'Not Just Little Adults' – A Pediatric Trauma Primer

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ABSTRACT

This article describes pediatric trauma care and specifically how a pediatric trauma center, like Hasbro Children's Hospital, provides specialized care to this patient population. The authors review unique aspects of pediatric trauma patients broken down into anatomy and physiology, including Airway and Respiratory, Cardiovascular Response to Hemorrhage, Spine Injuries, Traumatic Brain Injuries, Thoracic Injuries and Blunt Abdominal Trauma. They review certain current recommendations for evaluation and management of these pediatric patients. The authors also briefly review the topic of Child Abuse/Non-accidental Trauma in pediatric patients. Although Pediatric Trauma is a very broad topic, the goal of this article is to act as a primer and describe certain characteristics and management recommendations unique to the pediatric trauma patient.

KEYWORDS: pediatric trauma care, pediatric trauma center, non-accidental pediatric trauma

INTRODUCTION

Trauma is the leading cause of death and disability in children and adolescents, accounting for 1/3 of all Emergency Department (ED) visits in patients less than 15 years of age.[1] There are significant differences between adult and pediatric trauma patients including anatomic variations in size, body proportions and ossification of the skeleton, physiologic responses to injury, patterns of injury, and psychological, emotional and social needs. This paper reviews some of the unique characteristics of pediatric trauma patients and how specialized care at Pediatric Trauma Centers (PTC) benefits this population.

Pediatric trauma patients who receive care at PTCs have been shown to have improved outcomes.[2] PTCs have specialized infrastructure, medical staff, ancillary support personnel and medical equipment to specifically assess and treat injured children. The Pediatric Trauma Team at Hasbro Children's Hospital (HCH) is jointly led by board-certified pediatric emergency medicine physicians and pediatric surgeons. In 2012, injured patients represented almost 13,000 of the 50,000 patients treated in the HCH ED.

Injured pediatric patients arriving at the HCH ED are immediately triaged by skilled RNs who evaluate mechanism of injury, physiologic parameters, perform gross assessment of injuries and activate the trauma system. There is a tiered response based on the mechanism of injury and physiologic condition of the injured patient. All patients are evaluated by a pediatric emergency physician who works in concert with the pediatric surgical team. When pediatric trauma patients are hemodynamically unstable or have sustained injuries that put them at immediate risk of mortality without rapid treatment, the highest trauma response is activated. This tier of the pediatric trauma system includes the following resources: the presence of the pediatric trauma attending surgeon, pediatric anesthesia, and respiratory therapy, notification of the operating room, blood bank, laboratory, Pediatric ICU, chaplain and social work services.

All pediatric trauma patients are systematically assessed according to the Advanced Trauma and Life Support (ATLS) protocols[3] beginning with a primary assessment focusing on the "ABCs" – Airway, Breathing, and Circulation. Each component is assessed and secured by the physicians before moving to the next with the goal of immediately addressing and correcting physiologic derangements, such as hypoxia or hypotension that could result in secondary insult or death if not recognized and treated quickly. Once stabilized, a secondary assessment is performed with a complete head-to-toe physical exam and may include laboratory and radiologic evaluations. Examinations are repeated throughout the initial resuscitation period to assess response to treatment or evidence of physiologic deterioration. When the correct disposition is determined, the patient is then transferred from the ED to the operating room, inpatient bed, or discharged home.[3] For those patients admitted to the hospital, tertiary assessments are carried out to identify any other injuries that were not apparent during the initial evaluation.

UNIQUE ASPECTS OF PEDIATRIC TRAUMA PATIENTS

Airway and Respiratory Reserves

Hypoxia and inadequate ventilation are the most common causes of pediatric cardiopulmonary arrest following trauma, therefore, efficient and effective airway management is a critical aspect for pediatric trauma.[4] The unique features of infant and pediatric airway anatomy and respiratory physiology make airway management one of the most challenging

components of pediatric trauma care. Infants and small children have relatively large heads that may result in flexion of the neck and airway causing airway obstruction in the unconscious patient. Children also have small oral cavities, relatively large tongues, and a more anteriorly and superiorly positioned larynxes compared to adults, limiting visualization of the airway during interventions. Clinicians at PTCs are specially trained in pediatric airway management using appropriately sized equipment based on the patient's age and size. Advanced techniques such as video-assisted laryngoscopy are sometimes utilized to establish a secure airway while minimizing manipulation of the patient's head and neck. Once intubated, due to relatively short tracheas, pediatric patients are at increased risk of endotracheal tube displacement, either into the right mainstem bronchus or accidental extubation if the tube is under tension. Appropriately securing the tube, adequate, safe sedation and close monitoring when transferring pediatric patients can help prevent complications.[5]

