

Original Research

Surgical Stabilization of Rib Fractures in Geriatric Patients at a Level I Trauma Center – Preliminary Results

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Abstract

The role of surgical stabilization rib fractures (SSRF) in geriatric trauma patients remains controversial despite growing evidence supporting SSRF in selected patients with severe chest wall injuries. The decision to do surgical stabilization of rib fractures in the elderly patient is more complex with recommendations for surgery to be individualized on a case-by-case basis. In this preliminary report, we describe the development of a multidisciplinary Chest Wall Injury Service that utilizes a standardized treatment algorithm and the Pain-Inspiration-Cough (PIC) score to guide management of older adults with rib fractures. A retrospective descriptive review was performed of older adult trauma patients (≥ 65 years) undergoing SSRF after implementation of a Chest Wall Injury Service (CWIS) at an American College of Surgeons verified Level 1 Trauma Center. The service integrates trauma and orthopedic surgeons and employs radiographic criteria and PIC score assessment to assist in selection of patients for SSRF. Following the implementation of CWIS, 358 older adult patients sustained rib fractures, of whom 22 (6.1%) underwent SSRF. Mean age was 74.3 ± 6.3 years, mean Injury Severity



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Score was 16.1 ± 9.3 , and 14 patients (64%) had flail chest. Mean time from admission to SSRF was 3.1 ± 2.2 days. One patient (4.5%) died within 30 days of surgery from cause unrelated to rib fixation. Four patients (18.2%) experienced minor complications. Incentive spirometry volumes improved significantly from 725 mL preoperatively to 1145 mL postoperatively ($p < 0.001$). A multidisciplinary CWIS incorporating trauma and orthopedic expertise and an objective treatment algorithm facilitated the management of selected geriatric patients with severe rib fractures. Preliminary outcomes demonstrated low mortality, acceptable morbidity, and significant improvement in pulmonary functioning after SSRF. Larger studies are needed to further evaluate this approach.

Keywords

Aged; rib fractures; thoracic injuries; wounds and injuries; fracture fixation; internal

1. Introduction

Surgical stabilization of rib fractures (SSRF) has been used sporadically since the early 1900s but has gained more widespread acceptance in the past 20 years, and is now firmly entrenched in the surgeon's armamentarium, particularly as it relates to trauma patients with flail chest or multiple rib fractures [1]. Historical management of rib fractures focused on conservative measures with a specific focus on optimization of pain control and pulmonary function. In 2025, the World Society of Emergency Surgery and the American Association for the Surgery of Trauma (WSES-AAST) [2] as well as the Chest Wall Injury Society (CWIS) [3] released consensus statements recommending that SSRF be considered as an alternative treatment in hemodynamically stable patients with a flail chest (defined as 3 or more rib fractures broken in 2 or more place) or multiple ipsilateral rib fractures that are severely displaced or protruding into lung parenchyma. These recommendations come in light of many studies showing a distinct morbidity and mortality benefit to SSRF [4-8].

However, despite recent recommendations looking favorably on SSRF as a management strategy in severe chest trauma, the role of SSRF in older adults remains controversial. The WSES-AAST guidelines [2] state that advanced age represents a 'relative contraindication' to SSRF, but that surgical stabilization may be considered on a case-by-case basis. There are a few studies examining the role of SSRF in older adults with equivocal results in terms of outcomes [9-13]. To address this need, our institution developed a multidisciplinary Chest Wall Injury Service (CWIS) that integrates trauma and orthopedic surgery expertise and utilizes an algorithmic approach incorporating the Pain-Inspiration-Cough (PIC) score to guide evaluation for SSRF. The objective of this preliminary report is to describe the development and implementation of this CWIS and its patient-selection algorithm, while presenting early clinical outcomes as preliminary evidence of the feasibility and safety of this approach in older adult trauma patients.

2. Methods

2.1 Chest Wall Injury Team: An Integrated Approach

At our Level I trauma center, to facilitate better care for patients with traumatic rib fractures, we have implemented an integrated Orthopedic/Trauma service line dedicated to the mutual care of the complex rib fracture patient. This integrated program currently consists of two Orthopedic Surgeons and one Trauma Surgeon who provide multidisciplinary consultation on all patients at our institution receiving SSRF to determine if operative management is appropriate.

