



Overview

- Epidemiology
- Differences primary survey (ABCD)
- Pediatric Trauma
- Disclaimer: APLS (civilian)
Newborn and BLS

Epidemiology

- Injury is the most frequent cause of death
- Approximately 20% to 40% of deaths may be preventable.

What are the common mechanisms of injury in children?

Mechanisms of Injury in Children

- Falls are the most common mechanism of injury (39%)
- Vehicular-related trauma is the next most common (38%)
- Burns
- Smaller body absorbs energy in a more concentrated area



Special Considerations

Anatomical

Weight

Airway/Breathing

Circulation



Characteristics

- Disproportionate head size
- Prone to C-spine injury
- Solid visceral injuries more likely to stop bleeding
- Pediatric patient—compensates well but deteriorates rapidly
- Bones bent but don't break
- Large surface area to mass ratio

Weight (European standard)

- Newborn 3,5 kg
First year: $4 + 0,5$ (months)
- Formula till the age of 10:
 $8 + (2,5 \times \text{age})$
- PRIL / Breslow
(Pediatriesch Resuscitatie en Interventie Lint)

Differences between Adult and paediatric airway

- Dimensions smaller
- Head relatively larger in infants (neutral position)
- Tongue relatively larger
- Short Jaw
- Palate long
- Long more U-shaped Epiglottis



Differences between Adult and paediatric airway

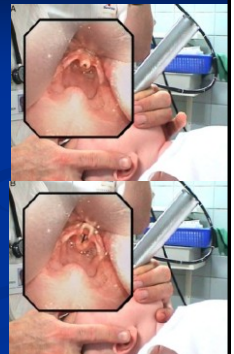
- Larynx located more cephalad
- Vocal cords angled more anteriorly (straight blade)
- Airway narrowest at the cricoid cartilage (un)cuffed tubes
- Laryngospasm



Intubation

- Laryngoscope grip
- Straight or bend blade
- Slight pressure on Larynx

Acta An Scan 2009, Hölm-Knudsen et al

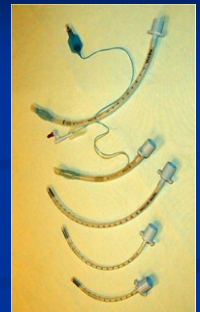


Intubation

- | | |
|--------------------------------------------------------------------------------|------------------------------------------------------------------------|
| ■ Straight Blade | ■ Curved/Bend Blade |
| - Epiglottis completely out of sight | - Epiglottis and tongue ventral |
| - Pressure on back side causes vagal stimulation (laryngospasm or bradycardie) | - Less vagal reaction (Vallecule innervated by glossopharyngeus nerve) |

Endotracheal Tube (Europe)

- Tube
 - diameter = $\frac{\text{Age (year)} + 4}{4}$
 - length
 - oral = $\frac{\text{Age} + 12}{2}$
 - nasaal = $\frac{\text{Age} + 15}{2}$



Breathing

- Normal ventilatory rate varies with age

"Work of Breathing"

- Frequencies
- Intercostal muscle use
- Inspiratory and expiratory sounds
- Moaning
- Use of Axillary breathing muscles
- Use of "Nose"

Physiology

Age (years)	RR (x/minute)	Pulse	Systolic BP (mm Hg)
< 1	30-40	110-160	70-90
1-2	25-35	100-150	80-95
2-5	25-30	95-140	80-100
5-12	20-25	80-120	90-110
>12	15-20	60-100	100-120

Breathing

- Efficacy of breathing
(Chest-excursions, SaO₂, Air passage)
- Pulmonary contusions can occur without rib fractures
- Cardiac arrest is usually preceded by respiratory failure/respiratory arrest
- Gastric distention may impede ventilation

Circulation

- Frequency
- Pulse
- Cap Refill
- BP

Circulation

- Normal pulse and BP values vary with age
 - Pulse decreases with age
 - BP increases with age
- Compensate well
 - Signs of shock more subtle
 - BP may not fall until > 30% of total blood volume lost; late sign in hypovolemic shock
 - Can deteriorate rapidly

Physiology

Age (years)	RR (x/minute)	Pulse	Systolic BP (mm Hg)
< 1	30-40	110-160	70-90
1-2	25-35	100-150	80-95
2-5	25-30	95-140	80-100
5-12	20-25	80-120	90-110
>12	15-20	60-100	100-120

