



INITIAL ASSESSMENT AND STABILIZATION OF THORACIC TRAUMA IN PEDIATRIC PATIENTS: A NARRATIVE REVIEW

Stiven Martínez Beleño

MD. Universidad de Cartagena

ABSTRACT

The management of pediatric thoracic trauma necessitates a multidisciplinary approach adhering to Advanced Trauma Life Support (ATLS) principles. Initial stabilization involves securing the airway, ensuring adequate ventilation, and maintaining circulation through IV fluid resuscitation and, if necessary, blood transfusions. Definitive care includes chest tube thoracostomy for pneumothorax or hemothorax and potential surgical interventions for major injuries. Effective pain management employs opioids, non-opioid analgesics, and regional anesthesia techniques. Long-term follow-up addresses complications like respiratory dysfunction and involves rehabilitation programs to support recovery and improve outcomes.

KEYWORDS : Pediatric Trauma, Thoracic Injuries, Chest Trauma, Wounds and Injuries, Advanced Trauma Life Support Care.

INTRODUCTION

Thoracic trauma in children, though infrequent, presents a significant challenge in pediatric emergency care due to anatomical and physiological differences from adults. It is estimated that between 4% and 8% of children with trauma present with thoracic injuries, with an associated high mortality rate ranging from 15% to 26%. Common mechanisms of injury include motor vehicle accidents, falls, and physical abuse, with blunt trauma accounting for 85% of cases. The specific characteristics of the pediatric thorax, such as greater compliance and less ossification, increase the likelihood of intrathoracic injuries without visible rib fractures. This article reviews the existing literature on the initial evaluation and stabilization of children with thoracic trauma, highlighting the most effective diagnostic and therapeutic methods. Rapid identification of life-threatening conditions and the implementation of appropriate interventions are crucial for improving clinical outcomes in this vulnerable population (1).

METHODS

This narrative review was conducted to evaluate the stabilization and management of thoracic trauma in pediatric patients. A comprehensive search was performed across four databases: PubMed, Cochrane Library, Embase, and Google Scholar. The search terms used included "pediatric thoracic trauma," "chest injury in children," "pediatric trauma management," and "thoracic injury stabilization." The inclusion criteria were original research articles, review articles, and clinical guidelines published in English from 2000 to 2024, focusing on the evaluation and stabilization of thoracic trauma in children. Following a detailed assessment of these articles based on the predefined inclusion criteria, 15 articles were retained for the final review.

Epidemiology

Thoracic trauma in children accounts for approximately 5-12% of all pediatric trauma cases. It is a significant cause of morbidity and mortality, with motor vehicle accidents being the leading cause, followed by falls and sports injuries. In the United States, pediatric thoracic trauma results in over 2,000 hospital admissions annually. Blunt trauma is more common than penetrating trauma, comprising about 85% of cases, with rib fractures present in 5-10% of injured children (1,2).

Anatomical Considerations

The pediatric thorax differs anatomically from the adult thorax, making children more susceptible to specific types of injuries. Children have more flexible and compliant ribs, which can absorb energy without fracturing, but this flexibility also allows for significant internal organ damage without obvious external signs. The mediastinum in children is relatively mobile, which can lead to different patterns of injury. Additionally, the smaller size of the thoracic cavity and the close proximity of vital structures mean that even minor trauma can result in significant injury. These anatomical differences necessitate specialized approaches in both the assessment and management of thoracic trauma in children (3).

Types Of Thoracic Injury

Thoracic injuries in children can be broadly categorized into blunt and penetrating injuries. Blunt thoracic injuries are more common, accounting for approximately 90% of cases, and typically result from motor vehicle accidents, falls, or sports-related incidents. These injuries can cause rib fractures, pulmonary contusions, pneumothorax, hemothorax, and cardiac contusions. Due to the flexibility of pediatric ribs, significant force can cause internal injuries without visible rib fractures. Penetrating injuries, though less frequent, can result from sharp objects like knives or from gunshot wounds and can lead to life-threatening conditions such as hemopneumothorax, cardiac tamponade, and great vessel injuries. Additionally, traumatic asphyxia, a rare but serious condition, occurs due to severe compressive forces on the thorax, leading to cyanosis and petechiae of the upper body. Each type of injury requires careful assessment and tailored management to address the unique challenges presented by pediatric thoracic trauma (4).

Initial Evaluation

Evaluation of thoracic trauma in children necessitates a systematic approach to ensure prompt and accurate diagnosis, facilitating appropriate management of injuries. The evaluation process adheres to the principles of Advanced Trauma Life Support (ATLS), commencing with the primary survey which emphasizes the assessment of airway, breathing, and circulation (ABCs) (5).

