Chapter 1

A Statement

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A 3-year-old boy with a bead stuck up his nose. A helpless 4-month-old girl with a devastating traumatic brain injury…from abuse. A 15-year-old with four months of persistent headaches, countless healthcare visits…and today…diagnosed with a brain tumor.

Kids are unique. They are different. And most certainly…they are incredibly special.

Kids represent our future.

As clinicians, we are entrusted with someone's most valuable possession, their child. We are entrusted to take care of them, to fix them, to cure them. Sometimes, it may be as simple as removing a nasal foreign body or reducing a nursemaid's elbow. Very easy, yet incredibly satisfying. But for other children, the situation and consequences are much more dire. In critical situations, we are asked to save them, *to save their lives*. A child on a bicycle hit by a car…An infant in cardiogenic shock from a critical coarctation…Or a teenager with anaphylaxis from a peanut ingestion. We are there to save their lives.

We who take care of children must be ready for these dramatic and life-threatening encounters. But we must also be prepared for the less obvious, the less dramatic, the "subtle" presentation. A fussy 4-month-old infant with abusive head trauma may harbor only one small diagnostic clue, such as a small scalp bruise, which the astute physician must discover. Failure to identify equates to further abuse. A wheezing 4-month-old infant during RSV season may actually harbor an undiagnosed cardiomyopathy. Can we pick out that needle in the haystack? That child with a persistent headache, could it be a brain tumor, carbon monoxide poisoning, or just a simple migraine headache? And the ever so common sore throat that you see day in and day out in Fast Track, will your next encounter be Lemierre's syndrome?

Just think how vastly the care of the pediatric patient has evolved in the past 75 years. In the middle of the last century, antibiotics were rarely used, we didn't have vaccines for measles or *Haemophilus influenzae* or *Streptococcus pneumoniae*, bacterial meningitis was common and deadly, and the care of the pediatric trauma patient was similar to that of the dark ages. As an example, in 1946, Caffey described a series of pediatric patients with subdural hematomas and long-bone fractures. He writes, "For many years we have been puzzled by the roentgen disclosure of fresh, healing and healed multiple fractures in the long bones of infants whose principal disease was chronic subdural hematoma." At the time, we still hadn't heard of the term "child abuse." Several years later, in 1962, Kempe and colleagues introduced the term "The Battered Child Syndrome" in a landmark *JAMA* article.[1] Today, hundreds of articles, conferences, and teaching seminars discuss non-accidental trauma.

Technology has also changed pediatric care. Seventy-five years ago we struggled to interpret low-quality X-rays. Today, we have pediatric X-ray technicians and pediatric radiologists. The CT scan was not invented until 1972! Today, low-dose CT, clinical indications for CT, PECARN traumatic brain injury prediction rules, and "pan-scan" are ever so common medical vernacular for the pediatric patient. Imagine a shift in the ED without a CT scan machine?! And of course there is ultrasound, first used for clinical purposes in the 1950s. Today, not only is there three- and four-dimensional ultrasound, but also pediatric emergency medicine physicians who perform point of care emergency ultrasound and make life-saving treatment decisions based upon these immediate bedside images.

In this book, the authors present dozens of interesting pediatric case vignettes. A pediatric story is followed by thought-provoking clinical questions, many very "cool" images, and subsequently an engaging discussion of the diagnostic topic. The authors discuss a wide range of clinical situations, such as trauma,

toxicology, resuscitation, orthopedics, and infectious disease. There are simple "bread-and-butter" cases described, things we see and do everyday. A nursemaid's elbow, a lodged foreign body, appendicitis, and pharyngitis. The reader will also experience critical scenarios, cases in shock, respiratory failure, and multi-trauma. These are unique situations where seconds count to save a young one's life.

As you read through this book, remember, you are the safety net for our children.

Kids are unique, kids are special.

Kids represent our future.

