A-B-C-D Now What: Various Clinical Courses
After the Trauma Bay Evaluation

Shaun A. Steigman MD
Hillary J. Collyer RN, MSN, CPNP, CCRN

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Objectives

1. To list various clinical criteria for admission to the pediatric ICU

2. To describe current management of patients with solid organ injuries (i.e. liver/spleen/kidney)

3. To describe scenarios which observation and physical exam is superior to radiology in determining the need for hospitalization or surgery
Disclosures

The following are true stories and are intended for mature audiences only.

Contains graphic pictures.

Viewer discretion is advised.
Pediatric Trauma

- Trauma is still the leading cause of morbidity and mortality ages 1-14 yr
- Pediatric Mechanism Deaths: MVA (50/50 Ped/Bicycle vs Occupant), drowning, house fires, homicides, and falls
- Most blunt trauma is sustained unintentionally (play or sports)
- Blunt injuries > Penetrating 12:1
ATLS principles guide the assessment and resuscitation of injured patients, both children and adults.

Primary survey - process that includes the ABCDEs of trauma care and identifies life threatening conditions by adhering to the following sequence:

A - Airway maintenance with cervical spine protection
B - Breathing and ventilation
C - Circulation and hemorrhage control
D - Disability
E - Exposure/Environmental control

Secondary survey - Head-to-toe physical exam, history, imaging

But what happens after they leave the trauma bay…
BURNS
Burn #1

- 5 month old male brought to the Hasbro ED with complaint of left ankle, groin, and scrotal burns

- Dad was bathing patient in the sink the morning of presentation, using sprayer to rinse child off. The patient started crying and the water was noted to be steaming

- Patient was removed from the sink, he continued to cry, the father noted the groin to be erythematous and blistered

- Despite this the father left the patient with the grandmother and went to class. 7 hours later was called by Grandmother after patient was not improving.
Burn #1

- Primary Survey
- Secondary Survey - 1.5% TBSA superficial second degree scald burn to penis, scrotum, perineum, and L medial ankle
Burn #2

- 15 mo old female presents to Hasbro ED with complaint of facial and right chest burns

- Mom states that she had just heated up the sauce and the patient reached up and grabbed the spoon flinging the sauce onto her face.

- Mom immediately washed off sauce and brought her to an OSH. She was then transferred for further management.
Burn #2

- Primary Survey

- Secondary Survey- 3% TBSA superficial second degree burns to R cheek, forehead, and eye. 0.5% TBSA superficial second degree burn to R anterior chest
Pediatric Burns - Scald

- Scald burns are the most common thermal injuries in children < 3 yrs
- Primary survey of the burn patient is like that of any other trauma patient:
  
  A-B-C-D-E

**Preventing hypothermia is a PRIORITY**

**Cover with CLEAN DRY sheets**
Secondary survey begins with obtaining history of events leading to injury:

1. Circumstance of injury (i.e. flame, scald, chemical, and electrical)
2. Extent of burn - “Rule of Nines” differs in children
   **Size of patient’s hand including fingers represents ~ 1% TBSA**
3. Determine depth of burn (degree)
   **Disproportionally thin skin**
Initial Burn Management

1. Stop the burning process

2. Fluid Resuscitation
   - Children 3ml LR x KG x % TBSA

3. Pain management

4. Topical wound management-dependent on burn depth
   - Bedside debridement
   - Application of topical agent (Silvadene, bacitracin…)

5. Specific anatomic considerations:
   - Face
   - Eyes- Ophtho consult
   - Ears
   - Hands/Feet
   - Genitalia/Perineum
Pediatric Burns - Scald

**Admission to PICU:**
1. > 15 % TBSA
2. Fluid resuscitation
3. Pain management

**Admission to Floor:**
1. Fluid Resuscitation
2. Circumferential burns
3. Facial/Eye burns
4. Pain management
5. Further wound management
6. Rule out child abuse

**If discharged home, follow-up in burn clinic

** Children < 4yr ALWAYS evaluate for child abuse. High level of suspicion triggered when:**

- Pattern of injury not compatible with history
- Abnormal distribution of burn
- Long delay between burn and seeking treatment
• 10 yo female transferred to Hasbro ED from OSH with complaint of frostbite to bilateral hands

