

Chapter 53

Approach to Spinal Trauma in the ICU



53.1 Introduction

Spinal trauma in the ICU presents complex challenges requiring a systematic, multidisciplinary approach. The initial management prioritizes stabilization, airway protection, and the prevention of secondary injuries, particularly spinal cord damage. Adherence to Advanced Trauma Life Support (ATLS) protocols and careful spinal motion restriction (SMR) are essential during the early phase. Timely imaging, including MRI, plays a crucial role in diagnosing spinal cord injuries and guiding surgical decisions. Moreover, hemodynamic and respiratory support, along with vigilant neurological monitoring, are critical for optimizing outcomes. This chapter explores these key components in the management of spinal trauma in the ICU [Ref: Algorithm 53.1].

53.2 Initial Assessment and Stabilization and Screening

- **ATLS Protocols and Multi-trauma Management:** Rigorously apply Advanced Trauma Life Support (ATLS) protocols, especially in patients presenting with multiple injuries, to ensure comprehensive and systematic assessment. Prioritize airway, breathing, and circulation (ABC) management, focusing on preventing secondary spinal cord injury [1, 2].
- **Spinal Motion Restriction (SMR):** For hemodynamically stable patients, utilize SMR rather than full immobilization to avoid complications associated with prolonged rigid immobilization, such as pressure ulcers and respiratory compromise. Recent guidelines discourage the routine use of traditional rigid cervical collars and hard backboards in ABCDE-stable patients due to increased discomfort and secondary risks [3, 4].

- **Prehospital Spinal Stabilization Choices:** In prehospital settings, consider vacuum mattresses as a safer alternative to rigid backboards for spinal stabilization. Vacuum mattresses provide effective motion restriction while minimizing discomfort and pressure-related complications.
- **Thoracolumbar Trauma Considerations:** For thoracolumbar trauma, avoid unnecessary fusion unless fracture instability or progressive neurologic deterioration is noted. Evidence increasingly supports the use of instrumentation without fusion for certain stable fractures. Percutaneous fixation is a minimally invasive option that can reduce recovery times and infection risks.

53.2.1 Screening

Cervical

- The presence of paraplegia or quadriplegia/tetraplegia is presumptive evidence of spinal instability.

Thoracolumbar

- The presence of paraplegia or a level of sensory loss on the chest or abdomen is presumptive evidence of spinal instability.

53.3 Airway Management in Cervical Spine Injuries

- **Advanced Airway Techniques with Inline Stabilization:** Secure the airway cautiously to prevent exacerbation of cervical spine injuries. Incorporate advanced airway techniques such as awake fiberoptic intubation or video laryngoscopy to maintain inline stabilization and minimize cervical spine movement.
- **Avoidance of Cricoid Pressure:** Updated guidelines from the Difficult Airway Society (DAS) and the American Osteopathic Association (AOA) advise against the use of cricoid pressure in cases where it might exacerbate cervical spine injuries. Cricoid pressure can potentially cause cervical spine displacement and should be avoided.

53.4 Imaging and Neurological Assessment

The bony level of injury refers to the specific vertebral level at which bony damage has occurred. The neurological level of injury describes the most caudal segment of the spinal cord that has normal sensory and motor function on both sides of the body. Any motor or sensory function below the injury level constitutes an incomplete injury and should be documented appropriately.

Central cord syndrome, anterior cord syndrome, and Brown-Sequard syndrome are the different injury patterns that are encountered in cases of spinal cord injury. Central cord syndrome is characterized by a disproportionately greater loss of motor strength in the upper extremities than in the lower extremities, with varying degrees of sensory loss. Anterior cord syndrome is characterized by paraplegia and a bilateral loss of pain and temperature sensation. Position, vibration, and deep pressure sense are preserved (dorsal columns sensations). Brown-Sequard syndrome consists of ipsilateral motor loss (corticospinal tract) and loss of position sense (dorsal column), associated with contralateral loss of pain and temperature sensation (spinothalamic tract). This is associated with penetrating injury.

