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Clinical Reviews

Ultrasound-Guided Serratus Anterior Plane Block for Acute Pain Management in Emergency Medicine: A Systematic Review

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□ **Abstract—Background: Use of the serratus anterior plane block (SAPB) by emergency physicians is increasing. Clinical evidence supporting its utility in the emergency department (ED) is limited and has not been comprehensively summarized. Objective: The aim of this review was to summarize and evaluate the utility of ultrasound-guided SAPBs performed by emergency physicians for acute pain management in the ED. Methods: Adhering to Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, a systematic literature search of the PubMed, Scopus, and Cochrane databases was performed from database inception to October 2023. Published articles reporting on SAPBs performed by emergency physicians were reviewed and qualitatively summarized. Results: Fourteen articles reporting on 81 patients were identified, among which SAPBs were performed by emergency physicians for five separate indications, including rib fracture, tube thoracostomy, acute herpes zoster, chest wall burns, and unspecified chest wall injury. Overall, SAPBs performed by emergency physicians were associated with improvements in subjective and objective measures of pain, and no complications were reported following the blocks. Conclusions: The SAPB performed by trained emergency physicians may be a reasonable analgesia strategy for managing several causes of acute chest wall pain in the ED, though evidence to date is limited and further higher quality research is needed. © 2025 Elsevier Inc. All rights are reserved, including those for text and data mining, AI training, and similar technologies.**

□ **Keywords—serratus anterior plane block; regional anesthesia; nerve block; emergency medicine; pain management**

Introduction

The ultrasound-guided serratus anterior plane block (SAPB) is a relatively new thoracic fascial plane block that provides chest wall analgesia for a variety of indications. First described by Blanco in 2013, this block involves administration of a large volume of local anesthetic into the fascial plane either superficial or deep to the serratus anterior muscle, anesthetizing the lateral cutaneous branches of the intercostal nerves of the T2 to T9 dermatomes (1). The SAPB is most frequently used in the perioperative setting, including for breast surgery, minimally invasive cardiac surgery, and thoracoscopic procedures (2–4). It is also commonly employed in hospitalized trauma patients to manage pain associated with anterior and lateral rib fractures. Its efficacy for posterior rib fractures is unclear. Ultrasound-guided SAPBs performed by regional anesthesiologists have been shown to significantly decrease pain and opioid utilization among hospitalized patients with multiple rib fractures (5).

With increased proficiency in point-of-care ultrasound (POCUS), emergency physicians are more commonly using ultrasound-guided regional anesthesia techniques, including the SAPB, in the emergency department (ED). Most published reports of SAPBs performed by emergency physicians have been described in the context of rib fractures (6,7). Several other indications for this block have been reported, including acute herpes zoster pain and emergency thoracic procedures (8).

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Previous systematic reviews have summarized the efficacy of the SAPB in the perioperative setting (2–4) and in hospitalized patients with rib fractures (5). No studies have comprehensively summarized the utility of the SAPB performed for acute pain management in the ED. Therefore, this systematic review was designed to summarize and evaluate the evidence regarding SAPBs performed by emergency physicians.

Methods

Search Strategy

The PubMed, Scopus, and Cochrane databases were searched to identify publications describing SAPBs performed by emergency physicians in the ED or prehospital setting. Each database was queried from inception through October 2023 to identify relevant publications using the following search strategy: "serratus anterior plane block" OR "serratus anterior block" OR "serratus plane block."

Inclusion Criteria

Published reports of SAPBs performed by emergency physicians in the ED or prehospital setting were considered. Articles were excluded if they reported blocks performed by non-emergency physicians or in the perioperative setting. Diagnostic studies, cadaveric or anatomic studies, studies on healthy participants, review articles, and ongoing clinical trials were excluded. No language restrictions were applied if non-English publications were able to be translated to English using online translation.

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed throughout this review (9). Screening of article titles, abstracts, and manuscript texts was performed independently in duplicate by two authors (RJG, JXH). Any disagreements were resolved by consensus, and additional eligibility questions were directed toward an ultrasound fellowship–trained emergency physician (EEH) and the senior author (JAK). The references of all eligible studies were manually screened to identify any additional records not captured during the database search. Due to the overall low quality of literature, which mostly included small case series and case reports, a formal risk of bias evaluation was not performed.