• Patient states that she missed the school bus in the AM and decided to walk home in subzero weather

• While walking, she slipped and fell in the snow, hitting R hand and R knee on fence

• She was wearing thin cotton gloves. Total exposure time was ~ 45 min

• She then went home and fell asleep with Mom, woke up from pain, noted edema and blisters
Burn #3

- Primary

- Secondary-

  L hand- Edema and blisters to digits 3-5

  R hand- Edema and blisters to digits 2-5, some spontaneous rupture of blisters

  R hand Xray- No fracture
Pediatric Burns - Cold Injury

- Most commonly occur secondary to environmental exposure w/o appropriate protection
- Localized - Frostbite
- Systemic - Hypothermia
- Physiological changes are distinct
Pediatric Burns - Cold Injury

Mild Injury

- Bright red or normal coloration
- Warm
- Pinprick sensation present
- Painful
- Paresthesias
- Lg vesicles with clear fluid
- Rapid onset of edema
- Superficial eschar

Deep Injury

- Deep purple and cool
- Does not blanch with pressure
- Minimal pain
- Small hemorrhagic vesicles that occur late and don’t extend to the tips of digits
- Slow onset of edema
- Deep structures demarcate and mumify
Pediatric Burns - Cold Injury

- Initial treatment for frostbite is the same regardless of perceived depth of injury:
  - Remove damp/constrictive clothing, replace with dry/loose clothing
  - Injury should not be rubbed or massaged
  - Rewarming should not be attempted until at a burn center
  - Fluid resuscitation is rarely required for isolated frostbite
  - Administration of pain medication, including ibuprofen
  - Clear/white blisters are debrided, purple/bluish left alone
  - Topical wound management
Burn # 3

• Admit to floor for pain control
• Wound management- 1xD Silvadene dressing changes
• PID #2 to OR for debridement of bilateral hands and fingers, application of Awbat glove
• Discharged home PID #4
Burn # 4

- A 1 yr old female presents after being found with a frayed lamp cord in her mouth.
- Mom states that she heard the child crying and found her within seconds.
Burn #4

- Primary
- Secondary- < 1% TBSA superficial second degree burn to lips
- EKG- Normal
Pediatric Burns - Electrical

- Frequently encountered in the pediatric setting, low voltage (<1,000 volts) accidents being the most common.
- Common etiologies include faulty insulation, electric appliances, frayed electrical cords, and the insertion of metal objects into wall sockets.
- Usually creates minimal cutaneous injury and usually no deep muscle damage.
- Injuries involving the face or oral cavity commonly look much worse than they are and NO initial surgical debridement should be performed.
Pediatric Burns- Electrical

- Estimate extent of surface burn
- Fluid resuscitation - 4ml LR x KG x % TBSA burn
- 12-lead EKG, if normal 4 hours of cardiac monitoring, repeat EKG after 4 hours
- Overnight cardiac monitoring is not recommended if normal EKG, no history of unconsciousness, cardiac arrest, or abnormal rate or rhythm
- PO trial
- Pain medication
- Follow up at Burn clinic
Blunt Trauma
13yo M with ADHD engaged in verbal altercation at school. Pushed into bleachers by classmate. Complained of lower chest and upper abdominal pain.

Trauma Bay evaluation
- HR 80s, BP 110/70
- Alert and interactive
- CTAB
- Lower chest contusion
- Epigastric and BL upper quadrant tenderness

Labs: Hgb 13, Hct 39
Blunt Abdominal Trauma #2


- Initially OSH, then transferred to Hasbro

- Trauma Bay evaluation
  - VS: HR 90, BP 100/60
  - Normal exam except for diffuse abdominal tenderness, worst in RUQ

- Labs: Hgb 10.5, Hct 30.7
Solid Organ Injuries

- 8-12% of children with blunt trauma have abdominal injury
  - Abdominal injuries 30% more common than thoracic
  - Abdominal injuries 40% less likely to be fatal

- Spleen and liver most common abdominal injuries
  - 1/3 each

- Non-operative management is the standard of care in children, >90% successful
  - Clinical parameters are paramount
Table 2. Resource Utilization and Activity Restriction in 832 Children With Isolated Spleen or Liver Injury