Reference

1. Kempe CH, Silverman FN, Steele BF, et al. The battered-child syndrome. *JAMA* 1962; 181: 1–24.

Chapter 2

Resuscitation

Case 1

Contributing Author: Erica Escarcega

History

The patient is a 10-year-old male brought in by EMS as a trauma alert after his bicycle was struck by a car at low speed. According to bystanders, the front wheel of the bicycle was struck by the front end of the car while the child was attempting to cross an intersection. The child fell forward over the handlebars and then landed on the street. The child was unhelmeted. There was a loss of consciousness at the scene for approximately 1 minute. He sustained significant facial injury, with soft-tissue swelling, and is unable to speak. He occasionally spits out a moderate amount of blood, but is able to handle his secretions and does not appear to be in respiratory distress. He was unable to ambulate at the scene and cries in pain with every touch.

Past Medical History

- None. He sees his pediatrician regularly and is UTD on vaccinations.

Medications

- None.

Allergies

- NKDA.

Physical Examination and Ancillary Studies

- *Vital signs*: T 98.6 °F, HR 114, BP 110/68, RR 20, O_2 sat 100% on room air.
- *General*: The patient is distressed, anxious, and crying. However, he is able to cooperate with examination.

Table 2.1 Glasgow Coma Scale. A score of 15 is normal. A score of 8 is considered comatose. A score of 3 is entirely unresponsive. In children < 4 years of age, modified verbal response includes 5 - smiles/coos, 4 - cries and is consolable, 3 - cries inappropriately or persistently, 2 - grunting or moaning, agitation, and 1 - no response.

Eyes open	Voice response	Motor response
• 4: spontaneous • 3: voice • 2: pain • 1: no opening	• 5: coherent speech • 4: confused • 3: inappropriate words • 2: incomprehensible sounds • 1: no speech	• 6: follows commands • 5: purposeful/ localizes • 4: withdraws to pain • 3: decorticate • 2: decerebrate • 1: no movement

- *Primary survey*:
  - ***A**irway:* Child with swollen bleeding tongue, but able to spit. No pooling secretions.
  - ***B**reathing:* Good air entry, adequate effort and oxygenation.
  - ***C**irculation:* Tachycardic, good central and peripheral pulses.
  - ***D**isability:* GCS 12 (eyes open spontaneously: 4, verbal is incomprehensible: 2, motor able to follow commands: 6) (see Table 2.1).
  - ***E**xposure:* Multiple abrasions and contusions.
- *Secondary survey*:
  - *HEENT*: PERRL. Mucous membranes are moist. There is significant swelling to the right mandible with abrasions over the right cheek, chin, and forehead. A 2-cm laceration is present to the left side of the tongue, with moderate active bleeding. Patient is currently in a c-collar and cries with palpation of the posterior c-spine. Trachea is midline.
  - *Cardiovascular*: He is tachycardic, with normal rhythm and no M/R/G. Peripheral pulses are normal. Capillary refill < 3 seconds.

Figure 2.1 FAST examination with free fluid.

- *Lungs*: CTA bilaterally, with no W/R/R. No chest-wall tenderness.
- *Abdomen*: The patient's abdomen is diffusely tender; however, soft and non-distended without rebound or guarding. There are no palpable masses on examination.
- *Extremities and skin*: There are multiple abrasions including a large abrasion over the right flank, right arm, bilateral palms, bilateral knees, and shins. Abrasions are dirty, impregnated with asphalt, and have minimal venous oozing at the time of examination. There is tenderness to palpation over the right hip. The patient is unable to tolerate range of motion of the right leg secondary to pain. He has tenderness over the left knee and cries with attempts at range of motion. He has full range of motion of bilateral upper extremities.
- *Neurologic*: He has tenderness over the c-spine. No thoracic or lumbar spine tenderness. No step-offs present on palpation of the spine.
- *Ancillary studies*: FAST examination with free fluid (Figure 2.1).

Questions for Thought

- What steps should be taken to evaluate and stabilize a pediatric trauma victim?
- How do pediatric trauma patients differ from adult trauma patients?
- What injuries are common in children who have been victims of severe trauma?
- How much blood volume can a child lose prior to becoming hypotensive?

Diagnosis

- Multiple trauma.