Data Abstraction

From each eligible article, data was collected regarding authors and year of publication, location of study, number of patients and patient demographics, indication for SAPB, block approach and pharmacologic agents used, clinical outcomes, and adverse events. Due to the wide heterogeneity in reporting of results and overall limitations in study designs, a comprehensive meta-analysis was not performed. Information abstracted from included articles was qualitatively summarized.

Results

The search query identified 876 unique records. Fourteen published articles satisfied eligibility criteria and were included in this analysis. No additional relevant articles were identified in the references of included articles. Detailed results of the literature search and screening process are described in a PRISMA flowchart (Figure 1). Regarding study design, five studies were small case series describing up to 20 patients, and the remaining nine articles were case reports of 1 to 3 patients. No comparative or randomized studies were identified. Articles were published between the years of 2017 and 2024 and were performed in the United States (7,8,10–17), Australia (18–20), and India (6). One study was published online at the time of database search and subsequently printed in a journal volume in 2024; for the purpose of this review, this study was included for analysis and referenced by its final date of publication (18). The 14 included articles reported on 81 patients who received a total of 82 SAPBs for the following indications: rib fractures, tube thoracostomy, acute zoster pain, chest wall burns, and unspecified chest wall injuries. Compiled demographic data and reported indications for the SAPBs can be found in Table 1. Several additional articles were identified that reported SAPBs performed by anesthesiologists in the ED or trauma bay; however, these were excluded from analysis as they were not performed by emergency physicians.

All blocks utilized either ropivacaine (ranging from 15 to 40 mL of 0.375% to 1%) or bupivacaine (ranging from 20 to 44 mL of 0.25% to 0.5%) as the primary anesthetic agent. Additionally, some blocks were supplemented with small volumes of lidocaine (10,15) or adjuvants including epinephrine (7,8,10), dexamethasone (16), and methylprednisolone (8). Table 2 displays the agents or combinations of anesthetic agents used in each article.

In 12 articles accounting for 65 blocks, anesthetic was administered within the superficial serratus plane superficial to the serratus anterior muscle and deep to the latissimus dorsi muscle (6–8,10–12,14–17,19,20). In three articles (4 blocks), anesthetic was administered within the deep serratus plane deep to the serratus anterior muscle and superficial to the ribs (8,11,13). Target planes for each article are listed in Table 2. In one study, the target plane was not explicitly mentioned, though

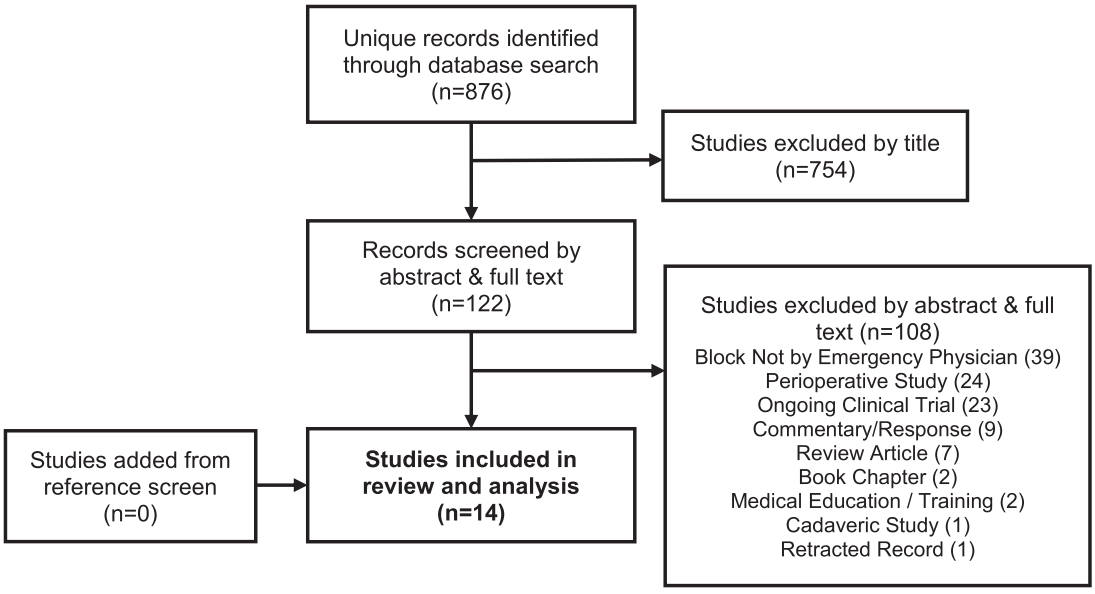

Figure 1. PRISMA (preferred reporting items for systematic reviews and meta-analyses) diagram of search strategy.

