



## Pediatric Trauma

(Not Just Small Adults)  
**Sunday, Oct 28 2007**

Dr. Aayed Al-Qahtani (MD, FRCSC, FACS)

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SURG GP.  
425



### Outline :

- ♣ Background .
- ♣ Trauma scores .
- ♣ Principles and Approach .
- ♣ ABC's .
- ♣ Specific injuries
  - Head, C-Spine, Chest, Abdominal, Burns
- ♣ Abuse .

### Background :

- ♣ Leading cause of death in pediatric age .
- ♣ < 5 years → highest risk .
- ♣ Boys > girls .
- ♣ Blunt > penetrating
  - falls > MVA > MPA > rec > abuse > drown > burns .
- ♣ Regionalized peds trauma centers .
  - improved mortality of severely injured child .

### Basic ATLS concepts include :

- ♣ Treat the greatest threat to life first.
- ♣ The lack of a definitive diagnosis should never impede the application of an indicated treatment.
- ♣ A detailed history is not an essential prerequisite to begin evaluating an acutely injured patient.



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### Principles :

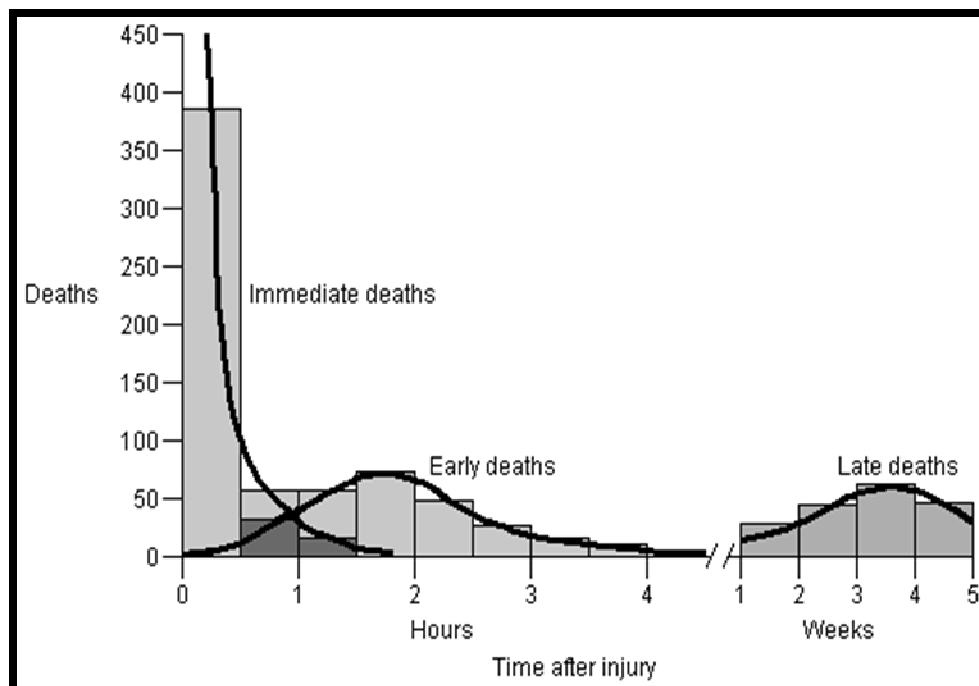
Improper resuscitation has been identified as a major cause of preventable pediatric death.

Common errors in resuscitation include failure to:

- ♣ Open and maintain the airway.
- ♣ Provide appropriate and adequate fluid resuscitation to head injured children.
- ♣ Recognize and treat internal hemorrhage.

### Trimodal distribution of death from injuries :

- ♣ The first peak of death is within minutes of the injury usually due to:
  - Brain , brain stem, high spinal cord, heart, great vessels.
- ♣ The second peak occurs within minutes to several hours of the injury
  - This is the period that ATLS focuses upon.
- ♣ The third death peak occurs several days to weeks after the initial injury
  - Sepsis, MSOF .



### Criteria for transfer to trauma centre :

- ♣ Multi-system .
- ♣ Unstable .
- ♣ Axial skeleton bone .
- ♣ Neurovascular injury .
- ♣ Acute cord injury .
- ♣ Complicated TBI .
- ♣ Low trauma score .



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## Trauma scores :

### ♣ Pediatric Trauma Score (PTS)

- accurate predictor of injury severity .
- -4 to 12 , <8 increased mortality .

### ♣ Revised Trauma Score (RTS)

- same as adults .
- <12 increased mortality .