2.2 Our Algorithm

Our algorithm (Figure 1) incorporates the current guidelines of the Chest Wall Injury Society for rib plating and follow up [14, 15]. Initial evaluation is performed by the trauma team as the patient is transferred into the emergency department. If the patient has a rib fracture and concomitant orthopedic injury, the Orthopedics team is consulted and the collaboration between the two teams begins. Most rib fractures are isolated, noncontiguous, or not associated with significant pain or respiratory compromise and are treated nonoperatively. This includes multimodal pain regimens including acetaminophen, non-steroidal pain regimens, gabapentin, and liberal use of regional nerve blocks such as the erector spinae block [16]. Narcotics are reserved only for breakthrough pain when multimodal pain regimens and regional nerve blocks fail to control pain. Patients with three or more contiguous rib fractures, those with flail chest, and those intubated due to respiratory compromise would be potential candidates for SSRF and the Chest Wall Injury service would be consulted. Rib fractures are confirmed with chest radiograph (CXR) or CT imaging. Patients are then stratified based on radiographic and physiologic criteria. CXR findings suggestive of severe injury (e.g., multiple contiguous, displaced, segmental, bilateral, or sternal fractures) prompt further anatomic evaluation with CT and 3D reconstruction or physiologic assessment using the validated Pain Inspiration Cough (PIC) score [17]. The PIC score is a decision-making adjunct to decide if a patient should be treated with non-operative management versus SSRF (Figure 2).