Discussion

- *Epidemiology*: It is estimated that 12,175 children die every year in the USA due to traumatic injuries, with the largest percentage of fatal injuries related to motor vehicle accidents.[1] Of motor vehicle-related fatalities, an average of 3,724 children die each year as occupants of the vehicle, 724 of annual fatalities are pedestrians, and 162 children are struck by a vehicle while riding their bicycles.[1] Seatbelt and bicycle helmet laws are measures that have been taken to attempt to reduce the number of childhood fatalities; however, pediatric trauma continues to be a major concern for public health, both in the USA and internationally.[2]
- *Pathophysiology*: Trauma presents a different disease spectrum in children as compared to adults. The bones of children are generally more pliable than those of the more calcified adult skeleton; therefore, fractures are often sustained in the setting of higher force mechanisms and internal injuries may occur despite an absence of fractures.[2,3] The proportionally larger and softer skull in small children results in an increased risk of traumatic brain injuries as well as facial injuries. Additionally, the ligaments of the child's c-spine have an increased laxity, which may increase the risk of c-spine injury that may not be seen on radiography. In regards to the circulatory system, a child's heart has a fixed stroke volume, which results in a reliance on an increase in heart rate in order to improve cardiac output. The low cardiopulmonary reserve in small children may result in a rapid, precipitous progression into shock. Hypothermia may also occur more quickly in children due to their higher relative body surface area.
- *Presentation*: Children are often unable to provide history and may not be able to cooperate with examination, which makes evaluation for the

extent of injuries challenging. Significant injuries may exist despite an inability to elicit tenderness on physical examination, especially in the setting of a decreased mental status. Indeed, the most common cause of pediatric trauma mortality is in fact head injury, and specific decision rules exist to guide the clinician in determining when neuroimaging is indicated. This is covered in Case 2 in this chapter.

Neck and spine injuries can be devastating, but are relatively uncommon in children. Children are more likely to have a ligamentous injury than a c-spine fracture. Decision rules exist for neuroimaging in neck injury, as well, and this is covered in Case 3 in this chapter.

The most common intrathoracic injury in significant blunt trauma is pulmonary contusion and the most common immediately life-threatening injury in children is tension pneumothorax.[4] Children may also sustain rib fractures, simple pneumothorax, hemothorax, pneumomediastinum, as well as injuries to the heart, aorta, and diaphragm in the setting of blunt trauma. Children may have significant intrathoracic trauma in the absence of rib fractures.

Abdominal injuries are common after severe blunt trauma with highest risk of injury to the liver and spleen.[5] Be wary of signs of injury related to seatbelts (such as abdominal bruising) as this may be an indication of significant underlying injury.[3,4] Fractures of the lumbar spine (Chance fracture) are caused by a flexion-distraction injury associated with lap belts and are often accompanied by GI injuries. Children presenting with femur fractures may also have concomitant intra-abdominal and intrathoracic injuries as these fractures are generally associated with a high impact mechanism.[3]

- *Diagnosis*: Many decision rules have been formulated with the goal of reducing radiation exposure in children. Although as many as 58 percent of intra-abdominal injuries present with abdominal pain, significant injuries may be missed due to the unreliability of the patient's examination; therefore, providers should have a low threshold for CT of the abdomen in patients with significant mechanism, especially in the setting of hypotension and laboratory abnormalities, including decreased HCT, hematuria, and elevated liver enzymes.[5] Signs which should increase suspicion for intrathoracic injuries include hypotension, tachypnea, abnormal mental status, and abnormal lung sounds on auscultation and should prompt the performance of CXR.[4] CXR, however, may miss up to 40 percent of intrathoracic injuries and if suspicion remains high despite negative CXR, further studies should be considered such as chest CT.[4] FAST examinations are often performed quickly at the bedside to evaluate for the presence of free fluid in the abdomen as well as around the heart; however, a negative FAST does not obviate the need for further imaging.
- *Treatment*: Cases of severe trauma are ideally managed by a multidisciplinary team consisting of emergency providers, surgeons, nurses, respiratory therapists, intensivists, radiologists, and subspecialists. Treatment of all pediatric traumas should begin with a primary survey and stabilization, as taught in ATLS courses, and should follow the ABCDE mnemonic (*A*irway, *B*reathing, *C*irculation, *D*isability, *E*xposure).[3] This algorithm applies to all causes of shock, not just shock related to trauma. In traumatized patients, the c-spine should remain immobilized until the child has been completely assessed.

