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CHEST WALL INJURY
RIB FRACTURES
Evidence Based Medicine Guideline

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SUMMARY

Traumatic chest wall injury is a major cause of morbidity and mortality. Rib fractures lead to atelectasis, pneumonia, and acute respiratory failure. Protocol-driven rib fracture management has been demonstrated to improve outpatient outcome. Management typically includes multi-modality pain management using both non-steroidal anti-inflammatory agents (NSAIDS) and opiates, aggressive pulmonary support, and potentially surgical rib plating.

RECOMMENDATIONS

- **Level 1**
  - **Early rib fixation (within 72 hours) for flail chest reduces ventilator days, pneumonia, and intensive care unit length of stay (LOS).**
- **Level 2**
  - **Protocol-driven management of patients with rib fractures has been shown to improve outcomes.**
  - **Multimodal treatment regimens should be used in patients with multiple rib fractures, including scheduled non-steroidal anti-inflammatory agents (NSAIDs), acetaminophen, muscle relaxants, and as-needed low-dose narcotics.**
  - **Initiate narcotic therapy with the lowest opiate dosage that achieves pain control with careful use in the elderly.**
  - **Patients with multiple, contiguous, bi-cortically displaced fractures may benefit from surgery.**
- **Level 3**
  - **Scheduled analgesic agents are the most appropriate approach to medication dosing.**
  - **In patients with multiple rib fractures, intravenous NSAIDs can be instituted to help achieve acute pain control.**
    - **Ibuprofen 400-800 mg IV q 6 hours OR ketorolac tromethamine 15-30 mg IV q 6 hours**
    - **IV NSAID therapy should be limited to a maximum of five (5) days**
  - **IV narcotics or patient-controlled analgesia (PCA) opiates can be utilized to control pain that is not adequately managed with oral medications alone.**
  - **Epidural analgesia and intercostal nerve blockade may be a valuable adjunct to multimodal pain medication regimens.**

INTRODUCTION

Acute traumatic chest wall injury is a leading cause of morbidity in the trauma population (1,2). Chest wall injuries are found in half of all blunt thoracic trauma patients, and 10% have rib fractures with a considerable risk of pulmonary-related morbidity and mortality (3-5). Patients with rib fractures are at particular risk for developing pulmonary complications such as atelectasis, pneumonia, and respiratory failure due to poor chest wall mechanics,

LEVEL OF RECOMMENDATION DEFINITIONS

- **Level 1:** Supported by multiple, prospective randomized clinical trials or strong prospective, non-randomized evidence if randomized testing is inappropriate.
- **Level 2:** Supported by prospective data or a preponderance of strong retrospective evidence.
- **Level 3:** Supported by retrospective data or expert opinion.

decreased ventilatory capacity, and diminished ability to cough and clear secretions (6,7). The majority of simple rib fractures are treated non-operatively using pain control and pulmonary hygiene, and ultimately heal spontaneously without major complications (3,7).

Computed tomography (CT) is recognized as the gold standard for the diagnosis of rib fractures and sternal fractures and can detect associated thoracic injuries in over 80% of patients with bony chest wall injuries (1,8).

Morbidity and mortality in patients with rib fractures is substantial and related to specific demographic, radiologic, and physiologic parameters, such as age, number of fractures, and spirometry, respectively. Age and number of fractures are key prognostic factors; each extra rib fracture increases mortality risk by ~19%, and elderly patients have markedly higher complication rates (5,6,8). Protocol-driven management has been demonstrated to improve outcomes in patients with rib fractures specifically. Protocolized management utilizes a combination of objective and subjective patient factors to stratify the risk of respiratory decompensation in patients with acute traumatic rib fractures. Not only can it be used to safely disposition patients to the most suitable location within the hospital, it is notably helpful in mitigating unexpected ICU admissions (7).

Acute traumatic rib fracture-related pain can be challenging to control. Narcotic medications have traditionally been the mainstay of therapy, but are increasingly falling out of favor due to their well-known side effect profile including respiratory depression, delirium, hypotension, constipation, and addiction (9). Multi-modality pain therapy that includes both non-steroidal anti-inflammatory agents (NSAIDS) and as needed opiates has been demonstrated to result in improved pain control with less opiate use and decreased morbidity (10). While most rib fractures heal uneventfully with pain control and aggressive pulmonary support, some patients require more invasive treatment to prevent future pulmonary complications (9,10). Surgical fixation of rib fractures has been increasingly performed in recent years to stabilize the chest wall especially in patients with flail chest (8).