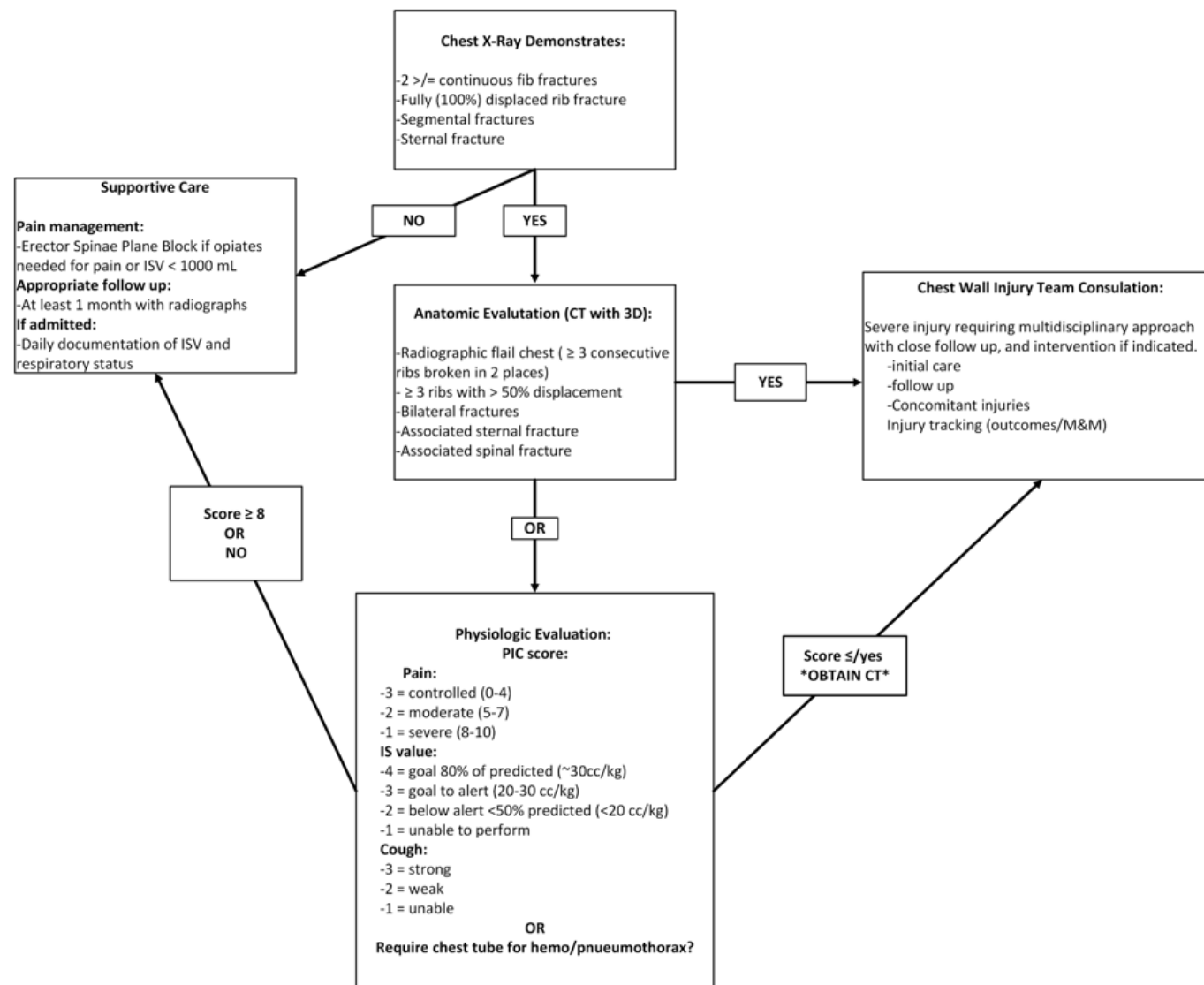


Figure 1 Chest Wall Injury Service Algorithm.

PIC Score									
1 2 3 4 5 6 7 8 9 10									
Pain	Inspiration					Cough			
Patient reported 0-10 score	Utilizing Incentive Spirometry; goals set by Respiratory Therapist					Assessed by bedside nurse			
3-Controlled (Pain Intensity Scale 0-4)	4-Above goal volume					3-Strong			
2-Moderate (Pain Intensity Scale 5-7)	3-Goal to alert volume					2-Weak			
1-Severe (Pain Intensity Scale 8-10)	2-Below alert volume					1-Absent			
	1-Unable to perform Incentive Spirometry								

Figure 2 PIC Score.

The PIC score was incorporated into the Chest Wall Injury Service algorithm as an objective assessment tool to assist in patient evaluation. The threshold of <8 was adopted from previously published PIC-based clinical pathways and was used as a trigger for multidisciplinary Chest Wall Injury Team consultation [18]. A PIC score ≥ 8 would place the patient in supportive care with lateral utilization of erector spinae plane blocks and opiate-free pharmacologic modalities of pain control with opiates reserved for breakthrough pain. The PIC score is repeated daily. A PIC score ≤ 7 , persistent symptoms, or concerning imaging would mandate Chest Wall Injury (CWI) Team consultation to evaluate the potential need for SSRF. The CWI team provides longitudinal, multidisciplinary care, including initial evaluation and assessment for SSRF using CT with 3D reconstruction, management of concomitant injuries, structured follow-up, and tracking of rib fracture fixation in a dedicated registry.

Following the CWI team consultation, patients are selected for SSRF by using a combination of injury pattern and physiologic impairment in alignment with Chest Wall Injury Society (CWIS) guidelines. Anatomic indications include chest wall instability, flail segments, or multiple (>3) significantly displaced rib fractures identified on CT with 3D reconstruction. Operative intervention is prioritized in patients with these fracture patterns who demonstrate ongoing respiratory compromise despite optimized nonoperative management, including inadequate pulmonary function, uncontrolled pain limiting ventilation, or inability to wean from mechanical ventilation. Patients are simultaneously assessed for contraindications, including hemodynamic instability, severe traumatic brain injury, and competing higher-priority injuries. When appropriate, SSRF is performed early in the clinical course, typically within 72 hours of injury.

Assignment of operating surgeon is based on injury pattern, associated injuries, surgeon expertise, availability, and clinical circumstances. Postoperative care, follow-up, and registry tracking are coordinated by the primary operative team. Standard follow-up includes routine evaluation at approximately 3 months, with extended follow-up, including one year assessment.