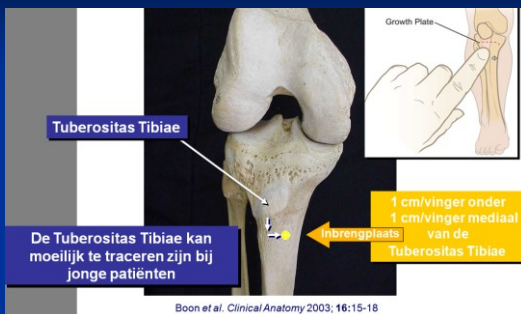
Circulation (ERC Guidelines)

- Newborn life support (3:1)
- Pediatric life support Ratio
(Brachial artery, CPR 15:2, position)
- Normal blood volume 70-80 cc/kg
- Resuscitation Fluids: Crystalloid 20 cc/kg

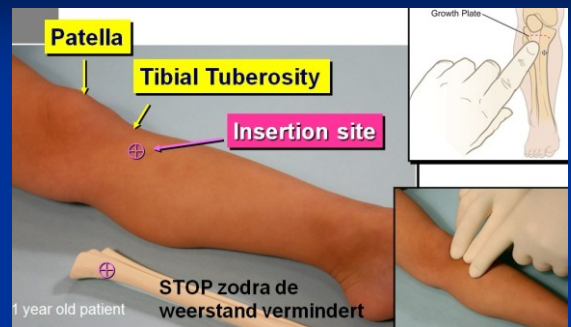
Circulation

- Up to 6% of small children in arrest or shock never have successful access achieved; 25% take > 10 minutes
 - Order of priority and timing of access sites dependent on urgency of clinical situation
- peripheral / cutdown / intra osseous

Intraosseous Venous Access



Intraosseous Venous Access



Intraosseous Venous Access

- Blood draws
- Venous blood gas
- Fluid bolus
- Drug administration
- Contraindicated:
Fracture / Wounds
- Temporally



Disability

- Assessing level of consciousness may be difficult (modified GSC scale)
- Patient's activity level and response to environment may be the best indicators
- Be patient and reassuring

Ogen openen (E4)			
Score	0 - 1 jaar	>1 jaar	
4	Spontaan	Spontaan	
3	Op bidt spreken	Op aanspreken	
2	Op pijn	Op pijn	
1	Geen reactie	Geen reactie	
Best Verbal Response (V5)			
	0 - 2 jaar	2 - 5 jaar	>5 jaar
5	Passend luiden, lachen	Passende woorden en geluiden	Alert, praat
4	Huilt	Minder gebruikelijke woorden	Verward
3	Niet passend luiden	Huilen, krijen	Onsamenhangende woorden
2	Kraakt	Kraakende geluiden	Overstaanbaar
1	Geen reactie	Geen reactie	Geen reactie
Best Motor Response (M6)			
	0 - 1 jaar	>1 jaar	
6	Spontaan en gericht	Geborzaam	
5	Lokaliseert de pijn	Lokaliseert de pijn	
4	Trekt terug op pijn	Trekt terug op pijn	
3	Abnormaal buigen	Abnormaal buigen	
2	Abnormaal strekken	Abnormaal strekken	
1	Geen reactie	Geen reactie	

Tabel 1-15 Pediatric Glasgow Coma Scale
Wanneer uitvraag moeilijk is, kan de score van 3-15. Een totaal score van < 8 wijst op ernstig neurologisch deficit.

Expose/Environment

- Children are more prone to hypothermia
 - Larger surface area relative to overall body weight and size
 - Rapid loss of heat
- maintain body temperature with warmed fluids, blankets, heat lamps

Be Prepared

- Alert (Pediatric) Staff and trauma team
- Team Meeting:
 - Nurses
 - PA/Residents
 - Consults (Radiologist, Anesthesia, Neurosurgeon, Pediatric surgeon)
 - Supervisor (who is in charge)



Be Prepared

- Use of whiteboard: MIST
- Documentation
- Evaluation (Lessons learned)