Table 1. Compiled Demographic Information for Included Articles and Reported Indications for Serratus Anterior Plane Blocks (SAPBs) Performed by Emergency Physicians

No. of Patients, n	81
No. of blocks performed, n	82
Mean age, years	57.9*
Male patients, n (%)	44 (64.7%)*
Indications for SAPB, n†	
Rib fractures	64
Tube thoracostomy	3
Acute zoster pain	2
Chest wall burn	1
Chest wall injury (prehospital)	14

* Values and percentages based on articles that reported respective demographic information.

† Given that some cases had multiple indications for SAPB, the number of reported indications exceeds the total number of blocks performed.

cross-sectional imaging obtained after some of the blocks identified fluid presumed to be anesthetic adjacent to the serratus anterior muscle in the superficial serratus plane (40%), deep serratus plane (40%), or both planes (20%) (18). The SAPBs were administered with the patient in lateral decubitus position in four articles (7,10,11,17), supine position in five articles (12,13,15,19,20), and either lateral decubitus or supine in two articles (6,14). Three articles did not explicitly mention the position in which the patients received the blocks (8,16,18).

While there was variability between articles in their reporting of patient follow-up, there were no reported complications or adverse events attributed to the SAPBs performed in any of the articles.

Rib Fractures

Management of rib fracture pain was the most frequently reported indication for SAPBs performed by emergency physicians. Overall, SAPB resulted in considerable reductions in pain scores on patients with anterior, lateral, and posterior rib fractures (6–8,11,14,17,20). One prospective series of 20 patients with anterior or lateral multiple rib fractures (MRFs) found that pain scores at rest and during incentive spirometry (IS) decreased by 2.5 (95% confidence interval [CI]: 1.24–3.76) and 2.4 (95% CI: 1.27–3.53), respectively, on the 11-point Numeric Rating Scale (NRS) at one hour after SAPB with 30 mL of 0.34% bupivacaine (14). In a series of 20 patients with unilateral MRFs of unspecified location, pain scores decreased from 6.5/10 to 3/10 at four hours after SAPB with 30 mL of 0.5% ropivacaine (20). In one case of anterior MRFs, pain score decreased from 8/10 to 2/10 by 20 min following SAPB with 44 mL of 0.27% bupivacaine and lasted for 11 h (17). One case of lateral MRFs reported "noted improvement" in pain and reported that numbness was achieved at the site of the affected dermatomes after SAPB with 28 mL of 0.25% bupivacaine with epinephrine (7). A report of two cases noted a decrease in dynamic pain from 8 to 9/10 to 0/10 after SAPB

Table 2. Summary of SAPB Indications, Technical Details, and Physicians Performing Blocks, as Reported in Individual Articles

First Author, Year	Patients (n)	Indication for SAPB	Anesthetic Dosing ± Adjuvants	Block Plane[†]	Patient Positioning	Physician(s) Performing Block
Benesch et al. (10)	1	Chest wall burn, bilateral	10 mL 1% ropivacaine + 5 mL 1% lidocaine with epinephrine (15 mL total per side)	Superficial	Lateral decubitus	Emergency physician, not otherwise specified
Di et al. (7)	1	MRFs Chest tube	28 mL 0.25% bupivacaine with epinephrine	Superficial	Lateral decubitus	Emergency physician, not otherwise specified
Durant et al. (11)	2	MRFs	30 mL 0.5% ropivacaine	Superficial Deep	Lateral decubitus	Emergency physician, not otherwise specified
Goldsmith et al. (12)	1	Herpes zoster	27 mL 0.25% bupivacaine	Superficial	Supine	Emergency physician, not otherwise specified
Harrington et al. (18)	13	Chest wall trauma, prehospital	20–40 mL ropivacaine (0.8–2.5 mg/kg)	N/M	N/M	11 EMS physicians, who obtained competency in SAPB based on their hospital-based practice
Khalil et al. (13)	1	Chest tube	0.5% ropivacaine (1 mL/kg)[*]	Deep	Supine	Emergency physician, not otherwise specified
Kring et al. (14)	20	MRFs	30 mL 0.34% bupivacaine	Superficial	Supine Lateral decubitus	1 ED attending physician, 2 ED ultrasound fellows, and 3 senior EM residents, each of whom attended a 1-hour didactic and hands-on SAPB training session
Lee et al. (15)	1	MRFs	20–30 mL 0.25% bupivacaine[*]	Superficial	Supine	Emergency physician, not otherwise specified
Lentz et al. (16)	3	MRFs IRF	20 mL 1% ropivacaine 20 mL 0.5% bupivacaine + 10 mg dexamethasone	Superficial	N/M	ED ultrasound fellowship-trained physician faculty

