**
Nushin Moussavi,
Email: n.moussavi@yahoo.com

**Citation:** Abdorrahim-Kashi E, Rajabi M, Zarrati S, Yazdani A, Moussavi N. Intercostal nerve block in supine position for urgent tube thoracostomy in trauma patients: a randomized-controlled study. J Emerg Pract Trauma 2025;11(1):33-38. doi:10.34172/jept.1767

## Abstract

**Introduction:** Tube thoracostomy is one of the most painful procedures for trauma patients. Therefore, we aimed to evaluate the effectiveness of a variation of intercostal nerve block in the posterior axillary line in the supine position for trauma patients who are candidates for urgent chest tube insertion.

**Methods:** For this randomized controlled study, normotensive and conscious trauma patients needing urgent chest tube insertion, admitted to Shahid Beheshti Hospital of Kashan from May 2023 until September 2024, were enrolled. Based on the sample size of 20 per group, 40 patients were included and allocated using 4-block randomization to the control group ($n=20$), receiving only local anesthesia, and the intervention group ($n=20$), receiving local anesthesia with the addition of a modified intercostal block with lidocaine in the posterior axillary line in the supine position. Pain intensity was assessed using the Visual Analogue Scale during and 1 hour after the procedure. One-way analysis of variance was used for normally distributed continuous variables, while the Mann-Whitney *U* test was used for non-normally distributed continuous variables. Comparisons of categorical variables were performed using the $\chi^2$ test or the Fisher test, as appropriate. $P<0.05$ was considered statistically significant. Clinical significance was defined as a decrease of $\geq 1$ point on the VAS for pain.

**Results:** Forty patients with a mean age of 41.1 ± 1 6.06 years , including 30 males (75%), completed the study. The Visual Analogue Scale Score for pain during the procedure was 8.26 in the intervention group, compared with 9.05 in the control group, indicating a non-significant reduction of 0.79 in pain intensity (*P*-value = 0.17). The Visual Analogue Scale Score for pain one hour after the procedure was 5.57 in the intervention group, compared with 6.63 in the control group, indicating a small but clinically relevant reduction of 1.06 (*P*-value = 0.07).

**Conclusion:** A modified intercostal block in the posterior axillary line is feasible in the emergency room, technically simple, and can provide a modest decrease in pain after chest tube insertion. Higher efficacy might be achievable through ultrasound guidance or by simultaneously blocking the collateral branch of the intercostal nerve at the superior border of the ribs.

**Keywords:** Thoracostomy, Chest tubes, Nerve block, Analgesia, Pain

## Introduction

Thoracic injuries are reported in more than 30% of polytrauma patients and are associated with high morbidity and mortality (1). The mortality rate in patients with thoracic injuries is nearly two times higher than that of those without (1,2). Pain control is a priority in the management of trauma patients with chest trauma and rib fractures, as uncontrolled pain leads to ineffective coughing, shallow breathing, and increased risk of pneumonia (3, 4). One of the most painful procedures for trauma patients is insertion of a thoracostomy tube (chest tube), which is required in up to 90% of severe chest trauma patients (5). Although systemic analgesia is usually added to local anesthesia, patients experience much pain during chest tube insertion.

There are several methods for achieving analgesia in the thoracic region via regional nerve blocks. Unfortunately, most information about regional analgesia mainly comes from elective settings, such as thoracic surgeries, and might not be reproducible in emergencies, especially in trauma patients (6-7). Nevertheless, a summary of different thoracic regional analgesia methods, their efficacy, and

the anatomy of the intercostal nerve is presented below.

Anatomy: The thorax is innervated from the ventral rami of thoracic spinal nerves, the intercostal nerves, which are located below the corresponding rib and between the intercostal muscles. During its course, the collateral and then the lateral cutaneous nerves branch off from the intercostal nerve. The collateral branch innervates the intercostal muscles, parietal pleura, and periosteum of the rib. It arises close to the costal angles and courses along the superior border of the inferior rib. The lateral cutaneous branch divides into anterior and posterior branches and innervates the lateral part of the thoracic wall. Finally, the intercostal nerve terminates as the anterior cutaneous branch laterally to the sternum, providing the medial innervation of the chest wall (8).

