Pediatric Trauma Life Support
for Prehospital Care Providers

Head & Spinal Trauma

3rd Edition

1

Head & Spinal

- **Objectives – Head Trauma**
  - Describe the anatomy of the pediatric head and brain
  - Describe the pathophysiology of pediatric traumatic brain injury
  - Discuss primary versus secondary brain injury
  - Describe the development of secondary brain injury
  - Describe the assessment and management of the pediatric patient with traumatic brain injury

2

Head & Spinal

- **Objectives – Spinal Trauma**
  - Describe how trauma and pediatric spinal anatomy and physiology poses specific concerns
  - Describe acceptable equipment and steps for spinal motion restriction
  - Identify the criteria for removing a child from a car seat

3

Head & Spinal

- **Case Study Scenario**
  - Scene of an 8-year-old boy involved in a bicycle accident
  - Child tried to jump bike over a bale of hay and lost control
  - Flew approximately 5 feet (1.5 meters) through air and landed on gravel road
  - Was not wearing a helmet

4

Head & Spinal

- **You arrive on the scene**
  - How would you approach this patient?
  - What injuries should you suspect from this mechanism of injury?
  - How would you care for this patient?

5

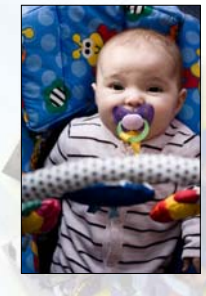
Head & Spinal

- **Pediatric Head & Brain Injuries**
  - Most common cause of traumatic death
  - Mechanism of injury varies with age
  - Early resuscitation and aggressive treatment of hypoxia and prevention of shock is essential

6

Head & Spinal

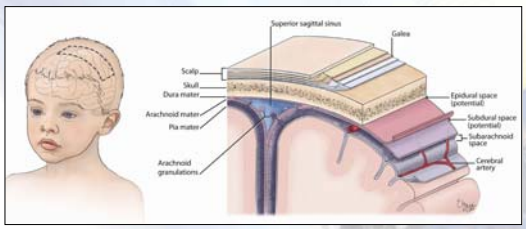
- **Anatomy and Physiology**
  - Scalp is very vascular
  - Head is the largest part of the body
  - Weak upper extremity, neck muscles
  - Soft skull
  - Suture lines



7

Head & Spinal

- **Anatomy of the Pediatric Brain**



8

Head & Spinal

- **Pathophysiology**
  - Primary brain injury
    - Direct result of actual traumatic event
  - Secondary brain injury
    - Occurs as result of brain's response to primary injury
    - Preventable – due to hypoxia, hypotension, hypoventilation, bleeding
    - Prehospital mission is to prevent secondary injury

9

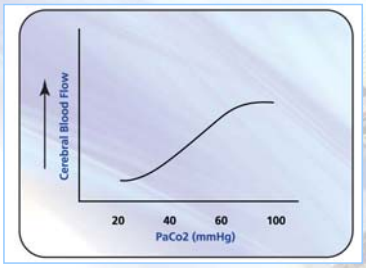
Head & Spinal

- **Secondary Brain Injury**
  - Secondary injury is worse in children than adults
  - Children usually have a better recovery rate for a given GCS than adults
    - Hypoxia and/or hypotension nullifies this advantage
      - Children who are allowed to become hypoxic or hypotensive have a far greater mortality rate
  - Treat aggressively!

10

Head & Spinal

- **Intracranial Pressure**



11

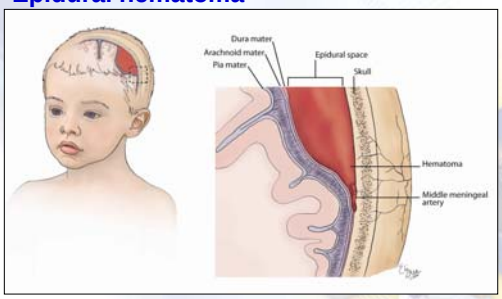
Head & Spinal

- **Types of Head Injury**
  - Extracranial
    - Scalp lacerations
    - Closed fractures: linear, depressed, basilar
    - Open fractures
  - Intracranial
    - Epidural hematoma
    - Subdural hematoma
    - Diffuse axonal injury
    - Cerebral edema

12

Head & Spinal

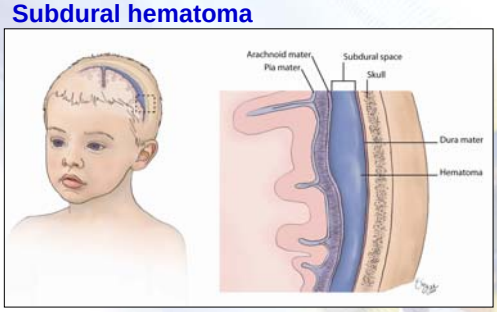
- **Epidural hematoma**



13

Head & Spinal

- **Subdural hematoma**



14

Head & Spinal

- **Cerebral Edema**
  - **May lead to herniation**
    - **Movement of brain tissue through the fibrous layers that surround the brain**
    - **Usually a terminal event**
  - **Signs of herniation may include:**
    - **Cushing's triad: irregular respiration (usually slow), bradycardia, hypertension**
    - **GCS of 3-8, progressive neurologic deterioration**
    - **Extensor posturing**
    - **Pupillary abnormalities (asymmetric or non-reactive)**
  - **Herniation the only indication for hyperventilation**