<table>
<thead>
<tr>
<th></th>
<th>CT Grade</th>
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<tbody>
<tr>
<td>Admitted to ICU (%)</td>
<td></td>
<td>I</td>
<td>II</td>
<td>III</td>
</tr>
<tr>
<td>No. of hospital days (mean)</td>
<td></td>
<td>4.3</td>
<td>5.3</td>
<td>7.1</td>
</tr>
<tr>
<td>No. of hospital days (range)</td>
<td></td>
<td>1-7</td>
<td>2-9</td>
<td>3-9</td>
</tr>
<tr>
<td>Transfused (%)</td>
<td></td>
<td>1.8</td>
<td>5.2</td>
<td>10.1*</td>
</tr>
<tr>
<td>Laparotomy (%)</td>
<td>None</td>
<td>1.0</td>
<td>2.7†</td>
<td>12.6†</td>
</tr>
<tr>
<td>Predischarge imaging (%)</td>
<td></td>
<td>13.9</td>
<td>32.4</td>
<td>34.8</td>
</tr>
<tr>
<td>Postdischarge imaging (%)</td>
<td></td>
<td>29.8</td>
<td>33.7</td>
<td>44.0</td>
</tr>
<tr>
<td>Activity restriction (mean)</td>
<td></td>
<td>5.1 wk</td>
<td>6.2 wk</td>
<td>7.5 wk</td>
</tr>
<tr>
<td>Activity restriction (range)</td>
<td></td>
<td>2-6 wk</td>
<td>2-8 wk</td>
<td>4-12 wk</td>
</tr>
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*Grade III versus grade IV; P < .014.
†Grade III versus grade IV; P < .0001.
Hasbro Trauma Database

- 10-year retrospective review
- Level I trauma center
- Data collection included presentation vital signs, grade of splenic injury, associated injuries, revised trauma score, nadir hemoglobin concentration, and injury severity score
- Outcome parameters included blood transfusion, angioembolization, and splenectomy rates
- 203 patient under 17 years with blunt splenic injury from 2001-2011
- Comparison made with national averages using the Kids’ Inpatient Database and a medical literature review
Splenectomy Rate

- APSA All
- APSA Isolated
- National Non-Trauma Centers All
- National Trauma Centers Isolated
- Hasbro All
- Hasbro Isolated

Percentage:
- 0%
- 2%
- 4%
- 6%
- 8%
- 10%
- 12%
- 14%
- 16%
- 18%
Transfusion and Embolization

![Graphs showing transfusion and embolization rates for Hasbro All, Hasbro Isolated, and National Isolated compared to National All.](image)
Decreased splenectomy rates need not be associated with increased rates of angioembolization or transfusion.

Pediatric trauma centers exemplify optimal non-operative management of pediatric blunt splenic injury.
Hospital Courses

- Grade V splenic laceration
  - Admitted to PICU x3d
  - Serial Hgb/Hct stable x3d
  - Pain control with PCA
  - Slowly introduced diet
  - Bedrest x6d
  - D/C home on HD 7

- Grade III liver laceration
  - PICU x2d
  - Serial Hgb/Hct stable x2d
  - Pain control with prn
  - Delayed diet
  - Bedrest x4d
  - D/C home on HD 5

- Outpt f/u in 6 weeks with U/S to determine timing to return to full activities
Blunt Abdominal Trauma #3

- 15yo M experienced worsening LUQ abdominal pain the day after a wrestling match.
  - h/o constipation – tried enema with little relief of abdominal pain
  - brought in by parents

- Trauma Bay evaluation
  - VS normal
  - Abrasion L hip
  - Localized abdominal tenderness to LUQ without rebound or guarding

Abdominal CT in Blunt Trauma

- Wonderful for solid organ injuries
- Sensitivity and specificities > 95%
- Less sensitive for hollow viscus injuries

Table 2. Test performance of helical abdominal CT for all patients with gastrointestinal injury (n=106).