Rib fractures are common among the traumatically injured and are increasing in incidence. An estimated 350,000 patients in the U.S. alone were diagnosed with rib fractures in the year 2017 (11). While the pain associated with a single rib fracture is relatively easy to control, the significant pain of multiple rib fractures can be challenging to manage. It can lead to decreased pulmonary function, increased hospital length of stay, and higher healthcare expenditures. The probability of pneumonia and death is directly correlated to the number of fractured ribs as well as the age of the patient (12). Additionally, the risk of respiratory decompensation in the setting of acute rib fractures has been shown to increase in patients with poor inspiratory effort and immobilization leading to pulmonary derecruitment. Use of a rib fracture protocol has recently been shown to reduce ICU length of stay, hospital length of stay, and pneumonia in patients with rib fractures (13). In addition, protocolization has been corelated with decreased mortality in acute traumatic thoracic injury patients (7).

Multi-modality therapy for multiple rib fracture-related pain control remains the standard treatment modality with early administration of NSAIDs, acetaminophen, muscle relaxants, and low-dose opiates (14). More recently, literature has shown a relationship between improved pulmonary function and pain control when intercostal chemical denervation and epidural analgesia are utilized (15). Severe rib fractures may require the use of mechanical ventilation if conservative management fails. Recently, surgical management of rib fractures has gained popularity. Indications for surgical fixation of rib fractures include flail chest, severe chest wall deformity, failure to wean from mechanical ventilation, chronic pain or disability, pulmonary herniation, non-union, and during thoracotomy closure. Increasing research points toward the benefit of operative reduction and fixation of these chest wall injuries in select patients. Of note, operative intervention does not replace the need for multimodal pain control (16).

LITERATURE REVIEW

Definitions

- Flail Chest: Fractures of ≥ 3 consecutive ribs in ≥ 2 locations, creating a free-floating segment (17)
- PIC Score: Composite score assessing Pain, Incentive Spirometry performance, and Chest Imaging to assist in triage and disposition (adapted from Denver Health and EAST guidelines) (18)
- Pulmonary Contusion: Parenchymal lung injury manifesting as alveolar hemorrhage and edema(19)

Initial Assessment and Management

Triage & Assessment (per ATLS) (20)

- Airway: Secure airway; cervical spine precautions
- Breathing: Evaluate for deformity, paradoxical motion, diminished breath sounds
- Circulation: Control bleeding, assess perfusion
- Disability: GCS, focal deficits
- Exposure: Full undressing with temperature management

Diagnostic Imaging

- Chest radiograph as an initial imaging study, specifically when the patient is unstable or access to CT is limited
- CT chest with contrast + reformatted rib images is gold standard (1,8)

Monitoring

- Continuous pulse oximetry
- Cardiac monitoring (if suspected concurrent cardiac injury)
- Serial respiratory assessments (inspiratory effort, cough, secretion management)
- Serial ABG
- Close interval follow-up imaging

Admission Location and Disposition Planning

Disposition of patients with rib fractures remains a critical decision point in trauma care, balancing the risks of respiratory deterioration against the benefits of early mobilization and resource stewardship. Rib fractures, particularly in the elderly or those with multiple injuries, are associated with significant morbidity and mortality, including pneumonia, respiratory failure, and prolonged hospital stays (21). Disposition decisions should therefore be structured, evidence-based, and tailored to individual patients. Furthermore, protocol-driven management of patients with rib fractures has been shown to improve outcomes (22).

A key challenge lies in the variability of injury patterns and patient physiology. Isolated rib fractures in younger patients are often self-limited and manageable in the outpatient setting. In contrast, similar injuries in older adults (≥ 65 years) confer a disproportionately high risk of complications, even with as few as two to three fractures, due to decreased pulmonary reserve, impaired cough reflex, and comorbidities (21).

The introduction of structured triage tools, such as the PIC (Pain, Incentive spirometry, Chest imaging) Score, helps standardize assessment by integrating clinical, functional, and radiologic data. Incentive spirometry volume is a particularly useful predictor of respiratory reserve. When combined with pain severity and imaging findings (e.g., flail chest, contusions, number and displacement of fractures), it enables a more nuanced assessment of risk (23). Radiologic findings are also critical. Pulmonary contusions and displaced or flail segments on CT imaging correlate with impaired ventilation and increased likelihood of requiring respiratory support. Such findings may not be apparent on plain radiographs underscoring the value of chest CT with rib reformating in triage planning and management (24).