### ♣ Injury Severity Score (ISS)

- cumbersome, underestimates survival .

## Pediatric trauma score :

	+2	+1	-1
Size (kg)	>20	10-20	<10
SBP	>90	50-90	<50
Airway	N	Secure	tenuous
CNS	awake	obtund	coma
Open Wound	none	minor	major
Fractures	none	Closed	open

- ♣ score +12 to -4
- ♣ 0% mortality ≥ 8
- ♣ 45% = 2
- ♣ 100% = 0
- ♣ transfer to pediatric trauma center if PTS <8 .

## Revised trauma score :

Glasgow Coma Scale Score	Systolic Blood Pressure (mm Hg)	Respiratory Rate (breaths/ min)	Coded Value
13-15	>89	10 - 29	10
9-12	76-89	>29	3
6-8	50-75	6-9	2
4-5	1-49	1-5	1
3	0	0	0

## Approach:

- ♣ ATLS .
- ♣ VS: plus, BP, temp, weight .
- ♣ Broselow tape .
- ♣ ABCs, C-spine, NG .
- ♣ consent?

### Principles :

- ♣ Kids are really not just small adults .
- ♣ airway and shock mgt paramount .
- ♣ head injury: ↑ morbidity & mortality .
- ♣ forces over small area → multi-systemic injury .
- ♣ little or no external injury .
- ♣ kids die from hypoxia and respiratory arrest .
- ♣ ↑ heat loss, glucose & fluid requirements .
- ♣ psyche sequel .



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### Primary survey :

- ♣ A = Airway maintenance with cervical spine control .
- ♣ B = Breathing and ventilation .
- ♣ C = Circulation with hemorrhage control .
- ♣ D = Disability: neurologic status (AVPU) .
- ♣ E = Exposure/ Environmental control: completely undress the patient, but prevent hypothermia .

### Airway :

- ♣ 2 x O<sup>2</sup> demands .
- ♣ respiratory failure #1 cause of arrest .
- ♣ no surgical airway < 10years .
- ♣ ET tube size: (16 + age)/4 .
- ♣ LMA as rescue if >4 feet tall .

### Anatomical airway issues in kids :

- ♣ big tongue, soft tissue → obstruction .
- ♣ soft trachea → no cuff .
- ♣ soft VC → no stylet .
- ♣ anterior larynx .
- ♣ short trachea .
- ♣ narrowest at subglottis .
- ♣ nose breathers < 6 months .
- ♣ big occiput
- ♣ big epiglottis → straight blade .

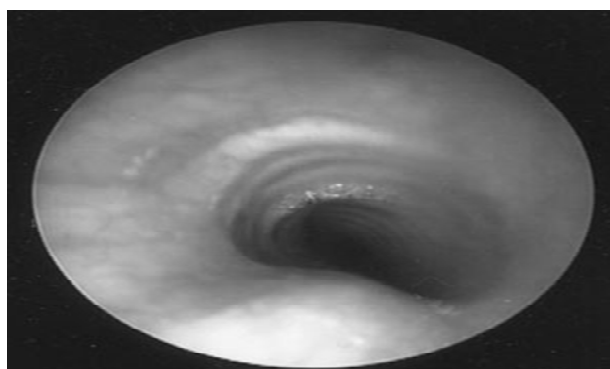
CHIN-LIFT MANEUVER



JAW-THRUST MANEUVER



## Pediatric Airway





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### RSI:

- ♣ Pre-treat *atropine* 0.02 mg/kg all < 6years .
- ♣ no defasciculating dose < 5 years .
- ♣ induction:
  - *ketamine* 1-2 mg/kg
  - *midaz* 0.2-0.3 mg/kg
  - *propofol* 2 mg/kg
  - *thiopental* 3-7 mg/kg
  - *etomidate* 0.3 mg/kg
- ♣ *sux* 2 mg/kg
- ♣ no evidence for *lidocaine* in kids .

