

Western Trauma Association Critical Decisions in Trauma: Management of rib fractures

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ABSTRACT: This is a recommended management algorithm from the Western Trauma Association addressing the management of adult patients with rib fractures. Because there is a paucity of published prospective randomized clinical trials that have generated Class I data, these recommendations are based primarily on published observational studies and expert opinion of Western Trauma Association members. The algorithm and accompanying comments represent a safe and sensible approach that can be followed at most trauma centers. We recognize that there will be patient, personnel, institutional, and situational factors that may warrant or require deviation from the recommended algorithm. We encourage institutions to use this as a guideline to develop their own local protocols. (*J Trauma Acute Care Surg.* 2017;82: 200–203. Copyright © 2016 Wolters Kluwer Health, Inc. All rights reserved.)

KEY WORDS: Algorithm; rib fracture; elderly; pain control.

Rib fractures are the most common chest injury sustained from a variety of primarily blunt injury mechanisms. They may be associated with other immediate or potentially life-threatening injuries. The pain associated with rib fractures, along with underlying pulmonary pathology, contributes to impaired gas exchange, and increased risks of pneumonia and respiratory failure. Although the overall mortality in adult patients with rib fractures is approximately 10%, deaths in young adults are generally attributed to associated injuries. In contrast, elderly patients with rib fractures have at least a 20% mortality that is often directly related to progressive respiratory failure and pneumonia.^{1–3} As the population ages, this problem will become even more prevalent in all trauma centers across the country. Thus, the need for guidelines to ensure appropriately aggressive treatment for rib fractures is increasingly important to prevent these complications.

Risk for Respiratory Compromise and Need for Close Monitoring

Patients with rib fractures should be monitored closely for respiratory decompensation. There are several ways to identify patients who have sustained significant rib fractures, although none have perfect sensitivity or specificity. One option is to use a

somewhat arbitrary age cutoff. Age is clearly arbitrary, and there are numerous ways of more appropriately identifying patients who are physiologically old. These measures of frailty are becoming more widespread, and the intent of this algorithm (Fig. 1) is to suggest that frail patients with rib fractures require more aggressive monitoring and intervention.^{4,5} Our recommendation, based on institutional protocol and experience, is to recommend that patients with more than two significant rib fractures who are older than 65 years be admitted to a monitored unit with ICU-level staffing recognizing that specific institutions already using other measures to identify frail patients should continue to do so. In patients with underlying pulmonary dysfunction, or those who are frail, consideration should be given to using a lower age threshold regardless of signs of respiratory compromise at the time of admission. Similarly, for those older than 65 who have no underlying comorbidities, minimal pain, and are in good overall health, a nonmonitored setting may be appropriate. An alternative method of identifying patients at risk for respiratory decompensation is to use some measure of respiratory compromise. Hypoxemia (oxygen saturation <92% on room air), inability to perform incentive spirometry greater than 1,000 cc or greater than 15 cc/kg, and a vital capacity of less than 1.4 or less than 55% of predicted have all been used to identify these patients early.^{6–9} Others have suggested a much lower threshold, using a cutoff of 30% of predicted vital capacity to identify patients likely to develop complications.¹⁰ As with any screening test, the sensitivity of the criteria is most important; if there is no respiratory deterioration 24 hours after admission, the patient can be safely moved to a standard ward.

Severity of Rib Fractures

The anatomic definition of flail chest is three or more ribs broken in two or more places. This definition attempts to characterize a segment that is disconnected from the rest of the chest wall and moves paradoxically inward with inspiration. However, in most patients, the respiratory compromise that occurs with flail chest is not due to paradoxical movement but rather underlying