<table>
<thead>
<tr>
<th>Clinical Finding</th>
<th>Sensitivity, % (95% CI)</th>
<th>Specificity, % (95% CI)</th>
<th>PPV, % (95% CI)</th>
<th>NPV, % (95% CI)</th>
<th>LR(+)</th>
<th>LR(−)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumoperitoneum (n=22)</td>
<td>15 (9–23)</td>
<td>99.9 (99.8–100)</td>
<td>73 (50–93)</td>
<td>98.5 (98.2–98.8)</td>
<td>150</td>
<td>0.85</td>
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<tr>
<td>Unexplained intraperitoneal fluid (n=218)*</td>
<td>60 (50–70)</td>
<td>97.4 (97.0–97.8)</td>
<td>29 (23–36)</td>
<td>99.2 (99.0–99.5)</td>
<td>23</td>
<td>0.41</td>
</tr>
<tr>
<td>Unexplained intraperitoneal fluid (isolated finding, n=170)**</td>
<td>29 (21–39)</td>
<td>98.2 (98.1–98.3)</td>
<td>18 (13–26)</td>
<td>99.2 (98.9–99.5)</td>
<td>23</td>
<td>0.41</td>
</tr>
<tr>
<td>Bowel wall injury (n=77)</td>
<td>16 (10–24)</td>
<td>99.0 (98.7–99.2)</td>
<td>22 (13–33)</td>
<td>98.5 (98.2–98.8)</td>
<td>16</td>
<td>0.84</td>
</tr>
<tr>
<td>Extravasation of vascular contrast (n=7)</td>
<td>7 (3–13)</td>
<td>99.0 (98.9–100)</td>
<td>86 (42–100)</td>
<td>98.3 (98.0–98.7)</td>
<td>700</td>
<td>0.33</td>
</tr>
<tr>
<td>Mesenteric streaking/haematoma (n=52)</td>
<td>17 (10–25)</td>
<td>99.4 (99.2–99.6)</td>
<td>35 (22–46)</td>
<td>98.5 (98.2–98.8)</td>
<td>28</td>
<td>0.84</td>
</tr>
<tr>
<td>Fluid surrounding the duodenum (n=10)</td>
<td>6 (2–12)</td>
<td>99.3 (99.8–100)</td>
<td>60 (28–88)</td>
<td>98.3 (98.0–98.6)</td>
<td>60</td>
<td>0.94</td>
</tr>
<tr>
<td>Any finding (n=319)</td>
<td>76 (67–84)</td>
<td>96.0 (95.4–96.5)</td>
<td>25 (21–31)</td>
<td>99.6 (99.4–99.7)</td>
<td>190</td>
<td>0.25</td>
</tr>
</tbody>
</table>

PPV, Positive predictive value; NPV, negative predictive value; LR, likelihood ratio.

*Unexplained intraperitoneal fluid is intraperitoneal fluid but no solid organ injury on abdominal CT.
**Unexplained intraperitoneal fluid as an isolated finding is intraperitoneal fluid but no solid organ injury and no other evidence of gastrointestinal injury on abdominal CT.

Blunt Trauma #4

- 10 yo female presents to the Hasbro ED with complaint of abdominal pain
- She was an improperly restrained rear seat passenger involved in a high speed motor vehicle collision
Blunt Trauma #4

- **Primary**
  - Patent airway
  - Equal breath sounds
  - Vitals: 136 120/70, palpable peripheral pulses
  - GCS 15
  - Seatbelt sign
  - Abdomen softly distended, diffusely tender

- **Secondary**

CT Scan
Blunt Trauma # 4

- To OR for exploratory laparotomy
- Findings-
  Complete pancreatic transection
  Superior mesenteric vein injury
  Transverse colon injury – bucket handle
- Operation
  Exploratory laparotomy
  Repair of SMV injury
  Distal pancreatectomy
  Splenectomy
  Transverse colon resection with primary anastomosis
Blunt Trauma- Seatbelt Injuries

- Injuries sustained from improper restraint are related to a focused impact upon internal organs without adequate distribution of force.

- “Seatbelt injuries” are often associated with back pain, abdominal pain, and abdominal wall ecchymosis.

- Restraint recommendations for children based on age and size are designed to increase stopping distance and distribute force over a greater surface area.
Pancreatic Injury

- Pancreatic injuries occur in ~5% of patients with blunt abdominal trauma.