### Breathing :

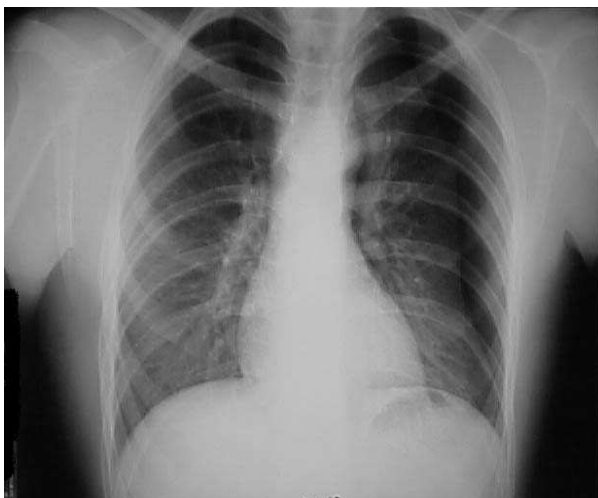
- ♣ Signs of distress: indrawing, tracheal tug, nasal flaring .
- ♣ infants:
  - immature response to hypoxia .
  - diaphragm 1° respiratory muscle
    - \* *easily fatigued* .
    - \* *aerophagia displaces diaphragm* .
- ♣ thoracic structures mobile → shift .

### Chest trauma :

- ♣ 2nd leading cause pediatric trauma death .
- ♣ compliant chest wall ∴ rib bone uncommon
  - significant injuries without external signs .
  - if the bone present, severe injury .
- ♣ Mobility of mediasternal structures more sensitive to tension pneumothoraces and flail segments .
- ♣ treat conservatively:
  - 15% require more than chest tube .
- ♣ pulmonary contusion most common, aortic injury rare .

### Life threatening thoracic injuries :

- ♣ Tension pneumothorax .
- ♣ Massive hemothorax.
- ♣ Cardiac tympanade .
- ♣ Flail chest .





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### Circulation:

- ♣ low BP LATE sign: kids compensate well
  - $\geq 25\%$  loss of blood volume .
  - minimum acceptable BP:  $70 + (2 \times \text{age})$  .
- ♣ signs of shock:  $\uparrow$ HR,  $\downarrow$ RR, mottled, cool,  $\downarrow$ pulses, altered LOC, cap refill  $< 2$  sec .
- ♣ scalp laceration can cause shock .
- ♣ IV's: antecubital, femoral, external jugular .
- ♣ attempt  $< 90$  sec, then intraosseous .
  - age limit?
  - landmarks?
- ♣ Fluids: crystalloid 20cc/kg x 2, then 10cc/kg pRBC .
- ♣ no role for MAST:  $\uparrow$  mortality .





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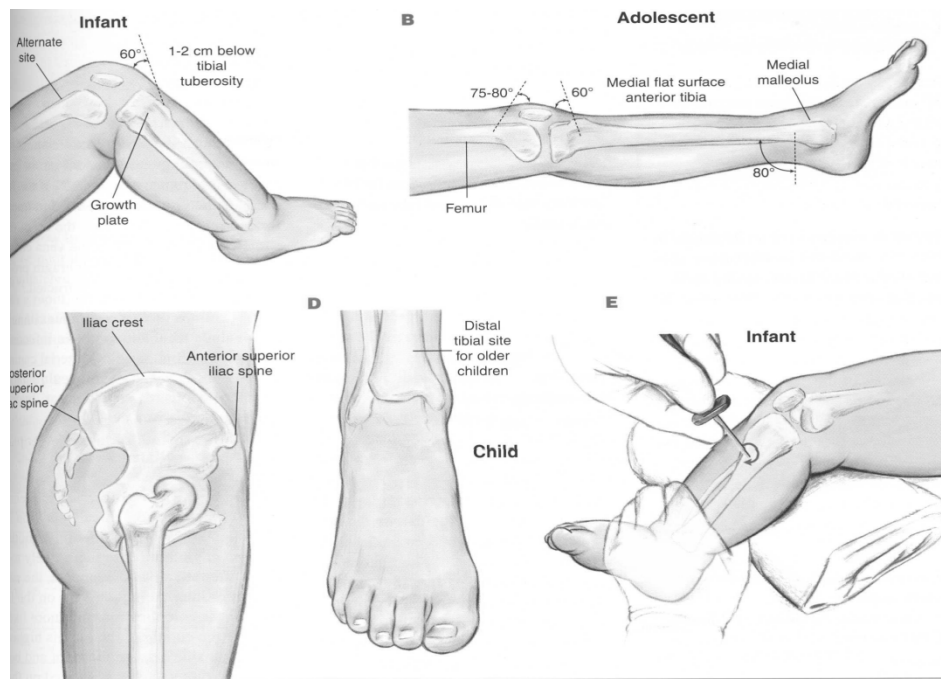
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## Secondary survey :

- ♣ Begins once the primary survey (ABC's) is completed, resuscitation has commenced and the patient's ABC's have been reassessed.
  - X-rays are before 2<sup>nd</sup> survey, just after primary.
- ♣ A head-to-toe evaluation including:
  - vital signs, and complete history and physical examination .
  - AMPLE :
    - ☛ A = Allergies .
    - ☛ M = Medications .
    - ☛ P = Past illnesses .
    - ☛ L = Last meal time .
    - ☛ E = Events/ Environment related to the injury .

