PediatricTrauma:Myths & Misconceptions

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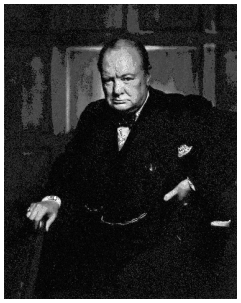
June 6,2013

"You can always count on surgeons (Americans) to do the right thing - after they've tried everything else."

Winston Churchill



Clinical Scenario

- A four-year-old male child was a rear seat unrestrained occupant in a rollover accident. There was no loss of consciousness and his GCS is 15. He has normal vital signs and a normal exam except for bruises on his extremities.
- What workup and evaluation is required?

Controversies in Pediatric Trauma

1. Does mechanism predict injury and outcome?
2. Do vital signs reliably predict blood loss?
3. The trauma lab panel: What works and when?
4. What is the significance of FIPF?
5. Does angio-embolization work in children?
6. What is the role of laparoscopy in trauma?
7. When is DVT/VTE prophylaxis necessary?
8. What is the outcome of cardiac arrest after CHI?

Pediatric Trauma: Demographics

- Trauma is the primary cause of death in children
- 500,000 hospitalizations and 20,000 deaths annually
- Boys injured more than girls w/ mean age 10 yrs
- Blunt trauma 90%, penetrating 10%
- Falls, MVA , sports injury, and NAT (assault/abuse)
- Injury (all ages) accounts for 10% of all medical expenses

Management of IAI in Pediatric Trauma

- IAI increases mortality and missed injuries result in delays in treatment and complications
- IAI complicates 50% of pediatric trauma
- A child's small size transfers more KE
- History helpful but exam challenging
- Elements of the history, exam, and mechanism of injury are important predictors of IAI

History

- The history is relevant as to the time and mechanism of injury
- Patterns of injury are age and activity specific
- MVA: Restraint, eject, rollover
- Bicycle: Head and handlebars
- Fall: Height (< or >15 feet)
- ATV: Rollover
- Sports: Snowboard/ski/football
- Assault: Abuse and non-accidental trauma (NAT)

Question 1: Heads and Handlebars in Bicycle Accidents

- Injury prevention is focused on helmets and CHI
- IAI in up to 75% with handlebar impact
- 221 patients:
  - 160 over handlebars
  - 61 on handlebars
- 19/61(on) required surgery
  - 2 Neck
  - 8 STI
  - 9 IAI (Small bowel, pancreas, kidney, colon)

Journal of Trauma, 2005

Physical Examination

Designed to identify and treat life threatening injuries and is directed by three priorities:

- Assessment for shock
- Mental status and neuro exam
- Abdominal evaluation

Assessment for Shock

- Tachycardia is the first response to hypovolemia
- Mental status changes, respiratory compromise, ↓ temp, ↓ capillary refill, ↓ pulse pressure, and pallor occur later
- Hypotension and oliguria occur late (>25% BV loss) and are inconsistent markers of hemorrhage

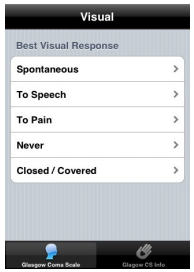
Question 2 :Hypotension and Blood Loss

- 194 blunt trauma patients
- Age:7.5, ISS:15, GCS:11.9
- Transfusion:23%
- Assigned injury:42%
- CHI only:43%
- Low blood pressure marker of CHI in children<6
- Hypotension worsens outcome in TBI

American Journal of Surgery, 2002

Mental Status and Neurological Exam

- GCS <15 require head CT
- CHI/TBI are primary causes of mortality
- Hypotension worsens outcome after CHI
- CHI compromises abdominal examination
- SCI masks significant IAI



Abdominal Examination

- Abdominal bruising, lap-belt (SBS), and handlebar marks increase the risk of IAI
- Distention is primarily due to aero-phagia
- Abdominal tenderness has an RR of 6 for IAI
- Rectal exam is not helpful (except pelvic fractures)
- Lumbar fractures ↑ risk of IAI independent of exam

Laboratory Testing

- Designed to treat the unstable patient early and screen the stable patient for IAI
- Obligatory trauma labs are expensive and of unproven benefit
- HCT: Establish baseline for NOM of IAI
- U/A: Cheap, fast, useful
- Chem: Glucose and K+↑ after injury
- LFTs: High NPV if< 130 with normal exam
- Coag: Anticoagulant use and F8 deficiency rare
- T&C: 75% drawn, 3% transfused

