The American Journal of Surgery (2012) 204, 910–914

The American Journal of Surgery®

The Southwestern Surgical Congress

Predicting outcome of patients with chest wall injury

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KEYWORDS:
Rib fractures;
Scoring system;
Rib fixation;
Mechanical ventilation

Abstract

BACKGROUND: Rib fractures occur in 10% of injured patients, are associated with morbidity and mortality, and frequently necessitate intensive care unit (ICU) care. A scoring system that identifies the risk for respiratory failure early in the evaluation process may allow early intervention to improve outcomes. The aim of this study was to test the hypothesis that a scoring system based on initial clinical findings can identify patients with rib fractures at greatest risk for morbidity and mortality.

METHODS: A simple scoring system to stratify risk was developed and applied to patients through a retrospective trauma registry review. Points were assigned as follows: age $<$ 45 years = 1 point, age 45 to 65 years = 2 points, age $>$ 65 years = 3 points; $<$3 fractures = 1 point, 3 to 5 fractures = 2 points, $>$5 fractures = 3 points; no pulmonary contusion = 0 points, mild pulmonary contusion = 1 point, severe pulmonary contusion = 2 points, bilateral pulmonary contusion = 3 points; and bilateral rib fracture absent = 0 points, bilateral rib fracture absent present = 2 points. A review of trauma registry patients with rib fractures (June 2008 to February 2010) at a state-designated level 1 trauma center was performed. Data reviewed included age, number of fractures, bilateral injury, presence of pulmonary contusion, classification of the contusion, length of hospital stay, mechanical ventilation, ICU admission, and length of stay. The scoring system was retrospectively applied to 649 patients to determine validity.

RESULTS: A score $\leq$ 7 indicated lower mortality (24 of 579 [4.2%]) compared with patients with scores $>$ 7 (10 of 70 [14.3%]) (Fisher's 2-sided P = .0018). Patients with scores $\leq$ 6 were less likely to be admitted to an ICU (29.7%) compared with those with scores $\geq$ 7 (56.7%) ($P < .0001$). Patients with total scores $<$ 7 were less likely to require intubation (20.6%) compared with those with scores $\geq$ 7 (40.0%) ($P < .0001$). Patients with scores $\leq$ 4 had shorter lengths of stay (36.0% $<$5 days) compared with those who had scores $>$ 4 (59.7%) ($P < .0001$).

CONCLUSIONS: A simple scoring system predicts the likelihood that patients will require mechanical ventilation and prolonged courses of care. A score of 7 or 8 predicted increased risk for mortality, admission to the ICU, and intubation. A score $>$ 5 predicted a longer length of stay and a longer period of ventilation. This scoring system may assist in the earlier implementation of treatment strategies such epidural anesthesia, ventilation, and operative fixation of fractures.

Rib fractures occur in >10% of injured patients and are associated with significant morbidity and mortality. Mortality rates up to 25% have been documented in some series.[1–3] Associated complications that frequently develop in these patients include respiratory failure secondary to altered chest wall mechanics from the fractures and respiratory

Presented at the annual meeting of the Southwestern Surgical Congress, Rancho Palos Verdes, CA, March 27, 2012.

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Manuscript received March 8, 2012; revised manuscript May 21, 2012

0002-9610/$ - see front matter © 2012 Published by Elsevier Inc.
http://dx.doi.org/10.1016/j.amjsurg.2012.05.015