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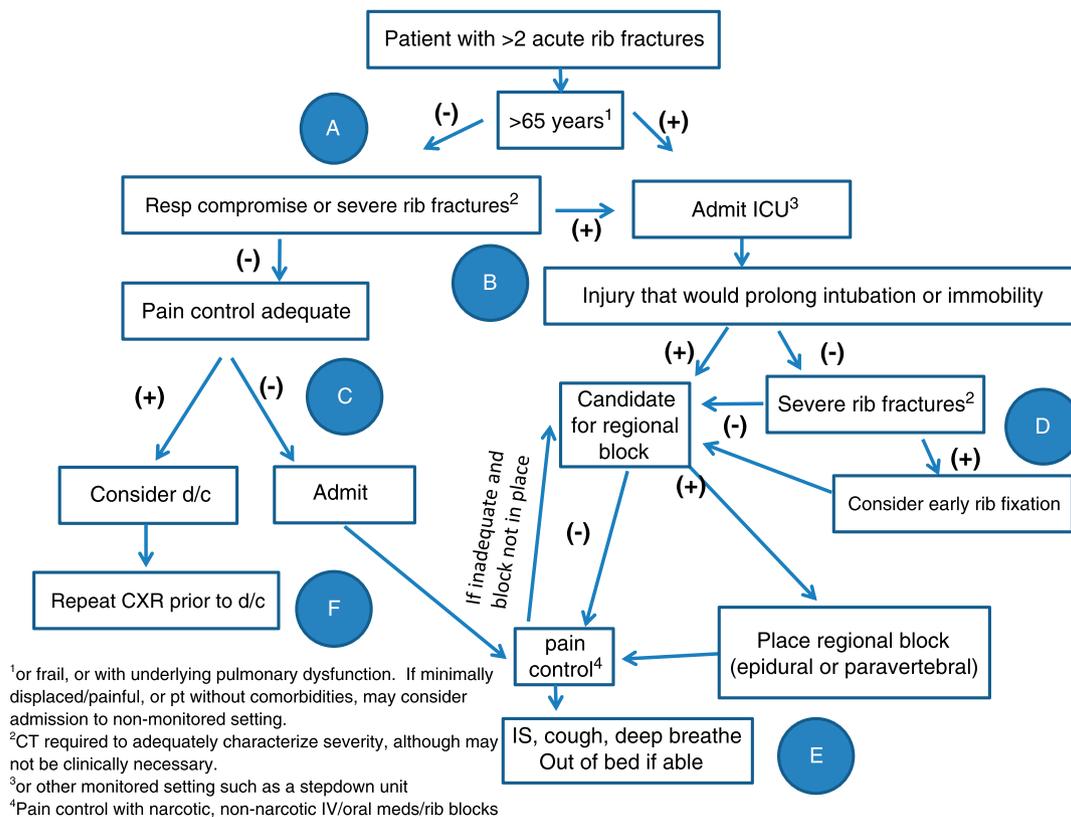


Figure 1. Western Trauma Association rib fracture algorithm. *Circled letters* refer to corresponding areas within the text.

contusion and pain. In the same way, multiple ribs that are broken in a single place, or fewer ribs that are significantly displaced, may be associated with pain that is much greater than that generated by a flail segment with minimal displacement. Rather than rely on a standard definition of a flail segment, some measure, which incorporates the number of fractures, presence of bilaterality, location and distribution in the chest, and degree of displacement, has been proposed to better identify those at risk. These characteristics have been incorporated into a rib fracture score described by Pieracci et al.¹¹ Computed tomography of the chest with three-dimensional reconstruction is necessary to adequately assess anatomic severity if rib fixation is being considered; it is not necessary solely to document or determine severity of fractures. In addition to purely anatomic considerations, the severity of the underlying pulmonary contusion may contribute significantly to the degree of hypoxemia or respiratory compromise. For this reason, the use of clinical judgment combining physiologic derangements and anatomic considerations to assess severity is necessary.

