Johnny Walker

- Ring down: 4 yo pedestrian vs. auto with LOC
- P 120; BP 80/60; RR 25, crying
- Airway patent
- Chest mild TTP/no distress
- CRT=3 seconds
- Abdomen NTTP/bruising
- Awake, alert, crying

Sunday, January 22, 2012
What are important anatomic and physiologic differences between kids and adults with chest and abdominal trauma?

Which imaging tests are indicated for kids with blunt trauma? Plain films? US? CT?

What injuries do kids get?

What is the appropriate management of kids with IAI? What if the CT’s are negative?
Pediatric Trauma: The Problem

- Leading cause of death/disability in kids 1-18 years

- 50% of all deaths under 15 years

- Per year:
  - 1.5 million injuries
  - 500K hospitalizations
  - 20K deaths
Why are kids so vulnerable?

- Smaller bodies --> force of trauma distributed more widely --> more injuries

- #1 Inappropriate restraint in MVC:
  - New AAP recommendations

- #2 PVA: <5 years old or >30mph

- #3 Height of fall: predicts head/ortho not as much chest/abdominal injury
Differences in injury patterns: Chest

- More pliable rib cage: ribs bend --> less protection for thorax --> pulmonary contusions (#1)

- Immature intercostals/ pliable rib cage --> earlier respiratory failure

- Aorta/mediastinum/diaphragm injuries VERY uncommon

- More mobile mediastinum --> tension pneumothorax
Differences in injury patterns: Abdomen

- Liver/spleen/kidney not well protected by ribs/muscles
- Better vasoconstrictive response
- Solid organ bleeding tends to stop
- Pitfall of hypotension
Shock in kids

- CRT > 2-3 seconds/cool skin
- Low urine output
- AMS
- ↑ HR / narrow pulse pressure
- Lactate > 3-4
- DON’T wait for hypotension
Approach to Johnny Walker

A: Patent

B: Nl RR/no distress/mild TTP

C: BP 80/60; P125; CRT=3 sec, lactate=7! IV/Fluids

D: Alert, crying; hx LOC

E: Naked! Cover him up!
What’s next? Radiation!

- 4 million CT’s in kids 2007
- 700% increase in CT’s in 10 years
- Most radiosensitive organs:
  - Bone marrow, breast, thyroid, lung
The Problem: adults non-major trauma-->40mSV radiation in first 24 hours*

322 extra cancers/100K trauma pts

Kids: much more (10-15x) radiation sensitive and more lifetime to develop cancer

Increased risk of CA: >10mSv? >50mSv?

Avoiding unnecessary radiation

- Irradiate only when/where necessary
- Pediatric specific imaging protocols
- Avoid repeat/multiphase scans
- Consider MRI/US
- Discourage CT at non-trauma centers
Who needs a trauma series?

- 986 kids <16 years: 98% NPV

Decision rule for chest trauma/CXR:

- Low BP/Increased RR
- Abnormal chest exam
- GCS<15
- Femur fracture

WHO NEEDS A TRAUMA SERIES?

• Retrospective study:

  • 91 patients >2 years; GCS 15
  • Localizing findings?
  • No localizing findings--> 100% NPV for CXR/pelvis abnormality

• Bottom line: not everyone needs an x-ray

Rollover Dean: does he need films?

- 2 yo restrained rear car seat in rollover MVA
- VS WNL
- PE WNL
- Playing with your glasses
- CXR? Pelvis XR?
When should I do a chest CT?

- 18 mo old fall 20 feet out of window
- VS WNL; nl MS
- PE: chest wall ttp, no crepitus; RUQ ttp
- CXR/pelvis XR?: YES
- If CXR(-)--->chest CT?
Chest injuries in kids

- 30-40% of injuries not identified on initial CXR
- 68X more radiation in chest CT than CXR: lungs, breast, thyroid
- Common injuries: pulm contusion, PTX, HTX, rib fractures
- VERY uncommon injuries: vascular, mediastinal
Impact of chest CT on management

- 235 kids CXR and CT done
  - 1/3 CXR abnormal
  - 2/3 CT abnormal

- <5% got any chest procedure

- <10% of kids with PTX on CT got a chest tube (all seen on CXR or CT abd)

- 91% of CT findings within 1 cm of dome of liver --> visible on CT abd

- Is dedicated CT chest necessary?

Patel, Pediatr Radiol 2010
CT if suspicion of:

- Vascular injury (e.g. wide mediastinum on CXR or ongoing chest tube output)
- Other mediastinal injury (e.g. pneumomediastinum)
- Tracheo-bronchial injury (ongoing chest tube air output)
- Significant vertebral fx on plain XR
Alternatives to chest CT

- Repeat upright CXR in few hours
  - Upright improves sensitivity
  - Pulm contusions blossom
  - PTX/HTX get bigger
- Extended FAST ultrasound:
  - PTX/HTX
- CT abdomen only if indicated
Ultrasound and the unstable child

- 5 yo MVC ejected
- P150, BP 70/55
- Abd/pelvis TTP
- Pelvic fracture on XR
- Persistent hypotension despite aggressive pRBC
- Bleeding: pelvis or abdomen?
Ultrasound: the head injured Child

- 3 yo unconscious PVA
- P140, BP 95/60
- Pupils asymmetric-->quick CT head then craniotomy
- Can belly be “cleared” of major bleeding?
- What is sensitivity of FAST for significant hemoperitoneum in kids?
Role of FAST exam: hemoperitoneum?