Two commonly used scoring systems to decide whether a scan is warranted in cases of suspected cervical spinal trauma are the Canadian C-Spine Rule and the NEXUS (National Emergency X-Radiography Utilization Study) Criteria. Both are primarily used for cervical spine injuries in the emergency setting to determine the need for imaging in alert, stable patients.

53.4.1 Canadian C-Spine Rule

The Canadian C-Spine Rule is a decision-making tool to determine if cervical spine imaging is necessary in alert and stable trauma patients.

High-Risk Criteria (any of these mandates imaging):

- Age \geq 65 years.
- Dangerous mechanism of injury (e.g., fall from height (1 m/5 stairs), axial load to head, high-speed motor vehicle accident (>100 km/h, rollover, ejection), motorized recreational collision, bicycle collision).
- Paresthesias in extremities.

Low-Risk Criteria (if any of these are present, further assessment can be considered before imaging):

- Simple rear-end motor vehicle accident.
- Sitting position in the emergency department.
- Ambulatory at any time since the injury.
- Delayed onset of neck pain.
- Absence of midline cervical spine tenderness.

Range of Motion Test:

- If low-risk criteria are met, ask the patient to rotate their neck 45 degrees left and right.
- Decision: If the patient can perform this rotation without pain, imaging may be safely avoided.

53.4.2 NEXUS Criteria (*National Emergency X-Radiography Utilization Study*)

The NEXUS criteria are another widely used set of rules to rule out cervical spine injury without imaging in alert, stable patients.

A patient can be cleared clinically without imaging if *all* the following criteria are met:

- No posterior midline cervical tenderness.
- No evidence of intoxication.
- Normal level of alertness (Glasgow Coma Scale score of 15).
- No focal neurological deficit.
- No painful distracting injuries (such as a long bone fracture or significant soft tissue injury).

Decision: If any of these criteria are not met, cervical spine imaging is recommended to rule out injury.

- Primary screening modality is multidetector CT (MDCT) from the occiput to T1 with sagittal and coronal reconstructions.
- MRI Importance and Timing: Perform imaging as early as possible, with MRI being critical for detecting soft tissue injuries and spinal cord damage. MRI should be done on a normal MDCT imaging to rule out occult instability (isolated ligamentous spine injury that results in instability without an associated fracture and/or subluxation). Early MRI aids in intervention planning, surgical decision-making, and provides reliable neuroprognostic information, particularly in determining rehabilitation goals.
- Standardized Neurological Assessments: Utilize standardized neurological assessment tools such as the American Spinal Injury Association (ASIA) Impairment Scale for consistent documentation of injury severity, baseline function, and progression assessment during the ICU stay. Daily ASIA assessments can monitor neurological changes and are crucial for revising long-term prognosis.

53.5 Hemodynamic and Respiratory Management

- Optimizing Hemodynamics: Maintain mean arterial pressure (MAP) goals generally above 85 mmHg to promote spinal cord perfusion during the acute phase of injury. Adjust this target in elderly patients or those with comorbidities and multi-trauma, where aggressive blood pressure management may pose risks. When fluids alone are insufficient to sustain adequate MAP, vasopressors (particularly norepinephrine, dopamine, and phenylephrine) are recommended. Avoid excessive fluid administration to minimize the risk of pulmonary edema.

Spinal shock patients usually do not respond much to fluid. Moreover, they are more likely to present with bradycardia in contrast to tachycardia in hypovolemic shock.

- **Monitoring Respiratory Function:** Vigilantly monitor respiratory function in patients with cervical and high thoracic injuries, as these can impair respiratory/intercostal muscles leading to respiratory failure. High cervical injury patients may require prolonged mechanical ventilation. In selected cases of lower cervical injuries, noninvasive ventilation support may be beneficial.