Be Prepared

- Fall of Height
- Boy 8 years (= 28 kg)
- Tube = 6 (5.5 - 6 - 6.5 cuffed)
- Fluids 560 cc Ringers lactate
- Adrenaline 2.8 cc (1:10.000) = 1 cc = 0,1 mg/kg
- Defib 150 J

Communication/CRM

Teamwork Example 1



Head Injury

- Present in 50% of pediatric blunt trauma
- Responsible for > 70% of pediatric traumatic deaths

Initial management:

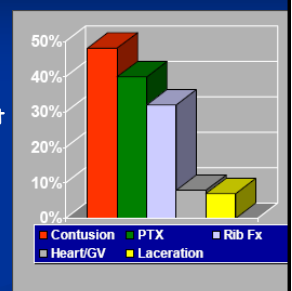
- ABC's, assume c-spine injury, intubate for GCS < 9
- CT scan for any altered level of consciousness or focal defect
- Maximization of cerebral perfusion pressure

Cervical spine injury

- Rare !
- Majority occur in upper 3 cervical segments C1-C3
- Increased incidence with airbag injuries
- Up to 35% of cervical cord injuries occur in the presence of normal radiographs - *SCIWORA*
- If non-tender, alert, and no distracting injuries, then clinical clearance acceptable
- Clearance may require flexion/extension films, CT, or MRI

Thoracic injuries

- 15% overall mortality
- compliant chest wall - more prone to significant injury without rib fracture
- higher incidence of tension hemo- or pneumothorax



Abdominal injuries

- Elastic ribs
- Thinner abdominal wall
- Horizontal diaphragm
- Bladder more abdominal

Abdominal injuries

- Majority of civilian injuries blunt, frequently with multiple organs involved

- Majority of war-related injuries *penetrating*

Evaluation

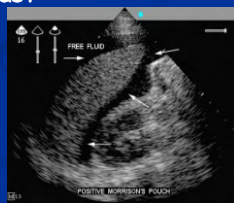
- **History**
- **Physical examination I**
- Adjuncts: NG tube, Urine Catheter



Abdominal injuries

Evaluation

- laboratory examination
- ultrasound
- CT scan w/ or w/o contrast
- peritoneal lavage (Rare)



Spleen

- most commonly injured intra abdominal organ
- majority (90-95%) can be treated nonoperatively
- diagnosis by ultrasound / CT scan
- initial management consists of bedrest, serial exams and Lab follow up
- limited ambulation when abdominal symptoms resolve

Non Operative Treatment

- Bleeding will stop by itself
- Adequate observation
- Frequent monitoring
- Proper Fluidbalance
- Availability of surgeon



Operative Treatment

- Salvage of spleen decreases morbidity and mortality

Grade II



spleen0003a
Grade 2 splenic injury
src: Caesar M. Urolic

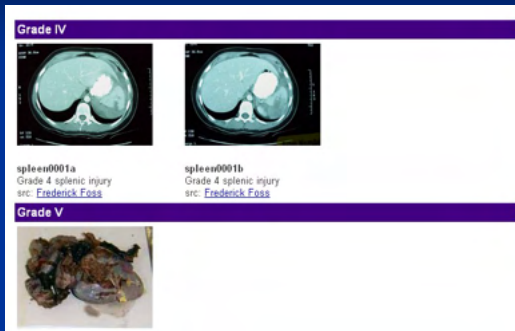


spleen0003b
Grade 2 splenic injury
src: Caesar M. Urolic



spleen0003c
Grade 2 splenic injury
src: Caesar M. Urolic

Operative Treatment



Liver

- commonly injured organ, frequently associated with other abdominal injuries
- diagnosis by abdominal CT scan; suggested by acute elevation of transaminases
- conservative management similar to that for splenic trauma
- Longterm complications infrequent

Pancreas

- relatively uncommon injury
- characterized by delayed diagnosis and repair
- diagnosis suggested by:
 - marked abdominal pain and tenderness
 - unexplained peritoneal fluid on CT scan
 - elevated and/or rising serum amylase and lipase
 - transection visualized on CT scan

Pancreas

- injury usually located at neck of pancreas
- must rule out Abuse

Bowel

- more commonly recognized
- difficult to diagnose
 - peritonitis
 - unexplained fluid
 - bowel wall thickening or "focal ileus" sign
 - lap-belt complex
- may present with delayed SB obstruction due to posttraumatic stricture