Regional Analgesia: There are numerous techniques for thoracic regional analgesia. Intrapleural, epidural, paravertebral, and intercostal blocks are often used, and high efficacy is expected from these techniques; however, there is unfortunately no strong evidence of a benefit in patient outcomes (9). Serratus anterior plane block, erector spinae block, and rhomboid intercostal block are other examples of regional analgesia techniques used in the thoracic region.

Epidural analgesia: Provides effective, bilateral analgesia and is often used for thoracic surgeries. The effect of epidural anesthesia in trauma patients and rib fractures is less prominent. A meta-analysis in 2009 showed no positive effect for epidural analgesia on mortality and hospital stay in patients with rib fractures. In addition, epidural analgesia was associated with higher morbidity, especially hypotension (10,11). Epidural analgesia proved more effective when combined with systemic or local analgesics, with failure rates of 9–30% reported (12).

Paravertebral block: Provides analgesia in the thoracic region comparable to epidural analgesia but is unilateral. A meta-analysis showed no different pain scores between paravertebral and epidural analgesia after thoracotomy, but higher opioid consumption after paravertebral block. Epidural analgesia was associated with more side effects like hypotension, urinary retention, and vomiting (10,11).

Intercostal nerve block: The intercostal nerve block is a bedside procedure with a low complication rate, and most physicians are familiar with it (13). A systematic review in 2021 evaluated the effect of intercostal nerve block compared with epidural and paravertebral blocks after thoracotomy. It showed that intercostal nerve block was associated with lower pain scores during the first 24 hours compared with systemic analgesia and was non-inferior to epidural and paravertebral blocks. However, opioid consumption during the first 48 hours was higher. Therefore, an intercostal nerve block was recommended for cases in which epidural and paravertebral blocks are not indicated (14). In 2022, Yamazaki et al. showed that intercostal nerve block was non-inferior to epidural block for thoracoscopic surgeries (but not thoracotomy) (15). On the contrary, Sun et al. showed better pain control by adding paravertebral or erector spinae block to intercostal block after video-assisted thoracoscopic surgery (VATS) (16).

Serratus anterior plane block: This technique is used in thoracic and breast surgeries. In one randomized controlled trial, the effect of a serratus anterior plane block was equivalent to that of an intercostal block after VATS surgery (17). Another randomized controlled study, published in 2022 by Zhang et al., showed lower opioid consumption with rhomboid intercostal and erector spinae blocks compared with serratus anterior block after VATS (18). A recent meta-analysis demonstrated comparable analgesic effects with intercostal nerve block under direct thoracoscopic visualization and serratus anterior plane block with ultrasound guidance after thoracoscopic surgery (19). Although the serratus anterior plane block is reported in trauma patients and rib fractures, it is likely to provide successful analgesia only for lateral rib fractures due to direct spread, but not anterior or posterior rib fractures (20).

Recommendations and guidelines: The Eastern Association for the Surgery of Trauma and the Anesthesiology Society recommend placing strong emphasis on patient values and preferences when selecting analgesia (9). The PROSPECT guidelines for video-assisted thoracoscopic surgery do not recommend epidural analgesia and propose unilateral regional analgesia (paravertebral block, erector spinae block, or serratus anterior plane block) because of comparable effectiveness and lower complication rates compared with epidural analgesia (21). An important factor to consider in choosing anesthesia is the feasibility of implementation. In a survey of an intensive care unit in France, 70% of physicians stated that patients with an indication for regional anesthesia (paravertebral or epidural anesthesia) did not receive it due to limited experience, ignorance of guidelines, or a lack of protocol (22).

Unfortunately, local and regional analgesia are not often used in emergent and urgent situations like trauma, because of limitations in positioning of trauma patients, lack of time and expertise, and sometimes limited equipment in the emergency department. Most published studies on regional analgesia are performed in the elective setting after thoracic surgery, where experienced surgeons and anesthetists can manage stable patients with full equipment (usually with ultrasound guidance) and without time constraints. Therefore, guidelines for thoracic analgesia according to the literature review might not be generalizable to emergencies, especially to trauma patients.

Given the limitations of regional analgesia in the emergency department, we evaluated the effectiveness of adding a simple intercostal nerve block in the posterior axillary line in the supine position compared with local analgesia alone in normotensive, conscious trauma patients who were candidates for urgent chest tube insertion.