Pain Control

The most important aspect of pain management is provision of adequate pain control using a multimodality approach. Oral or intravenous acetaminophen along with oral or intravenous nonsteroidal anti-inflammatory agents provides significant pain relief and decreases overall opioid requirements.¹²⁻¹⁴ Local anesthetic, either in the form of rib blocks or intrapleural use, is effective.¹³ For patients with severe pain, early use of regional

anesthesia (epidural or paravertebral) improves pain control, and seems to improve outcome, particularly in the elderly.¹⁴⁻¹⁹ One of the issues with the use of regional anesthesia in these patients is the need for concomitant DVT prophylaxis, as most of these patients are at high risk for thromboembolism. Current evidence-based guidelines from the American Society of Regional Anesthesia and Pain Medicine recommend that epidural catheters be placed at least 10 to 12 hours after a prophylactic dose of low-molecular weight heparin and that a prophylactic dose be given at least 2 hours after epidural catheter removal. Using standard measures of coagulation, placement of an epidural catheter is safe in patients with an international normalized ratio of less than 1.5. Finally, a period of 3 days without drug before epidural catheter placement is necessary for apixaban and rivaroxaban and 5 days for dabigatran, with a period of 6 hours before drug initiation after removal of the epidural catheter recommended. The same guidelines are recommended for paravertebral blocks.²⁰ Another issue with the use of regional blocks is the variability in the absolute and relative contraindications that exists across practices, and the lack of standard recommendations. Generally accepted absolute contraindications from the anesthesiology literature include patient's refusal, uncorrected hypovolemia, increased intracranial pressure, infection at the site, and allergy to local anesthetic. Relative contraindications include coagulopathy, platelet count of less than 100,000, a patient unable to cooperate with the neurological examination, anatomic abnormalities, sepsis, unstable spine due to trauma, and positioning problems. The list reported by trauma surgeons for both absolute

and relative contraindications is much longer.²¹ The current focus on overuse of opioid pain medication more globally highlights the need to use non-narcotic treatments for rib fracture pain, which have good evidence of effectiveness.

Rib Fixation

The strategy to improve function and decrease pain with most fractures is to minimize movement, employing internal or external fixation. Older attempts to do this for rib fractures, with taping or banding, limited chest wall excursion and subsequent lung expansion, leading to further respiratory compromise. Current approaches use smaller plates and screws using either a minimally invasive technique or a formal thoracotomy. It has been difficult to show an advantage over standard treatment with regard to pain, ventilator-free days, overall length of stay, quality of life, or survival. This has been primarily due to the heterogeneity of the patient population, delay in treatment, and selection bias of the treating surgeons.²² However, three small randomized controlled trials do suggest significant benefit in selected populations, as do larger prospective observational series, some retrospective series, and a meta-analysis. These benefits include fewer days of invasive and noninvasive ventilation, fewer patients with pneumonia, and fewer patients with tracheostomy. Impact on pain is more variable and effect on long-term functional outcomes unknown.^{11,23–30} Despite the suggestion of benefit, there is still no consensus on how best to select patients that could be helped, and how widely this potentially beneficial therapy should be used. The meta-analysis concludes that additional prospective randomized trials are necessary due to the reliance on primarily small retrospective studies. When deciding whether rib fixation is a good option, there are a few things to consider other than the severity of the rib fractures. First, the patient should be free of other injuries that would prolong intubation or immobility, such as a severe head injury or pelvic fracture. In these cases, rib fixation is not likely to alter the patient's overall clinical course, as the benefits that have been most clearly shown are related to decreasing ventilator days. Second, the fixation should occur early, ideally within 48 hours of admission, to maximize the likelihood of avoiding ventilator-associated complications that would independently increase ventilator days. Lastly, if the patient needs either a video-assisted thoracoscopy or thoracotomy at any point, the ribs can be fixed during either of these procedures.

Pulmonary Hygiene

Pulmonary hygiene, pulmonary toilet, cough and deep breathe, get out of bed. This is probably the most commonly written order for patients with rib fractures, and its importance is a deeply held belief by practitioners. However, data supporting this intervention in improving outcome in patients with rib fractures are lacking. Despite the lack of data, overwhelming anecdotal experience and Western Trauma Association expert consensus support its inclusion in the treatment algorithm for patients with rib fractures.