Age must be explicitly incorporated into disposition decisions. Elderly patients have higher rates of silent hypoventilation, delayed decompensation, and poor tolerance of opioid analgesia. As such, even moderate injuries in this population may warrant ICU or intermediate-level monitoring and aggressive respiratory support (21,25).

Disposition pathways must also reflect institutional resources and practices including access to thoracic epidural placement, rib plating, respiratory therapy, and intermediate care units. Early ICU admission and multidisciplinary support have been shown to reduce morbidity in high-risk patients (21).

In summary, disposition decisions in rib fracture management should integrate objective scoring tools, imaging, functional assessment, and age. The adoption of structured criteria, such as the expanded PIC score with radiologic and age modifiers, supports safer triage, improves outcomes, and facilitates consistency across providers and institutions.

Table 1: PIC Score Framework (Modified Denver Health Model)

Component	0 pts	1 pt	2 pts
Pain (0–10)	Controlled (<4)	Moderate (4–6)	Severe (>6) despite therapy
IS Volume	≥15 mL/kg	10–14 mL/kg	<10 mL/kg
Imaging	No contusion, ≤2 rib fx	3–5 rib fractures, minor contusion	Flail chest, >5 rib fx, large contusion

Total Score (0–6):

- **0–2:** Low acuity – likely floor or discharge
- **3–4:** Moderate – step-down/telemetry
- **5–6:** High acuity – ICU or surgical candidate

Table 2: Comprehensive Disposition Guideline for Rib Fracture Patients

Location	Criteria
Discharge	PIC Score 0–2, ≤2 nondisplaced rib fractures, pain well-controlled on PO meds, IS ≥15 mL/kg, SpO_2 >94% on room air, **Age <65**, no pulmonary contusion, reliable follow-up
Inpatient Floor	PIC Score 2–3, 3–5 rib fractures, no flail segment, IS ≥10 mL/kg, mild/moderate pain, small/no contusion, **Age <65** OR **>65 but clinically robust and no comorbidities**
Step-down / Intermediate Care (IMCU)	PIC Score 3–4, ≥5 rib fractures OR mild contusion, PCA or high-flow O_2 required, IS 8–10 mL/kg, **Age ≥65**, or frail with risk factors (COPD, OSA, CHF)
ICU	PIC Score 5–6, flail chest, IS <8 mL/kg, intubated or NIV-dependent, epidural catheter placed or planned, large pulmonary contusion, **Age ≥65 with any pulmonary compromise**
OR (Rib Plating)	Indicated if flail chest with respiratory failure, multiple displaced ribs impairing ventilation, failure of conservative management, chest wall instability (regardless of age)

Note: Elderly patients (≥ 65 years) with ≥ 3 rib fractures have significantly higher risks of pneumonia, respiratory failure, and mortality. Lower thresholds for ICU admission should be used.

<u>Non-Operative Management</u>

Pain Control

- Mild Injury: PO acetaminophen + NSAIDs ± PRN opioids
- Moderate to Severe:
    - IV opioids (PCA preferred)
    - Regional anesthesia:
        - Thoracic epidural (first-line for flail chest)
        - Paravertebral or erector spinae plane block
        - Intercostal nerve block (limited duration)

Acute traumatic rib fracture-related pain can be challenging to control. Narcotic medications have traditionally been the mainstay of therapy but are increasingly falling out of favor due to their well-known side effect profile including respiratory depression, delirium, hypotension, constipation, and addiction. Multi-modality pain therapy that includes both non-steroidal anti-inflammatory agents (NSAIDS) and as needed opiates has been demonstrated to result in improved pain control with less opiate use and decreased morbidity (26).

While the pain associated with a single rib fracture is relatively easy to control, the significant pain of multiple rib fractures can be challenging to manage. It can lead to decreased pulmonary function, increased hospital length of stay, and higher healthcare expenditures (27). The probability of pneumonia and death is directly correlated to the number of fractured ribs as well as the age of the patient (28). Multimodal therapy for rib fracture-related pain control remains the standard treatment strategy with early administration of NSAIDs, acetaminophen, muscle relaxants, and low-dose opiates (29).