## Methods

This study was a single-center, parallel-group, randomized controlled superiority trial with an allocation ratio of 1:1, designed, conducted, and reported according to CONSORT guidelines and in compliance with the ethical standards of the Declaration of Helsinki. Ethics committee approval (IR.KAUMS.MEDNT.REC.1402.305) and randomized trial registration (IRCT20240530061) were completed. The trial was conducted to compare the superiority of standard local anesthesia versus standard local anesthesia plus intercostal nerve block in reducing pain during chest tube insertion in trauma patients. Eligible participants were normotensive and conscious trauma patients requiring chest tube insertion admitted to Shahid-Beheshti Hospital, Kashan, between May 2023 and September 2024. Inclusion criteria included systolic blood pressure ≥ 90 mmHg, respiratory rate < 30 breaths per minute, oxygen saturation ≥ 90%, and Glasgow Coma Scale (GCS) score ≥ 14. Patients were excluded if they experienced hemodynamic, respiratory, or neurologic deterioration during the study period or required emergency interventions, thereby ensuring that patients received fluent, standard care. All data were collected at the trauma and emergency department of Shahid-Beheshti Hospital, Kashan, Iran, a tertiary referral center for trauma patients. Sample size calculation was based on a previous study showing a 2.5-point reduction in pain with a significance level ($\alpha$) of 0.05 and power ($1-\beta$) of 90%. A minimum of 18 patients per group was required; to account for potential dropouts, a sample size of 40 (20 per group) was considered. Fifty-eight patients were assessed for eligibility. Eighteen patients were excluded due to hypotension, hypoxia, or decreased consciousness. Finally, 40 patients were enrolled (Figure 1). The random allocation sequence, using a 4-block randomization scheme, was generated by a statistician not involved in patient recruitment. Allocation concealment was maintained using sequentially numbered envelopes prepared by a third party. Eligible patients were identified and enrolled by the attending trauma physician. The random allocation sequence was implemented by a junior resident who opened the sealed envelope after taking informed consent and immediately before the intervention. The procedure was performed by a senior resident trained by an anesthesiologist (second author) for an intercostal block. The participants were randomized into two groups. For group 1 (control), local anesthesia included the injection of 10 mL of lidocaine 1% into the dermis, subcutaneous fat, periosteum, and subcostal margin. Group 2 (intervention) received the same local anesthesia as the control group and a modified intercostal nerve block at the posterior axillary line targeting the 5th, 6th, and 7th ribs with 10 mL lidocaine 2%, administered five to ten minutes before chest tube insertion. Patients were positioned slightly laterally with a towel under the shoulder to facilitate nerve block administration. For both groups, intravenous analgesia (meperidine 1 mg/kg) was administered, and a thoracostomy tube was inserted in the 5th or 6th intercostal space at the midaxillary line. Thoracostomy tubes of size 36 or 40 were used as clinically indicated. The primary outcome was pain intensity during and 1 hour after chest tube insertion, verbally assessed using the Visual Analogue Scale (VAS), with scores ranging from 1 (minimal pain) to 10 (worst pain). Due to the nature of the interventions, neither care providers nor patients were blinded. However, pain scores were assessed by trained physicians who were blinded to group assignments. Missing data were retrieved from patient files; if unavailable, the patient was excluded from the study. A survey supervisor performed data monitoring, and interim analyses were conducted twice after the attending surgeons (1st and 5th authors) allocated 10 and

