Pediatric Emergency Trauma Care: Current Topics And Controversies

Volume I

Based on current evidence, develop strategies to manage pediatric patients presenting with blunt chest trauma, submersion injuries, traumatic cervical spine injuries, sports trauma, and nonaccidental trauma

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Product Preview Information

The information contained herein is a representative sample of the complete product, and it is intended to provide a sense of the quality and comprehensive nature of the product.

This book includes two issues of PEM Practice and one issue of EM Practice Guidelines Update that have been reviewed and updated with current research and more recent guidelines. Also included are two chapters of new content that review updated guidelines as well as evidence-based practical information for patient management. This book was designed to mirror volumes I and II of the adult counterpart products.

Included In This Book:
1. 100 pages of evidence-based content, covering 5 critical topics
2. 18 AMA PRA Category 1 Credits™ that are trauma specific
3. Summarized information to help you keep up with current guidelines and best practices
4. Treatment recommendations to help you determine the critical actions required when caring for these patients
5. And much more!

The 5 topics covered in this volume address some of the most pressing concerns for emergency clinicians:
1. Acute Cervical Spine And Spinal Cord Injury (Update covers the 2016 NICE guidelines)
2. Blunt Chest Trauma (Update includes more recent research)
3. Drowning And Submersion Issues (Update covers the 2016 Wilderness Medical Society Guidelines)
4. Orthopedic Sports Injuries (new content)
5. Nonaccidental Trauma (new content)

This product is available in print and online. Each order includes access to the pdf version of the book.
Pediatric Emergency Trauma Care: Current Topics And Controversies, Volume I

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This activity has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education.

Accreditation Statement: EB Medicine is accredited by the ACCME to provide continuing medical education for physicians.

Credit Designation Statement: EB Medicine designates this enduring material for a maximum of 18 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

Needs Assessment: The need for this educational activity was determined by a survey of medical staff; review of morbidity and mortality data from the CDC, AHA, and NCHS; evaluation of prior activities for emergency medicine clinicians, physician surveys, meetings with board-certified physicians, and attendance at annual conferences.

Goals: The goal of this activity is to increase clinician competency in the management of various types of trauma in pediatric patients.

Learning Objectives: At the conclusion of this CME activity, you should be able to:
1. Discuss the effects of blunt trauma to the pediatric chest and identify the diagnostic and treatment options for commonly encountered injuries such as pulmonary contusions, rib fractures, and pneumothoraces; as well as less common injuries such as blunt cardiac injuries, commotio cordis, nonaccidental trauma, and aortic injuries.
2. Initiate emergency management of the drowning victim, manage the hypothermic drowning patient, recognize the predictors of outcomes and limitations when resuscitating the drowning pediatric patient, and discuss the 2016 Wilderness Medical Society drowning recommendations.
3. Differentiate the recommendations for imaging of the cervical spine in children aged < 3 years and those for children aged > 3 years; describe the ideal immobilization position for children aged < 8 years with potential spinal cord trauma; assess the work-up of spinal cord injury without radiographic abnormality; and discuss the updated NICE guideline recommendations.
4. Distinguish the presentations of accidental trauma versus nonaccidental trauma, noting red flags and risk factors for abuse in the history and physical examination; manage these conditions appropriately; and report the trauma to the appropriate sources.
5. Describe the differences in injury patterns between pediatric and adult athletes, and manage a wide range of pediatric sports medicine conditions ranging from benign to emergent.

Target Audience: This enduring material is designed for emergency medicine physicians, physician assistants, nurse practitioners, and residents.

Course Director:
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There have been no major new recommendations to the assessment and management of pediatric blunt thoracic trauma since the 2013 Pediatric Emergency Medicine Practice evidence-based review titled “Emergency Management of Blunt Chest Trauma in Children: An Evidence-based Approach.” Additionally, there are no established guidelines with a protocol for the use of computed tomography (CT) in the evaluation of blunt thoracic trauma. The recurrent theme of the majority of publications includes limiting ionizing radiation and differentiating radiographic-apparent abnormalities from clinically significant injuries that would require intervention.

A 2013 retrospective multicenter cohort study of 425 pediatric patients with blunt thoracic trauma determined odds ratios (ORs) for positive findings on chest x-ray (CXR) associated with significant thoracic injuries on chest CT.1 Nine of the cases had a “normal” CXR, but had significant thoracic injury determined by chest CT. Only 1 injury required intervention, a hemopericardium detected by focused assessment with sonography for trauma (FAST). The other 8 out of 9 “missed” injuries included hydrothoraces and/or pneumothoraces that did not require chest tube insertion. The presence of a hydrothorax and/or pneumothorax and isolated subcutaneous emphysema detected on CXR were associated with an adjusted OR of 10.8 and 19.8, respectively, for significant injuries found on chest CT.

