Traumatic Brain Injury

Leading cause of death and disability in 1-45 year age group
- Predictive value of GCS ≤ 8
- Life changing disabilities: range from memory/personality changes to severe or persistent vegetative states

Mechanism of Injury in TBI
- The Injury
- Secondary injuries
- Complications of injury

The Injury (closed or open head injury)
- Deceleration
  - Coup contra coup
  - Hemorrhage
  - Diffuse Axonal Injury
  - Rotational
- Blunt trauma
- Penetrating trauma
- Diffuse Axonal Injury

Anterior Fossa #

Middle Fossa #
Lefort Type I

Lefort Type II

Lefort Type III

Mechanism of Injury in TBI

- Secondary Injuries
  - Hypotension
  - Hypoxemia
  - Severe anemia
  - Hypercarbia/acidosis
  - Hypoglycemia
  - Seizures

- Associated Injuries
  - Vertebrocarotid dissection
  - Cervical spinal cord injury
  - Thorac-abdominal trauma
  - Shock

- Complications
  - Infection
  - DVT
  - GI bleed
  - Secondary stroke

GCS

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Paediatric-GCS

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**Glasgow Coma Scale**
- Significant and reliable indicator of severity
- Measure prehospital and repeatedly and over time to follow change
- Measure after ABCs stabilized and preferably before sedating drugs administered
- Best response in first 24 hours most predictive
- ≤ 8 high probability of poor outcome

**CLOSED BOX THEORY**
- 5-10% CSF
- 5-10% blood
- 80% tissue

**Cerebral Perfusion Pressure (CPP)**

\[
CPP = MBP - ICP
\]

**Cerebral Edema**
- Trauma, hemorrhage or hypoxia triggers inflammation
- Capillary leak causes edema
- Edema worsens as blood flow improves
- Maximizes 48-96 hours
- New ischemia causes new cycle
- Symmetrical or asymmetrical

**Cerebral Injury (trauma, ischemic event)**
- Decreased CPP
- Increased Intracranial Volume
- Increased ICP
Management

- Prevent secondary injury
- Reduce the stuff in the box (brain, blood, CSF)
- Make the box bigger (decompressive craniotomy or craniectomy)
- Reduce brain oxygen requirements

Prevent Secondary Injury

- Assessment
  - Change
  - Headache, visual disturbances, vomiting
  - Swollen fontanelles (children)
  - Dilation, asymmetry or decreased reactivity of pupils
  - Decrease or asymmetry of motor function
  - Decrease in level of awareness or responsiveness
  - Beware!
    - Hypertension
    - Bradycardia
    - Respiratory alkalosis

Monitoring

- ICP
  - Only reliable way to know if elevated
  - Used to maintain determine CPP requirements
  - Patients with GCS < 7 and CPP > 70 had better outcomes than historical controls
  - TBI guidelines recommend ICP monitoring if GCS 3-8 with abnormal cranial findings on CT
  - Also with normal CT if:
    - > 40 years of age
    - Unilateral or bilateral posturing
    - SBP < 90

ICP Monitoring

- Types
  - Intraventricular
  - Parenchymal
  - Sub dural bolts
  - Epidural
Jarad sustains a closed head injury and C3 acute spinal cord injury during a motor vehicle injury. When paramedics arrive, he is found to be VSA. He has return of circulation after 10 minutes of CPR and ACLS. Initial CT head shows very little differentiation between grey and white matter.

ScvO2 93%
Arterial lactate: 4 mmol/L

Noninvasive Monitoring
- No reliable methods available yet
- Ultrasound-based may be promising
- Doppler TCD (measures blood flow velocity in proximal circulation)
- Intraocular pressure with hand held ultrasound
- Tympanic membrane displacement

Prevent Secondary Injury
- Airway
  - Intubate for GCS of 8 or less or fluctuating LOC
  - Intubation with neuroprotection
  - TBI = C spine injury until proven otherwise
  - Rapid sequence intubation; skilled intubator
  - High risk for and consequence to aspiration

Prevent Secondary Injury
- Maintain oxygenation:
  - 100% before suctioning
  - PEEP or not?

Prevent Secondary Injury
- Seizure prophylaxis and management
  - No level I evidence for routine prophylaxis
  - Consider for EDH, SDH, cerebral bleed, penetrating trauma, depressed skull fracture
  - Prophylaxis with dilantin X 7 days
  - Normal electrolytes; avoid rapid sodium changes
  - Normoglycemia (avoid hypo or hyperglycemia)
  - Recognize and treat (benzos, dilantin, propofol)
  - Consider continuous CEEG
Prevent secondary injury
Osmotic Diuretics

Mannitol
- 1gm/kg over 20-30 minutes for hernia syndromes
- Rebound rise 4-6 hours later that can be greater than pretreatment level
- Continued use based on ICP
  - .25-5 gm/kg over 30-60 minutes
  - maintain serum osmolality between 300-330

Hypertonic Saline
- Augments BP
- May protect blood brain barrier
- May be anti-inflammatory
- May be cell protective
- ? Best dose

Gastric decompression at admission
Patency of jugular veins (collars, trach ties)
Reduce intrathoracic and abdominal pressures
Minimize coughing
  - Analgesia, sedation, NMB if severe
  - Hyperventilate before suctioning

Hyperventilation for refractory intracranial hypertension
  - Reduction in PCO2 reduces cerebral blood flow (therefore, “stuff in the box”)
Reduce Metabolic Rate
- Analgesic: Propofol is not an analgesic
- Sedation
- Fever control
- Seizure control
- NMB if refractory
- Consider hypothermia if refractory

Surgical Decompression
- ICP monitoring with craniectomy
- Can prevent progression to neurological death (potential for persistent vegetative

http://thejns.org/?mi=3bwiax&af=R

Prevention of Complications
- DVT prophylaxis: when to anticoagulate?
- Gut prophylaxis
- Early feeding with small bowel feeding tube
- CLI
- VAP
- Meningitis
  - ICP line
  - Basal skull fractures
  - CSF leaks

Organ Donation
- Brain death
- Donation after cardio circulatory death