

# ***MAJOR TRAUMA***

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- The **general goal** of **prehospital trauma care** is **rapid assessment**, support of the **ABCs**, **immobilization**, and **transportation**. Outcomes of patients with major or life-threatening trauma are significantly improved in a **pediatric trauma center** or in an adult center with pediatric trauma certification compared with level I or II adult trauma centers.
- The initial assessment of a seriously injured child should involve a systematic approach, including a **primary survey**, **resuscitation**, **secondary survey**, **postresuscitation monitoring**, and definitive care.

- The **primary survey** focuses on the **ABCDEs** of emergency care, as modified for trauma from the ABCs of cardiopulmonary resuscitation. The assessment of the **airway** and **breathing** components should include meticulous control of the **cervical spine** (especially if the patient has an altered mental status), evaluation for **anatomic injuries** that could impair air entry or gas exchange, and consideration of the likelihood of a full stomach (risk of aspiration pneumonia). **Circulation** can be assessed via observation (heart rate, skin color, mental status) and palpation (pulse quality, capillary refill, skin temperature) and restored (via two peripheral intravenous lines, when possible) while control of bleeding is accomplished through the use of direct pressure.

- Assessment for **disabilities (D)** , including **neurologic status**, includes examination of **pupil size** and **reactivity**, a brief mental status assessment (**AVPU**-alert; responds to voice; responds to pain; *unresponsive*), and examination of **extremity movement** to assess for spinal cord injury
- The **Glasgow Coma Scales** can direct decisions regarding the initiation of cerebral resuscitation in patients with suspected closed head injuries.
- **E**, which stands for **exposure**, requires a full assessment of the patient by **completely disrobing** the child for a detailed examination of the entire body. The examiner should ensure a neutral thermal environment to **prevent hypothermia**.

On completion of the primary survey, a more detailed **head-to-toe examination** (the **secondary survey**) should ensue. The purpose of this careful re-examination is to **identify life-threatening** and **limb-threatening injuries** and **less serious injuries**. The prioritization of definitive care needs is determined by the injury findings collected from the primary and secondary surveys, the child's physiologic response to resuscitation, and data from continuous monitoring. A **tertiary survey**, including **repeat primary** and **secondary surveys** along with review of **laboratory tests** and **radiologic studies**, should be performed **within 24 hours**.

# LABORATORY AND IMAGING STUDIES

- **Screening laboratory** studies during initial resuscitation often include :  
an arterial blood gas, serum lactate, base deficit, and mixed venous oxygen saturation assists in determining adequacy of resuscitation in many patients.
- **Radiographic** studies are determined by the pattern of injuries. A head computed tomography (**CT**) scan should be obtained in patients with evidence of head trauma or a history of loss of consciousness. Patients with obvious **injury** to the **thorax** or **abdomen** or who have pulmonary or abdominal symptoms may benefit from a **CT scan**. The **focused abdominal sonography for trauma** is gaining popularity because of concerns about radiation exposure. A **spiral enhanced CT scan** should be performed if there is concern about **aortic injuries**.

# Initial Laboratory Evaluation of the Major Trauma Patient

## HEMATOLOGY

Complete blood count  
Platelet count  
Type and cross-match

## URINALYSIS

Gross  
Microscopic

## CLINICAL CHEMISTRY

Amylase  
AST/ALT

## RADIOLOGY

Cervical spine films  
Anteroposterior chest radiograph  
Radiographs of all apparent fractures  
Computed tomography scans where indicated for head, chest, and abdominal trauma

# CLINICAL MANIFESTATIONS AND TREATMENT

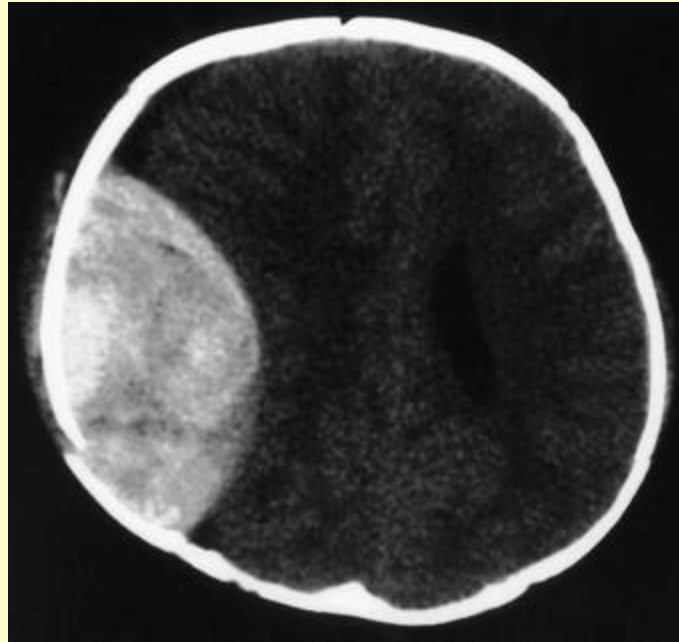
- **Head injuries** and **injuries to the limbs** are the **most common**. **Multiple organ** involvement is also common, with **30% to 45%** of pediatric trauma patients having **multiple injuries** and at least one skeletal fracture. **Penetrating trauma** is becoming more frequent and now accounts for **10% to 20%** of all pediatric trauma admissions. After the initial evaluation and stabilization, the team focuses on the involved organ systems



