Pediatric Trauma Scenarios
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Trauma is the number one killer of children over age one

Objective – discuss pediatric trauma cases to identify characteristics unique to children that predispose them to trauma.
Ped vs auto

The first warm day of spring a 6 year-old, distracted by her balloon crosses the street and is struck by a car. She is thrown 20 feet landing on pavement.

She has:

- a large laceration to the forehead, initial LOC and abdominal bruising and distention.
- When EMS arrive she is crying and asking what happened and complaining about her head. GCS is 14.
- Vital Signs  HR 132, BP 82/40, RR 32, cap refill is 3 ½ seconds
Ped vs. Auto

- EMS should:
  - Apply a c-collar only and allow her assume a position of comfort?
  - Apply full spinal immobilization?
  - Apply no spinal immobilization?
  - Start an IV at 75ml/hour?
  - Start 2 large bore IVs and a bolus of 20ml/kg?
Ped vs Auto

• The patient arrives fully immobilized with a bolus of IV fluid running
• The 12 cm laceration on the scalp is bleeding actively
• GCS is 15 but she seems confused, PEARL
• HR 122, BP 84/40, RR 30, cap refill is 3 seconds
• Her chest is clear but her abdomen is tender, distended, and firm
Ped vs Auto

- What to do?
- Direct pressure to the actively bleeding head wound using Combat Gauze if needed
- Labs are drawn including a type and cross match
- A second large bore IV is started
- CT of the head with C1-C2 without contrast
- CT of the abdomen and pelvis with contrast
Ped vs Auto

CT of the head –
• small subdural
Ped vs Auto

- CT of the abdomen/pelvis
- Grade IV liver laceration
- Grade III R renal laceration
- R adrenal hematoma
- Grade I splenic laceration
- Perforated small bowel
Ped vs. Auto

• Findings: CT head – small subdural
  CT Abdomen - grade IV hepatic laceration with active bleeding and free air, renal lac

• Definitive care:
  – To the OR for repair of the ruptured viscous from the CT scanner.
  – Admit to the PICU (60 minutes from door to PICU)
  – Hemoglobin / Hematocrit - 8/22 Repeat every 6 hours
  – Transfuse 1 unit of PRBC
  – Close scalp laceration
  – Perform serial abdominal exams
Ped vs auto

- Surgical repair
Ped vs auto
Ped vs auto

Why are kids hit by cars

- Kids are impulsive and will follow a ball or another child into the street.
- They think if they see the car, the car sees them and will stop.
- They have a unique visual field.
- They can't judge distance or speed.
- When struck by a car, they turn into the car like a deer in the headlights instead of turning away and using their arms to break their fall.
Ped vs auto

- Small kids often go under a slower moving vehicle.
- When a child under 8 goes air born, they will land on their head.
Fall from a second/third story window

- 18-month old male is found by the mailman who saw the child fall from the window landing on a concrete sidewalk below.

He has:
- an abrasion to the scalp, is breathing but unresponsive. The bystander calls for help and the babysitter emerges from the apartment. 911 and the parents are called.

- When EMS arrive he is posturing. GCS is 4.
- Vital Signs  HR 104, BP 106/54, RR 8 and shallow, cap refill is 3 ½ seconds
Fall from a second story window

EMS should:
- Apply a c-collar only transport on the cot?
- Apply full spinal immobilization using a towel role?
- Apply no spinal immobilization?
- Start an IV at 40ml/hour?
- Start 2 large bore IVs and a bolus of 20ml/kg?
Fall from a second story window

- An Alpha trauma team activation is sent
- The patient arrives in the ED fully immobilized with a towel role for cervical stabilization.
- An LMA has been placed and the patient is being bagged
- An IO is in the left tibia
- Upon exam the head has a large boggy area, GCS is 4T and the right pupil is unreactive
- A peripheral IV is started and labs and T&C is ordered
- HR falls to 64, BP 110/60, and Mannitol is given
- Neurosurgery is called stat and the patient is taken to CT
Fall from a second story window

CT shows:
Fall from a second story window

- He goes directly to the OR (in less than 30 minutes from OR notification) for the evacuation of a large subdural hematoma.
Fall from a second story window

- In the OR
Fall from a second story window

- Why do kids fall out of windows?
- In warmer weather, small kids climb up on furniture to see what is outside. They lean against the screen (if there is one) to get a better view. The screen gives way and the small child with a large head falls head first. Especially during nap time, they may get up unattended and explore.
- The surface they land on plays a significant role in the severity of the injury.
Fall from a second story window

