

Recommendation grade: Strong

3e. Prolonged activity restrictions may be beneficial for contact sports and intense activity.

Level of evidence: Moderate

Recommendation grade: Strong

C. Specific organ injuries

4. Chest Wall Injury

4a. Chest wall Injuries and Rib Fixation

PICO: (4a) What are the indications for operative rib fixation and the optimal timing in polytrauma and ICU-requiring trauma patients with or without TBI?

Surgical rib stabilization has experienced renewed interest over the past 5–10 years. There is, however, no level-1 evidence determining which patients benefit from surgical stabilization of rib fractures (SSRF) or the optimal timing thereof. The highest level of evidence exists on ventilated patients with flail chest, in this subgroup SSRF is associated with 2.8 days more ventilator free days based on a medium size multicenter randomized controlled trial (RCT) from North American centers [75]. Additionally, one previous smaller single center RCT from Australia showed that SSRF of flail chest patients on the ICU was associated with 2 days shorter non-invasive ventilation [76]. Neither of the studies showed mortality benefit among flail chest patients. RCTs so far have not shown benefit of SSRF for non-ventilated patients with multiple rib fractures [77].

Several non-randomized observational studies documented good outcomes of chest wall injured patients with SSRF in both ventilated and non-ventilated patients with low complication rates. The generalization of these results is difficult because of the nature of the studies, the selection bias, and the lack of control population. There are however, two prospective studies of rib-fixation in TBI polytrauma patients and both show some benefit [78, 79]. A recent large prospective observational cohort study on non-operatively managed multiple rib fracture patients identified the contemporary benchmark for the management of multiple rib fractures as chest physiotherapy, pleural cavity drainage, and multimodal analgesic therapy, including timely regional blocks. This cohort of patients with a median of six rib fractures with mean age of 57 years, median ISS of 17, had an average 7 days of hospital stay, 2 days of ICU stay, 18% had pneumonia with very good 12-month functional outcomes, and the mortality rate was 1.5% [80]. This was supported in three recent systematic reviews and meta-analyses, reporting improved pneumonia incidence, slightly reduced length of stay, and minimal complications [81–83].

One RCT showed earlier fixation to have better outcomes than later (> 48 h) with some evidence of less inflammatory response in the early group and a shortened ventilator, ICU and hospital length of stay [84]. This same result was not found with the Dutch multicenter study, where there were no differences between fixation and non-operative management [85, 86]. Late rib

fixation for selected patients with persistent pain and non-union is also safe and effective [87].

The focus of future interventional studies must achieve significantly better outcomes with SSRF than these contemporary outcomes with comprehensive non-operative care. If it is decided to follow a SSRF management pathway, theoretically earlier surgical intervention is beneficial (compared to later surgery), but this is also the timeframe when multimodal pain therapy is likely to maximize its effect, thus further studies specifically focusing on timing of interventions are required to address this clinical question.

4a. Summary and recommendations:

There is moderate quality evidence to support rib-fixation for flail chest or > 3 contiguous fractures, those with TBI and in the older patient, to reduce pneumonia, tracheostomy, ICU, and total hospital LOS. There is no evidence to prefer early versus later fixation, in selected patient populations.

Level of evidence: Moderate

Recommendation grade: Weak

4b. Chest wall injury: chest drain management

PICO: (4b1) and (4b2) What are the indications for and the management of chest drains in the trauma patient and (4b3) at what point in the management is safe removal possible?

The role of chest drains in the trauma patient are accepted practice as the treatment for hemothorax or pneumothorax, whether in the emergency department, the operating room, or in the ICU secondary often to procedural complications. Placement may be empiric in the resuscitation phase, after initial assessment and chest X-ray, or even after CT-scan, when the measured size of the pneumothorax is larger than 35 mm at the level of the third ribspace and in patients at risk of tension pneumothorax, such as due to positive pressure ventilation [88–91]. What is controversial however, include the aspects of optimal chest-tube size, type of reservoir, and timing of removal, and these questions are often challenged. The role of prophylactic antibiotics remains an area for debate with most studies not showing any clear role for pneumonia prevention, whereas some reduction in empyema in the penetrating cohort is recorded [92, 93]. Removal at end of expiration or maximal inspiration appears to make no difference [94, 95]. Additionally, how to manage excessive drainage and the role or lack thereof for drain-suction therapy remain areas of debate. The latter will potentially delay mobility and as such is relevant to the ERATIC concept. The most recent review article (addressing both trauma and non-trauma drains) suggests no difference with smaller versus larger tubes, and better outcome with short-term suction overnight and removal on ‘waterseal’ at volumes varying from 50–200 mL/24 h, although a recent paper suggests this benefit of low-pressure suction may be overstated [96–99]. Addition of thoracic cavity suction evacuation prior to chest tube placement did not show a benefit in the one comparative cohort study; however, irrigation and suction appeared to reduce the