(*continued on next page*)

Table 2. (*continued*)

First Author, Year	Patients (n)	Indication for SAPB	Anesthetic Dosing ± Adjuvants	Block Plane[†]	Patient Positioning	Physician(s) Performing Block
Lin et al. (8)	6	MRFs Herpes zoster Chest tube	20–30 mL 0.25% bupivacaine 20 mL 0.5% bupivacaine + 60 mg methylprednisolone 30 mL 0.25% bupivacaine with epinephrine	Superficial Deep	N/M	Emergency physician, not otherwise specified
McLean et al. (19)	1	Chest wall trauma, prehospital	40 mL 0.375% ropivacaine	Superficial	Supine	EMS flight physician
Paul et al. (6)	10	MRFs	38–40 mL 0.25% bupivacaine	Superficial	Supine Lateral decubitus	Emergency physician trained in POCUS and procedural ultrasound, under supervision of ED attending physician
Schnekenburger et al. (20)	20	MRFs	30 mL 0.5% ropivacaine	Superficial	Supine	Emergency physician, who received training in SAPB procedure
Schultz et al. (17)	1	MRFs	44 mL 0.27% bupivacaine	Superficial	Lateral decubitus	Resident physician, under direct supervision of ED attending physician

MRFs = multiple rib fractures; IRF = individual rib fracture; ED = emergency department; EM = emergency medicine; EMS = emergency medical system; POCUS = point-of-care ultrasound; SAPB = serratus anterior plane block; N/M = not mentioned.

* Concentration or dosing not explicitly mentioned.

† Block plane referring to superficial serratus plane (Superficial) or deep serratus plane (Deep).

with 30 mL of 0.5% ropivacaine, though in one of these cases the pain returned 10 h later and that patient required an epidural (11).

In one series of 10 patients in which the majority had either posterior or posterolateral rib fractures, pain scores improved from 9/10 to 1.5/10 at one hour after SAPB with 38–40 mL 0.25% bupivacaine (6). Another series described four patients with anterior, posterior, or posterolateral MRFs, three of whom experienced complete relief of pain after the block, and the fourth patient who was initially unable to lay flat for cross-sectional imaging due to pain was able to do so after receiving a block (8).

One series of three patients with anterior or lateral MRFs objectively assessed block efficacy by measuring diaphragmatic excursion on bedside ultrasound and respiratory rate (16). Average diaphragmatic excursion increased by 52.7% and average respiratory rate decreased by 6 breaths per minute at 60 min after the block. In this report, two patients received 20 mL of 1% ropivacaine and the third patient received 20 mL of 0.5% bupivacaine with 10 mg of dexamethasone.

Tube Thoracostomy

Three SAPBs were performed on patients requiring tube thoracostomy (7,8,13). One patient sustained multiple lateral rib fractures complicated by a hemothorax requiring tube thoracostomy (7). While the primary indication for the SAPB was for rib fracture pain, administration of 28 mL of 0.25% bupivacaine with epinephrine successfully anesthetized the chest wall to allow for chest tube placement without additional analgesia. In another case, a patient had a pigtail catheter placed to drain a moderate-sized pleural effusion, for which she did not require any additional analgesia other than a SAPB with 30 mL of 0.25% bupivacaine (8). The final case involved a SAPB with 1 mL/kg of 0.5% ropivacaine that successfully anesthetized the chest wall in an adolescent patient who underwent placement of a pigtail catheter for a spontaneous pneumothorax (13). Of note, this patient subsequently returned to the ED several days later with recurrence of the pneumothorax for which he had another pigtail catheter placed, this time under procedural sedation. Following the placement of the second chest tube, the patient commented that he preferred the SAPB over procedural sedation because he had persistent pain at the site of the new chest tube and disliked the effects of the procedural sedation medications.