*A*irway: orotracheal intubation is the preferred method of securing the airway in the absence of facial or laryngeal trauma if there are signs of respiratory distress, apnea, airway obstruction, or decreased mental status resulting in an inability to protect the airway.[3] In the rare cases where orotracheal intubation is contraindicated or unable to be established, a surgical airway is necessary. Needle cricothyroidotomy is a temporizing measure which can be used in young children. Standard cricothyroidotomy may be performed in children over the age of 12 in which the cricothyroid membrane can be palpated.[3] Nasotracheal intubation is not recommended in children. Hoarseness or crepitus may suggest a laryngeal injury that is best managed in consultation with ENT. In these cases, cricothyroidotomy may worsen the patient's injury, and stabilization of the airway in an operating suite may be required.

*B*reathing: The patient should be evaluated for bilateral breath sounds, the absence of which should prompt immediate intervention with placement of chest tubes to relieve suspected pneumothorax or hemothorax.[3] The most common cause of cardiac arrest in children is hypoxia, so it is vital to establish appropriate ventilation in pediatric trauma victims using weight-based lung volumes and titrating to oxygenation and end-tidal carbon dioxide or using serial ABGs.

*C*irculation: Evaluation of the circulation of a child is best performed by assessing peripheral perfusion (capillary refill and quality of peripheral pulses) as patients may lose more than 25 percent of their blood volume before becoming hypotensive.[3] Crystalloid fluid boluses of 20 mL/kg (preferably warmed) should be given initially, followed by boluses of 10 mL/kg of blood if needed. IV access in small children can be challenging, and IO access should be obtained if peripheral access cannot be obtained after two attempts.[3]

*D*isability: The disability portion of the ABCDE mnemonic refers to the patient's neurologic status. The Glasgow Coma Scale (GCS), which is commonly used in adult trauma, may also be used in the evaluation of mental status in pediatric trauma with modification of the verbal score in children under the age of 4. This score contributes to imaging decisions in the head-injured patient.

*E*xposure: Be sure to fully expose and inspect the patient for external signs of injury. Palpate for deformity, swelling, and crepitus. During the assessment, care should also be taken to keep the child as warm as possible to avoid hypothermia, which can worsen coagulopathy and acidosis. If the child's condition worsens at any point during the assessment, the primary survey should be repeated, beginning with reassessment of the patient's airway.

Once the primary survey is complete and the child is stable, a careful head-to-toe examination, called the secondary survey, takes place. Every inch of the child should be examined to avoid missing injuries.

Imaging should be performed in a stabilized patient after the primary survey as directed by findings during examination of the child. Children with multiple severe injuries may need to be managed in a staged approach, addressing the most life-threatening injuries first followed by further stabilization prior to subsequent interventions.[6]

- *Disposition*: Children presenting to a center without PICU capabilities, who are seriously injured, should be stabilized and transferred to a trauma center. It is appropriate for EMS to bypass a non-trauma center to bring children who are hemodynamically stable to the appropriate nearest trauma facility.

Historical clues	Physical findings	Ancillary studies
• High impact mechanism • Loss of consciousness	• Tachycardia • External signs of trauma (abrasions, contusions, lacerations, crepitus, deformities) • Tenderness to abdomen, spine, and lower extremities	• Positive FAST

Follow-Up

Although the patient had a positive FAST, he was hemodynamically stable to undergo CT scanning to further assess his injuries. CT chest, abdomen, and pelvis performed with IV contrast showed a grade III splenic laceration without active extravasation. CT facial bones revealed a non-displaced mandibular fracture. CT head showed no intracranial hemorrhage or skull fractures and CT c-spine was negative for fractures or dislocations. An X-ray of his left knee showed a non-displaced patellar fracture. The tongue laceration was sutured and his jaw was banded shut by ENT. The patient was admitted to the PICU for airway monitoring as his tongue had swollen significantly and there was concern of potential airway compromise. He also underwent serial abdominal examinations and hemodynamic monitoring for his splenic laceration. His patellar fracture was managed conservatively by orthopedics with splinting. The bands for his mandibular fracture were exchanged for wires when the swelling resolved. After an uneventful stay in the ICU, he was eventually discharged home with ENT, general surgery, and orthopedics follow-up.