## Head injury:

- ♣ leading cause of death in peds trauma (80%) .
- ♣ 90 % "minor" .
- ♣ falls > MVA > MPA > bicycle > assault .
- ♣ few require surgery: 0.4 -1.5% .
- ♣ no evidence in peds for early surgery .
- ♣ 4-6% with normal exam have ICH on CT
  - ?significance
  - ?long term sequel .

## Head injury: Anatomic differences :

### Protective

- ♣ Fontanelles .
- ♣ open sutures .
- ♣ plasticity .



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### Susceptible

- ♣ big head → torque .
- ♣ soft cranium → injury without fracture .
- ♣ less myelin → more shearing forces .
- ♣ prone to reactive hyperemia .

### Head injury: Types of injury :

- ♣ contusions, DAI, SAH, parenchymal .
- ♣ epidural: uncommon, <4 years, subtle presentation, minor trauma .
- ♣ subdural: common, poor outcome, <1 year .
  - SBS: vomit, FTT, LOC, seizure, retinal hemorrhages .

### Head injury: Assessment :

- ♣ Pediatric GCS: not predictive in infants .
- ♣ signs of ↑ ICP in infants:
  - full fontanelle, split sutures, alt. LOC, irritable, persistent emesis, “setting sun” sign .

### Skull fracture :

- ♣ 20 x ↑ risk ICH
  - 50% of parietal bone, 75% of occipital bone .
- ♣ linear > depressed > basilar .
- ♣ X-rays not sensitive nor specific .
- ♣ 90% linear bones have overlying hematoma .
- ♣ “growing skull bone”:diastatic → dural tear → meninges herniate, prevents closure: NSx F/U .
- ♣ depressed bone: may miss on CT .

Interpretation?







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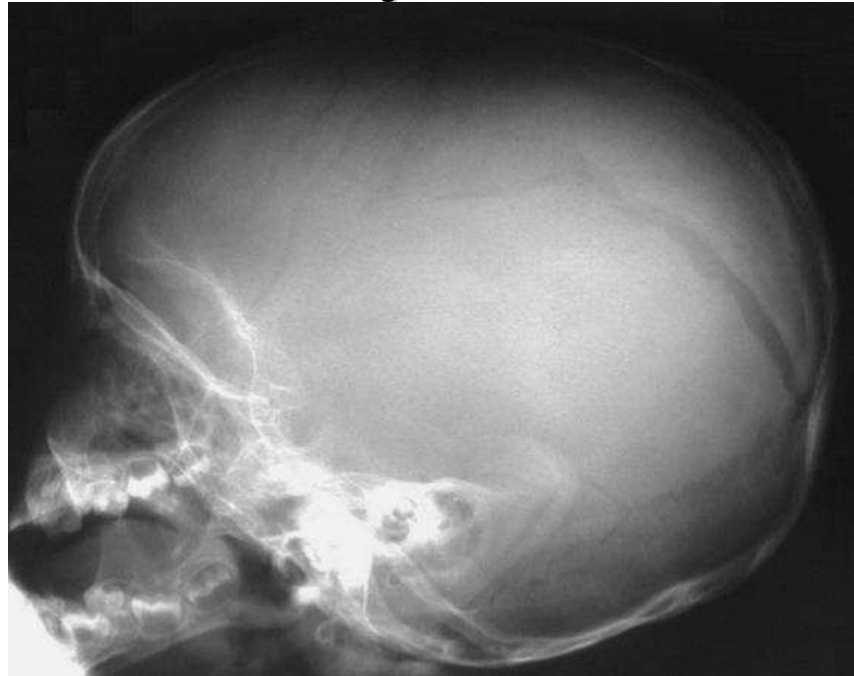
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## Growing Skull Fracture