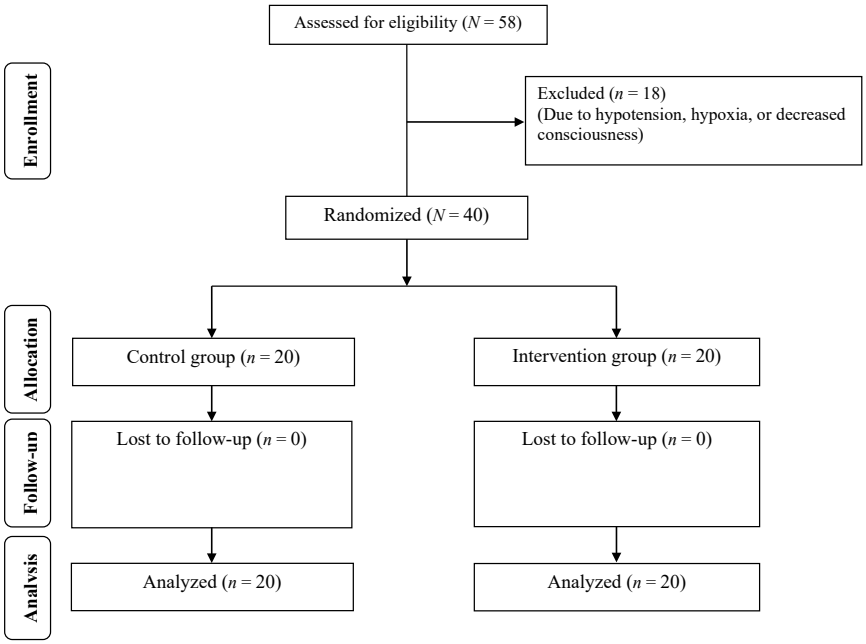


**Figure 1.** Flowchart of patient allocation and randomization

20 patients, respectively, to assess outcomes, technical challenges, and eventual complications. One attending surgeon (5th author) was responsible for communicating with team members regarding whether a protocol modification would be required. Data were securely preserved by the 3rd author and were available at any time to the surgeon treating the patient. Statistical analysis was done by SPSS version 26 (IBM, USA). The Kolmogorov–Smirnov test was used to determine the normality of data distribution. Continuous variables were expressed as mean ± standard deviation. Categorical variables were expressed as numbers (percentages). One-way analysis of variance was used for normally distributed continuous variables. The Mann-Whitney *U* test was used to analyze differences among groups for non-normally distributed continuous variables. Comparisons of categorical variables between groups were performed using the $\chi^2$ or Fisher tests, as appropriate. $P < 0.05$ was considered statistically significant, but changes were considered clinically significant if a decrease of ≥ 1 point in VAS for pain was achieved.

## Results

Fifty-eight patients were assessed for eligibility; 18 were excluded due to hypotension, hypoxia, or decreased consciousness. Finally, 40 patients were enrolled and randomly assigned to Group 1 (control, $n = 20$) and Group 2 (intervention, $n = 20$). All of the patients completed the study and were analyzed for the primary outcome (see Figure 1). The study started in May 2023 and ended in September 2024. The mean age was 41.1 ± 16.06 years, and 75% were males. Blunt trauma was the mechanism of trauma in 35 patients (87.5%), and the remaining patients presented with penetrating chest trauma. Vital signs at admission, including systolic and diastolic blood pressure, heart rate, $O_2$ saturation, and respiratory rate, are presented in Table 1, showing no statistically significant difference between the two groups (Table 1). The mean VAS score for pain during the procedure was 8.26 in the intervention group, compared with 9.05 in the control group, indicating only a non-significant reduction of 0.79 in pain intensity (*P*-value = 0.17). The mean VAS score for pain 1 hour after the procedure was 5.57 in the intervention group and 6.63 in the control group, indicating a small but clinically relevant reduction of 1.06. With a *P*-value of 0.07, statistical significance was not achieved (Table 1).

## Discussion

In the present study, we describe a modified intercostal block technique performed in the supine position, which proved feasible for urgent chest tube insertion in trauma patients. A decrease of 1.06 in the VAS pain score was observed 1 hour after chest tube insertion, which is lower than in similar studies assessing the efficacy of intercostal block after tube thoracostomy. Luketich et al. reported a Visual Analogue Scale (VAS) score for pain of 6.2 during chest tube insertion. They were able to reduce it to 3.7 with the implementation of a protocol to reduce pain and anxiety. We observed similar results in our center in a previous study in the elective setting. With the addition of an intercostal block to routine local anesthesia, a reduction of the VAS for pain from 6.5 to 3.5 was observed in patients requiring chest tube insertion for pleural effusion (6, 7).

A meta-analysis evaluating the effectiveness of intercostal block after thoracic surgery showed only a 1.4-point decrease in VAS pain scores at 7–24 hours after surgery compared with systemic analgesia (14), results comparable to those of the present study.