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Case 2

Contributing Author: Michael Leonard

History

A 5-year-old male presents to the ED after being struck by a bicycle ridden by another child. The child had been playing on the sidewalk. The child struck his head on the pavement. Bystanders rushed to the scene and EMS was contacted immediately, who note the patient was briefly unconscious. Upon arrival, abrasion is noted to the right parietal area, and the child is confused and agitated. He does not follow commands but appears to be moving all extremities.

Past Medical History

- Full-term birth with no complications, developmentally normal, immunizations are UTD.

Medications

- None.

Allergies

- Strawberries.

Physical Examination and Ancillary Studies

- *Vital signs*: T 98.6 °F, HR 115, RR 18, BP 100/60, O_2 sat 100% on room air.
- *General*: Confused and agitated, resisting any effort to examine him.
- *Primary survey*:
  - *Airway*: Patent, no pooling secretions.
  - *Breathing*: Clear and equal breath sounds.
  - *Circulation*: Intact central and peripheral pulses.
  - *Disability*: GCS 13 (eyes = 4, speech = 4, motor = 5), non-focal.
  - *Exposure*: Bleeding laceration to right parietal area, with palpable bony depression and numerous facial abrasions. Abrasion to right elbow. No bony deformity. Bleeding is controlled.
- *Secondary survey*:
  - *HEENT*: Lacerations and abrasions as noted. Normal ear examination without evidence of hemotypanum or periauricular ecchymosis. Normal funduscopic examination without evidence of hyphema and with apparently normal extraocular movements from a limited examination due to patient cooperation.
  - *Neck*: Non-tender, child spontaneously ranging neck, with no apparent pain.
  - *Cardiovascular*: Heart with regular rate and rhythm, no M/R/G, good capillary refill.
  - *Lungs*: CTA bilaterally, with no W/R/R.
  - *Abdomen*: Soft, no tenderness, no rebound or guarding, no masses.
  - *Extremities*: No deformity. Abrasion on elbow as noted. Normal range of motion.
  - *Axial skeleton*: No back tenderness or step-offs, pelvis stable to rock and compression.
  - *Neurologic*: Confused, disoriented, and uncooperative. Examination appears non-focal and symmetric.

Questions for Thought

- What is the differential diagnosis of pediatric head injuries?
- What additional testing or imaging would be useful in this patient?
- What instructions should be given to the parents of children with less severe injuries?

Diagnosis

- Fall with depressed parietal skull fracture, dural tear with surrounding brain edema but without evidence of intracranial hemorrhage.

Discussion

- *Epidemiology*: The incidence of ED visits for TBI-related issues has been increasing over the last several years with the highest incidence (1,889 visits/100,000 person-years) occurring in children less than 3 years old.[1] Fortunately, the vast majority of pediatric head trauma is benign and the resultant rate of TBI-related deaths is lowest in the 0–4 year (4.3/100,000) and 5–14 year (1.9/100,000) age groups.[2] Hence, the challenge for the EM provider relates to identifying the rare cases of a potentially devastating condition within an exceedingly common presenting complaint.
- *Pathophysiology*: The majority of pediatric head injuries are due to blunt traumatic mechanisms. Significant injuries are rare but can result in skull fractures or intracranial injuries, including epidural, subdural, or subarachnoid hemorrhages. Additionally, the increasing emphasis on the long-term effects of concussion has contributed to the increasing number of ED visits. The pathophysiology of concussions or mild TBI is complex and incompletely understood and remains an area of evolving research.
- *Presentation*: Key components of the history include details of the mechanism of injury, any reported loss of consciousness, vomiting, or headache following the incident, and any change in behavior. In the case of a motor vehicle accident, acquire details from EMS or witnesses about the location of the child in the car, the extent and location of damage to the vehicle, whether the child was restrained and secured appropriately in a car seat, and any history of vehicular ejection. If the child fell, obtain information about the height of the fall or if the fall was from standing. If the child was on a bicycle, identify whether a helmet was worn at the time of the incident. Any history that seems implausible or does not fit with the injury pattern demonstrated on physical examination raises the possibility of abuse. Whenever practical, query the patient directly about mechanism, headache, or nausea. Elicit further details from the patient's parents regarding whether the child is acting normally and at his or her baseline.