Cardiovascular Response to Hemorrhage

Children are better able to maintain relatively normal blood pressure despite significant blood loss, compared to adults. Studies have shown that pediatric patients can maintain a perfusing pressure with up to 35-40% blood loss prior to becoming hypotensive.[3] Furthermore, infants and small children must increase their heart rates to increase stroke volume and improve cardiac output. Therefore, any interventions or medications that decrease heart rate may cause a rapid and detrimental loss of perfusion.

SPECIFIC INJURIES

Spine Injuries

Spine injuries are relatively uncommon in the pediatric trauma patient, with approximately 1000 spinal cord injuries occurring each year in the United States.[6] About one-half of patients with vertebral fractures have no neurologic findings. Conversely, some patients have spinal cord injuries without radiographic abnormality (SCIWORA), where the normal laxity of the soft tissues of the child's spinal column leads to damage of the spinal cord without fracture or ligamentous injury. Spinal immobilization is therefore recommended when there is concern for cervical spine injuries based on mechanism of injury or if the patient cannot be adequately assessed due to agitation or altered mental status. Immobilization can be done with a pediatric C-collar and a rigid backboard.

Physical exam and plain radiography are the standards of care in pediatric spine evaluation. Plain radiographs have a higher relative sensitivity for diagnosing cervical spine fractures in pediatric patients compared with adults because children do not have the degenerative orthopedic changes seen in adults.[7] A concerted effort should be made to reduce radiation exposure with pediatric patients, especially to sensitive tissues like the developing thyroid gland. If there is a concerning finding on plain films or high clinical suspicion for fracture, a selective CT is more sensitive than plain films and is recommended. In contrast to adults who are more likely to suffer lower c-spine injuries, most spinal injuries in young children involve the upper c-spine due to their relatively larger heads that create a fulcrum-like effect on the upper c-spine region.[8] If there is concern for ligamentous injury or SCIWORA, patients should be placed in an extended wear rigid collar and best evaluated in concert with a pediatric spine specialist and may require MRI.

Traumatic Brain Injury

Traumatic brain injury is the leading cause of death in pediatric trauma patients. While the best management is prevention, once the injury has occurred, it is critical to prevent secondary insult to the brain from hypoxemia and hypotension.[9]

Early establishment of a secure airway and close monitoring and management of the hemodynamic status of patients are paramount. Rapid sequence intubation (RSI) should be employed using medications selected for their adjunctive neurologic properties. Lidocaine premedication can minimize increased ICP. Etomidate also has neuroprotective properties through its effects on intracranial pressure, cerebral blood flow, and cerebral metabolic rate of oxygen consumption.[10] In addition, etomidate maintains blood pressure. Either polarizing or non-polarizing paralytics are acceptable; however, agents that are rapidly cleared are ideal as they have minimal impact on ongoing assessment of the neurologic exam. Hyperventilation is no longer recommended as a PaCO2 <35 mmHg may result in cerebral ischemia. The use of continuous end tidal CO2 monitoring is recommended, with a target between 35-38 mmHg. Head of bed elevation 30 degrees may also decrease ICP; however this has not been well studied in children. When there is evidence of elevated ICP, Mannitol and 3% hypertonic saline boluses may transiently decrease ICP.[11,12] Goals should be limited to initial stabilization and expedited transfer to a PTC. Delays in transfer for imaging beyond a chest x-ray should be avoided. If neuroimaging has been obtained, it is important to share the findings with the PTC prior to transfer and to ensure a copy of the images accompanies the patient.[3]

Luckily, up to 98% of head trauma is not severe. A recent large, multicenter study established guidelines with an online calculator, "The Pediatric Head Injury/Trauma Algorithm" to identify those patients who had a low risk of a clinically important traumatic brain injury.[13,14,15] These guidelines can help clinicians safely avoid unnecessary head CTs and radiation exposure in many pediatric patients.

Thoracic Injuries

Thoracic injuries are the second leading traumatic cause of death in children.[16] The ribs and sternum are not fully ossified until late in adolescence so the chest wall provides less

protection to underlying vital structures, thus a significant amount of energy is transferred to the lungs, heart and great vessels. The most common life threatening thoracic injuries are tension pneumothorax, cardiac tamponade, airway obstruction, open pneumothorax and massive hemothorax and all can be rapidly addressed in the ED.