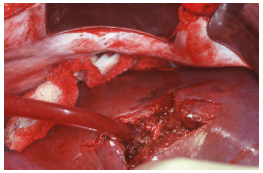
Question 3: Utility/ Futility of Trauma Labs

- HCT: Establish baseline for NOM of BAT
- U/A: Screen for renal/external injuries
- Coag: CHI with GCS<14, major fractures, major STI
- LFTs: Reduce CT >high NPV of normal values
- Chemistry, amylase, lipase: no value

Annals of Emergency Medicine, 2002

Base Deficit in Shock

- Be <(-5) at time of injury predicts high mortality
- 65 patients with mortality of 20%
- Age = 6 High ISS
- 13 deaths BE <-5
- 0 deaths BE >-5
- 8 patients without decrease in BE = 100% mortality
- Change in the endpoints of resuscitation



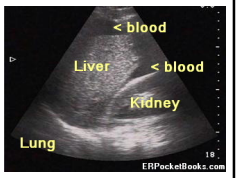
Journal of Trauma, 2002

Diagnostic Workup

- C- spine/CXR/pelvis
- CT scans of head, chest, abdomen and pelvis
- Balance risk of radiation vs ruling out IAI
- Indications for CT imprecise and not evidence-based
- Tenderness, bruising, hematuria, and AMS
- Limited utility for HOI

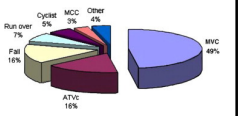
Ultrasound (F.A.S.T.)

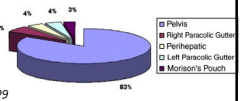
- Portable, inexpensive, quick
- Four views plus pericardium
- Recognize FIPF(80 - 90%)
- Spec/Sens/NPV (50%)
- Adds little to the NOM of IAI
- Negative FAST does not eliminate the need for CT



Question 4: Significance of FIPF in BAT

- FIPF found by a CT without SOI
- 670 patients < 14 years
- 94 isolated FIPF
- Age=7.7; ISS= 10.2
- Exam
  - Bruising = 30%
  - Tenderness= 17%
  - AMS =12%
- 91 improved; 3 who worsened had diagnostic laparoscopy





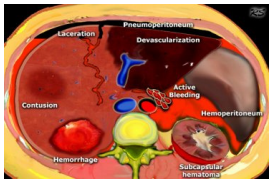
Journal of Pediatric Surgery, 2009

CT Imaging: Indications

- AMS, spinal cord injury, intubated / ventilated
- Bruising, ecchymosis, tenderness
- Assault / handlebars / lap-belt
- Gross hematuria, elevated LFTs, (+ FAST)
- Preverbal child with distracting injury (e.g long-bone fracture)

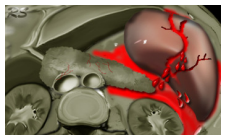
BAT: CT FIndings

- Hemo- peritoneum
- Extravasation and blush
- Laceration
- Hematoma
- Contusion
- Pneumo-peritoneum
- Infarction



Splenic Trauma

- Most common SOI occurs in up to 50% of BAT
- LUQ tenderness, rib fractures, contusion
- AAST grade doesn't predict outcome
- Successful NOM (90%) avoids OPSI
- Treatment varies by hospital type
- Splenectomy 5x more likely in general hospital
- NOM results in decreased costs, fewer transfusions, less infection, shorter LOS



AAST Grading System: Splenic Trauma

Splenic CT Injury Grading Scale	
Grade I	Laceration(s) < 1 cm deep Subcapsular or central hematoma <1 cm diam
Grade II	Laceration(s) 1-3 cm deep Subcapsular or central hematoma 1-3 cm diam
Grade III	Laceration(s) 3-10 cm deep Subcapsular or central hematoma 3-10 cm diam
Grade IV	Laceration(s) >10 cm deep Subcapsular or central hematoma >10 cm diam
Grade V	Splenic tissue maceration or devascularization

Splenic CT Grading System

To remember this system:

- Grade 1 < 1 cm
- Grade 2 ~2 cm (1-3 cm)
- Grade 3 >3 cm
- Grade 4 >10 cm
- Grade 5 = devascularization & maceration

The shortcomings of this grading scale are:

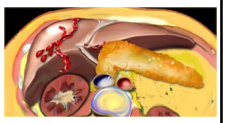
- Underestimate injury extent
- Inter-observer variability
- Does not include active bleeding, contusion, and post-traumatic infarcts
- Most importantly it provides no predictive value for non-operative management (NOM)

High Grade Splenic Trauma


Hemoperitoneum surrounds spleen and liver. A splenic hematoma and laceration are seen. There is active bleeding with a contrast blush (blue arrow) with density similar to the aorta. Surgery or angio-embolization may be required.