- Pediatric trauma
  - Pancreatic injuries occur ~2%
  - Pancreatic ductal injuries occur ~0.12%-0.4%

- Signs and symptoms
  - Abdominal pain (78%)
  - Abdominal wall ecchymoses – “seatbelt sign” (35%)

- Diagnosis
  - CT abd/pelvis
  - ERCP

Blunt Trauma # 4

- Admitted to PICU post-op-
  Intubated overnight
- Lengthy and complicated post-operative course including prolonged ileus, intraabdominal abscess and pancreatic drainage
- Discharged home on POD #48 tolerating a regular diet with no drains
Blunt Trauma #5

- 15 yo male presented to Hasbro ED with complaint of abdominal wall wound
- Patient states he was doing a “trick” on his bicycle when the handlebar hit him in the abdomen
Blunt Trauma #5

- Primary survey

- Secondary survey
  
  Local wound exploration- soft tissue defect with no appreciation of violation into peritoneal cavity

  CT scan

  Washout of wound

  Tetanus vaccine
Blunt Trauma # 5

- Admitted to floor to Pedi Surg for observation and serial abdominal exams
- AM exam- noted to have omentum protruding from the wound
- OR for wound exploration
- Repair of traumatic ventral hernia
- Discharged home on PID #5
Penetrating Trauma
Penetrating Trauma #1

- 13 yo male who presents to Hasbro ED with complaint of handlebar in thigh
- Patient states he was riding his bicycle, went up the curb and while in mid-air came down on the bicycle handlebar
- EMS was able to cut off the remainder of the bike, leaving the handlebar impaled in his L medial thigh
Penetrating Trauma #1

- Primary

- Secondary

Handlebar impaled in L medial thigh, entrance anteriorly, exit posterior upper thigh

LE neurovascular exam intact

Xray L femur

Tetanus vaccine
Penetrating Trauma #1

- OR for removal of foreign body, wash out, debridement, and packing of wound
- Handlebar missed every significant vascular and nerve trunk
- Post-op antibiotics
- Wound care
- Admitted to floor
- Discharged PID # 3
Penetrating Trauma #2

- 7 yr old female who presents to Hasbro ED with complaint of vaginal bleeding
- Reports was playing on the dock with friends, when one pushed her off the dock
- She straddled a pipe on the dock as she fell into the water
- Noted immediate pain and copious amounts of bleeding from vagina.
- Brought to the ED by both parents
Penetrating Trauma #2

- Primary Survey
- Secondary Survey

Genital exam deferred secondary to anxiety and pain
To OR for exam under anesthesia, repair of lacerations
Penetrating Trauma - Genital

- Injuries to the female external genitalia are most all result of a straddle injury
- Although, sexual assault must always be considered. If so appropriate documentation is crucial
- In children, most complete exams are done under sedation or anesthetic, secondary to pain and psychological stress
- Careful inspection of the urethra, vagina, and rectum should be done
- Debridement of injured tissue and repair of extensive lacerations
- Foley catheters are left in place in some situations
Penetrating Trauma #3

- 15 yo male who presents to the Hasbro ED with rectal injury
- States he was playing “Man Hunt” with friends, he climbed a fence, not noticing a metal pole
- He landed with his perineum on the tip of the pole, the pole entered his rectum (~ 15 cm)
- He self-extricated himself from the pole
- Was embarrassed to tell parents, but eventually did after 2 hours secondary to bleeding from rectum and excruciating pain
- Brought in by parents as soon as they were aware of accident
Penetrating Trauma #3

- Primary
- Secondary

Significant wound of the perineum as well as suspicion for rectal injury

To OR for rigid sigmoidoscopy, exploratory laparotomy, creation of diverting colostomy, and perineal wound repair
Penetrating Trauma- Rectal

- Majority are either from impalement from child abuse or sharp objects
- Ascertaining the extent of injury frequently requires exam under anesthesia
- Primary closure is safe and successful when the laceration is limited and not associated with peritoneal contamination
- Extensive injuries, those with significant peritoneal contamination require proximal diversion with an end colostomy and drainage of the distal injured perirectal space
- Meticulous repair of the injured anal sphincter musculature
- Debridement of nonviable tissue
Penetrating Trauma #3