# Head Trauma

- A GCS or **Pediatric GCS** score should be assigned to **every** child with **significant head trauma**. Patients with **low scores 6-24 hr after injuries** have **poorer prognoses**.
- In the ED, **CT scanning** of the head **without a contrast** agent has become **standard** to determine the type of injury. Diffuse cerebral injury with edema is a common and serious finding on CT scan in severely brain-injured children. Focal evacuable hemorrhagic lesions (e.g., **epidural hematoma**) occur less commonly but may require **immediate neurosurgical intervention**

# epidural hematoma



- **Monitoring of ICP** should be strongly considered for children with severe brain injury, particularly for those with a **GCS score of 8 or less** and **abnormal head CT findings**.
- Hypoxia, hypercarbia, hypotension, and hyperthermia must be aggressively managed to **prevent** secondary brain injury. **Cerebral perfusion pressure** should be maintained **>40 mm Hg** at least (although some experts recommend an even higher minimum).
- Compared with **adults** with similar injuries, **children** are thought to have **better functional outcomes**.

# Spinal Cord Trauma

- Although spinal cord injury is not common in pediatric trauma patients, it is **potentially devastating** when it occurs. **Cervical spine immobilization** should be maintained until a spinal cord injury is ruled out. **Cervical spine radiographs** are **not sufficient** to rule out a spinal cord injury because the **immature vertebral column** in children may allow stretching of the cord or nerve roots with no radiologic abnormality (spinal cord injury without radiologic abnormality [**SCIWORA**]) ; when it is suspected, **magnetic resonance imaging** should be performed. **Controversy** exists regarding the use of **methylprednisolone** for children with **blunt** spinal cord injury. It is **not** indicated for **penetrating** spinal cord injury.

# Thoracic Trauma

- Thoracic injury occurs in only about 5% of children hospitalized for trauma, yet it is the **second leading cause of death**. Pulmonary contusion, pneumothorax, and rib fractures occur most commonly, and patients may present without external signs of trauma. Patients with pulmonary parenchymal injury should receive supportive treatment to ensure adequate oxygenation and ventilation.
- Most pediatric **blunt** thoracic injuries can be managed **without surgery**. Injury to the heart and great vessels is rare but requires urgent diagnosis and treatment. **Great vessel injury** should be suspected if a **widened mediastinum** is seen on chest radiograph.

# Abdominal Trauma

Injury to the abdomen occurs in approximately **8%** of pediatric trauma patients. The **relative size** and closer proximity of intra-abdominal organs in children **increase** the risk of **significant injury** after **blunt** trauma. **Penetrating** trauma, which accounts for less than 10% of pediatric abdominal trauma, may result in a child who is asymptomatic or who presents in **hypovolemic shock**.

Performing **serial physical examinations** is the primary method of obtaining information on which to base decisions regarding **operative intervention**. **Abdominal wall bruising** is an important physical examination finding and is associated with significant **intra-abdominal injury** in more than 10% of patients. **Operative intervention** may be required in patients whose **vital signs** are **persistently unstable** in the face of aggressive fluid resuscitation, **even** in the **absence** of extravascular volume loss or an enlarging abdomen. The presence of **peritoneal irritation** or **abdominal wall discoloration**, together with signs of **intravascular volume loss**, indicates the need for **laparotomy**.

Abdominal CT is invaluable for assessing hemodynamically stable children with intra-abdominal trauma. Operative exploration is based on CT and physical findings and may be indicated when peritoneal irritation, hypovolemia, or free air on plain film is present.

Most blunt solid organ injury is handled nonoperatively. Clinical observation is important, because most failures with nonoperative management occur in the first 12 hours

# Injury to the Spleen

- The most frequently injured abdominal organ in children is the spleen. Suspicion of a splenic injury should be heightened if there are left upper quadrant abrasions or tenderness.
- A positive *Kehr sign* (pressure on the left upper quadrant eliciting left shoulder pain) is due to diaphragmatic irritation by the ruptured spleen and strongly suggests splenic injury. CT scans are used to grade splenic injury from 1 to 5 (grade 1, capsular tear or nonexpanding subcapsular hemorrhage, to grade 5, completely ruptured spleen).