A 2016 retrospective chart review of 166 pediatric patients with blunt thoracic trauma found 33 patients with 45 injuries detected on diagnostic imaging.2 While statistically significant predictors of abnormal imaging included hypoxia (OR, 5.57) and abnormal pelvic findings (OR, 5.52), the majority of patients did not require any procedural intervention. The authors concluded that abnormal findings needing clinical intervention can be found on initial CXR and that any additional abnormal findings detected on CT are not necessarily clinically relevant.

A 2014 prospective observational study evaluated pediatric trauma patients with mechanisms of injury suspicious for chest injury, but who were asymptomatic for chest and abdomen injury on examination. Of the 42 patients enrolled, 11 injuries were found by CT imaging3. All injuries to the chest and abdomen were stable and required no procedural interventions. The authors concluded that there is no benefit in advanced imaging in patients with low clinical suspicion for injury.

The overall theme continues that advanced imaging offers little clinical impact when there is a low clinical suspicion for significant injury. The risk of ionizing radiation and consequences of downstream testing can be detrimental and should be weighed when making clinical decisions.

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The Wilderness Medical Society published an updated guideline in June 2016 titled “Wilderness Medical Society Practice Guidelines for the Prevention and Treatment of Drowning.” Relevant articles were identified and assessed by expert physicians and then used to create recommendations for management of drowning. The recommendations were graded based on the quality and type of evidence (eg, 1A, strong recommendation with high-quality evidence using randomized controlled trials without important limitations, or overwhelming evidence from observational studies; 1C, strong recommendation with low-quality or very low-quality evidence using observational studies or case series; 2C, weak recommendation with low-quality or very low-quality evidence using observational studies or case series).

The guidelines succinctly summarize the evidence for management of drowning, with a portion of the guidelines focused on rescuing the victim and out-of-hospital care. The authors call for use of consistent terminology regarding drowning to facilitate obtaining accurate data and research. Additionally, the authors of the guidelines emphasize that determining the type of drowning (freshwater vs saltwater, wet vs dry, etc) does not have any impact on management, as the physiologic insult is always hypoxemia and potential cardiopulmonary arrest. Recommendations for management, as stated in the Wilderness Medical Society practice guidelines that are applicable to the emergency clinician, are detailed below.

Initial Resuscitation

Hypothermia
- Recommendation: Treat hypothermia aggressively with active and passive measures dependent on patient conditions and available resources. (Recommendation grade: 1C)

Cardiopulmonary Resuscitation And Prioritization Of Airway
- Recommendation: Establishing an airway and providing oxygen are priorities in the initial resuscitation of a drowning patient. For the patient in cardiac arrest, provide positive-pressure ventilation in addition to chest compressions using the traditional Airway-Breathing-Circulation model of resuscitation. (Recommendation grade: 1C)

Oxygenation
- Recommendation: For resuscitation of a drowning patient, oxygen should be delivered at the highest concentration available, based on the patient’s tolerance and available resources or provider training. For the patient in respiratory distress or arrest, providing positive-pressure ventilation is preferred over passive ventilation. (Recommendation grade: 1C)

Cervical Spinal Immobilization
- Recommendation: Spinal immobilization should be considered in patients with evidence of spinal injury, such as focal neurological deficit or history of high-risk activity, and in patients who exhibit altered mental status. Spinal immobilization should not take priority over initial resuscitation of a patient with severe respiratory distress who requires aggressive airway management. (Recommendation grade: 1C)
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The National Institute for Health and Care Excellence (NICE) published an updated guideline in February 2016 titled “Spinal Injury: Assessment and Initial Management.”¹ This guideline is similar to publications by the American Association of Neurological Surgeons and the Congress of Neurological Surgeons (AANS/CNS) in 2013,² with a few unique changes. As with previously published guidelines, the low incidence of pediatric spinal cord injury (SCI) and the paucity of research data limit the quality of evidence that would allow strong recommendations to be built.³ In the United States in 2009, the incidence of SCI was 24 per 1 million patients aged < 21 years.³ Additionally, there are no high-performing validated clinical decision rules for clearance of pediatric patients at risk for SCI.⁴⁻⁶ The complexity of creating these decision rules for pediatric patients increases, given the unique injury patterns that change relative to patient age, changes in spinal musculoskeletal development of pediatric patients, and the varying injury mechanisms.⁵⁻⁷ The aim of the NICE guideline is to limit harm – from ionizing radiation, missed injury, and unnecessary immobilization or testing – while providing safe, efficient, and cost-effective care. It should be noted that the age cutoff in the 2016 NICE guideline is patient age < 16 years, whereas the AANS/CNS guidelines have a patient cutoff age of < 18 years and the American College of Radiology (ACR) uses an age cutoff of < 14 years in their Appropriateness Criteria.¹,²,⁸