Injury severity and patient age following traumatic injury are two of the strongest predictors of patient survival. Younger patients tend to fare better with injuries that cause significant morbidity and mortality among older patients. Multiple rib fractures are associated with significantly increased morbidity and mortality compared to single rib fractures. Bulger et al. showed a difference in mortality of 10% vs. 22% in young (18-64 years) vs. old (≥ 65 years) patients with rib fractures (30). There were also differences in ventilator days (3.1 vs. 4.3 days), intensive care unit days (4.0 vs. 6.1 days), and hospital length of stay (10.7 vs. 15.4 days) among young vs. old patients. Recent studies have also shown significantly increased mortality among elderly patients admitted to a trauma center with rib fractures and that the disability associated with rib fractures can be longer lasting than previously recognized (31,32).

Intermittent, scheduled analgesia [as compared to patient-controlled analgesia (PCA) dosing or epidural analgesia] has been shown to be equally effective in pain control for elderly patients with blunt thoracic trauma (33). PCA dosing (while useful in acute post-operative pain) is becoming less common in the treatment of rib fractures. It is typically reserved for hard-to-control pain or patients with chronic opiate usage.

Yang et al. demonstrated a decreased risk of pulmonary complications in a retrospective review of patients receiving IV ketorolac within 4 days of sustaining rib fractures compared to a control group (34). They also found a decrease in ICU days as well as an increase in ventilator-free days without the apparent risks commonly attributed to NSAID use (e.g., gastrointestinal bleed, kidney injury, impaired fracture healing).

Ibuprofen (IV or oral) is a non-narcotic adjunct for the treatment of post-surgical and post-traumatic pain. Southworth et al. studied the use of IV ibuprofen in a multicenter randomized trial of elective orthopedic and abdominal surgical patients (35). Patients were given IV morphine by PCA and randomized to receive either 400 or 800 mg of IV ibuprofen or placebo. The first dose of the study drug was administered intraoperatively at the time of wound closure and then every six hours for the first 48 hours of admission. The drug was then continued at the discretion of the investigator within a maximum duration of five days. Median morphine use was significantly less in the 800 mg ibuprofen group ($p=0.03$). Median pain scores were also significantly lower in the 800 mg and 400 mg ibuprofen groups compared to the placebo group.

Similarly, in a study performed at Orlando Regional Medical Center, Bayouth et al. retrospectively compared a cohort of patients with traumatic rib fractures who received IV ibuprofen and narcotics to an age and rib fracture-matched control group receiving narcotics only (36). Early IV ibuprofen therapy in patients with traumatic rib fractures significantly decreased narcotic requirement and resulted in clinically significant decreases in hospital length of stay.

Contraindications to ibuprofen usage include, but are not limited to (37):

- Known hypersensitivity to ibuprofen or other NSAIDs
- Asthma, urticaria, or allergic-type reactions after taking aspirin or NSAIDs
- Peri-operative use in the setting of coronary artery bypass graft (CABG)