- Install window gates in 2nd story windows.
- Only open the window several inches – not enough for the child’s head to fit.
- Do not place furniture in front of the window.
Carried in seizing without explanation

- 6-month-old male is carried into the front door of the ED by the mother’s boyfriend. Mother is working and on her way. The baby is actively seizing. He reports the child may have choked.
- The child is afebrile T 98.6, actively seizing and pale
- He has:
  - No bruising
- Vital Signs:
  - HR 162, BP 72/56, RR 12,
  - cap refill is 4 seconds
Carried in seizing without explanation

• In the ED he is
  – Placed on 100% O2 via non-rebreather
  – IV is established – labs and blood cultures are drawn
  – Ativan is given IV - seizing is less apparent
  – After several minutes, the child continues to seize and additional anti-seizure medications are given – no change
  – RSI and intubation are complete.
  – The child goes quickly to CT (in less than 30 minutes from arrival)
Carried in seizing without explanation

CT shows
- Large acute subdural with midline shift
- Mass effect and effaced basal cisterns
- Loss of gray-white differentiation due to severe swelling
- Anticipate high intracranial pressures
Carried in seizing without explanation

- Skeletal survey shows:

  Chest radiograph taken 6 days after injury reveals multiple healing fractures at costovertebral junction and lateral ribs bilaterally.
Carried in seizing without explanation

• The child is admitted to the PICU and Trauma Service is notified. Neurosurgery, Orthopedic Surgery, Social Work, Child Advocacy, Child Protective Services, and the police are all notified.

• At risk siblings will be seen in the Emergency Department or their PCP.

• Survivability is doubtful and his outlook is grim.
Carried in seizing without explanation

Normal Retina scan of the eye

Retinal hemorrhages are common in children that have been shaken violently
Carried in seizing without explanation
Abuse statistics

• It is estimated that only 10% of abuse cases are ever diagnosed according to the Center for Disease Control.
• Montgomery County and our surrounding area has an unusually high abuse rate, over double benchmarking stats against aggregate data from 73 pediatric trauma centers.
• Dayton Children’s admits on average 32 children for abuse annually and abuse has been the number one cause of pediatric traumatic deaths 5 of the last 6 years.
• At risk times include winter holidays and financial downturns
• At risk age is any child that is pre-verbal and during potty training
Abuse statistics

Warning signs:
- Arrival to the ED by private car ready to code
- Delay in seeking care
- Injuries inconsistent with the story or a story in evolution
  - Frequently used stories – no explanation, falling down stairs, off the couch or off the bed, choking, the 3-year-old sibling hit him with a toy.
ATV crash

10-year-old riding a full sized 700 pound ATV. As he looks over his shoulder for his friend and runs into a tree. The ATV flips landing on his head and neck. The friend goes for help. His mom calls 911 and follows the friend back to her son. She rolls the ATV off of him. He is unresponsive with a lot of oral secretions. The mom turns him to his side to help with the blood and secretions and awaits EMS. CareFlight is called.
ATV crash

He has:

• Bruising and abrasions to the face. He is responding to pain.
• He is suctioned. When CareFlight arrives he is quickly intubated, a towel roll applied to his neck, immobilized on a backboard. An IV is started. GCS was 11 prior to intubation.
• Vital Signs  HR 118, BP 106/68, RR 14, cap refill is 2 seconds
ATV crash

- He arrived to the ED fully immobilized with towel roll to c-spine
- He has 2 IVs
- He is sedated, chemically paralyzed and intubated
- He has breath sounds bilaterally
ATV crash

- Portable chest –
- the ETT sits at C5 level and is advanced slightly.
ATV crash

- Portable C-spine – the towel role is replaced by a Miami-J C-collar
ATV crash

Bilateral mandibular fractures
ATV crash

- Injuries include
  - Alanto/occipital disassociation (internal decapitation)
  - Concussion with prolonged loss of consciousness, facial lacerations
  - Bilateral fractured mandibular condyles
ATV crash

Operative intervention day 2 (all completed during the same operative time)

- Tracheostomy by Pediatric Surgery
- Halo traction applied by Neurosurgery
- Mandibular fracture fixation by Plastic Surgery
- G-tube placement by Pediatric Surgery
ATV crash

Immediately following 1st surgery
ATV crash

• By day 10
  – He is conscious and oriented and neurologically intact
  – Second surgery includes fusion of C1-C4
  – The halo is left in place
ATV crash

Day of discharge (hospital day 32)— He is shooting staff with silly string and nerf guns.