  Initial assessment of the child should be focused on the ABC algorithm instituted with ATLS training to identify and intervene upon any potentially life-threatening conditions. An initial neurologic assessment of the child must account for age-specific variation in relation to expected findings. Following primary assessment, the secondary survey, including a head-to-toe examination, should be completed. Specific focus on scalp examination for any hematoma, lacerations, or other signs of trauma should be performed. Hemotympanum, posterior auricular ecchymosis (Battle's sign), or periocular ecchymoses that spare the tarsal plates (Raccoon eyes) are potential signs of a basilar skull fracture that, although rare, should be promptly evaluated by a trauma surgeon. Funduscopic examination, including evaluation for retinal hemorrhages, and complete eye examination, assessing for hyphema, globe rupture, and corneal injury, should be completed; if there is concern for non-accidental trauma, a formal examination by an ophthalmologist should be performed to assess for retinal hemorrhages.
- *Diagnosis*: Although ultrasound has been evaluated for the diagnosis of skull fractures, intracranial evaluation typically requires CT imaging, and recent efforts have been focused on limiting the exposure to ionizing radiation, particularly in the pediatric population.[3] To this extent, identifying which children are most at risk becomes a critical component of the evaluation and diagnosis of a potentially serious injury while limiting the risks from testing. Several decision aids have been developed and when compared in prospective trials, the PECARN clinical decision rules were found to be superior to other guidelines.[4] The PECARN consortium evaluated 42,412 children (less than 18 years old) presenting to 25 North American EDs, to develop a set of highly sensitive clinical decision aids that predict which children are at risk for intracranial injury and may benefit from imaging.[5] The decision aids include separate algorithms for children less than 2 years old and for older children. Each algorithm stratifies patients into three distinct groups:

Table 2.2 PECARN high- and intermediate-risk definitions for children with head injury[5]

	Children less than 2 years old	Children greater than 2 years old
High risk (CT recommended)	Palpable skull fracture	Signs of basilar skull fracture
	GCS ≤ 14 including any signs of altered mental status (agitation, somnolence, repetitive questioning, or slow responses to verbal communication)	
Intermediate risk (observation versus CT)	Loss of consciousness greater than 5 seconds Occipital, parietal, or temporal scalp hematoma Not acting normally per parent	Loss of consciousness any period History of vomiting Severe headache
	Severe mechanism of injury, including: a motor vehicle collision where the patient was ejected, the collision involved the death of another passenger, or a rollover; the patient was a pedestrian or a bicyclist without helmet and was struck by a motor vehicle; or the patient's head was struck by a high-impact object	
	Fall > 3 feet	Fall > 5 feet

- *High-risk patients* warranting immediate imaging, with a greater than 4 percent risk of clinically important TBI (ciTBI).
- *Intermediate-risk patients* who may be observed or may warrant imaging based upon additional factors (approximately 1 percent risk of ciTBI).
- *Low-risk patients* who are unlikely to benefit from imaging (<0.05 percent risk of ciTBI).

Low-risk patients are those who do not meet any criteria for high or intermediate risk. Based upon the high sensitivity demonstrated in multiple validation studies, the risk of clinically significant TBI is exceedingly low in these patients, and the risks of imaging likely outweigh any benefit. The different risk categories are shown in Table 2.2.

For those children in the intermediate-risk group, the decision whether to observe or perform imaging on the patient should be considered in consultation with the child's parents and in accordance with the physician's experience and comfort. Observation allows the opportunity to assess for symptom evolution, which might warrant a change in care. Ultimately, like any decision aid, the use of the PECARN algorithm is meant to be a guideline and should not supersede clinician judgment.