Repeat Chest X-ray Before Discharge

Both hemothoraces and pneumothoraces are common in patients with rib fractures and can present in a delayed manner. Many of these will require treatment with a chest tube. For this reason, a chest x-ray before discharge should be considered, whether or not the patient has been admitted to the hospital.

DISCLOSURE

The authors declare no conflicts of interest.

REFERENCES

- Bulger EM, Arneson MA, Mock CN, Jurkovich GJ. Rib fractures in the elderly. *J Trauma*. 2000;48(6):1040–1046.
- Bergeron E, Lavoie A, Clas D, Moore L, Ratté S, Tetreault S, Lemaire J, Martin M. Elderly trauma patients with rib fractures are at greater risk of death and pneumonia. *J Trauma*. 2003;54(3):478–485.
- Stawicki SP, Grossman MD, Hoey BA, Miller DL, Reed JF 3rd. Rib fractures in the elderly: a marker of injury severity. *J Am Geriatr Soc*. 2004;52(5):805–808.
- Cook AC, Joseph B, Inaba K, Nakonezny PA, Bruns BR, Kerby JD, Brasel KJ, Wolf SE, Cuschieri J, Paulk ME, et al. Multicenter external validation of the Geriatric Trauma Outcome Score: a study by the Prognostic Assessment of Life and Limitations After Trauma in the Elderly (PALLIATE) consortium. *J Trauma Acute Care Surg*. 2016;80:204–209.
- Joseph B, Pandit V, Zangbar B, Kulvatunyou N, Hashmi A, Green DJ, O'Keefe T, Tang A, Vercruyse G, Fain MJ, et al. Superiority of frailty over age in predicting outcomes among geriatric trauma patients: a prospective analysis. *JAMA Surg*. 2014;149:766–772.
- Todd SR, McNally MM, Holcomb JB, Kozar RA, Kao LS, Gonzalez EA, Cocanour CS, Vercruyse GA, Lygas MH, Brasseaux BK, et al. A multidisciplinary clinical pathway decreases rib fracture-associated infectious morbidity and mortality in high-risk trauma patients. *Am J Surg*. 2006;192:806–811.
- Brown SD, Walters MR. Patients with rib fractures: use of incentive spirometry volumes to guide care. *J Trauma Nurs*. 2012;19(2):89–91.
- Bakhos C, O'Connor J, Kyriakides T, Abou-Nukta F, Bonadies J. Vital capacity as a predictor of outcome in elderly patients with rib fractures. *J Trauma*. 2006;61:131–134.
- Carver TW, Milia DJ, Somberg C, Brasel K, Paul J. Vital capacity helps predict pulmonary complications after rib fractures. *J Trauma Acute Care Surg*. 2015;79:413–416.
- Legare C, Sawatzky JA. Dyspnea in the thoracic trauma patient: a human response to illness. *J Trauma Nurs*. 2010;17:36–42.
- Pieracci FM, Rodil M, Stovall RT, Johnson JL, Biffl WL, Mauffrey C, Moore EE, Jurkovich GJ. Surgical Stabilization of severe rib fractures. *J Trauma Acute Care Surg*. 2015;78:883–887.
- Bayouth L, Safcsak K, Cheatham ML, Smith CP, Birrer KL, Promes JT. Early intravenous ibuprofen decreases narcotic requirement and length of stay after traumatic rib fracture. *Am Surg*. 2013;79(11):1207–1212.
- Karmakar MK, Ho AM. Acute pain management of patients with multiple fractured ribs. *J Trauma*. 2003;54(3):615–625.
- Kieninger AN, Bair HA, Bendick PJ, Howells GA. Epidural versus intravenous pain control in elderly patients with rib fractures. *Am J Surg*. 2005;189(3):327–330.
- Allen MS, Halgren L, Nichols FC 3rd, Cassivi SD, Harmsen WS, Wigle DA, Shen KR, Deschamps C. A randomized controlled trial of bupivacaine through intracostal catheters for pain management after thoracotomy. *Ann Thorac Surg*. 2009;88:903–910.
- Simon B, Ebert J, Bokhari F, Capella J, Emhoff T, Hayward T 3rd, Rodriguez A, Smith L, Eastern Association for the Surgery of Trauma. Management of pulmonary contusion and flail chest: an Eastern Association for the Surgery of Trauma practice management guideline. *J Trauma Acute Care Surg*. 2012;73:S351–S361.
- Truitt MS, Murry J, Amos J, Lorenzo M, Mangram A, Dunn E, Moore EE. Continuous intercostal nerve blockade for rib fractures: ready for primetime? *J Trauma*. 2011;71:1548–1552.
- Gage A. The effect of epidural placement in patients after blunt thoracic trauma. *J Trauma Acute Care Surg*. 2014;76:39–45.
- Bulger E, Edwards T, Klotz P, Jurkovich GJ. Epidural analgesia improves outcome after multiple rib fractures. *Surgery*. 2004;136(2):426–430.
- Horlocker TT, Wedel DJ, Rowlingson JC, Enneking FK, Kopp SL, Benzon HT, Brown DL, Heit JA, Mulroy MF, Rosenquist RW, et al. Regional anesthesia in the patient receiving antithrombotic or thrombolytic therapy: American Society of Regional Anesthesia and Pain Medicine

