How does TBI in Children Impact Health Care?

- **Impact**
  - 600,000 ED visits/year
  - 60,000 Hospitalizations
  - 3000 Deaths
  - $1 billion in annual hospital cost
- **Children at Risk**
  - Age 0-4 Falls
  - Age 15-19 Motor Vehicle


Classification of TBI

- **Mild**
  - GCS 14-15
- **Moderate**
  - GCS 9-13
- **Severe**
  - GCS ≤ 8


Mild TBI

- Approximately 75% of all TBI Patients are classified as Mild
- Intracranial hemorrhage is identified in 20% of this population
- 3% undergo a surgical intervention.
Characteristics of Mild

- GCS 14-15
- Headache
- Nausea
- Brief loss of Consciousness
- Confusion/amnesia
- Difficult to concentrate
- CT Scan Negative/Positive

Imaging and Risk Factors

- Imaging
  - CT Scan vs MRI
- Risk Factors for Children
  - Size of Patient
  - Fast growing cells
  - Live longer

Exposure to Radiation

- Natural background radiation: 3 mSv per year
- Traveling on an airplane: 0.04 mSv per round trip
- Chest x-ray (2 views): up to 0.1 mSv
- CT Scan of Head: up to 2 mSv
Guidelines for the evaluation of suspected non-accidental trauma (NAT)

- ED Social Work Evaluation
- Photo Documentation
- MO SAFE Care Form/can defer to CPP as long as complete Hx is documented
- Admission
  - Trauma Consult
  - CPP Consult
- Imaging and labs (refer to chart)

### Types of Skull Fx

- Linear
  - No treatment
Linear Skull Fracture

Types of Skull Fx

- Linear
  - No treatment
- Comminuted (multiple fragments/dislodged)
- Depressed surgically elevated for cosmetic reasons

Open Comminuted depressed skull fx
Types of Skull Fx

- Linear
  - No treatment
- Comminuted (multiple fragments/dislodged)
- Depressed surgically elevated for cosmetic reasons
- Basilar (located base of skull/tear in the dura)
  - Fluid leaking from the ear/nose
  - No Antibiotics
  - Usually heals in 48 hours/implant drain to allow dura to heal

Case Study

- Description:
  - 12 year old boy with Traumatic Injury
  - Unintentional fall from Vehicle
- Description of Scene:
  - Lying in middle of street on his left side
  - Bystander holding piece of clothing to patient’s head
  - Stream of blood on street next to patient
  - Patient is unconscious
  - Snoring respirations
Halo Sign

Focal Injuries

- Subdural hemorrhage (SDH)
- Subarachnoid hemorrhage (SAH)
- Intracerebral hemorrhage (ICH)
- Intraventricular hemorrhage (IVH)
- Epidural hemorrhage (EDH)
Subdural hematoma

- Tearing of veins
- > 1 year
  - MVC
  - Falls
- ≤ 1 years
  - suspect abuse
  - Bilateral
  - Old and acute
- Management

Subdural Hematoma

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Case Study

- 5 month old/ ex 28 wk baby girl
- Unknown past medical history
- Presents from Neurosurgery Clinic where her cousin is being evaluated for a craniosynostosis
- Neurosurgeon notices infant had a large head circumference
- Admitted for evaluation
- Genetic workup
Case Study

• Patient had macrocephaly concerning for intracranial abnormality.
• Head CT shows enlarged subdural fluid collection consistent with subdural hygromas
• MRI showed findings concerning for possible trauma
• VP shunt placed without complications
• Blood breakdown products noted by surgeon
• No Genetic findings

Bilateral Subdurals

Case Study

• Concerns for malnutrition
• CPP work up
  – No retina bleeds
  – Skeletal Survey negative
• Follow up conversation with Aunt-in-law
  – Met patient for the first time 4 days ago
  – Felt her head was larger than normal that’s why she brought her with her to the Neurosurgery clinic
  – Found fingernail scratches on patients thigh and right side
  – Bruising on the right side of her head (had picture)
  – Stated mom had not fed patient 4 days prior to receiving her
  – Did not contact Child Division because family had recently been investigated and cleared
**Subarachnoid Hematoma**

- Disruption of small vessels in the cerebral cortex
- Most common hemorrhage in head trauma
- Infrequently associated with neurological deterioration

**Intracerebral Hematoma**

- [Image of intracerebral hemorrhage]

Anatomy of Brain

- [Diagram of brain anatomy]

Subarachnoid hematoma

- [Diagram of subarachnoid hematoma]

Intracerebral Hematoma

- Less common in children/trauma
- AVM and Stroke
- Acceleration/Deceleration
- Involve Temporal and Frontal Lobes
- Treatment