If patients evaluated by the Chest Wall Injury Service had concurrent orthopedic injuries, involving the shoulder girdle, clavicle, scapular, and proximal humeral fractures, these injuries were considered during operative planning but were not independent indications for SSRF. When operative treatment of both chest wall and orthopedic injuries was indicated, procedures were coordinated to allow management during the same operative window when feasible. The

assignment of the operating surgeon was influenced by the overall injury pattern, associated injuries, and clinical circumstances.

All trauma patients aged ≥ 65 years evaluated through the Chest Wall Injury Service between June 2024 and the study end date were reviewed. Patients with flail chests, multiple displaced rib fractures, bilateral rib fractures, associated sternal fractures, associated spine fractures, or physiologic impairment as determined by the PIC score were considered for multidisciplinary evaluation. Final decisions regarding SSRF were made jointly by the Chest Wall Injury Team based on injury pattern, physiologic status, radiographic findings, and overall operative candidacy. Not all geriatric patients with rib fractures were evaluated by the Chest Wall Injury Team. Consultations were primarily requested for patients with injury patterns or physiologic impairment that raised concern for potential SSRF candidacy. Given the small sample size, results are presented descriptively. After testing for normalcy using a Shapiro-Wilk test, a paired t-test was used to assess the pre and post SSRF IS volumes. Analysis was done in R version 4.5.1.

2.3 Ethics Statement

This project was determined to be a quality improvement initiative by the HealthPartners Institute IRB and exempt from oversight. Approved October 22, 2025 (IRB #0000002896).

3. Preliminary Results

The Chest Wall Injury service began at our Level I trauma center in June of 2024. Since that time there were 6,678 trauma admissions with 784 of those patients (11.7%) sustaining at least one rib fracture. Of those rib fractures, 358 (45.6%) were ≥ 65 yrs old, with the majority of older adult patients being treated conservatively without the need for SSRF., with 22 (6.1%) of these over the age of 64 and included in this report.

Of the older adult patients undergoing SSRF, ages ranged from 65 to 88 years old with a mean age of 74.3 years (standard deviation [SD] 6.3 years). Patients were primarily white (91%) males (73%) who were severely injured with a mean number of 8.1 (SD 4) ribs fractures and mean Injury Severity Score (ISS) of 16.1 (SD 9.3). Fourteen patients (64%) presented with clinical flail chest requiring SSRF and the mean time to SSRF was 3.1 days from admission (SD 2.2) (Table 1). The mean number of ribs fixed was 6.8 ribs.

Table 1 Demographics of Older Adult Patients Requiring SSRF.

Number of Older Adult Patients with Rib Fracture	358
Underwent SSRF, n (%)	22 (6.1%)
Age (years)	74.3 (6.3)
Male, n (%)	16 (73%)
White, n (%)	20 (91%)
Number of Ribs Injured	8.1 (4)
Flail chest, n (%)	14 (64%)
ISS	16.1 (9.3)
Time to SSRF (days)	3.1 (2.2)

All values are mean (standard deviation) unless otherwise stated.

In this preliminary descriptive cohort, observed outcomes following SSRF included low mortality, a low rate of minor complications, and improvement in pulmonary function. There was one patient reported 30-day mortality unrelated to their rib fixation (perforated bowel). Four patients (18.2%) had minor complications directly related to SSRF or its immediate postoperative course, including two chest wall hematomas that did not require drains, one seroma at a chest tube site managed expectantly, and one recurrent pleural effusion that required thoracentesis (Table 2). Postoperative incentive spirometry volumes were measured 48 hours following SSRF. Pulmonary function increased significantly from a mean pre SSRF IS volume of 725 mL to a mean post SSRF IS volume of 1145 mL ($p < 0.001$).

Table 2 Clinical Outcomes Among Older Adult Patients Undergoing SSRF.