Studies about regional blocks in the acute trauma setting are scarce. In one study in Iran, intercostal nerve block and erector spinae plane block were compared in chest trauma patients with limited pain area, showing superiority of erector spinae plane block, with a 3.9-point decrease in pain scores after 1 hour. Intercostal nerve block, although less efficient, was still able to achieve a significant decrease of 2.0 points2.0 points at 1 hour (from 7.4 to 5.4) (23).

In summary, the modified intercostal nerve block in the axillary line in the present study was less efficient than the classic nerve block in the paraspinal plane. This difference might be due to sparing of the collateral branch of the intercostal nerve, which branches off very early, close to the costal angles and courses along the superior border of the inferior rib. As pain during chest tube insertion does not only originate from skin and subcutaneous tissues, but also and probably predominantly from deep structures, i.e., the ribs, their periosteum, and the pleura, blockade of the lateral cutaneous branch might not be sufficient for appropriate analgesia and special attention should

**Table 1.** Demographic data and VAS score for pain in Group 1 (Control) and Group 2 (Intervention)

| Variables[a] | All patients (n = 40) | Group 1 (n = 20) | Group 2 (n = 20) | *P*-value |
|---|---|---|---|---|
| Age (years) | 41.1 (16.06) | 40.88 (15.16) | 41.30 (18.19) | 0.24 |
| Respiratory rate/min | 21.97 (3.13) | 22.35 (3.26) | 21.60 (3.03) | 0.43 |
| $SPO_2$ (%) | 92.07 (3.18) | 92.2 (3.3) | 91.95 (13.3) | 0.92 |
| Heart rate/min | 97.22 (13.36) | 101.1 (11.5) | 93.35 (14.23) | 0.25 |
| Systolic blood pressure (mmHg) | 118.25 (12.82) | 119.4 (13.26) | 117.1 (12.6) | 0.71 |
| Diastolic blood pressure (mmHg) | 73.97 (8.33) | 72.75 (8.54) | 75.2 (8.15) | 0.98 |
| VAS score during procedure | 8.65 (1.43) | 9.05 (1.07) | 8.26 (1.66) | 0.17 |
| VAS score 1 h after procedure | 6.1 (1.64) | 6.63 (1.6) | 5.57 (1.53) | 0.07 |

a: Data are presented as mean (standard deviation)

be paid to the collateral branch of the intercostal nerve. Future studies with simultaneous nerve blocks at the superior and inferior rib borders (to include the collateral branches) might provide more efficient pain control.

Another reason for lower effectiveness might be the time limitation during the procedure. As the study population needed urgent chest tube insertion, there was limited time to wait until the lidocaine spread in the tissues and the nerve was blocked effectively. The observation of decreased pain after 1 hour but not during the procedure strengthens this hypothesis. The time constraint is, and will always be, a major challenge for locoregional analgesia in emergencies.

Lastly, the intercostal block was performed using clinical landmarks rather than ultrasound guidance. Further studies assessing the feasibility and effectiveness of ultrasound-guided intercostal blocks might yield better results.

Another limitation of the study was that we used only the VAS score to assess pain and did not record the systemic analgesic dose after the procedure. In addition, the data represent only a small number of patients from a single trauma center. The small sample size might explain why no statistical significance was achieved, but conducting further studies with a larger sample size will probably not yield greater clinical significance, even if statistical significance is achieved.

## Conclusion

A modified intercostal block in the posterior axillary line, added to local anesthesia, allows the trauma team to accomplish a regional anesthesia for thoracostomy tube insertion in the supine position. This fast and simple technique is feasible in the emergency room and, in the present study, led to a 1.06 decrease in VAS for pain one hour after chest tube insertion. Future studies should be conducted to achieve a more effective blockade of the intercostal nerve, for example, by adding ultrasound guidance or by blocking an additional collateral branch of the intercostal nerve at the superior border of the rib.

### Acknowledgements

This study was derived from the doctoral thesis on surgery by the third author. The authors acknowledge and thank the Clinical Research Development Unit and Trauma Research Center of Kashan University of Medical Sciences.