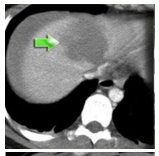
Liver Injury

- The liver is the second most common IAI in BAT
- Mortality (2.5%); 3X higher than mortality from splenic injury
- Increased mortality due to portal, hepatic, & caval injury
- NOM successful 85-90%
- Dual blood supply amenable -AE
- CT grade predicts complications
- Biloma, abscess, hemato-bilia, psuedo-aneurysm and GB necrosis

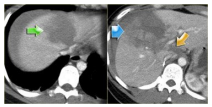
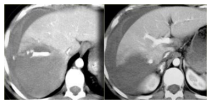


AAST Grading System: Liver Trauma

Hepatic CT Injury Grading Scale	
Grade I	Laceration(s) < 1 cm deep Subcapsular hematoma <1 cm diam
Grade II	Laceration(s) 1-3 cm deep Subcapsular or central hematoma 1-3 cm diam
Grade III	Laceration(s) 3-10 cm deep Subcapsular or central hematoma 3-10 cm diam
Grade IV	Laceration(s) >10 cm deep Subcapsular or central hematoma >10 cm diam Lobal maceration or devascularization
Grade V	Bilobar tissue maceration or devascularization




High Grade Liver Trauma

The green arrow shows hematoma and the yellow arrow shows a laceration. The blue arrow shows areas of contusion. There is fluid around the liver and a near transection. The contrast blush extends beyond lateral margin of the liver and there is hemo-peritoneum.

Renal Trauma

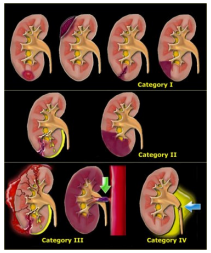
- Renal involvement occurs in 15% of BAT in children
- Bigger kidney, less fat, less bony cover
- NOM successful in 98% of HDs, I-III
- NOM successful in 92% of HGBRT
- Surgery reserved for HDus, penetrating, or extra renal injuries
- Severity of injury ≠ degree of hematuria
- ICU, interventional radiology, and endoscopy essential to NOM
- Complications: Infection, ileus, AVM, HTN

Figure 1. Kidney Injury.

Image from the abdominal CT scan of a 12-year-old boy who presented with gross hematuria after falling down multiple stairs at school. Note the ruptured left kidney (thin arrows) with surrounding hematoma (thick arrow). The pediatric surgeons who admitted this child successfully managed this injury non-operatively in a pediatric intensive care unit.

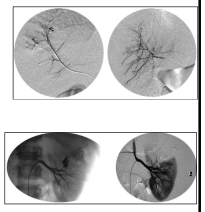
AAST Grading for Renal Trauma

Renal Injury Grading Scale	
Grade I	Contusion/subcapsular hematoma No parenchymal laceration
Grade II	Laceration <1 cm depth of renal cortex No urinary extravasation
Grade III	Laceration >1 cm depth of renal cortex No urinary extravasation
Grade IV	Laceration extending through renal cortex, medulla and into collecting system Minor renal artery/vein injury with contained hematoma
Grade V	Shattered kidney Devascularized kidney, hilar avulsion



Question 5: The Role of Angio-Embolization (AE) after BAT

- 125 patients with ASOI at a single center
- Seven AE; age= 12; ISS= 22.4
- Liver, spleen, kidney
- Pre-AE HCT decreased 6.7 g
- Post-AE HCT decreased 1.3 g
- Safe and efficient for pediatric ASOI in HD-stable patient with bleeding



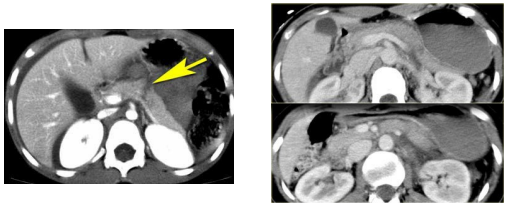
Journal of Trauma, 2010

Pancreatic Trauma

- Pancreatic involvement in 2% of blunt abdominal trauma
- Bicycle,assault, seat belt
  - 44 patients, age= 7, ISS = 10
  - MVC and bike = 52%
  - OI required in 50%
  - Fewer PC, same LOS
  - Ductal injury identified early=OI