### Predictors of ICH :

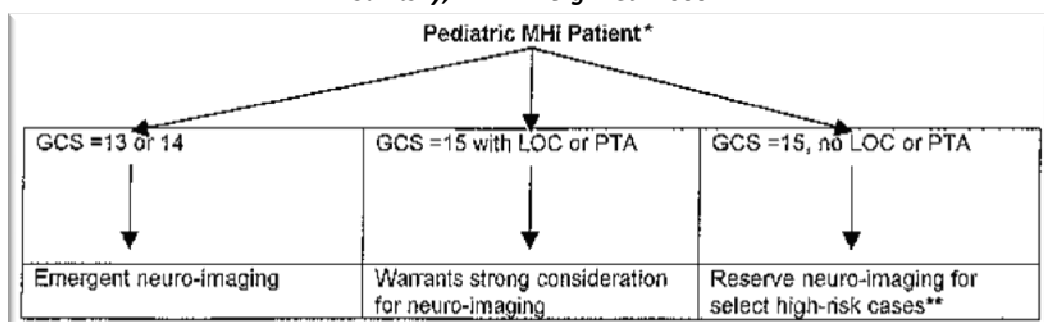
- ♣ **Greene, Pediatrics 1999**
  - Scalp hematoma most sensitive clinical predictor
- ♣ **Quayle, Pediatrics 1997**
  - depressed LOC (OR=4), focal neuro (OR=8), skull bone, LOC > 5 min, seizure (trend) .
- ♣ **Beni-Adani, J Trauma 1999**
  - TINS score for EDH; not validated .

### Who gets CT?

- ♣ **Children < 2 years .**
  - hard to assess .
  - prone to ICH, skull bone .
  - asymptomatic ICH (4-19%) .
  - low threshold .
- ♣ various algorithms, no consensus.

### CT head algorithms :

Savitsky, Am J Emerg Med. 2000





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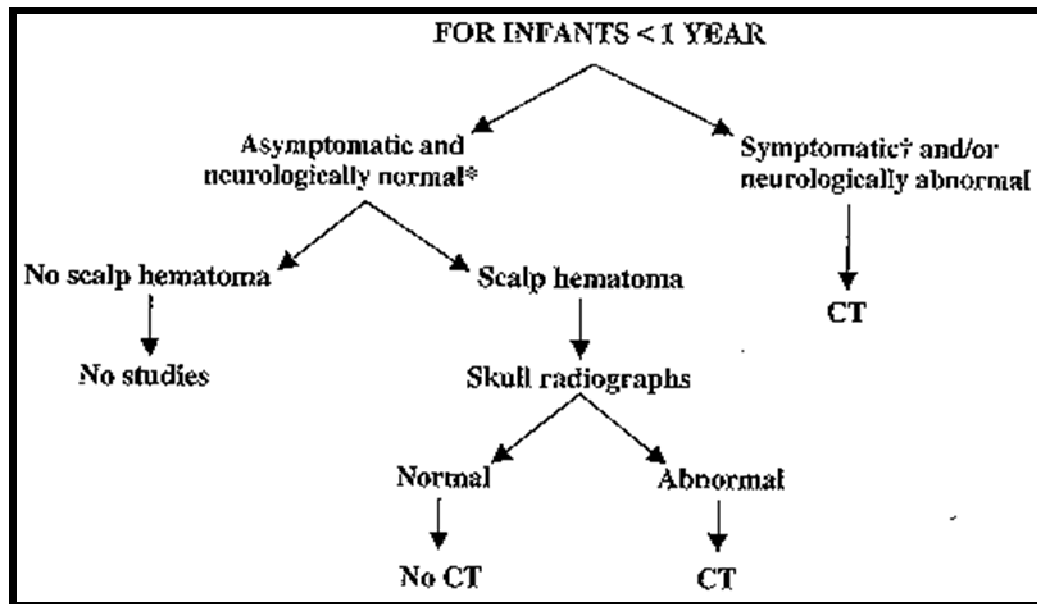
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*Quayle et al. J Neurosurg. 1990*

- ♣ alt LOC, focal deficit, palpable depression, basal skull #, seizure .
- ♣ all HI < 1 year .

### AAP Guidelines:



### Management:

- ♣ MAP > 70 teen, 60 child, 45 infant .
- ♣ hyperventilation: not in 1st 24 hr .
- ♣ mannitol: no studies .
- ♣ HTS: small studies .
- ♣ Euglycemia: ↑glucose worse neuro outcome .
- ♣ prophylactic anticonvulsants: consider in moderate/severe HI, >1 seizure or prolonged .
- ♣ prophylactic Abx for basil skull bone : no role .
- ♣ Normothermia: temp > 38.5 worse neuro outcome .

### Hypertonic Saline :

♣ *Simma et al. Crit Care Med 1998*

- prospective RCT, 35 TBI kids
- RL vs. HTS
- fewer interventions to keep ICP<15 HTS group.
- shorter ICU stay with HTS (3 days) .
- same survival and total hospital stay .