Thumbs up for going home!
At follow up: Out of the halo but still in a C-collar.

Multiple out patient swallow studies are performed and he can now manage liquids.
Miracle Max
Motorized wheeled vehicles

• Children don’t develop the judgment it takes to ride these vehicles until at least 16 years.
• Often they don’t have the strength to control the vehicle to correct even minor bumps.
• We see children as young as 4 riding with others and even driving ATVs.
Burns

• Parents of a 2-year-old are awakened Saturday morning by screaming. The parents report child was found in the bathroom with severe burns to her hands with the water in the sink running. Parents call 911.

• She has:
  • Some open and some intact blisters to her hands. Both the palm and dorsal hands are burned evenly to just past the wrist.
  • When EMS arrive she is alert and crying uncontrollably.
  • Vital Signs: HR 140, BP 112/P, RR 44, cap refill is 2 seconds
Burns

• EMS should:
  – Apply a c-collar only and allow her assume a position of comfort?
  – Apply full spinal immobilization?
  – Apply no spinal immobilization ?
  – Start an IV at 75ml/hour?
  – Start 2 large bore IVs and a bolus of 20ml/kg?
  – Cover the wounds, provide a weight appropriate dose of pain medicine and transport?
Burns

• On arrival she is alert and screaming. The parents believe she got up by herself to use the potty, pulled her step stool to the sink to wash her hands and she was burned.

• Is this story plausible?
# Burns

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Duration of exposure to result in 3° scald burn</th>
</tr>
</thead>
<tbody>
<tr>
<td>155°F</td>
<td>1 second</td>
</tr>
<tr>
<td>148 °F</td>
<td>2 seconds</td>
</tr>
<tr>
<td>140 °F</td>
<td>5 seconds</td>
</tr>
<tr>
<td>133 °F</td>
<td>15 seconds</td>
</tr>
<tr>
<td>127 °F</td>
<td>1 minute</td>
</tr>
<tr>
<td>124 °F</td>
<td>3 minutes</td>
</tr>
<tr>
<td>120 °F</td>
<td>5 minutes</td>
</tr>
<tr>
<td>100 °F</td>
<td>Safe Bathing Temperature</td>
</tr>
</tbody>
</table>

(Scalds and Burns ABA 2000)
Burns

- On arrival to the ED, IV access was gained, pain medicine was given
- Burns were de-roofed
- Bacitracin and adaptic applied and a fluffy dressing placed in each palm and dressing applied like a boxers glove
- Burn surface area was estimated at 4%, but the patient is admitted due to the location of the burns.
Burns

• Depth of the burn is not always apparent at presentation. The following guidelines for healing apply to children. Adolescents and adults may require an additional week to heal.

• Wound healing in < 12-14 days:
  – indicates superficial partial thickness burn
  – typically does not result in permanent scarring

• Wound healing in 14-20 days:
  – indicates deep partial thickness wound
  – increased risk scarring in children
  – split thickness grafting is usually indicated
Burns

• Wound healing in > 20 days:
  – Indicates full thickness burn injury
  – Grafting is indicated for deeper wounds
  – Burns of the face and ears are managed conservatively with delayed grafting (at one month)
  – Burns around joints, hands and top of feet are managed aggressively due to increased risk of contracture
Burns

- Biosynthetics can be used on clean superficial partial thickness burns.
  - Cut the biosynthetic several cm larger than the wound
  - Stretch the biosynthetic a small amount and adhere with steri-strips or Mastisol.
  - Dress with Kerlix
  - Avoid getting the dressing wet
  - Initial dressing change occurs in 2-3 days to evaluate how the biosynthetic has adhered to the burn.
  - Drain any fluid at the dressing change.

Cont.
Burns

Advantages of biosynthetics

• Permeable
• Transparent
• Limits or eliminates dressing changes
• Flexible but remains in contact with the healing surface
• Maintains moisture without excess fluid build up

Day 1
Burns

Day 10
Because of the severity of the burns, the fire department went to the apartment and measured the water temperature. It was 147 degrees. The family was not aware that the water heater for the apartment had been replaced and the person doing the installation turned the temperature all the way up so the family would have hot water when they got home. By the next morning it was really hot. Hot enough to cause these injuries in just 2 seconds.
Burn Facts

• Burns account for 10% of all child abuse and are associated with other acute injuries 20% of the time.
• The most common burns of abuse are from scalding water and cigarettes.
• Look for sock or glove-like circumferential injuries.
• Burns of abuse are frequently associated with potty training accidents.
GSW – BB wound?