Genitourinary

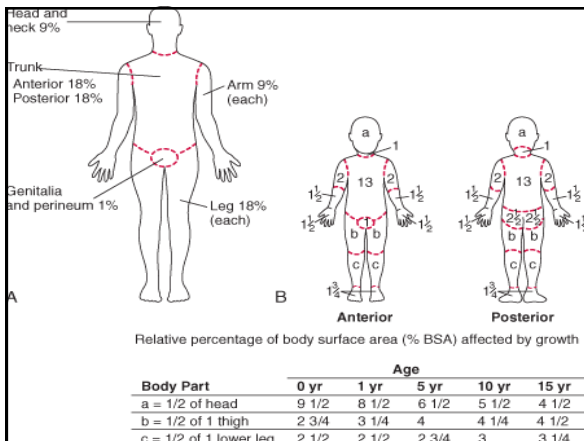
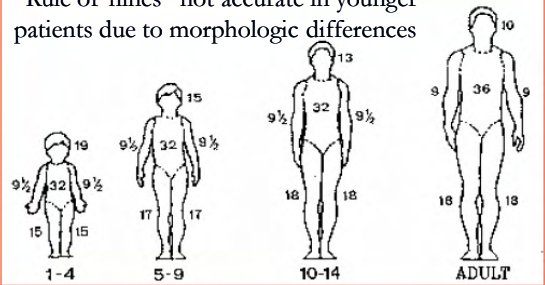
- bladder injuries more likely to be intraperitoneal
- kidney is the most commonly injured GU organ
 - proportionally larger
 - more mobile, more intra abdominal position
 - less protective perirenal and abdominal wall fat
- contrast CT scan diagnostic study of choice
- most treated nonoperatively

Burns

- Leading cause of pediatric trauma deaths in the home (hot liquids). More Scald burns than flame burns
- Different body proportions
- Thinner skin (injury in infants leads to severe burn than in older children or adults)
- Different psychosocial needs
- Slower reactions to painful stimuli
- Tendency to hypothermia
- Increased fluid needs

Burns

“Rule of nines” not accurate in younger patients due to morphologic differences



Burns

- Children > 10 % TBSA: 4 ml Hartmann Solution/kg body weight/percent burn

+ Maintenance with glucose/saline
 100 ml/kg up to 10 kg, plus
 50 ml/kg from 10-20 kg, plus
 20 ml/kg for each kg over 20 kg

Start at time of burn, not from the time of presentation
 Half of the calculated volume is give in the first 8 hrs, the remaining over the subsequent 16 hrs
 Beware of Hyponatraemia in children

Burns

- Refer to pediatric burns center for:
 - > 15% TBSA injury
 - inhalation injury
 - burns of hands, feet, face, genitalia
 - chemical or electrical burns
 - infected burns
 - children with significant preexisting conditions
- www.brandwonden.nl

Prevention



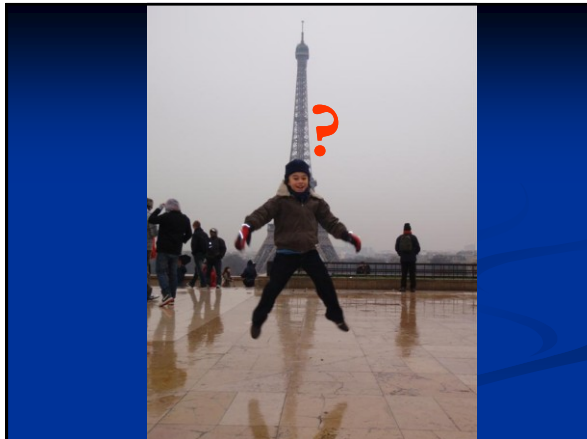
Prevention

- Unintentional injury is the #1 killer of children age 14 and under in the U.S.
- Unintentional injury kills more children every year than any other cause - including disease, homicide and suicide!
- 90% of these unintentional injuries can be prevented!



Childabuse

- Suspicion of non-accidental injury
 - late presentation
 - vague or inconsistent history from different observers
 - History not compatible with injury pattern
 - other or old signs of trauma
 - cigarette marks, shoes and socks scalds



Summery

- Epidemiological characteristics
- Anatomical and physiological differences in the injured child
- Specifics of management of the injured child
- Childabuse