Outcome	Result
30-day mortality, n (%)	1 (4.5%)
30-day mortality related to SSRF, n	0
Any postoperative complication, n (%)	4 (18.2%)
Chest wall hematoma not requiring drainage, n (%)	2 (9.1%)
Seroma at chest tube site, n (%)	1 (4.5%)
Recurrent pleural effusion, n (%)	1 (4.5%)

Of the 22 patients, 14 (63.6%) were discharged to a transitional care unit, 6 (27.3%) were discharged home, 1 (4.5%) was discharged to acute inpatient rehabilitation, and 1 (4.5%) was discharged to a long-term acute care facility (Table 3). Every patient discharged home had a hospital length of stay (LOS) of eight days or less. The mean LOS was 12.5 days. None of the patients with seven or more ribs fixed were discharged home. Overall, 16 patients (72.7%) were required to be discharge to a post-acute care facility. Patients discharged home had a median LOS of 5.5 days compared with 11.5 days among patients discharged to post-acute care.

Table 3 Discharge destination.

Discharge destination	Result
Transitional Care Unit, n (%)	14 (63.6%)
Home, n (%)	6 (27.3%)
Rehabilitation, n (%)	1 (4.5%)
Long-term acute care hospital, n (%)	1 (4.5%)

4. Discussion

Our early experience with a dedicated Chest Wall Injury service has shown acceptable outcomes with SSRF in the older adult trauma patient. It is important to note that the vast majority of older adult rib fracture patients (94%) were able to be treated conservatively without surgical intervention. An important objective screening tool that is part of chest wall injury protocol at our institution is the PIC score, which assists in differentiating those who would benefit from SSRF compared to conservative management [17]. The PIC score has been widely used to provide clinical prognostication, need for ICU care, acute respiratory distress syndrome (ARDS) rates, and even

cardiac arrest with ROSC [16]. To our knowledge, this is the first time the PIC score has been used as an objective measure in deciding when to consult surgical services for SSRF. Our cohort of older adult trauma patients showed significant improvement with a mean increase of 420 mL in IS volume post-SSRF, with only relatively minor local wound complication despite being severely injured with a mean ISS of 16.1.

SSRF has previously been examined in older adult patients in a few select studies. A study by Zangbar et al. [9] looked at 6 years (2017-2022) of the Trauma Quality Improvement Database (TQIP) and calculated a modified frailty index on patients over 65. There were 53,630 total patients who met the definition of frail and had rib fractures. Of those, 2% underwent SSRF. Although there was a benefit in mortality in the SSRF group (5.4% vs 10.2%; $p < 0.001$), there was no difference in ventilator-associated pneumonia, ARDS, or need for tracheostomy and SSRF was associated with longer hospital and ICU length of stay. Chen Zhu et al. [10] also using the TQIP database examined 758 patients who underwent SSRF and compared to conservative management. In this study, there was a lower mortality in SSRF group (4.2% vs 7.3%; $p = 0.01$), however there was a higher rate of tracheostomy and ventilator associated pneumonia in the SSRF group. Our study adds preliminary data to the growing body of literature of SSRF in older adults, demonstrated by its safety with an acceptable morbidity and mortality.

Severe chest wall trauma results in not only mechanical impairment but also a significant systemic inflammatory response. Tissue injury associated with trauma and subsequent surgical intervention triggers activation of inflammatory pathways through damage-associated molecular patterns and recruitment of inflammatory cells, including neutrophils, monocytes, and platelets. Recent studies have demonstrated that the magnitude of tissue injury and surgical trauma is associated with measurable changes in inflammatory biomarkers, including the neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio, monocyte-to-lymphocyte ratio, and other systemic inflammatory indices [19, 20]. These biomarkers have been proposed as objective measures of the physiologic response to trauma and surgical intervention and could provide insight into the severity of the inflammatory response. While the present study focused primarily on the development and implementation of a multidisciplinary CWIS and its patient-selection algorithm, future investigations may evaluate the relationship between inflammatory biomarkers and outcomes following SSRF in older adult patients.

This case series is not without limitations, notably its retrospective nature and small sample size. There were not enough patients (due to the novel recent development of the Chest Wall Injury Service) to allow for meaningful statistical comparison to other modes of rib fracture management. Future studies should investigate SSRF in the older adult population, prospectively, using a larger cohort of SSRF patients possibly using a multi-institutional format.