♣ *Khanna et al. Pediatrics 2000*

- 10 kids with TBI, resistant to conventional Rx
- statistically sign ↓ICP with HTS .

### C-Spine Injuries :

- ♣ Less common in kids, higher mortality .
- ♣ assoc with HI .
- ♣ falls>MVA>sports (trampolines).
- ♣ <8 years: 2/3 above C3 .



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### C-Spine: Anatomic differences :

- ♣ big head, less muscles → torque, fulcrum C2-3 .
- ♣ cartilage > bone, lax ligaments → injury without bone.
- ♣ pseudosubluxation
  - C2-3, C3-4: 3-4 mm or 50% vertebral body width .
  - use *Swischuk's line* .
- ♣ prevertebral space: C2=7mm, C3=5, C7=2cm .
- ♣ facets joints horizontal, anterior wedging vertebral bodies .
- ♣ predental space 4-5 mm .
- ♣ incomplete ossification, multiple centers .

### C-Spine Imaging :

- ♣ 3-views : AP, Lateral, Open mouth .
  - 94% sensitive - but SCIWORA

#### ♣ *Flexion-extension?*

➢ *Ralston Acad Emerg Med 2001*

💡 *no added info if 3 views normal .*

### SCIWORA :

- ♣ 16-50% SCI!!
- ♣ < 9 years .
- ♣ transient neuro symptoms (parasthesias) .
- ♣ recur up to 4 days later .
- ♣ bottom line:
  - CT/MRI if abn neck/neuro exam, distracting injuries, alt. LOC, high risk mech DESPITE normal 3-views.

### Case :

- ♣ 6- year-old girl fell off bike
- ♣ What's the abnormality?





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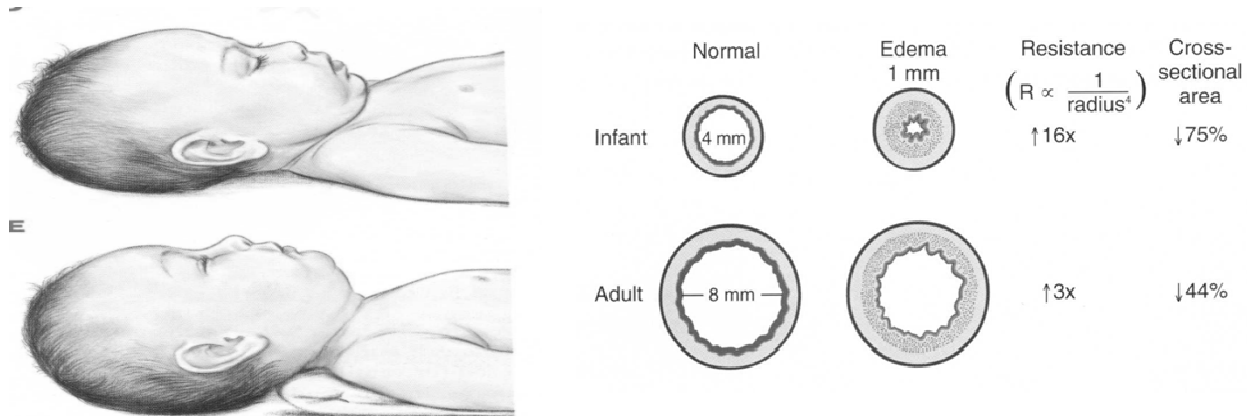
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## Endotracheal intubation :

- ETT size? - Broselow
- $\frac{\text{Age (years)} + 4}{4}$
- cuffed? - Uncuffed < 8 years old (exceptions)
- depth of insertion? - Depth of insertion (cm):  
tube ID (mm) x 3  
or age (years)/2 + 12

## Failed intubation :

- ♣ BMV with Sellick
- ♣ LMA an option
- ♣ No cricothyroidotomy under 8 years
- ♣ In a pinch: Needle cric .