- Two-year-old shot at close range with a BB gun to the head.
- He was taken to an outside facility. He had minimal bleeding and decreased level of activity.
- An IV was started, baseline labs were drawn and a head CT was completed.
- He was transferred to Dayton Children’s Hospital.
GSW – BB wound?

To OR: Exploration and debridement of the gunshot wound and removal of in-driven bony fragments, evacuation of the hematoma in the tract

- Injury severity score 25
- Hospital length of stay – 26 days
- Discharged to in-patient rehab with weakness of R face and body, G-tube
• Three-year-old shot in the back with a pellet gun
• Lacerated Kidney
• Duodenal perforation X2
• Mesenteric Colon Hematoma
• To the OR for repair of duodenal perforations
GSW – BB wound?

To the OR for repair of duodenal perforations

Admitted for 6 days
Shot or not?

Eight year-old out playing, heard a pop, felt a sting
• To the ED several hours later complaining of chest pain.
Shot or not?

This time without the electrodes
Shot or not?

The BB is in the pericardial sac

The patient is admitted for 3 days. No surgical retrieval is needed.
Points to consider

- 21,000 injuries occur annually from BB wounds
- From 1990 – 2000, 39 Americans died of BB wound injuries, 32 were children younger than 15
- Technical Advances = higher velocity
- Muzzle velocity can match that of firearms
- Entrance wounds are deceptively small
- Fear of telling parents delays care
- Lack of supervision & unstructured use are high risk factors
- Medical management should equal that of firearm injuries
Air powered vs gun powder

- Air powered guns are capable of the same injuries as low-velocity firearms.

Muzzle Velocity:
- Air powered = 150-1200 ft/sec
- Firearms = 750-1450 ft/sec (high velocity 2000-3000 ft/sec)

<table>
<thead>
<tr>
<th>Gun types</th>
<th>Velocity</th>
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<tbody>
<tr>
<td>.22 long rifle:</td>
<td>1255 ft./sec.</td>
</tr>
<tr>
<td>.25 ACP:</td>
<td>810 ft./sec.</td>
</tr>
<tr>
<td>.38 Special</td>
<td>755 ft./sec.</td>
</tr>
<tr>
<td>9-mm</td>
<td>1160</td>
</tr>
<tr>
<td>.45 ACP ft./sec.</td>
<td>885</td>
</tr>
<tr>
<td>.357 Magnum</td>
<td>1235 ft./sec.</td>
</tr>
</tbody>
</table>
BB guns are guns, not toys

- The new and improved BB guns shoot up to 1,200 ft./sec
- Body Penetration can be achieved by velocities of 331 ft./sec.
- Ocular penetration can be achieved at 130 ft./sec.

Penetrating injury of the left globe
Normal Blood Pressures

- Normal BP for children over 1 year old
  80 + 2X the age in years

Example:
A child that is 8 years old should have a systolic BP of 96
80 + (2X 8) = 96

Any BP 10 points less than normal is hypotensive.
(Hypotension is a very late sign of shock.)
ET tube placement

• The size of the tube should equal the diameter of the child’s little finger or nares.
• It should be taped at 3 times the size of the tube.

Example:
If the correct size ETT is a 4, it should be taped at 12cm at the lip. (3X 4 = 12)
Blood Glucose

• **Hypoglycemia** early in trauma is usually more likely in children under one-year-old but can be seen in older children under extremely stressful situations. (Treat it!)

• **Hyperglycemia** early in trauma is more common in children over one-year-old. It is a stress reaction. (Don’t treat it or be very careful!) Children are very sensitive to insulin.
Potassium

- Hypokalemia is common in the first 24 hours after a significant traumatic injury especially with a head injury. This finding is benign and will resolve within the next 24 hours and should not be treated unless the patient is going urgently to the OR.

- If going to the OR, attempt to increase the potassium to 3.0.
Summary

- Children get hurt because:
  - They think they can’t be
  - They don’t have good judgment
  - They don’t always have good supervision
  - The games they play make them go faster and higher
  - They don’t have the strength or coordination
  - They investigate their world like it is a job
  - They rely on adults to keep them safe!
Questions?