An additional consideration in treatment of older adults with rib fractures is frailty. Although age is frequently used as an indicator of physiologic reserve, frailty may more accurately reflect a patient's ability to tolerate injury and operative intervention. Zangbar et al. [9] recently examined frail geriatric patients with rib fractures using a modified frailty index and demonstrated that SSRF was associated with reduced mortality when compared with nonoperative management. Furthermore, Choi et al. [21] developed a Rib Fracture Frailty Index specifically for geriatric patients with multiple rib fractures, highlighting the potential utility of frailty-based risk stratification in this population. Future iterations of the CWIS algorithm should consider incorporation of validated frailty measures and comorbidity burden alongside anatomic injury characteristics and physiological

criteria such as the PIC score. Such refinement could further improve identification of older adults most likely to benefit from SSRF while identifying patients at increased risk for postoperative complications.

Another limitation of this study is that the PIC score threshold incorporated into our algorithm has not been specifically validated as a criterion of SSRF selection in geriatric patients. We intentionally sought to incorporate an objective and reproducible measure into the CWIS algorithm rather than relying solely on subjective clinical judgment. Although the threshold was adopted from a previously published PIC paper, further investigation is needed to determine its utility and predictive performance in older adult populations.

5. Conclusion

A multidisciplinary Chest Wall Injury Service integrating trauma and orthopedic surgery expertise and utilizing an objective algorithm incorporating the PIC score facilitated the management of selected older adult patients with severe rib fractures. In this preliminary cohort, SSRF was associated with low 30-day mortality (4.5%), a low rate of minor complications (18.2%), and significant improvement in incentive spirometry volumes following surgery. These findings provide preliminary evidence supporting the feasibility and safety of this multidisciplinary approach. Future directions will be to build on this early experience to provide more objective data displaying the benefits of SSRF in the older adult population. This could be through evaluating the relationship between inflammatory biomarkers, frailty, physiologic recovery, and outcomes following SSRF in older adult patients. Incorporating these variables into future iterations of the protocol may further improve risk stratification and optimize selection of older adult patients for operative intervention.

Author Contributions

Conception and Study design: FR, BL. Literature Review: FR, IG, NL. Data acquisition: BL, NL. Data Analysis and Interpretation: FR, IG, NL. Drafting of the manuscript: FR, IG, NL. Critical revision: FR, IG. Editorial oversight: DW, JK, BB.

Competing Interests

The authors have declared that no competing interests exist.

References

1. Shaban Y, Frank M, Schubl S, Sakae C, Bagga A, Hegazi M, et al. The history of surgical stabilization of rib fractures (SSRF). *Surg Pract Sci*. 2022; 10: 100084.
2. Coccolini F, Cremonini C, Moore EE, Civil I, Balogh Z, Leppaniemi A, et al. Thoracic trauma WSES-AAST guidelines. *World J Emerg Surg*. 2025; 20: 78.
3. Sermonesi G, Bertelli R, Pieracci FM, Balogh ZJ, Coimbra R, Galante JM, et al. Surgical stabilization of rib fractures (SSRF): The WSES and CWIS position paper. *World J Emerg Surg*. 2024; 19: 33.
4. Tanaka H, Yukioka T, Yamaguti Y, Shimizu S, Goto H, Matsuda H, et al. Surgical stabilization of internal pneumatic stabilization? A prospective randomized study of management of severe flail chest patients. *J Trauma*. 2002; 52: 727-732.