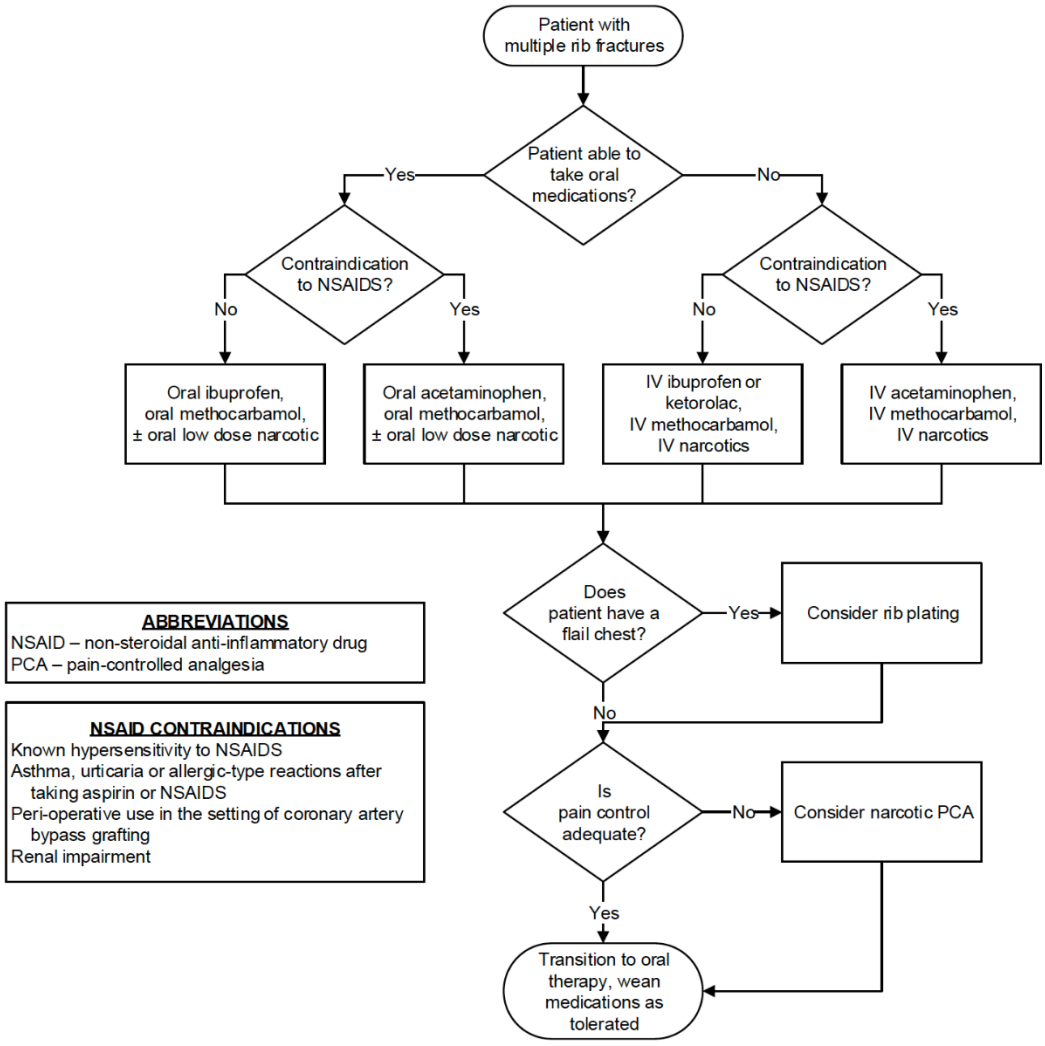
Precautions for ibuprofen usage include:

- Serious and potentially fatal cardiovascular thrombotic events
- Serious gastrointestinal reactions
- Hepatic effects
- Hypertension
- Congestive heart failure and edema
- Renal Impairment
- Serious skin reactions (Stevens-Johnson Syndrome, Toxic Epidermal Necrolysis)

Muscle relaxants, such as methocarbamol, have been demonstrated to improve pain control in patients with multiple rib fractures. Gabapentin has been utilized in the multimodal treatment of rib fractures, but there is no consensus on its proven benefit. A recent randomized control trial of gabapentin vs. placebo in critically ill patients with rib fractures showed no benefit to gabapentin use with similar hospital and ICU length of stay, incentive spirometer recordings, and pulmonary complications (38).

The evidence supporting abenefit to epidural analgesia for pain control following traumatic rib fracture is conflicting (39,40). Given the cost and procedural risks associated with this therapy, further research is necessary before definitive recommendations on epidural analgesia can be made.

Multi-modality Pain Control for Rib Fractures



Pulmonary Support

- Incentive spirometry (goal ≥15 mL/kg tidal volume) (41)
- Chest physiotherapy, PAP, oscillating nebulizer therapy (PEP), cough assist
- Oxygen support as needed
- NIV (BiPAP): For borderline respiratory status or pulmonary contusion (42)
- Intubation Criteria:
    - Severe hypoxia/hypercapnia
    - Flail chest with fatigue
    - Altered mental status or airway protection

Associated injuries to manage/consider

- Pulmonary contusion – supportive care (43)
- Pneumothorax/Hemothorax – chest tube drainage (see Pneumothorax and Hemothorax Guideline)
- Cardiac contusion – telemetry, repeat ECG/troponin (44)
- Great vessel injury – CTA + vascular surgery consult
- Diaphragmatic rupture – diagnostic laparoscopy or CT scan (45)

Surgical Stabilization of Rib Fractures

Rib Fixation Indications

- Severe flail chest with respiratory compromise
- ≥ 3 displaced rib fractures with failure of medical management
- Nonunion or malunion of rib fractures
- Significant chest wall injury or deformity
- Persistent pain impairing ventilation or mobility

Timing: Within 48–72 hours preferred
Service: Trauma or Thoracic surgery (46)

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