- Admitted to floor post-op
- Pain management
- Wound care
- PID #4 returned to OR for exam under anesthesia, wound debridement and dressing change
- Discharged home on PID # 7 with colostomy in place
- Returned 3 months later for reversal of colostomy
- Discharged home on POD # 6
Penetrating Trauma #4

- 16yo M watching a high school football game, jumped by several strangers inflicting multiple stab wounds with knife

- Trauma Bay evaluation
  - HR 110s, BP 130/80
  - Uncomfortable, no respiratory distress
  - CTAB
  - Multiple stab wounds to torso: chest and abdomen
  - Laceration to LUE, no active bleeding, neurovascularly intact distally
Hasbro OR

- CXR in trauma bay: no PTX
- Abdominal exploration
  - Bowel uninjured
  - Diaphragm uninjured
  - L retroperitoneum without hematoma
- Laparotomy and fascial lacerations closed
- LUE laceration washed out and closed
Penetrating Trauma #5

- 16yo M “sitting in his backyard” at midnight when hit with multiple gunshots. Complaining of abdominal pain.

- Trauma Bay evaluation
  - VS: HR 80, BP 130/95, airway intact
  - GSW at epigastrium, R-mid flank, lateral R hip, L forearm
  - CTAB
  - Abdomen diffusely tender with rebound

- CXR: normal
Exploratory Laparotomy

- Laceration through liver, through gall bladder, and through lower pole of R kidney
  - Connects epigastrium to R mid flank site
  - No frank exsanguination

- Interventions
  - Repaired R renal laceration
    - Padded with tail of omentum
  - Cholecystectomy
  - Liver laceration left alone

- Discovered GSW at L hip posteriorly
  - Rectal exam without gross blood
  - Urine clear in foley
Hospital Course

- PICU x1d, then floor
- PCA for pain control
- NGT and Foley x2d
- Slowly initiated diet by POD 4
- D/C home on POD 6
Multi-Trauma

- 16yo M front-seat passenger returning home with twin brother after Friday night high school football game
- High-speed head-on MVC
- Fatality in other vehicle
- Unresponsive and intubated at scene. Stabilized at Newport Hospital then transferred by Medflight to Hasbro ED.
Trauma Bay Evaluation

- HR 135, BP 105-125 / 70-80, rr 30, O2sat 99%

- Primary
  - GCS 3
  - Airway: intubated, position confirmed
  - Clear BS BL
  - Well perfused

- Secondary
  - R pupil 2mm
  - Significant facial injuries, with L periorbital lacerations and fat prolapse from L orbit
  - Chest without external injuries, abdomen soft
  - No extremity motor exam, toes upgoing BL
Injury Summary

- Brain
  - IPH of basal ganglion and temporal lobe
  - Small SDH

- Face
  - L orbital blowout fx with retrobulbar hematoma
  - L nasal lacrimal duct injury
  - Maxillary, zygomatic fx → LeFort I fracture
  - L periorbital lacerations

- Abdomen
  - Large hemoperitoneum
  - Possible splenic hilar laceration
  - Chance fx of L2
Trauma Bay Decision Making

- Injury prioritization
  - Brain trumps
  - HD stable enough to sit on abdominal findings

- Admitted to PICU
  - EVD/bolt placed at bedside by Neurosurgery
  - Ophthalmology consult → orbit sufficiently decompressed
  - Kept in cervical collar

- Over next 4 hours progressive hypotension despite IVF and PRBC transfusion
  - Brought to OR for laparotomy
  - SB avulsion from mesentery at 3 locations, each resected with primary anastomosis
  - No splenic injury
Hospital Course

- TBI
  - EVD x3 wks
  - hypertonic saline
  - seizure prophylaxis
  - sedation
- Respiratory failure
  - Post-op PTX after laparotomy → CT placed
  - Tracheostomy at HD 12
- Face
  - Lacerations repaired at bedside by Ophtho
  - Initial grim prognosis of L eye
  - ORIF with plastics for LeFort fracture
- GI
  - SB resection
  - G-tube placed
Long-Term Recovery

- Hospital Course x2m in PICU
- D/C to rehab
- Eventual recovery to near-baseline neurologic function
- Additional operations for L eye
- Decannulated trach and G-tube removed
References