- Holmes 2007: meta-analysis*
  - Sensitivity: 66-80%
  - Specificity: 95-97%

- Fox 2011: prospective 357 pts#
  - 52% sensitivity/96% specificity

- Delay between US and CT

- Up to 1/3 of solid organ injury without blood in belly

# Fox, *Acad EM* 2011.
Role of FAST exam in kids

- HD unstable: bleeding from belly? pericardial tamponade?
- HD stable:
  - Helpful if you see blood; if you don’t...?
- Future: severe mechanism/nl PE: serial US to triage to low risk?
What about the belly?

Booster-less Bill

- 6 yo “restrained” without booster in head-on MVA 30mph
- VS WNL, GCS 15
- No abd pain or TTP but seatbelt bruising RUQ and low abdomen
- CT abdomen indicated?
Mechanism of injury not as predictive of IAI as for head/orthopedic injury

Proper restraint in MVC much more predictive of injury:

Up to 3X more likely to be injured if not or improperly restrained
Well, why not CT?

- 897 kids with CT abd
- Nearly 70% normal
- 18 kids with ex-lap: few true surgical findings
- CT with non-specific findings -->unnecessary laparotomy
- Significant radiation (10-14mSv)

Fenton, *J Ped Surg* 2004
1119 kids <18 years

Decision rule for CT abdomen:
- Low SBP
- Abdominal TTP
- Femur fracture
- Labs: AST>200, ALT>125
  HCT<30, UA>5 RBC/hpf

Sensitivity: 95%
Specificity: 37%

Abdominal CT decision rule

- Missed injuries:
  - Low GCS
  - Low thoracic tenderness
  - Seatbelt sign**
  - Problems with hematuria
  - PECARN study in progress
What's the word on seatbelt signs?

- Poorly located lap belt --> skin bruising and bowel injury
- Lutz 2004: OR for IAI with SBS 232!
- Sokolove 2005: SBS increased risk of IAI (OR 2.9) but all kids had pain or TTP
- If SBS but no pain/TTP consider prolonged observation/admit

Sokolove, Acad EM 2005
**Contrast in abdominal CT?**

- IV contrast: Yes
- Oral contrast: not necessary
  - Contrast rarely gets far enough to make a difference
  - Increased risk of aspiration, vomiting, and study delay.

Solid organ injuries: 
#1 Liver

- Laceration, hematoma, vascular
- Hemoperitoneum 2/3 of time
- Grading systems not so useful for operative decision-making
- 1-3% operative
- Active extravasation?

Sivit, AJR 2009
Solid organ injury: #2
Spleen

- Smaller --> more likely to shatter
- Hemoperitoneum: 75%
- 2% failure rate of NOM in kids* - rupture, pseudocyst, abscess

Solid organ injury: #3
Kidney

- Rarely isolated
- Parenchymal contusion/hematoma (direct blow): delayed contrast
- Collecting system (deceleration)
- Renal artery: urgent repair (<2 hrs)

Sivit, AJR 2009
Solid organ injuries: #4 Pancreas

- Uncommon
- Mechanism: compression (body) or flank blow (tail)
- CT: peri-organ fluid, stranding, enlargement
- Management controversial:
  - NOM: more pseudocysts if ductal injury*

NOM and solid organ injury

Retrospective 1729/1818 kids: 7 pediatric trauma centers

5% failure rate: most <12 hrs

Multiple organ injury

Greater injury severity

Pancreas injury (18% failure)

Holmes, J Trauma 2005
Hollow viscus injuries: #1 Bowel

- CT: FF, wall thickening, dilated loops, fat stranding, free air
- Partial thickness-->hematoma
  - Tx: NOM, bowel rest
  - SBO
- Full thickness=rupture
  - Tx: OR
- Unexplained FF/PE nl/mild: serial exams?
Hollow viscus injuries: Bladder

- CT cystogram: extravasation of IV contrast
- Extra-peritoneal (pelvic fx): NOM
- Intra-peritoneal (lap belt shearing): immediate OR

Sivit, AJR 2009
Management of IAI

- Booster-less Bill has a liver lac, peri-pancreatic fluid and bowel wall thickening-->obs-->more pain-->OR

OR ASAP:

- Persistent HD instability
- Bowel rupture
- Renal artery injury
- Intra-peritoneal bladder rupture
Management of IAI

• Possible OR:
  • Pancreatic injury
  • Active extravasation

• NOM: most everything else!

• Laparoscopy?*
  - HD stable and equivocal CT for bowel/diaphragm/pancreas injury or severe pain

*Gaines, Semin Pediatr Surg 2010
Glowing Gloria

3 yo MVA rollover

VS WNL; PE: SBS with mild TTP

CT: normal

Can I discharge Gloria?
After the normal CT....

- Meta-analysis 2596 kids with CT
- NPV of CT: 99.8%
- If CT negative:
  - Consider 6 hr obs
  - D/C if normal and no SBS
  - If SBS, prolonged obs/admit

Hom, *Acad Emerg Med* 2010
In a nutshell

Mechanism not as predictive of chest/abd trauma in kids

Mediastinal injuries are VERY rare

Dedicated CT chest rarely adds anything unless high suspicion for mediastinal injury

Seatbelt signs, AMS, and low thorax TTP--->risky for IAI
In a nutshell (cont):  

- Kids RARELY go to the OR  
- Kids with a negative belly CT can go home if they are pain free and don’t have a SBS