

## Short review

### Is it Time to Rethink Age as a Predictor of Morbidity and Mortality in Patients with Rib Fractures?

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#### Abstract

Historically, older patients with rib fractures have had worse in-hospital and post-discharge health outcomes than young and middle-aged patients. In this brief review, we have assessed the current literature, which indicates that age has become a less relevant indicator of complications and mortality among rib fracture patients. Advances in rib fracture management, especially in the past decade, have significantly reduced mortality and complication rates in geriatric patients. In the meantime, studies demonstrating similar rates of complications among older and younger patients have emerged. Despite these findings, age continues to be used as a critical indication for ICU and hospital admissions for rib fracture patients. And thus, it is possible that young adult and middle-aged patients are being overlooked or undertreated as a result of intensive care unit or hospital admission criteria. Most young or middle-aged patients are often sent home. Consequently, a significant proportion of hospitalized rib fracture patients tend to be geriatrics, and this likely causes a considerable increase in the intensive care unit burden. Also, geriatric patients typically have a longer length of hospitalization, leading to a higher cost of hospitalization. Therefore, a functional assessment of rib fracture patients, irrespective of age, will likely improve short and long-term patient outcomes.

**Keywords:** Age; Geriatric; In-hospital; Post-discharge; Rib fracture

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#### Introduction

Elderly patients with rib fractures are typically admitted to the intensive care unit on the premise that pneumonia is the most common complication in this sub-population [1,2]. Indeed, previous studies have shown a significantly higher incidence of pneumonia among those aged  $\geq 65$  than in younger patients with any (24.7% vs. 13.0%;  $p < 0.001$ ) or isolated thoracic trauma (34.2% vs. 10.7%;  $p < 0.005$ ) rib fractures with pneumonia associated with 3.8-times higher odds of death [3]. Moreover, older patients with any (19.4% vs. 9.2%;  $p < 0.01$ ) or isolated thoracic trauma (14.6% vs. 0%;  $p < 0.005$ ) rib fractures had higher mortality rates - with advanced age (aged  $\geq 65$ ) being associated with 5-times higher odds of mortality after adjusting for injury severity and comorbidities [3]. Additionally, several other epidemiological studies [4] and meta-analyses [5] suggest that patients aged  $\geq 65$  with blunt-trauma rib fractures have elevated mortality risks compared to younger patients. However, recent advances in imaging, pharmacological, surgical, and postoperative pulmonary rehabilitation modalities have significantly reduced the risk of pneumonia and mortality in older rib fracture patients [1,2,6-8]. For instance, a recent trauma registry analysis from the United States suggests that mortality in the geriatric population with rib fractures may be as low as 4% with a median length of hospitalization of 4 days or less irrespective of the number of fractures [9]. In a single-site study, Colling et al., also reported a mortality rate of 4% among rib fracture patients (median age = 57 years) and that advanced age was a poor predictor of mortality [10].

Similarly, Abdulrahman et al., reported mortality rates of 2% in  $< 45$ -year-old blunt chest trauma patients with  $\geq 3$  rib fractures and 6% in  $\geq 45$ -years-old age group [11]. McGuinness et al., more recently reported mortality rates of 0% in  $< 45$ -year-old patients and 3% in both 45-65 and  $> 65$  age groups [12]. Furthermore, Testerman reported similar mortality rates and length of hospitalization in blunt trauma rib fracture patients (excluding patients with severe head injuries, abdominal injuries, and deaths within 24 hours) who were under 44 years old with 1 to 4 fractures, under 44 years old with  $> 4$  fractures, 45 years or older with 1 to 4 fractures, and 45 years or older with  $> 4$  rib fractures [13]. Given the improved survival of older rib fracture patients and the narrowing gap in mortality rates between young and older populations, there is a growing need for assessing and improving the hospital and post-discharge outcomes of surviving rib fracture patients.

#### Health outcomes of surviving rib fracture patients

A growing body of literature reports the health outcomes of surviving rib fracture patients. For example, Abdulrahman et al., reported similar in-hospital outcomes in patients aged  $< 45$  years compared to the  $\geq 45$ -years-old age group, including the incidence of pneumothorax, hemothorax and ventilatory support. However, Abdulrahman did note that the older group was more likely to undergo chest tube insertion (26 vs. 14 %;  $p = 0.04$ ) and have a more extended stay in the trauma intensive care unit (median 11 vs. 3 days;  $p = 0.001$ ) [11]. In a recent study, McGuinness et al., reported a shorter median length