## Pediatric trauma :

- ♣ Usual ABC's (sugar) and C-spine
- ♣ Use your Broselow
- ♣ Weight can also be estimated:  
< 8: (AGE x 2) + 8  
> 8: AGE x 3



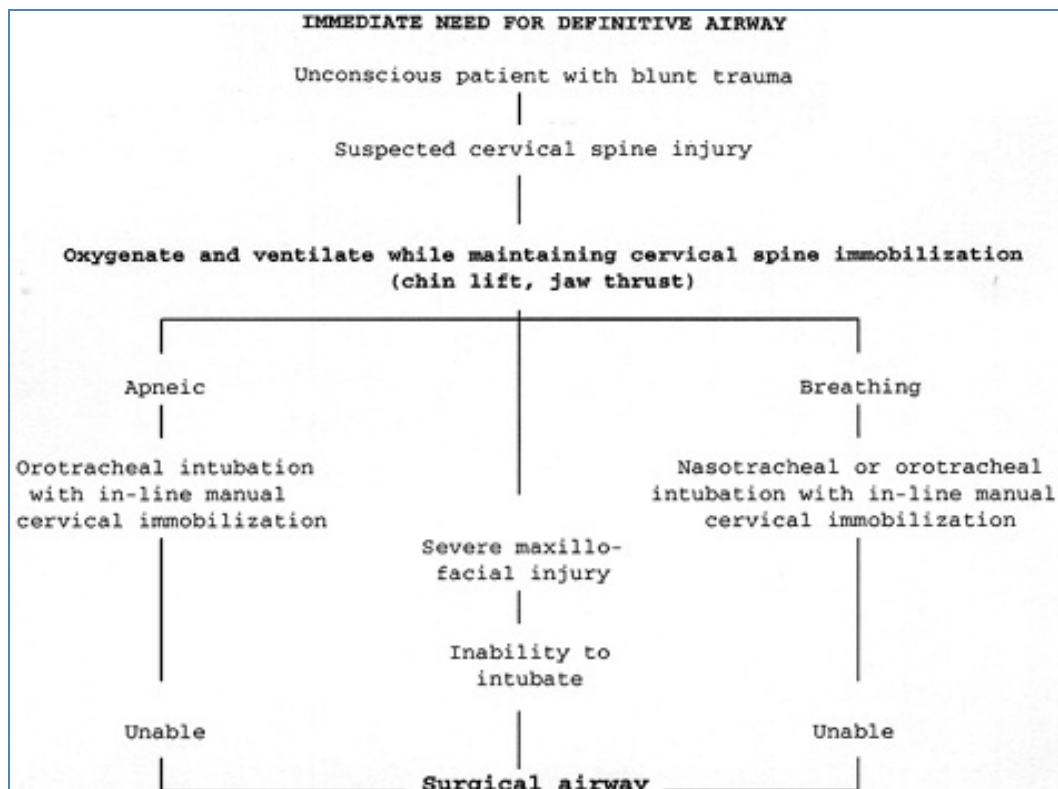
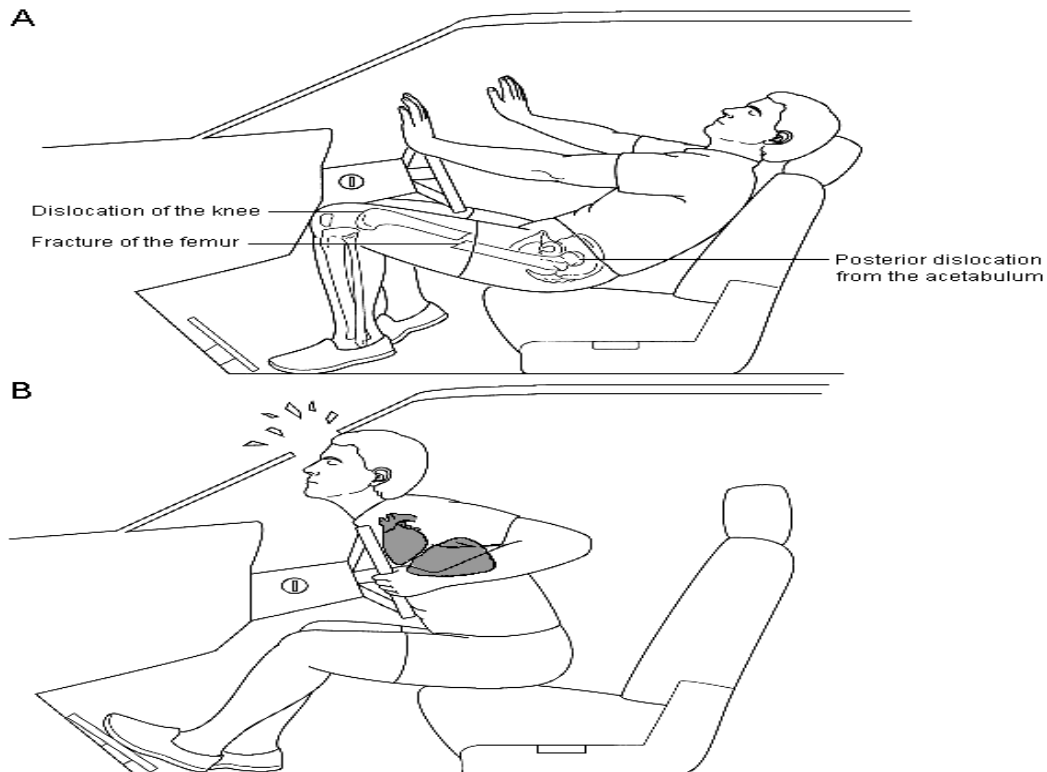
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### Abdominal trauma :