Herpes Zoster

Two reported cases of herpes zoster on the anterolateral chest wall were managed with SAPBs in the ED, either with 20 mL of 0.5% bupivacaine with 60 mg methylprednisolone (8) or 27 mL of 0.25% ropivacaine (12). In both cases, patients had significant improvements from their initial reported pain scores of 10/10. Neither patient required any additional analgesics while in the ED, and both were discharged shortly after the block and did not have any return visits to the ED for zoster-related pain.

Chest Wall Burn

One patient received bilateral SAPBs each consisting of 10 mL of 1% ropivacaine and 5 mL of 1% lidocaine with epinephrine for deep partial thickness burns spanning across his anterior chest over the T2 to T5 dermatomes (10) After the block, he reported complete analgesia for up to 18 h and did not require intravenous opioids until 30 h after the block. He was subsequently discharged from the hospital two days later without any additional regional anesthesia. Of note, this was the only patient in this review who received bilateral SAPBs.

Prehospital Blocks

Two articles reported SAPBs performed by emergency medical system (EMS) physicians during transit either from the field or between hospitals (18,19). One patient with suspected rib and hip fractures received an ultrasound-guided SAPB with 40 mL of 0.375% ropivacaine and fascia iliaca block while in aerial transit to the hospital from a remote location, after which he experienced complete resolution of his chest wall pain (19). He remained pain-free at the rib fracture site until the next day when he was taken for operative repair of his hip fracture and never required any additional regional anesthesia or patient-controlled analgesia for his rib pain. More recently, Harrington et al. 2024 reported a series of 13 patients with thoracic trauma who underwent SAPBs by an EMS physician in either the prehospital setting or during transit between hospitals (18). All 10 patients for whom postblock pain was documented reported improvement after the block, and no patient developed signs or symptoms of local anesthetic systemic toxicity (LAST). This study noted that four of the 13 patients who received a block were inappropriately selected to receive the procedure in the field, three of whom had major internal hemorrhage identified on definitive imaging upon arrival to the trauma center.

Discussion

Emergency physicians have successfully used the SAPB to manage acute pain associated with rib fractures, herpes zoster, chest wall burns, tube thoracostomies, and chest wall trauma in the prehospital setting. The SAPB, when

performed by emergency physicians, has been effective in relieving both subjective and objective measures of pain, without resulting in any major complications.

Outside of the perioperative setting, the SAPB is frequently incorporated as part of a multimodal analgesia strategy to manage chest wall pain associated with rib fractures. Insufficiently treated chest wall pain can lead to a number of potentially severe complications, including pneumonia, respiratory failure requiring intubation, and prolonged inpatient and internsive care unit (ICU) hospitalizations (21). In particular, elderly trauma patients with rib fractures are at increased risk for pneumonia and death (22). A recent randomized controlled trial showed that hospitalized rib fracture patients who received an anesthesiologist-performed SAPB had decreased parenteral analgesic consumption, lower pain scores, and fewer complications compared to the control group that received only patient-controlled analgesia (23). Moreover, SAPBs performed early in hospitalization may also reduce rates of ICU admissions among patients with rib fractures (24).

Most literature has suggested the SAPB to only be effective for anterior and lateral rib fractures, given the relatively limited posterior spread of local anesthetic with the SAPB (1,25). A prior report in the anesthesia literature documented two cases of failed SAPBs in patients with posterior rib fractures (26). However, a recent anatomic study demonstrated posterior spread of injectate as far as the medial border of the scapula in cadaveric models with rib fractures, though this spread was limited to the anterior border of the latissimus dorsi muscle on cadavers without trauma (27). Interestingly, several articles evaluated in this review reported successful analgesia with the SAPB in ED patients with posterior or posterolateral rib fractures (6,8,15). Moreover, a series of five patients with isolated posterior rib fractures reported improved subjective pain and decreased opioid consumption following anesthesiologist-performed SAPBs (28). Given these results, further investigation into the utility of the SAPB in posterior rib fractures is warranted.