- **Nonoperative** management is the treatment of **choice** for most serious **splenic injuries**, **unless** there is **continued large blood loss** (**transfusion** requirement: **>25-40 mL/kg/day**) or **hemodynamic instability**.
- If a **splenectomy** is performed, patients should receive **penicillin prophylaxis** and should receive pneumococcal and ***Haemophilus influenzae* vaccines** to decrease the increased risk of overwhelming sepsis.

# Liver Trauma

- Major trauma to the **liver** is a serious cause of morbidity and accounts for **40%** of all **deaths** associated with blunt abdominal trauma in children. **Severe hemorrhage** is more common in patients with liver injury than with other abdominal injuries because of its **dual blood supply**. Without significant vascular injury, hepatic injury presents and behaves clinically like a splenic injury.
- **Nonoperative management** is **recommended** but requires **close clinical observation** for signs of ongoing blood loss or hemodynamic instability. Like splenic injury, there is a grading system based on the pattern of injury.

# Renal Injury

- The kidney is injured in 10% to 20% of cases of blunt abdominal trauma, and more than 40% of children with injured kidneys have other internal injuries. A young child's kidney is more vulnerable to trauma than an adult's because of its anterior position in the peritoneal cavity, a more compliant rib cage, and relatively immature abdominal muscle development.
- The diagnosis of renal injury is based on history and physical examination coupled with urinalysis showing blood and increased protein levels. An intravenous pyelogram, ultrasound, or CT may also be useful. Low-grade renal injury is usually managed conservatively, consisting of bed rest, catheter drainage, and monitoring for resolution of injury by ultrasound or CT. Surgery may be required for falling hemoglobin levels, refractory shock, or urinary obstruction caused by clots.

# Pancreatic Injury

- Injuries of the pancreas are **less common** in children than in adults but are seen in **bicycle** handlebar injuries, motor vehicle crashes, and nonaccidental trauma. The diagnosis is difficult unless there is obvious injury to overlying structures, such as the stomach or duodenum.
- **Diffuse abdominal tenderness, pain, and vomiting** may be accompanied by **elevations** of **amylase** and **lipase** but may **not occur** until **several days** after the injury. Hemodynamic instability secondary to retroperitoneal hemorrhage may be the presenting sign. **Nasogastric suction** and **parenteral nutrition** are indicated in the management of these patients. **Nonoperative** management is appropriate for contusions, but **surgical** intervention may be required in patients with **distal transection**. **Drainage** of **pseudocysts** in patients who develop them may be required if they are **unresponsive** to **bowel rest** and **parenteral nutrition**.

# Intestinal Injury

- Injury to the intestine occurs **less frequently** than injury to **solid** intra-abdominal organs and varies with the amount of intestinal contents. A **full bowel** is likely to **shear** more easily than an empty bowel. Shearing occurs at **points of fixation** (the ligament of Treitz, the ileocecal valve, and the ascending and descending peritoneal reflections).
- **Abdominal tenderness** is a common finding with intestinal perforation. Peritoneal signs are seen in less than 50% of children. **Pneumoperitoneum** occurs in only 20% of patients, but when present it should prompt **surgical exploration**. Serial physical examinations are useful when the clinical picture is uncertain.
- **Duodenal hematoma** can occur in the absence of perforation. Duodenal hematomas result from blunt injury to the abdomen, and affected patients often present with **persistent pain** and **bilious emesis**. Most hematomas respond to **nonoperative** management with gastric decompression and parenteral nutrition.

# COMPLICATIONS

- Patients requiring hospitalization for multiple trauma are at risk for a variety of complications based on the type and severity of injury. **Sepsis** and **multiple organ failure** may occur in children with multiple trauma. **Delays in enteral nutrition** because of an ileus may further **increase** the **risk of sepsis** secondary to translocation of bacteria across the intestinal mucosa.
- **Renal failure** secondary to **myoglobinuria** may be seen in children who sustain crushing or electrical injuries and burns. **Deep venous thrombosis** is **unusual** in the pediatric population, but **prophylaxis** for **older children** ( **>14 years** of age ), who will be immobilized because of injury, is often provided

# PROGNOSIS

- Injuries are the largest cause of **morbidity and mortality** in children, accounting for **more than 60%** of deaths in children **1 to 19 years** of age. **Mortality rates** for patients with **head injuries** range from **6% to 16%**, with younger children having higher mortality rates. Isolated thoracic injury has a mortality rate of 5%, which increases to 25% if there is a concurrent head or abdominal injury.
- Penetrating trauma accounts for 10% to 20% of pediatric trauma admissions. **Penetrating** injuries caused by **firearms** have significant mortality, with **30%** of victims dying in the **field** and another **12%** in the **emergency department**. Morbidities are numerous and include hypoxic-ischemic brain injury, loss of limbs, and psychological dysfunction.