- *Treatment*: After initial resuscitation of a patient with a traumatic head injury, the identification of any clinically significant TBI warrants immediate consultation with an appropriately trained neurosurgeon or transfer to a center capable of managing these injuries. Additional interventions, such as the use of osmotic agents (including hypertonic saline and mannitol) and seizure prophylaxis, may be warranted based upon the severity of the injury and the potential for worsening due to evolution of the initial injury. These agents should be given in consultation with a neurosurgeon, and in cases where a child shows evidence of increased intracranial pressure (hypertension, bradycardia, worsening of mental status), osmotic agents may be life-saving. These agents, though, are only temporizing, and definitive care is surgical. There is further discussion of these topics in Chapter 10, Case 3.
- *Disposition*: The majority of pediatric patients presenting to the ED can be safely discharged home. Any patient identified as an intermediate risk, who is not undergoing imaging, should be observed in the ED for several hours and reassessed throughout that period and prior to discharge. All patients and their parents should be given detailed return instructions for repetitive vomiting, worsening pain, or alterations in mental status. It is also critical to educate patients and families on injury prevention, focusing on the inciting event. In particular, seatbelt and helmet safety should be addressed.

For patients diagnosed with a concussion, the current evidence supports a limited period of rest (1–2 days) with stepwise return to activity.[6] Due to the developing arena of concussion management and the potential for long-term monitoring, the patient should be referred to a physician specially trained in this area, such as a sports medicine physician.

Historical clues	Physical findings	Ancillary studies
• High-risk mechanism • Loss of consciousness	• Altered mental status/GCS • Palpable skull fracture	• Child warrants CT

Follow-Up

The child underwent CT scanning and, due to dural violation, had operative elevation of his depressed skull fracture. He was hospitalized for 10 days and then transferred to a rehabilitation center, where he has recovered with no deficits.

References

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Case 3

Contributing Author: Donald Jeanmonod

History

A 4-year-old female presents to the trauma bay via EMS. She was the restrained passenger-side rear-seat passenger in a booster seat in a car involved in a multicar accident on the interstate at highway speeds. There was a fatality within her vehicle. It is unknown if she had loss of consciousness. EMS immobilized the child on a pediatric immobilization board and initiated IV access. Their primary survey has identified a significant scalp laceration, whose bleeding they have attempted to control with direct pressure, and an obviously deformed right femur. The child was administered 1 μg/kg of fentanyl pre-hospital.

Past Medical History

- Unknown.

Medications

- Unknown.

Allergies

- Unknown.

Physical Examination and Ancillary Studies

- *Vital signs*: T 97 °F, HR 146, RR 32, BP 96/54, O_2 sat 94% on room air.
- *Primary survey*:
  - *Airway*: The child is somnolent and there is blood noted at the oropharynx.
  - *Breathing*: Respirations are sonorous but present bilaterally.
  - *Circulation*: The child is tachycardic and has intact distal pulses in four extremities.
  - *Disability*: GCS is 9 (eyes = 2, speech = 3, motor = 4), and the child seems to respond to pain in all four extremities.
  - *Exposure:* Right-femur deformity, 12-cm scalp wound with venous oozing, bruising to abdomen.
- *Secondary survey*:
  - *HEENT*: 12-cm full-thickness laceration to the right parietal-occipital area with venous oozing. The skull beneath appears to be intact. No hemotympanum. Eyes open to pain. Pupils 4 mm and reactive bilaterally. Blood noted within oropharynx from an unknown source.
  - *Neck*: Neck is immobilized in a c-collar. Trachea is midline, without subcutaneous emphysema appreciated.
  - *Chest*: Clavicles intact, but ecchymosis noted over the right shoulder. Lungs are rhonchorous bilaterally. Chest wall is stable without subcutaneous emphysema.
  - *Heart*: Tachycardic and regular.
  - *Abdomen*: Non-distended and soft, without apparent tenderness. There is an ecchymosis over the lower abdomen.
  - *Pelvis*: Stable to rock and compression. No perineal hematoma.
  - *Extremities*: There is deformity of the right femur with moderate thigh hematoma. The