With increased expertise in POCUS and procedural ultrasound in the ED, emergency physicians are frequently utilizing regional anesthesia techniques for acute pain management in the ED. While most academic EDs perform ultrasound-guided regional anesthesia to some extent, there remains variability in utilization, training, and individual physician competency across different institutions (29). Among the 14 articles evaluated in this systematic review, only five explicitly mentioned the experience level or specialized training or expertise that the physicians received prior to performing the blocks (6,14,16,18,20). Among these included explicit mention of dedicated SAPB and regional anesthesia procedural training sessions (14,20), skills training from hospital-based practice (18), specialized procedural ultrasound training (6), or ED ultrasound fellowship-trained physician faculty directly performing the blocks (16). The remaining articles did not explicitly specify whether the performing emergency physicians received any specific training or had any specialized experience prior to performing the blocks. Nonetheless, the SAPBs evaluated in this review were overwhelmingly successful and safe.

Most articles in this review evaluated the success of SAPBs by comparing subjective pain before and after the block, all of which demonstrated improvement in pain scores following the block (6,7,11,12,14,17,19,20). In addition to assessing subjective pain, articles evaluated in this review quantified block efficacy using objective measures, including vital capacity on incentive spirometry (14,15) and diaphragmatic excursion on ultrasound (16). While assessing improvements in subjective pain are crucial for guiding clinical care in the ED, evaluating objective measurements of pain may be equally as important, particularly in critically ill patients or those who are not able to effectively communicate their pain.

No complications or adverse events were reported following SAPBs performed by emergency physicians. Like all regional anesthesia techniques, there is a risk of significant complications following the SAPB, including pneumothorax, infection, hematoma, and LAST (30). While no cases of pneumothorax have been reported in the emergency medicine literature, one case of pneumothorax was reported after a SAPB performed prior to breast surgery (31). With proper technique and constant sonographic visualization of the needle, the risk of pneumothorax should be negligible since the target planes of the SAPB are superficial to the ribs (1). Moreover, no cases of LAST have been reported following SAPBs performed by emergency physicians. With this in mind, emergency physicians should be reassured that the risk of harm from the SAPB is extremely small and far outweighed by the benefits of the block.

Limitations

The main limitation of this systematic review was the small number of published articles describing SAPBs performed by emergency physicians and overall low quality of evidence. There were no randomized trials or comparative studies, and most articles were small case series or individual case reports. There was considerable variability in methodologies and outcome reporting of included articles, such that it was not possible to pool data to perform quantitative analysis to compare block techniques and outcomes. Additionally, some studies that reported on multiple types of blocks did not stratify results for patients who received a SAPB, which limits the ability to report the results of SAPBs in these studies. While there were

no complications reported among the articles reviewed, this is limited by the short follow-up time in most studies and the relatively small number of blocks performed.

Conclusions

Emergency physicians have performed the SAPB for several indications, including rib fractures, acute herpes zoster, chest wall burns, chest tube placement, and in the prehospital setting on patients with chest wall trauma. SAPBs administered by emergency physicians have largely been effective for improving both subjective and objective measures of pain and have not resulted in any complications. Future studies should continue to assess the utility of the SAPB in ED patients with chest wall pain and compare its effectiveness with other regional and multimodal analgesia techniques in this population.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Richard J. Gawel: Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation, Conceptualization. **Jennifer X. Hong:** Writing – review & editing, Writing – original draft, Data curation. **Erin E. Hassel:** Writing – review & editing, Writing – original draft, Investigation, Data curation. **Jeffrey A. Kramer:** Writing – review & editing, Writing – original draft, Supervision, Conceptualization.

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Article Summary

1. Why is this topic important?

Incorporating multimodal and opioid-sparing analgesia into emergency medicine practice can help better manage multiple causes of acute pain, while reducing the risk of complications associated with larger doses of systemic opioids, especially in patients with cardiorespiratory comorbidities.

2. What does this review attempt to show?

This review shows that the SAPB might be a safe and effective alternative analgesia strategy for several causes of acute chest wall pain commonly encountered in the ED.

3. What are the key findings?

Emergency physicians have utilized the SAPB for five indications, including rib fractures, acute herpes zoster, chest wall burns, chest tube placement, and in the prehospital setting on patients with chest wall trauma. The SAPB has been successful in improving pain and has not resulted in any complications in this population.

4. How is patient care impacted?

Emergency physicians can safely and effectively utilize the SAPB to manage multiple causes of acute chest wall pain. Effective multimodal analgesia that includes the SAPB can lead to fewer complications from poorly managed pain, accelerated dispositions from the emergency department, and improved overall patient care and satisfaction.