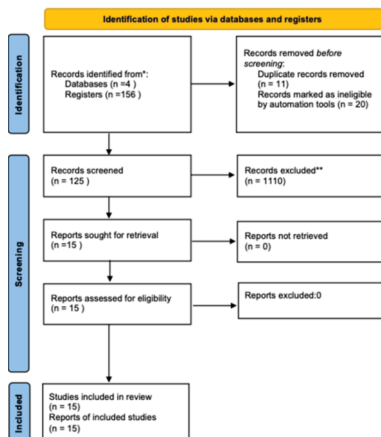


Figure 1. PRISMA.

Primary Survey

Initially, the airway must be confirmed to be patent. In severe trauma cases, it is imperative to assume the possibility of cervical spine injury until it is definitively excluded, necessitating proper immobilization. Following this, the child's breathing and ventilation are evaluated. Clinical indicators such as respiratory distress, asymmetrical chest movements, and abnormal breath sounds may suggest pneumothorax or hemothorax. Subsequently, circulation is assessed by checking for signs of shock or hemorrhage, examining pulse rate, blood pressure, capillary refill, and looking for external bleeding signs (6).

Secondary Survey

Upon completion of the primary survey and initial resuscitation, a more detailed secondary survey is conducted. This comprehensive head-to-toe examination, coupled with thorough history taking, provides critical insights into potential thoracic injuries. The mechanism of injury often offers significant clues about the nature and extent of the trauma (7).

Diagnostic Imaging

Chest radiography (CXR) is typically the first imaging modality employed, providing initial insights into rib fractures, pneumothorax, hemothorax, and pulmonary contusions. However, interpreting pediatric chest X-rays can be challenging due to the cartilaginous nature of the ribs and the presence of thymic shadow. The Focused Assessment with Sonography for Trauma (FAST) exam is invaluable for quickly identifying pneumothorax, hemothorax, and pericardial effusion. It is non-invasive and can be performed bedside, making it particularly useful for unstable patients (8).

Computed tomography (CT) scans of the thorax offer detailed imaging, crucial for assessing complex injuries, including mediastinal injuries, lung parenchymal damage, and vascular injuries. CT scans are especially useful when CXR findings are inconclusive or when multiple injuries are suspected. Although magnetic resonance imaging (MRI) is not routinely used in acute settings due to longer scan times and the need for sedation in children, it can be beneficial for evaluating spinal cord injuries and subtle thoracic injuries that are not clearly defined on CT scans (8,9).

Continuous clinical monitoring is indispensable. Vital signs, including heart rate, respiratory rate, oxygen saturation, and blood pressure, should be regularly checked. Serial examinations are crucial for detecting any changes in the child's condition that might indicate the development of new complications or progression of existing injuries. In certain cases, more specialized evaluations might be necessary. Bronchoscopy can be employed to assess airway injuries and retrieve foreign bodies in cases of penetrating injuries. Echocardiography is essential for evaluating cardiac injuries and pericardial effusion (10,11).

Management

The management of pediatric patients with thoracic trauma requires a comprehensive, multidisciplinary approach to ensure optimal outcomes. Thoracic injuries, although less common in children than in adults, can have severe consequences due to the pliability of the pediatric chest wall and the proximity of vital organs (11).

Initial Stabilization

The initial stabilization of a pediatric trauma patient focuses on securing the airway, ensuring adequate ventilation, and maintaining circulation. Endotracheal intubation may be necessary in cases of severe respiratory distress, altered mental status, or anticipated airway compromise. The use of rapid sequence intubation (RSI) protocols is common to facilitate safe and efficient airway management (11,12).

Once the airway is secured, attention shifts to breathing and ventilation. Supplemental oxygen is provided to maintain adequate oxygen saturation, typically aiming for levels above 94%. Mechanical ventilation may be required for patients with significant chest injuries such as flail chest, severe pulmonary contusions, or extensive rib fractures. In cases of tension pneumothorax, needle decompression followed by chest tube placement is performed emergently to relieve pressure and restore normal respiratory function (12).

Circulatory Support

Circulatory support is critical in the initial management phase. Intravenous (IV) access is established, and fluid resuscitation is initiated with isotonic crystalloids such as normal saline or lactated Ringer's solution. The goal is to maintain adequate perfusion and prevent shock. Blood transfusions may be necessary for patients with significant hemorrhage, guided by hemodynamic stability and laboratory results, including hemoglobin levels and coagulation profiles (12,13).