- ♣ 3rd leading cause of trauma death .
  - often occult fatal injury .
- ♣ blunt: MVA, bikes, sports, assault .

### Abdominal trauma: Anatomic issues :

- ♣ larger solid organs, less musculature, compact torso, elastic ribcage, liver & spleen anterior .
  - ↑ potential internal injury .
  - spleen>liver>kidney>pancreas>intestine .
- ♣ bladder intra-abdominal .
  - 10% have GU injury .
- ♣ low BP late sign of shock .
- ♣ mechanism
  - handlebars, lap belt .

### Abdominal Trauma: Assessment :

- ♣ low BP late sign of shock .
- ♣ clinical findings unreliable .
- ♣ shoulder tip pain, flank / lap ecchymosis .
- ♣ U/A, N/G .
- ♣ reassess, reassess, reassess .
- ♣ mechanism
  - handlebars, lap belt

### Abdominal imaging: CT :

- ♣ most widely used .
- ♣ stable pt only
- ♣ strongly consider in HI patient
  - 25% with GCS <10
- ♣ insensitive for hollow viscous (25% sens), pancreas (85% sens).

### Abdominal trauma: DPL :

- ♣ Rarely needed in pediatric.
- ♣ FP 5-14%
- ♣ ? solid organs, retroperitoneum, intestine .
- ♣ +ve:
  - >100,000 RBC (blunt in adult, in pediatric it is controversial ) .
  - >5,000 (GSW) .
- ♣ use: unstable, going to OR anyway .

### Abdominal trauma: FAST :

- ♣ **Murphy. Emerg Med J 2001: review**
  - 30-87% sensitive, 70-100% specific
- ♣ **Loiselle. Annals Emerg Med 2001:**
  - sens 55%, spec 83%, NPV 50%, PPV 86%
- ♣ **bottom line:**
  - insensitive, too specific .
  - FF ≠ lap, no FF ≠ no sign organ injury .
  - may replace DPL in unstable pt.





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### Abdominal trauma: Management:

- ♣ **spleen and liver:**
  - 90% conservative: admit, observe, Hct .
  - Why?
  - more fatal hemorrhage with liver injuries .
  - lap in unstable after resus .
- ♣ **hematuria:**
  - gross or >20 RBC + unstable → IVP in OR .
  - >10 RBC + stable → CT cysto .

### Burns :

- ♣ infants → spills > intentional immersions .
- ♣ older kids → flames .
- ♣ Rules of Nines doesn't work:
  - *Lund & Brouder* chart .
  - palm = 1%
- ♣ mgt same as adults .

### Child abuse :

- ♣ 1 million confirmed cases / year (US) .
- ♣ high index of suspicion .
- ♣ RF: poverty, single parent, substance abuse, <2 years, disability, low birth weight .
- ♣ cutaneous injuries most common .
- ♣ death 2° to head & abdominal trauma .
- ♣ interview child & parent separately .

### Child abuse: Clues :

#### History

- ♣ story ≠ injuries .
- ♣ history changing .
- ♣ injury ≠ development .
- ♣ delay seeking help .
- ♣ inappropriate level of concern .

#### Physical Exam

- ♣ multiple old and new bruises .
- ♣ posterior rib bone, sternum bone, spiral bone < 3 .
- ♣ immersion burns, cigarette .

### Child abuse: Head injury :

- ♣ blunt, acceleration/deceleration .
- ♣ 31% missed, 28% re-injured .
- ♣ fractures:
  - bilateral, cross sutures, diastatic, non-parietal .
- ♣ IC injuries:
  - SAH, subdural, ICH, edema .
- ♣ CT if suspect .



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### Child abuse: Management :

- ♣ Document .
- ♣ full P/E (rectal, genital).
- ♣ Photograph .
- ♣ B/W: CBC, PT/PTT, LFTs, lipase, U/A .
- ♣ skeletal survey .
- ♣ CT head, abdominal prn
- ♣ Child Protection.

**To Get The Slides**

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