Blunt Abdominal Trauma

Blunt abdominal trauma is the third most common cause of pediatric trauma deaths, but is the most common unrecognized fatal injury. Many serious abdominal injuries have non-specific or subtle external signs, so a systematic approach is important to avoid a missed diagnosis.[17,18] Splenic and hepatic injuries are the most common followed by renal, small bowel and pancreatic injuries. Children have very compliant chest and abdominal walls, and a relatively larger volume of viscera with less fat within a smaller AP diameter. As a result, the liver and spleen are less protected by the rib cage, placing them at increased risk of injury during blunt trauma. Common mechanisms include high-speed motor vehicle collisions, falls from greater than 20 feet, and direct blows to the abdomen (i.e., bicycle handlebar injury). Concerning exam findings include abdominal wall abrasions or bruising, seat-belt marks, tenderness or rigidity, distension, referred shoulder pain from diaphragmatic irritation, and emesis.[19] Abdominal wall bruising is a significant finding as one study of restrained children in MVCs found that those with a "seatbelt sign" were 232 times more likely to have intra-abdominal injuries than those without.[20]

The evaluation and management of pediatric blunt trauma has changed significantly in recent years. In addition to considering screening x-rays of the c-spine, chest and pelvis, screening laboratory studies may include CBC, type and cross, and urinalysis. LFTs, amylase and lipase are used selectively for patients who cannot give a reliable abdominal examination or if there is a concern for child abuse. Indications for CT scanning include >50 RBCs/HPF on urinalysis, LFTs >3 times normal, elevated pancreatic enzymes in the absence of facial trauma.[21,22,23] CT scanning should only be done in a hemodynamically stable patient.

Non-operative management (NOM) has been shown to be successful in >90% of solid organ injuries (liver, kidney, and spleen). It is preferable to preserve the spleen to allow for maturation of the immune system and to avoid the potential morbidity and mortality related to infection and sepsis. NOM for severe hepatic injuries may be complicated by bile leak or hemobilia, which can usually be managed with interventional radiology or endoscopic techniques. NOM should only be attempted under the direction of a surgeon in a facility with intensive care monitoring and the ability to take patients emergently to the operating room if they become unstable. Indications for operative management of solid organ injuries include: hemodynamic instability, persistent requirement for blood transfusions or evidence of bowel injury. Patients who remain hemodynamically unstable or are only transiently stable after resuscitation with crystalloid and blood should undergo exploratory laparotomy.

The FAST ultrasound exam (Focused Assessment with Sonography for Trauma) has been popularized for adult trauma patients. However, FAST has a low sensitivity (66%) in the hemodynamically stable pediatric trauma patient. A negative FAST does not exclude intra-abdominal injury, especially to retroperitoneal or hollow organs. A positive scan may suggest the need for CT, but it should not be used as the sole indication for laparotomy in children.[4]

Child Abuse/Non-accidental trauma

Victims of non-accidental trauma (NAT) present for medical care with a spectrum of trauma and non-trauma complaints. Over the past year, Hasbro Children's Hospital has cared for 236 children who are confirmed or suspected victims of child abuse injury and 4 deaths as a result of NAT. When evaluating and caring for pediatric patients, it is important to consider that young children are at increased risk of significant morbidity and mortality from child abuse, especially non-ambulatory infants and children. Risk factors for abuse include delayed medical care, injuries not consistent with the history or the patient's developmental stage, and unexplained bruising or oral trauma, especially in non-ambulatory patients. The HCH has a team of pediatric child abuse specialists at the Lawrence A. Aubin Sr. Child Protection Center. If NAT is suspected, medical documentation, radiographs and laboratory tests are critical components of forensic evaluations. Other children in a family may also be at risk, so involving law enforcement and child protective agencies (such as RI DCYF) to investigate the safety of the home is another important component in the management of these patients.

CONCLUSION

Pediatric injuries and trauma are common. As reviewed in this article, there are many differences between adult and pediatric trauma patients including anatomical, physiological, psychological, emotional and social. Understanding these differences and having a systematic approach to these patients is critical to providing excellent care, preventing secondary insult and avoiding oversight of potentially significant injuries. It is also important to understand how the specialized care at Pediatric Trauma Centers (PTC) can benefit this population of injured patients and when expedited stabilization and transfer to a PTC is the most appropriate disposition.

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Disclosures

None

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