Translating the more robust adult trauma data to pediatric patients is commonplace and necessary when there are no large, high-quality pediatric studies. As such, the Canadian C-Spine Rule (CCR) and the National Emergency X-Radiography Utilization Study (NEXUS) clinical decision rules have been the foundation for determining pediatric cervical spine clearance.⁹⁻¹⁰ Though neither the CCR nor NEXUS have been found to be well-performing with pediatric patients, the NICE guideline incorporates both the NEXUS low-risk criteria and the CCR for the immobilization and potential cervical spine imaging decision point. The authors of the NICE guideline address this by stating that “the benefits of using a risk tool, particularly in avoiding unnecessary imaging, in children outweigh the risks of not using a tool.”¹ Of note, the NEXUS criteria have added 2 new conditions, priapism and higher risk of spinal complication, in the initial assessment. The NICE guideline makes special mention for clinicians to “be aware that applying the Canadian C-Spine Rule to children is difficult and the child’s developmental stage should be taken into account.”

The ACR Appropriateness Criteria® note that “there is not sufficient evidence to establish the reliability of the NEXUS criteria in younger children, or to recommend whether radiography or CT [computed tomography] should be the initial imaging study.”¹ The NICE guideline recommends magnetic resonance imaging (MRI) as the initial imaging modality of choice for high suspicion of injury and only mention CT imaging when discussing high suspicion for thoracic or lumbosacral injury after abnormal plain radiographs.¹ Moving directly to MRI may bypass the clinicoradiologic mismatch of neurologic injuries and normal plain radiographs of CT imaging, as seen in SCI without radiologic abnormality (SCIWORA) or neuroimaging abnormality (SCI-WONA). SCIWORA and SCIWONA are managed with continued spinal immobilization, neurosurgical and spine surgical specialists, and often serial imaging, as dynamic changes may progress.¹¹⁻¹² A clinical management pathway and the thresholds for testing and treatment can be found in Figure 1, page 60.

The theme of decreasing harm begins with the NICE guideline recommendation that a family member or caregiver should be present, within eyesight, during initial evaluation and stabilization of the pediatric patient. Again, the guideline addresses taking into consideration the child’s developmental stage and cognitive function when assessing, treating, and discussing care with the patient and caregivers. As pediatric patients may not be able to verbalize or cooperate with physical examinations, it is often a loss of function (one that may be recognized only with caregiver input) that can raise suspicion for SCI. When spinal injuries are discovered, utilizing neurosurgical or spine surgery specialists – or transferring to a dedicated trauma center where resources are available – should be paramount. As with past updates to management of spinal cord injuries, no pharmacologic neuroprotective intervention, such as steroids or medications to decrease future neuropathic pain, were found to be clinically significant or recommended.¹,² As with all patient encounters, clear documentation of clinical findings, the thought process for medical decision-making, and input from specialty consultants should be included in the medical chart.
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Chapter 4. Pediatric Nonaccidental Trauma

Introduction And Epidemiology

Child abuse is the general term for describing harm directed toward children. Many states recognize 4 major types of maltreatment in their definitions, including neglect, physical abuse, sexual abuse, and emotional abuse. According to the United States Department of Health & Human Services Child Welfare Information Gateway, child abuse is defined in the Federal Child Abuse Prevention and Treatment Act as “a recent act or failure to act on the part of a parent or caretaker which results in death, serious physical or emotional harm, sexual abuse or exploitation; or an act or failure to act which presents an imminent risk of serious harm.”1 The World Health Organization Report of the Consultation on Child Abuse Prevention from 1999 defines child abuse and maltreatment as “all forms of physical and/or emotional ill-treatment, sexual abuse, neglect or negligent treatment, or commercial or other exploitation, resulting in actual or potential harm to the child’s health, survival, development, or dignity in the context of a relationship of responsibility, trust, or power.”2

The National Child Abuse and Neglect Data System (NCANDS) is a voluntary organization that collects data on child maltreatment from all 50 states, the District of Columbia, and the Commonwealth of Puerto Rico. The latest NCANDS report, Child Maltreatment 2014, is the 25th printing and is available at the Administration for Children and Families website through the United States Department of Health & Human Services. In 2014, there were more than 3.2 million reported cases of potential child abuse in the United States.1 This represented 4.37% of the total population of children (74,356,370) at that time. One in 5 children (19.2%) who received a report had their cases substantiated and were found to be victims. Overall, the rate of child abuse has been estimated at almost 1 out of 10 children (9.4%), representing 702,008 victims.