### Author's Contribution

Conceptualization: Nushin Moussavi, Esmail Abdorrahim-Kashi, Sajjad Zarrati, and Mehdi Rajabi
Data curation: Nushin Moussavi, Sajjad Zarrati, and Mehdi Rajabi
Formal analysis: Sajjad Zarrati and Akram Yazdani
Funding acquisition: Nushin Moussavi, Esmail Abdorrahim-Kashi, and Sajjad Zarrati
Investigation: Nushin Moussavi, Esmail Abdorrahim-Kashi, and Sajjad Zarrati
Methodology: Akram Yazdani
Project administration: Nushin Moussavi and Sajjad Zarrati
Resources: Nushin Moussavi and Esmail Abdorrahim-Kashi
Software: Sajjad Zarrati and Akram Yazdani
Supervision: Nushin Moussavi, Esmail Abdorrahim-Kashi, and Mehdi Rajabi
Validation: Nushin Moussavi, Sajjad Zarrati, and Akram Yazdani
Visualization: Nushin Moussavi, Sajjad Zarrati, and Akram Yazdani
Writing–original draft: Nushin Moussavi, Esmail Abdorrahim-Kashi, Mehdi Rajabi, Sajjad Zarrati, and Akram Yazdani

### Competing Interests

None.

### Ethical Approval

This study was conducted in accordance with the ethical standards of the Declaration of Helsinki. Ethics committee approval (IR.KAUMS.MEDNT.REC.1402.305) and randomized trial registration (IRCT20240530061) were obtained, and informed consent was obtained from the patients or their relatives. All authors declare that they have no conflict of interest.

### Funding

Clinical Research Development Unit of Kashan University of Medical Sciences, Grant number: 4215

### References

1. Lundin A, Akram SK, Berg L, Göransson KE, Enocson A. Thoracic injuries in trauma patients: epidemiology and its influence on mortality. Scand J Trauma Resusc Emerg Med 2022;30(1):69. doi:10.1186/s13049-022-01058-6
2. Hardy BM, King KL, Enninghorst N, Balogh ZJ. Trends in polytrauma incidence among major trauma admissions. Eur J Trauma Emerg Surg 2024;50(3):623-6. doi:10.1007/s00068-022-02200-w
3. Beloy V, Dull M. Blunt chest wall trauma: Rib fractures and associated injuries. JAAPA 2022;35(11):25-31. doi:10.1097/01.Jaa.0000885136.91189.83
4. Simon JB, Wickham AJ. Blunt chest wall trauma: an overview. Br J Hosp Med (Lond) 2019;80(12):711-5. doi:10.12968/hmed.2019.80.12.711
5. Peter SD, Ozoilo KN, Isichei MW, Ale F, Njem JM, Ojo E, et al. Severe chest injury revisited - an analysis of the Jos University Teaching Hospital Trauma Registry. Niger J Clin Pract 2021;24(8):1247-51. doi:10.4103/njcp.njcp_92_21
6. Luketich JD, Kiss M, Hershey J, Urso GK, Wilson J, Bookbinder M, et al. Chest tube insertion: a prospective evaluation of pain management. Clin J Pain 1998;14(2):152-4. doi:10.1097/00002508-199806000-00011
7. Mousavi N, Davoodabadi A, Izadian M, Mohseni Mehran S, Aminipour M, Hajian A. Comparison of intercostal nerve blockage versus local anesthesia for tube thoracostomy insertion; a randomised controlled trial. Int J Surg Open 2022;47:100535. doi:10.1016/j.ijso.2022.100535
8. Glenesk NL, Rahman S, Lopez PP. Anatomy, thorax, intercostal nerves. In: StatPearls [Internet]. Treasure Island, FL: StatPearls Publishing; 2024.
9. Galvagno SM Jr, Smith CE, Varon AJ, Hasenboehler EA, Sultan S, Shaefer G, et al. Pain management for blunt thoracic trauma: a joint practice management guideline from the Eastern Association for the Surgery of Trauma and Trauma Anesthesiology Society. J Trauma Acute Care Surg 2016;81(5):936-51. doi:10.1097/ta.0000000000001209
10. Carrier FM, Turgeon AF, Nicole PC, Trépanier CA, Fergusson DA, Thauvette D, et al. Effect of epidural analgesia in patients with traumatic rib fractures: a systematic review and meta-analysis of randomized controlled trials. Can J Anaesth 2009;56(3):230-42. doi:10.1007/s12630-009-9052-7
11. Xu M, Hu J, Yan J, Yan H, Zhang C. Paravertebral block versus thoracic epidural analgesia for postthoracotomy pain relief: a meta-analysis of randomized trials. Thorac Cardiovasc Surg 2022;70(5):413-21. doi:10.1055/s-0040-1722314
12. Hermanides J, Hollmann MW, Stevens MF, Lirk P. Failed epidural: causes and management. Br J Anaesth