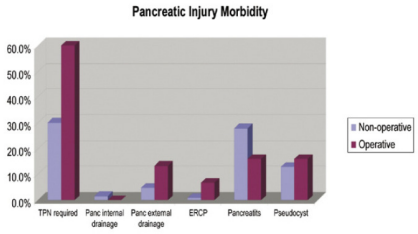
Journal of Pediatric Surgery, 2010

Pancreatic Trauma - CT



Left: The yellow arrow shows pancreatic transection in the proximal body secondary to child abuse. *Right*: Findings are of edema and fluid behind the body of the pancreas and around the pancreatic tail.

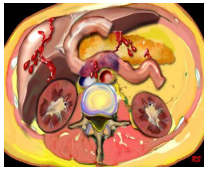
Pancreatic Trauma



Journal of Pediatric Surgery, 2007

Hollow Organ Injury (HOI)

- HOI occurs in 2% of VAT
- SBS, deceleration,compression
- Jejunum>duodenum>Ileum> colon
- Hematoma, perforation, mesenteric tear
- Tachycardia, tenderness, vomiting
- Delayed presentation with abuse
- Repeat CT with triple contrast

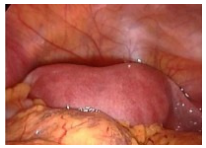


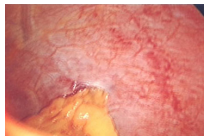
HOI in Blunt Abdominal Trauma

The CT reveals hemo-peritoneum and pneumo-peritoneum and the blue arrow indicates multiple segments of bowel with diffuse wall thickening.

Question 6 : The Role of Laparoscopy in Pediatric Trauma

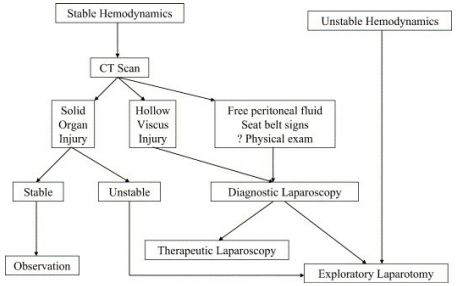
- 7,000 trauma admission
- 113 met operative criteria
- 32 underwent DL scope
- 9 no injury
- 3 no treatment
- 6 treatment via L-scope
- Diagnostic accuracy= 100%
- Avoids laparotomy= 40%



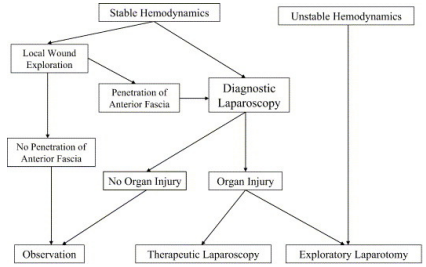


Journal of Pediatric Surgery, 2006

Algorithm for Laparoscopy in Blunt Abdominal Trauma



Algorithm for Laparoscopy in Penetrating Abdominal Trauma



Question 7 : Use of DVT/VTE Prophylaxis in Pediatric Trauma

- 14,000 patients
  Group I: 0-13y
  Group II: 13-17y
  Group III: >17y
- Group I: No events
- Group II: 2/3300
- Group III:57/10,549 (.5%)
- **Conclusion**: No prophylaxis required for children less than 13 and select therapy for patients at risk with CHI (GCS<9) >13 years

Journal of Trauma, 2005

Question 8: Prognosis for CA after CHI

- 40 patients: MVC 17, abuse 13
- GCS = 3
- 42%<2y, M= 97.5%
- PEA, VF, AS, temp>35.5
- No chest or abdominal injuries
- RA precedes CA> CHI; cerebral oxygen stores depleted in 20 seconds
- CBF< 50% @5";<9% @15"; and 0% @20"
- Stop resuscitation>15" of US-CPR
- Stop resuscitation for TT> 15"> CA with CHI

Journal of Trauma, 2010

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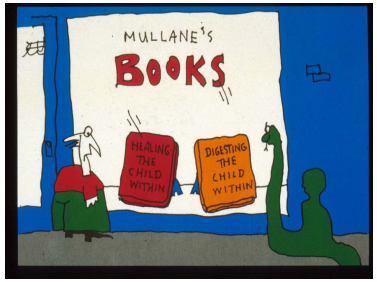

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