53.6 Surgical Interventions and Timing

- **Early Surgical Decompression:** Advocate for early surgical decompression, ideally within 24 hours, in cases of significant spinal cord compression to improve neurological outcomes. Early intervention can reduce secondary injury and enhance recovery potential [5, 6].
- **Minimally Invasive Surgical Approaches:** Utilize minimally invasive surgical techniques, including percutaneous fixation, when possible, to reduce recovery times and lower the risk of infection.
- **Role of Fusion in Thoracolumbar Trauma:** Avoid unnecessary fusion in thoracolumbar injuries unless there is fracture instability or progressive neurologic deterioration. Instrumentation without fusion is increasingly supported by evidence for certain stable fractures, preserving spinal mobility and reducing surgical morbidity.

53.7 Nonsurgical Management

For nonsurgical management of spinal trauma with confirmed injury but no surgical intervention planned, the following medical therapies are suggested based on the guidelines:

1. Pharmacological Management:

- **Steroids:** The use of high-dose methylprednisolone for spinal cord injury was widely practiced in the past; however, its routine use is now controversial due to limited evidence of long-term benefit and potential adverse effects. Many guidelines no longer recommend steroids as a standard therapy, but some practitioners may still consider it in specific cases within the first 8 hours of injury, weighing risks and benefits [7, 8].
- **Blood Pressure Management:** Maintaining a mean arterial pressure (MAP) >85 mmHg is critical for spinal cord perfusion, particularly in cervical injuries. Vasopressors like norepinephrine may be necessary if fluids alone do not achieve this target.

- **Pain Management:**

- **Neuropathic Pain:** For neuropathic pain resulting from spinal cord injury, gabapentinoids (e.g., gabapentin, pregabalin) and tricyclic antidepressants are recommended. Combination therapy with selective serotonin and norepinephrine reuptake inhibitors may also be considered if monotherapy is ineffective.
- **Ketamine:** As an adjunct for pain relief, ketamine has shown effectiveness in reducing neuropathic pain, particularly in the acute phase. It may be combined with opioids or other non-opioid analgesics in multimodal pain management.

- 2. **Respiratory Support:**

- **Tracheostomy and Respiratory Management:** In cervical spine injuries, respiratory support is often required. Early tracheostomy (<7 days) may reduce complications related to prolonged intubation, especially in injuries above C5. For respiratory muscle support, positioning with abdominal binders or Trendelenburg positioning can help maintain ventilation in patients with compromised breathing.

- 3. **Bladder and Bowel Management:**

- **Proactive bladder management** is critical due to the high risk of urinary retention and infection. A Foley catheter is generally placed initially to monitor urinary output and prevent bladder distension, while intermittent catheterization may be introduced later as needed.

- 4. **Preventive Measures:**

- **Pressure Ulcer Prevention:** Patients with limited mobility due to spinal trauma are at risk of developing pressure ulcers. Regular repositioning, the use of pressure-relieving surfaces, and monitoring of skin integrity are essential in ICU care.
- **DVT Prophylaxis:** Low-molecular-weight heparin or pneumatic compression devices are used to reduce the risk of deep vein thrombosis, given the high risk of thromboembolism in immobilized patients.

- 5. **Rehabilitation Support:**

- **Physical Therapy:** Early passive and active physical therapy, focusing on range-of-motion exercises and respiratory muscle training, is crucial to prevent complications such as contractures and to support eventual functional recovery.

53.8 Postoperative Care and Monitoring

- **Postoperative Vigilance:** In the ICU, prioritize the early detection of complications such as respiratory compromise, infection, and thromboembolism. Implement prophylactic measures where appropriate, including thromboprophylaxis and infection control protocols.
- **Ongoing Neurological Monitoring:** Conduct daily ASIA assessments to monitor neurological changes, which are crucial for revising long-term prognosis and guiding rehabilitation strategies.
- **Neuroprognostication and Family Communication:** Engage in transparent discussions with patients and their families regarding neuroprognosis, incorporating MRI findings, injury levels, and severity to set realistic expectations about functional outcomes. This approach facilitates shared decision-making and helps in planning for rehabilitation and long-term care.