Definitive Care

Definitive care involves addressing the specific injuries identified during the evaluation. For pneumothorax or hemothorax, chest tube thoracostomy is performed to evacuate air or blood from the pleural space. The chest tube is typically connected to a water-seal drainage system, and the volume and characteristics of the drainage are monitored closely. Surgical intervention may be required for certain injuries, such as major vascular injuries, diaphragmatic ruptures, or penetrating chest wounds. Thoracotomy, either emergent or planned, is performed based on the extent of injury and clinical indications (13).

Pain Management

Effective pain management is essential for pediatric patients with thoracic trauma. Pain can significantly impair respiratory function and hinder recovery. Analgesia is provided using a combination of systemic medications such as opioids (e.g., morphine or fentanyl) and non-opioid analgesics (e.g., acetaminophen or ibuprofen). Regional anesthesia techniques, such as intercostal nerve blocks or epidural analgesia, can provide effective pain relief and improve respiratory mechanics (13,14).

Monitoring and Support

Continuous monitoring of vital signs, oxygen saturation, and clinical status is crucial in the management of pediatric thoracic trauma. Serial chest X-rays and other imaging modalities are used to assess the progression of injuries and the effectiveness of interventions. Arterial blood gases and lactate levels are monitored to evaluate respiratory function and tissue perfusion (14).

Complications and Follow-Up

Patients with thoracic trauma are at risk for various complications, including respiratory failure, pneumonia, and acute respiratory distress syndrome (ARDS). Early recognition and treatment of these complications are essential. Prophylactic antibiotics may be considered for patients with open chest injuries or those undergoing invasive procedures (14,15).

In conclusion, the management of pediatric thoracic trauma requires a structured and evidence-based approach, emphasizing initial stabilization, definitive care, and continuous monitoring. Multidisciplinary collaboration and optimization of outcomes are essential for injured children.

REFERENCES

1. Peclet MH, Newman KD, Eichelberger MR, et al. Thoracic trauma in children: an indicator of increased mortality. *J Pediatr Surg* 1990; 25:961.

2. Black TL, Snyder CL, Miller JP, et al. Significance of chest trauma in children. *South Med J* 1996; 89:494.
3. Cooper A, Barlow B, DiScala C, String D. Mortality and truncal injury: the pediatric perspective. *J Pediatr Surg* 1994; 29:33.
4. Holmes JF, Sokolove PE, Brant WE, Kuppermann N. A clinical decision rule for identifying children with thoracic injuries after blunt torso trauma. *Ann Emerg Med* 2002; 39:492.
5. Bulloch B, Schubert CJ, Brophy PD, et al. Cause and clinical characteristics of rib fractures in infants. *Pediatrics* 2000; 105.
6. Barsness KA, Cha ES, Bensard DD, et al. The positive predictive value of rib fractures as an indicator of nonaccidental trauma in children. *J Trauma* 2003; 54:1107.
7. Holland AJ, Kirby R, Browne GJ, et al. Penetrating injuries in children: is there a message? *J Paediatr Child Health* 2002; 38:487.
8. Cooper A. Thoracic injuries. *Semin Pediatr Surg* 1995; 4:109.
9. Sarihan H, Abes M, Akyazici R, et al. Blunt thoracic trauma in children. *J Cardiovasc Surg (Torino)* 1996; 37:525.
10. Sartorelli KH, Vane DW. The diagnosis and management of children with blunt injury of the chest. *Semin Pediatr Surg* 2004; 13:98.
11. Kisson N, Dreyer J, Walia M. Pediatric trauma: differences in pathophysiology, injury patterns and treatment compared with adult trauma. *CMAJ* 1990; 142:27.
12. Gittelman MA, Gonzalez-del-Rey J, Brody AS, DiGiulio GA. Clinical predictors for the selective use of chest radiographs in pediatric blunt trauma evaluations. *J Trauma* 2003; 55:670.
13. Weerdenburg KD, Wales PW, Stephens D, et al. Predicting Thoracic Injury in Children With Multitrauma. *Pediatr Emerg Care* 2019; 35:330.
14. Rodriguez RM, Hendey GW, Marek G, et al. A pilot study to derive clinical variables for selective chest radiography in blunt trauma patients. *Ann Emerg Med* 2006; 47:415.
15. Beaver BL, Laschinger JC. Pediatric thoracic trauma. *Semin Thorac Cardiovasc Surg* 1992; 4:255.