5. Granetzny A, Abd El-Aal M, Emam E, Shalaby A, Boseila A. Surgical versus conservative treatment of flail chest. Evaluation of the pulmonary status. *Interact Cardiovasc Thorac Surg*. 2005; 4: 583-587.
6. Marasco SF, Davies AR, Cooper J, Varma D, Bennett V, Nevill R, et al. Prospective randomized controlled trial of operative rib fixation in traumatic flail chest. *J Am Coll Surg*. 2013; 216: 924-932.
7. Pieracci FM, Leasia K, Bauman Z, Eriksson EA, Lottenberg L, Majercik S, et al. A multicenter, prospective, controlled clinical trial of surgical stabilization of rib fractures in patients with severe, nonflail fracture patterns (Chest Wall Injury Society NONFLAIL). *J Trauma Acute Care Surg*. 2020; 88: 249-257.
8. Kasotakis G, Hasenboehler EA, Streib EW, Patel N, Patel MB, Alarcon L, et al. Operative fixation of rib fractures after blunt trauma: A practice management guideline from the eastern association for the surgery of trauma. *J Trauma Acute Care Surg*. 2017; 82: 618-626.
9. Zangbar B, Mehta R, Prabhakaran K, Jose A, Vetri R, Froula G, et al. Rib fractures in frail geriatric patients: Does surgical stabilization improve outcomes? *J Trauma Acute Care Surg*. 2026; 100: 40-46.
10. Zhu RC, de Roulet A, Ogami T, Khariton K. Rib fixation in geriatric trauma: Mortality benefits for the most vulnerable patients. *J Trauma Acute Care Surg*. 2020; 89: 103-110.
11. Pieracci FM, Leasia K, Hernandez MC, Kim B, Cantrell E, Bauman Z, et al. Surgical stabilization of rib fractures in octogenarians and beyond—What are the outcomes? *J Trauma Acute Care Surg*. 2021; 90: 1014-1021.
12. Christie DB, Nowack TE, Nonnemacher CJ, Montgomery A, Ashley DW. Surgical stabilization of rib fractures improves outcomes in the geriatric patient population. *Am Surg*. 2022; 88: 658-662.
13. Jensen S, Sanderfer VC, Porter K, Rieker MG, Maniscalco BR, Lloyd J, et al. Surgical stabilization of rib fractures in the geriatric trauma population is associated with equivalent outcomes to a younger cohort: A propensity matched analysis. *Injury*. 2024; 55: 111593.
14. Bauman ZM, Tian Y, Doben AR, Schubl SD, Pieracci FM, Kaye AJ, et al. Chest wall injury society guidelines for surgical stabilization of rib fractures: Indications, contraindications, and timing. *J Trauma Acute Care Surg*. 2025; 99: 522-532.
15. Forrester JD, Choudhry MS, Fernandez-Moure J, Kurle J, Patel B, Tung J, et al. Chest wall injury society recommendations for long-term follow-up after nonoperatively and operatively managed traumatic rib and sternal fractures. *J Trauma Acute Care Surg*. 2024; 98: 277-286.
16. Rogers FB, Larson NJ, Rhone A, Amaya D, Olson-Bullis BA, Blondeau BX. Comprehensive review of current pain management in rib fractures with practical guidelines for clinicians. *J Intensive Care Med*. 2023; 38: 327-339.
17. Bass GA, Stephen C, Forssten MP, Bailey JA, Mohseni S, Cao Y, et al. Admission triage with pain, inspiratory effort, cough score can predict critical care utilization and length of stay in isolated chest wall injury. *J Surg Res*. 2022; 277: 310-318.
18. Meyer CH, Freedberg M, Tanghal J, Castater C, Nguyen CT, Smith RN, et al. Does PIC score pick correctly? Evaluation of a modified-PIC based admission a single institution retrospective cohort study. *Injury*. 2025; 56: 111860.

19. Moldovan F. Correlation between peripheral blood markers and surgical invasiveness during humeral shaft fracture osteosynthesis in young and middle-aged patients. *Diagnostics*. 2024; 14: 1112.
20. Moldovan F. Sterile inflammatory response and surgery-related trauma in elderly patients with subtrochanteric fractures. *Biomedicines*. 2024; 12: 354.
21. Choi J, Marafino BJ, Vendrow EB, Tennakoon L, Baiocchi M, Spain DA, et al. Rib fracture frailty index: A risk stratification tool for geriatric patients with multiple rib fractures. *J Trauma Acute Care Surg*. 2021; 91: 932-939.