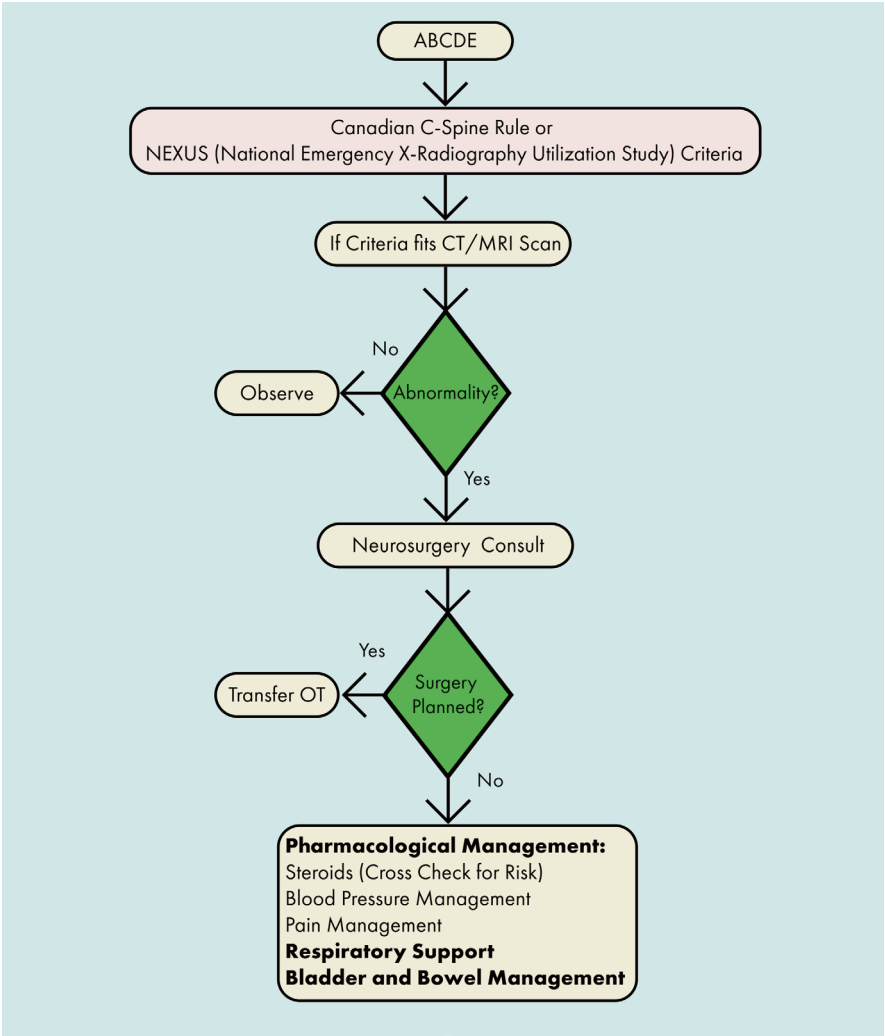
53.9 Rehabilitation and Long-Term Management

- **Early Mobilization and Rehabilitation:** Initiate rehabilitation as soon as the patient is medically stable, focusing on maximizing residual function, muscle strength, and developing adaptive techniques for daily activities. Early mobilization can improve outcomes and reduce complications such as muscle atrophy and joint contractures.
- **Multidisciplinary Approach:** Employ a multidisciplinary approach involving rehabilitation specialists, physical therapists, occupational therapists, and other relevant professionals. Evidence supports that such a comprehensive team significantly improves functional recovery and quality of life.

53.10 Conclusion

In conclusion, the approach to spinal trauma in the ICU requires a comprehensive, systematic method that prioritizes patient stabilization, early intervention, and continuous monitoring. Following protocols such as ATLS and utilizing appropriate spinal motion restriction techniques are essential to preventing secondary injury. Early surgical decompression, along with minimally invasive techniques, can improve outcomes, while careful respiratory and hemodynamic management is crucial for optimizing recovery. Regular neurological assessments guide clinical decisions, and rehabilitation, initiated early and supported by a multidisciplinary team, is key to enhancing long-term functional recovery. Effective communication with patients and families ensures informed decision-making and supports the overall care process.

Algorithm 53.1: Approach to spinal trauma in the ICU



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