Case Study

- 16 year old unrestrained passenger
- Vehicle reportedly going 90 mph
- Car rolled over several times and patient thrown from vehicle
- On arrival to OSH patient alert and talking
- Patient had a decrease in LOC and was intubated

Case Study (continued)

- CT Negative
- Cardiac Contusion
- Pulmonary Contusions
- Bilateral Pneumos
- Pelvic Fracture
- Grade III Liver Lac
- Left Femoral Fracture
Case Study (continued)

- Day 2 noted to have decreased movement of the right side.
- Neurosurgery consulted
- Patient to unstable to transport to CT till Day 4
- CT Reveals:
  - Large Left MCA infarct
  - Left Sided carotid dissection

Case Study (continued)

- EVD Placed
- Maximized ICP therapies to control her Intracranial Hypertension
- Initiated anti-coagulation therapy
- Hospital Stay:
  - 24 Days in ICU
  - 8 Weeks Rehab

Intraventricular Hematoma
Intraventricular Hematoma

- Uncommon in children & adults after head trauma
- Associated with other Intracranial Injuries
- High mortality/morbidity when associated with other ICIs
- Treatment

Epidural Hematoma

- Diagram showing Epidural Hematoma and related structures
Epidural Hematoma

- Arterial Bleed (meningeal artery)
- Not common in children (1-6%)
- Low morbidity rate
- Treatment

Diffuse Axonal Injury

- Major complication in TBI which leads to functional and psychological deficits.
- Frequently underdiagnosed with conventional imaging.
- Evident in 90 percent of all TBI
- Responsible for immediate and prolonged coma
- Coup Contra coup Injury
- Multi-focal

Pathophysiology
Diffuse Axonal Injury

Algorithm for Mild TBI

Management of children with mild traumatic brain injury and intracranial hemorrhage
Case Study

• 13-year-old male
• Previous history of 2 concussions from football in 2012
• 12:00 riding ATV
• No helmet
• Thrown an undetermined distance
• Questionable LOC
• Refused treatment at the scene

Case Study (Continued)

• 1st ED visit
  – Arrived at 1348
  – C/O back pain
  – Road rash on right side of face
  – Goose egg left temporal area
  – Having trouble staying awake
  – No nausea or vomiting
  – Pain score 5

Case Study (Continued)

• Head CT read as negative
• Diagnosed with concussion
• Patient discharged to home at 15:30.
Case Study (Continued)

• 2nd ER Visit at 2040
  – C/O intense headache around 1840
  – Not acting like himself/delusional
  – Lethargic
  – Had emesis x 3
  – Pupils go from reactive to non-reactive within 15 minutes
  – Decision is made to transfer patient to SLCH

Case Study (Continued)

• CT at 2122 reveals a epidural bleed
• Patient is now combative and with slurred speech.
• GCS ranges from 11-13

Case Study (Continued)

• SLCH Transport Team arrive at 21:50
• GCS 8
  – Pupils
    • Left 8 mm/fixed
    • Right 3 mm/fixed
  – 1 gram Mannitol bolus given
  – GCS Improves
  – Decision was made not to intubate for flight placed on NRB
  – Left for SLCH at 22:50
Case Study (Continued)

• Five minutes before flight landed:
  – Patient became less responsive
  – Noted to be posturing
  – Pupils remained unequal and fixed
  – Pt noted to have agonal breathing

Case Study (Continued)

• Upon arrival to EU
  – GCS improved from a 5 to 8
  – Pupils equal but non-reactive
  – Bradycardia
  – Intubated in EU
  – Emergent CT scan ordered

Case Study (Continued)
Case Study

- 12 year old gunshot wound to the head
- 0600 went to check ground hog trap
- Was found by family member ~1 hour later unresponsive and covered in blood
- 0701 SLCH Transport Team dispatched to scene.
- 0718 Transport Team arrives at patient’s

Case Study

- Pt Assessment:
  - Gunshot wound to the left eye brow with uncontrolled bleeding
  - Patient maintaining airway with normal CO₂
  - GCS 9
  - Intermittently answering questions
- EMT
  - Trauma packed for transport
  - 1L of NS given to maintain adequate BP

Case Study

- 0730 Helicopter leaves for SLCH
- Patient starts to decline
  - Decrease in LOC
  - Hypertension
  - Bradycardia
- Mannitol administered in flight.
Case Study

- 0751 Arrived at SLCH
  - GCS 8
  - Vital Signs stable
- ED
  - Hypertonic Saline given for bradycardia
  - Patient intubated
  - PRBC

CT Scan

CT Scan
Case Study