Figure 1. Victims Of Child Abuse

![Pie chart showing the distribution of cases reported to child abuse.](Image)

- 702,008 victims
- 1 in 5 reported cases determined victims
- Physical abuse 17%
- Sexual abuse 8%
- Neglect 75%
- 3,248,005 cases reported

Reported cases in the 50 United States, Washington DC, and Puerto Rico.

Figure 2. 2014 Child Abuse Reporting Sources

![Pie chart showing the sources of child abuse reports.](Image)

- Professionals (daycare, educators, law enforcement, social services, foster care)
- Physicians
- Nonprofessionals
- Unclassified

In addition, 1,500 deaths are attributed to child abuse each year. While these numbers are significant, they likely underestimate the incidence of abuse, as well as the morbidity and mortality, due to cases that are not reported and court determinations of abuse.

The youngest populations are the most vulnerable. Three-quarters of children who suffered from neglect were in their first year of life, and infants had at least twice the rate of abuse compared to all other age groups. Physical abuse was confirmed in 17% of reports and sexual abuse in 8.3% of cases. For 2014, a nationally estimated 1580 children died as a result of abuse and neglect at a rate of 2.13 per 100,000
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Chapter 5. Orthopedic Trauma In Pediatric Sports Injuries

Introduction
In addition to school team sports, participation in recreational sports is an increasingly popular trend among adults and children. Sports participation exposes the pediatric population to orthopedic trauma that can present differently than that seen in the adult population. As many pediatric athletes now specialize in specific sports year-round at an earlier age, they are at increased risk for orthopedic injuries. As such, the emergency clinician must be acutely aware of the differences in injury patterns between pediatric and adult athletes, and must be prepared to properly manage a wide range of pediatric sports medicine conditions ranging from the benign to the emergent. This guide is meant to provide a brief overview of the types of orthopedic injuries that may be encountered in the pediatric athlete.

Epidemiology
Sports- and recreation-related injuries account for nearly 20% of visits to the emergency department (ED) annually for patients aged ≤ 19 years.1 Approximately 12 million children aged between 5 and 22 years suffer a sports-related injury each year in the United States, which leads to 20 million lost days of school and approximately $33 billion in health care costs.2 The rate of injuries can be expected to increase as more children participate in sports3 and as the ability to recognize and diagnose concussion improves. While data regarding incidence rates of injuries in pediatric athletes are limited and sometimes conflicting, one meta-analysis found injuries to be highest, in decreasing order, for boys, in football, hockey, and soccer, and for girls, in soccer, basketball, and gymnastics.4 Older boys and girls (aged 13 years to college-level play) are at higher risk for injuries than younger athletes, likely due to increased muscle mass, speed of sport, and force generated on contact in older athletes. While football and soccer account for a disproportionately high rate of injuries due to the frequency of concussions, the discussion of pediatric concussion and traumatic brain injury is beyond the scope of this chapter.

Pediatric athletes are at increased risk of orthopedic injury due to developing physeal plates, softer, more pliable bones, and the presence of vulnerable apophyses.5 Recent steps have been taken to recognize and reduce the risk of pediatric orthopedic injuries, such as monitoring pitch counts as proposed by prominent orthopedic surgeons and societies.6 According to one society group, the sports associated with the highest incidence of pediatric musculoskeletal injury were football, basketball, cycling, and roller sports.7 Children specializing in different sports involving the same muscle groups (eg, swimmers and baseball pitchers) were at higher risk for musculoskeletal injury than those emphasizing different muscle groups (eg, soccer and golf).

Sideline Coverage And Prehospital Care
The emergency clinician will encounter most pediatric patients with sports-related complaints either immediately after or within several days of the trauma. Most sports-related emergencies can be managed without the need for emergent interventions and are typically managed with simple splinting and referral. Injuries that require emergent stabilization and management in pediatric patients are similar to those seen in adults (eg, sudden cardiac death, epidural hematoma, etc).

Though emergency clinicians are sometimes required to serve as sideline physicians for collegiate and professional teams,8 the role of the clinician is more often to manage acute or subacute pediatric orthopedic injuries in the ED. Musculoskeletal injuries are typically reduced and/or splinted initially in the prehospital setting, thus, obtaining a complete history from the emergency medical services (EMS) transporter is critical. Specific history from EMS should include the mechanism of injury, the sport, and, if possible, the type of play in which the injury occurred (Was it on a punt return? Was the patient at the bottom of a
# Chapter 5. Orthopedic Trauma In Pediatric Sports Injuries

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