15

Head & Spinal

- **Pediatric Spinal Injuries**
  - Uncommon in children, but devastating and often permanent
  - Cervical region most often affected
    - Upper C-spine in particular
  - Thoracic and lumbar injuries usually at the level of T11 – L2
    - Where rigid thoracic adjoin more mobile lumbar segments

16

Head & Spinal

- **Perform spinal motion restriction (SMR) if:**
  - Altered level of consciousness
  - Pain or tenderness along the spine
  - Mechanism of injury
    - If head or neck injury is suspected, best practice is to institute SMR immediately
  - Distracting injuries
    - Other major injuries

17

Head & Spinal

- **Scene Size-Up**
  - Mechanism of injury most important
    - If situation could injure spine, assume it did and take precautions!
  - Obtain history following possible head injury and ask about:
    - Loss of consciousness
    - Change in behavior
    - Amnesia for event
    - Severe headache
    - Vomiting

18

Head & Spinal

- **Initial Assessment**
  - General Impression
    - Speak to the patient
    - Note level of alertness, skin color, respiratory efforts
  - Level of Consciousness and SMR
    - Look for altered mental status; record GCS
    - Maintain SMR for all patients with suspected head or spine injuries

19

Head & Spinal

- **Initial Assessment**
  - Airway
    - Continue to protect the cervical spine, maintain SMR
    - Keep airway open and have suction available
    - Administer 100% oxygen to prevent hypoxia
    - Assist ventilation via BVM as needed
    - Endotracheal intubation only if necessary
      - Higher complication rate
      - Does not increase survival rate

20

Head & Spinal

- **Breathing**
  - Rate – fast, normal or slow?
    - Irregular respirations a sign of increased intracranial pressure
  - Quality
    - C-spine injury above level of C5 often causes apnea
  - Administer 100% oxygen
    - Prevent hypoxia
- **Ventilation**
  - Ventilate at normal rate unless cerebral herniation suspected

21

Head & Spinal

- **Recommendations of Brain Trauma Foundation**

	Normal rate	Hyperventilation rate
infant	25	35
child	20	30
adolescent	10	20

  - **Use these guidelines if you are unable to monitor etCO2**

22

Head & Spinal

- **Circulation**
  - **Assess rate and quality of pulse, capillary refill time, skin color and condition**
  - **Monitor carefully for signs of shock and treat as hypovolemic shock**
    - **Shock rare after isolated head injury**
    - **Neurogenic shock and upper cervical spine injury**
  - **Stop active external bleeding**
  - **Manage blood pressure**
    - **Bradycardia an ominous sign in a head-injured child**
      - **Indicates hypoxia or increased ICP**

23

Head & Spinal

- **Rapid Trauma Survey**
  - **Brief, targeted examination from head to toe**
  - **Note obvious head trauma**
  - **Look for other injuries**
  - **Note sensory and motor abnormalities in all four extremities**
  - **Note any mechanical breathing deficit**
  - **Brief neurological exam**
    - **Increased risk of spinal injury with head injury**
    - **AVPU (may have already been done)**
    - **Age-appropriate GCS**

24

Head & Spinal

- **Pediatric Glasgow Coma Scale**

	Patient < 2 years	Patient > 2 years	
Eye Opening	Spontaneous	Spontaneous	4
	To speech	To voice	3
	To pain	To pain	2
	None	None	1
Verbal Response	Coos, babbles	Oriented	5
	Cries irritably	Confused	4
	Cries to pain	Inappropriate words	3
	Moans to pain	Incomprehensible	2
	None	None	1
Motor Response	Normal movements	Obeys commands	6
	Withdraws to touch	Localizes pain	5
	Withdrawal-pain	Withdrawal-pain	4
	Abnormal flexion	Flexion-pain	3
	Abnormal extension	Extension-pain	2
	None	None	1

Total = Eye + Verbal + Motor

25

Head & Spinal

- **Transport Decision: Load and Go**
  - Decreased level of consciousness or altered mental status
  - Unstable airway
  - Respiratory insufficiency
  - Shock

26

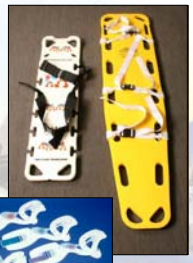
Head & Spinal

- **Critical Interventions**
  - Administer 100% oxygen
  - Support ventilation via bag-valve-mask if necessary; intubate only if BVM is ineffective
  - Establish IV/IO access and administer fluids if shock is suspected
    - Critical for children with head injury and shock to maintain cerebral perfusion
  - Stop seizures as soon as possible
    - Seizures increase ICP, decrease oxygenation
    - Benzodiazepines (e.g., diazepam, lorazapam)