distress from fracture-associated pain. Underlying pulmonary contusion plays a prominent role in the hypoxia that develops after chest wall injury. This complex pathophysiology often necessitates endotracheal intubation, prolonged mechanical ventilation, tracheostomy, and prolonged intensive care unit (ICU) length of stay.[4,5] In addition, poor pulmonary function and mechanical ventilation increase the risk for the development of pneumonia, which is a frequent cause of death.[1,2] Several factors have been shown to contribute to the morbidity and mortality associated with thoracic wall injury. These factors include age, the total number of fractures, and the presence of bilateral fractures. Increases in morbidity and mortality have been demonstrated in patients aged ≥ 65 years. Patients as young as 45 years of age have been shown to have worse outcomes, depending on the severity of the injury.[4,5] These differences in morbidity and mortality are due in part to the normal aging process that leads to an increased susceptibility to the occurrence of rib fractures and the development of complications. An increased number of fractures may be seen in younger patients because of mechanisms of injury associated with greater kinetic injury, while older patients' injuries may be related to decreased bone density.[4,5] Differences in the mechanics and physiology of the respiratory system as patients age include decreased oxygen exchange and a higher predisposition to developing infections. Both of these factors contribute to increased morbidity and mortality after thoracic trauma.[5] Other variables related to rib fractures include the presence of pulmonary contusions, pneumothorax, hemothorax, flail segments, and bilateral rib fractures.[4,5] Frequently used therapeutic modalities include pulmonary toilet, mobilization, and pain management with patient-controlled analgesia (PCA) or epidural analgesia. Adequate pain control allows deep breathing, enhanced respiratory excursion, and improved respiratory function. The use of epidural analgesia correlates with a reduction in mortality.[5,6] Mechanical ventilation and early operative intervention for fixation of the fractures may also be helpful with more severe injuries.[2,5–8]

Choosing the most appropriate interventions is important to minimize or prevent the complications that develop secondary to rib fractures. Optimal timing of therapeutic interventions such as thoracic epidural anesthesia can potentially prevent or decrease the need for mechanical ventilation as well as decrease the length of hospitalization required.[7–10] The earlier in the patient's course that interventions can be introduced would presumably provide the greatest benefit.[6] A reliable method to predict the clinical courses of these patients on presentation has not been readily available. A scoring system that provides early identification of patients at the greatest risk for respiratory failure may allow the early institution of intervention to improve outcomes. The purpose of this study was to determine if a simple scoring system can accurately predict within the first 24 hours of care which patients are most likely to have poor outcomes and require intensive care. By association, this group of patients would be most likely to have favorable responses to more aggressive modes of intervention directed at improving respiratory function.

Table 1 Chest wall trauma scoring system

Age (y)	Number of rib fractures
<45 = 1 point	<3 = 1 point
45–65 = 2 points	3–5 = 2 points
>65 = 3 points	>5 = 3 points
Score: ___	Score: ___
Pulmonary contusion	Bilateral rib fractures
None = 0 points	No = 0 points
Mild = 1 point	Yes = 2 points
Severe = 2 points	
Bilateral = 3 points	
Score: ___	Score: ___
Total score: ___	

Methods

This study was performed at a busy, state-designated level 1 trauma center. After obtaining approval from the institutional review board, a simple scoring system to stratify risk for patients with rib fractures was developed on the basis of currently available literature (Table 1). The scoring system was specifically formulated to use clinical data available at the time of initial patient evaluation. The validity of the scoring system was tested by retrospectively applying the system to a large group of injured patients through a review of registry data from a level 1 trauma center.

The trauma registry was reviewed for patients presenting with rib fractures between June 2008 and February 2010. A total of 649 patients with complete registry information were included in this study. The scoring system was retrospectively applied to each of these patient records to determine its validity and identify total scores with predictive efficacy. Data examined from the registry included patient age; the number of rib fractures; the presence or absence of bilateral rib fractures; the presence of pulmonary contusion; classification of pulmonary contusion as mild, moderate, or severe; the need for intubation and mechanical ventilation; ICU admission; and lengths of ICU and overall hospital stays. Patients were excluded from the analysis if they expired in the emergency department or were <18 years of age or if all necessary data were not available from the registry.

To test for significant differences in outcomes on the basis of total score, patients were divided into 2 groups, and Fisher's exact test was used. The groups were determined on the basis of visual assessment of the descriptive charts. For each of the 5 outcome variables, multiple groupings or cut points were assessed. If all groupings produced statistically significant results, the grouping using the lowest total score is reported here.