2012;109(2):144-54. doi:10.1093/bja/aes214
13. Lopez-Rincon RM, Hendrix JM, Kumar V. Ultrasound-guided intercostal nerve block. In: StatPearls [Internet]. Treasure Island, FL: StatPearls Publishing; 2023.
14. Guerra-Londono CE, Privorotskiy A, Cozowicz C, Hicklen RS, Memtsoudis SG, Mariano ER, et al. Assessment of intercostal nerve block analgesia for thoracic surgery: a systematic review and meta-analysis. JAMA Netw Open 2021;4(11):e2133394. doi:10.1001/jamanetworkopen.2021.33394
15. Yamazaki S, Koike S, Eguchi T, Matsuoka S, Takeda T, Miura K, et al. Preemptive intercostal nerve block as an alternative to epidural analgesia. Ann Thorac Surg 2022;114(1):257-64. doi:10.1016/j.athoracsur.2021.07.019
16. Sun L, Mu J, Gao B, Pan Y, Yu L, Liu Y, et al. Comparison of the efficacy of ultrasound-guided erector spinae plane block and thoracic paravertebral block combined with intercostal nerve block for pain management in video-assisted thoracoscopic surgery: a prospective, randomized, controlled clinical trial. BMC Anesthesiol 2022;22(1):283. doi:10.1186/s12871-022-01823-1
17. Pai P, Hong J, Phillips A, Lin HM, Lai YH. Serratus anterior plane block versus intercostal block with incision infiltration in robotic-assisted thoracoscopic surgery: a randomized controlled pilot trial. J Cardiothorac Vasc Anesth 2022;36(8 Pt A):2287-94. doi:10.1053/j.jvca.2021.10.022
18. Zhang JG, Jiang CW, Deng W, Liu F, Wu XP. Comparison of rhomboid intercostal block, erector spinae plane block, and serratus plane block on analgesia for video-assisted thoracic surgery: a prospective, randomized, controlled trial. Int J Clin Pract 2022;2022:6924489. doi:10.1155/2022/6924489
19. Jin J, Sun H, Zhang X, Wu X, Pan X, Lv D, et al. Comparison of intercostal nerve block and serratus anterior plane block for perioperative pain management and impact on chronic pain in thoracoscopic surgery: a randomized controlled trial. Clin J Pain 2024;40(12):691-9. doi:10.1097/ajp.0000000000001248
20. Lin J, Hoffman T, Badashova K, Motov S, Haines L. Serratus anterior plane block in the emergency department: a case series. Clin Pract Cases Emerg Med 2020;4(1):21-5. doi:10.5811/cpcem.2019.11.44946
21. Feray S, Lubach J, Joshi GP, Bonnet F, Van de Velde M. PROSPECT guidelines for video-assisted thoracoscopic surgery: a systematic review and procedure-specific postoperative pain management recommendations. Anaesthesia 2022;77(3):311-25. doi:10.1111/anae.15609
22. Blondonnet R, Begard M, Jabaudon M, Godet T, Rieu B, Audard J, et al. Blunt chest trauma and regional anesthesia for analgesia of multitrauma patients in French intensive care units: a national survey. Anesth Analg 2021;133(3):723-30. doi:10.1213/ane.0000000000005442
23. Armin E, Movahedi M, Najafzadeh MJ, Honarmand A, Rezaei Zadeh Rukerd M, Mirafzal A. Comparison of ultrasound-guided erector spinae plane block with intercostal nerve block for trauma-associated chest wall pain. J Emerg Med 2022;63(4):520-7. doi:10.1016/j.jemermed.2022.09.018