27

Head & Spinal

- **Packaging for Transport**
  - Apply appropriately sized cervical collar
  - Secure to pediatric back board (if available)
    - Modify an adult back board by padding under the shoulders to keep neck in neutral position
    - Use enough straps to secure and keep child as immobile as possible
      - Should not move if board is tilted



28

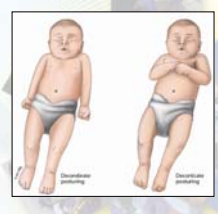
Head & Spinal

- **Car Seat Assessment & Extrication**
  - Abnormal assessment – injury suspected:
    - Extricate from the seat immediately!
    - Spinal motion restriction using pediatric backboard
  - Normal assessment – no abnormalities found:
    - May transport child in car seat if seat was appropriately restrained and not damaged
      - Apply cervical collar if possible
      - Secure head with padding
    - If child's condition deteriorates, extricate to backboard

29

Head & Spinal

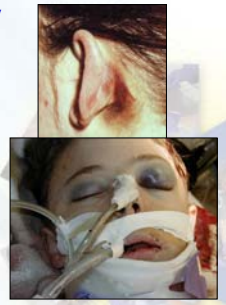
- **ITLS Secondary Survey**
  - Complete Neurological Exam
    - Repeat GCS
    - Pupillary examination
    - Motor and sensory examination
      - Ability to move extremities
      - Posturing
      - Sensory function: response to deep pain, light touch, pinprick, temperature
    - Behavioral changes



30

Head & Spinal

- **ITLS Secondary Survey**
  - Head Examination
    - External trauma: Lacerations, depressions, fractures
    - Swelling or hematoma
    - Fluid or blood from nose or ears
    - Battle's sign
    - Raccoon eyes
    - Check fontanel in infants



31

Head & Spinal

- **ITLS Secondary Survey**
  - Abdominal Examination
    - Evaluate for DCAP BTLS
      - Possible lumbar spinal trauma
  - Extremity Examination
    - Check pulse, motor function, sensation (PMS)
    - Reflexes preserved above, absent below level of injury

32

Head & Spinal

- **Case Study Continued**
  - Initial Assessment:
    - Poor general impression; lying motionless on ground and appears disoriented
    - Skin pale, cool and dry with no obvious bleeding
    - Opens eyes, localizes pain on pressure to forehead
    - Airway clear of blood, secretions, foreign matter
    - Respiratory rate of 18 bpm; normal but irregular
    - Radial pulse 80 bpm and slightly irregular
  - Ventilation assisted with bag-valve-mask and 100% oxygen

33

Head & Spinal

- **Case Study Continued**
  - A load-and-go patient because of:
    - Signs of shock
    - Decreased level of consciousness
  - Rapid Trauma Survey:
    - Bruise to right temple
    - Bleeding from right nostril
    - Pupils 4 mm in size, react to light
    - Examination of neck, chest, abdomen, pelvis, extremities normal
  - Patient packaged for transport to hospital

34

Head & Spinal

- **Case Study Continued**
  - En route, IV established
  - Vitals obtained: pulse 70 bpm, respiration 12 bpm, BP 100/60, pulse oximetry 95%
  - Neurological exam performed
    - Opens eyes to verbal stimuli, localizes to pain
    - Does not speak but makes incomprehensible sounds
    - Has gag reflex
    - GCS of 10 (Eyes 3, Verbal 2, Motor 5)
    - Right pupil dilates to 6 mm; left pupil remains at 4 mm

35

Head & Spinal

- **Case Study Decisions & Wrap-Up**
  - Medical direction notified
  - Assisted respirations at 30 bpm started
  - Upon arrival to pediatric trauma center, patient is intubated and CT scan performed:
    - Right epidural hematoma
    - Underlying frontal cerebral contusion
    - Stable fracture of 6th cervical vertebra
  - Patient taken into surgery for removal of clot and discharged after 2 weeks in neurosurgical ward

36

Head & Spinal

- **Points to Remember – Head Trauma**
  - Leading cause of traumatic death in the pediatric population is head injury
  - Large head and weak neck muscles predispose children to serious head injury
  - Manage ABCs aggressively
  - Do not allow head-injured patients to become hypoxic or hypotensive
  - All children with altered mental status should be considered Load-and-Go

37

Head & Spinal

- **Points to Remember – Spinal Trauma**
  - Pediatric trauma patients need spine protected
    - Often require padding to maintain neutral alignment
  - Maintain SMR for all patients with a dangerous MOI affecting head, neck or trunk as a precaution
  - Have a lower threshold for instituting SMR for young patients with less-developed communication skills
  - Trauma patients lose some ability to control airway when SMR is maintained, so reassess airway frequently

38

Questions?

39