of hospitalization in young patients; middle-aged and elderly patients had similar lengths of stay (3 days in <45 vs. 4 days in 45-65 and >65 age groups) [12]. The three age groups, however, had similar rates of intensive care unit admissions, intubation, pneumonia, empyema and acute respiratory distress syndrome [12]. Recently, we reported that patients  $\leq 65$  admitted to Doctor Hospital Renaissance Health had numerically higher mortality rates than patients  $>65$  (5.63% vs. 1.89%) with blunt trauma rib fractures [13]. Nonetheless, the odds of mortality did not differ significantly between the two age groups [13]. Furthermore, the median length of intensive care unit stay (0 days in both groups) and total length of hospitalization (5 vs. 4 days) were similar in young and older patients [13]. However, there are some indications that patients  $\geq 70$  years may have worse in-hospital outcomes than those aged 65-69 years [9]. Regarding post-discharge outcomes, Fabricant et al., reported that 59% of rib fracture patients experienced chest wall pain and 76% had prolonged disability at two months post-discharge follow-up [14]. The corresponding prevalence among those with isolated rib fractures was 64% and 69%, respectively [14]. Another study by Gordy et al. showed that 22% of rib fracture patients experienced chronic pain (28% among isolated rib fracture patients) and 53% experienced chronic disability (40% among isolated rib fracture patients) at six months follow-up [15].

While prolonged pain and disability remain of considerable concern, the disparity in long-term outcomes between middle-aged or younger patients and older patients seems to be narrowing. In a study that included patients who underwent rib fixation after major thoracic trauma, Marasco et al., demonstrated that while rib fracture patients continued to report lower quality of life and return to work rates 24 months after injury, patients aged  $\geq 55$  and  $<55$  years has similar Glasgow Outcome Scale Extended scores ( $5.9 \pm 0.1$  vs.  $5.8 \pm 0.1$  corresponding to moderate disability;  $p=0.61$ ), pain scores ( $2.8 \pm 0.2$  vs.  $2.9 \pm 0.2$ ;  $p=0.75$ ), and physical health-related quality of life scores ( $37.9 \pm 1.1$  vs.  $38.3 \pm 1.1$ ;  $p=0.81$ ) [16]. Similarly, in a long-term follow-up study with patients with multiple rib fractures, age was not associated with length of hospitalization, intensive care unit stay, or quality of life indicated by the EQ-5D index at three years of follow-up [17]. Interestingly, Marasco et al., also reported that patients aged  $\geq 55$  had a higher mental health-related quality of life score ( $50.9 \pm 1.1$  vs.  $47.1 \pm 1.0$ ;  $p=0.01$ ) than younger patients [16]. There is some evidence that younger patients with moderate-to-severe blunt rib trauma are more likely to require post-discharge reevaluation and hospital readmission [18,19]. However, there is also evidence to the contrary [20,21].

### The need to defocus age as a predictor of clinical outcomes in rib fracture patients

The emerging evidence strongly indicates that middle-aged and geriatric rib fracture patients may have similar morbidity and mortality outcomes following rib fracture, except for the length of hospitalization, which tends to be longer in geriatric patients. Consequently, several researchers have argued for the need to assess patients holistically and devise a treatment plan based on injury severity [22-26], respiratory sufficiency [27-30], or radiology-based scoring systems such as RibScore [31]. Using age as a predictor of morbidity and mortality has at least two unfavorable clinical consequences. First, young adult and middle-aged patients with rib fractures who may have similar risks of complication as older patients may be disadvantaged from receiving intensive care, as underscored by several studies, including ours, leading to poor in-hospital or post-discharge outcomes [12,13,32].

Secondly, age has been traditionally used as an indicator for intensive care unit admission. Since most young or middle-aged patients are often not hospitalized, a significant proportion of hospitalized rib fracture patients tend to be geriatrics [33,28,34-37]. This likely causes a considerable increase in the intensive care unit burden, with longer hospitalization in older patients and, as discussed above, a higher cost of hospitalization [37]. Recently, Prins et al., demonstrated that the healthcare cost of rib fracture patients sharply increases among those older than 45 years, irrespective of their admission status (hospital vs. at-home recovery) [37]. Moreover, there is evidence that most geriatric patients with isolated rib fractures do not need intensive care unit admission [38] and may be safely managed in the ward [26,39].

It is important to note that while most young or middle-aged patients are often not hospitalized, it is plausible that including this cohort of patients (who have a low representation in studies with hospitalized patients cited in this commentary) will alter the age-associated morbidity and mortality outcomes of rib fracture patients. Unfortunately, there is a scarcity of literature on the health-related outcomes of non-hospitalized young and middle-aged rib fracture patients and non-hospitalized patients in general to draw any meaningful hypothesis on how including this subpopulation may alter the currently accepted association between age and morbidity/mortality outcomes of rib fracture patients.

### Concluding remarks

The intensive care traditionally provided to geriatric patients due to their higher susceptibility to complications secondary to rib fractures has contributed significantly to the narrowing of the gaps in mortality and complication rates between younger and older patients. However, geriatric patients with rib fractures continue to have a longer length of hospitalization and higher cost, which a functional assessment of patients may circumvent - by emphasizing the patient's injury severity score, respiratory sufficiency and other validated scores (i.e., Rib-score) [40]. These changes, if implemented, will consequently reduce adverse outcomes for younger patients with rib fractures who may have a higher risk of complications or death.

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