- Evidence-Based Guidelines (Third Edition). *Reg Anesth Pain Med*. 2010;35(1):64–101.
21. Bulger EM, Edwards WT, de Pinto M, Klotz P, Jurkovich GJ. Indications and contraindications for thoracic epidural analgesia in multiply injured patients. *Acute Pain*. 2008;10:15–22.
 22. Winters BA. Older adults with traumatic rib fractures: an evidence-based approach to their care. *J Trauma Nurs*. 2009;16:93–97.
 23. Leinicke JA, Elmore L, Freeman BD, Colditz GA. Operative management of rib fractures in the setting of flail chest: a systematic review and meta-analysis. *Ann Surg*. 2013;258:914–921.
 24. Tanaka H, Yukioka T, Yamaguti Y, Shimizu S, Goto H, Matsuda H, Shimazaki S. Surgical stabilization of internal pneumatic stabilization? A prospective randomized study of management of severe flail chest patients. *J Trauma*. 2002;52:727–732.
 25. 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.
 26. Marasco SF, Davies AR, Cooper J, Varma D, Bennett V, Nevill R, Lee G, Bailey M, Fitzgerald M. Prospective randomized controlled trial of operative rib fixation in traumatic flail chest. *J Am Coll Surg*. 2013;216:924–932.
 27. Slobogean GP, MacPherson CA, Sun T, Pelletier ME, Hameed SM. Surgical fixation vs nonoperative management of flail chest: a meta-analysis. *J Am Coll Surg*. 2013;216(2):302–311.
 28. Wada T, Yasunaga H, Inokuchi R, Matsui H, Matsubara T, Ueda Y, Gunshin M, Ishii T, Doi K, Kitsuta Y, et al. Effectiveness of surgical rib fixation on prolonged mechanical ventilation in patients with traumatic rib fractures: a propensity score-matched analysis. *J Crit Care*. 2015;30(6):1227–1231.
 29. de Moya M, Bramos T, Agarwal S, Fikry K, Janjua S, King DR, Alam HB, Velmahos GC, Burke P, Tobler W. Pain as an indication for rib fixation: a bi-institutional pilot study. *J Trauma*. 2011;71(6):1750–1754.
 30. Doben AR, Eriksson EA, Denlinger CE, Leon SM, Couillard DJ, Fakhry SM, Minshall CT. Surgical rib fixation for flail chest deformity improves liberation from mechanical ventilation. *J Crit Care*. 2014;29:139–143.