The ABCs of TBI

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Outline
- Statistics
- Anatomy
- Classification of TBI
- Pathophysiology behind increased ICP
- PBtO2
- Management Strategies
- Mild TBI

TBI stats
- 2 million TBI’s treated each year in US, one every 15 seconds
- Leading cause of M&M in young adults
- Single severe TBI victim can generate 4 million dollars in lifetime costs
- Falls are leading cause of TBI in adults >65
- Adults ages >75 have highest rates of TBI related hospitalization and death
- 70-90% of TBI worldwide are considered “mild,” 1% of those require a surgical intervention

Classification of TBI
- Pathoanatomic
- Physical Mechanism
- Pathophysiologic
- Injury Severity

Pathophysiologic
- Primary Injury
  - Immediate damage done
- Secondary Injury
  - Potentially avoidable factors
  - Hypoxia, hypotension, hypercarbia, hyponatremia, seizures
Injury Severity

- **GCS**
  - 13-15 → Mild TBI
  - 9-12 → Moderate TBI
  - <8 → Severe TBI

Predicting Outcomes

- Study using data from CRASH trial looked at predicting outcomes (death at 14 days and death/disability at 6 months)
- Best predictors: age (>40), low GCS, obliteration of basal cisterns/third ventricle, pupillary response, other extracranial injuries

Rotterdam CT scoring

- Basal Cisterns: open, compressed, absent
- Midline Shift: < or > 5mm
- Epidural Mass Lesion
- IVH or Traumatic SAH

Imaging

- **Noncon Head CT**
- MRI
- CTA
- Other trauma imaging

ICP

- Monroe-Kellie Hypothesis: Blood, brain, CSF
- Normal ICP → 5-15mmHg (3-7mmHg young children)
- In TBI, the balance gets disrupted

Cerebral Perfusion Pressure (CPP)

- CPP = MAP-ICP
- Normal CPP >50mmHg
- CBF:
  - Directly proportional to CPP and vessel radius
  - Inversely proportional to blood viscosity and vessel length
**Causes of Increased ICP**

- Intracranial
  - Hematomas/Contusions
  - Ischemia
  - Hydrocephalus
  - Increased CBF
- Extracranial
  - Hypoxia
  - Hypercarbia
  - Hyper/Hypotension
  - Head rotation
  - Fever
  - Seizure
  - Increased intraabdominal pressure

**Monitoring in TBI**

- ICP
- Brain tissue oxygen
- Microdialysis
- Jugular venous saturation
- Cerebral blood flow

**What about brain tissue oxygen?**

- Secondary brain injury not always associated with increased ICP
- Study by Spiotta et al looked at conventional ICP/CPP management vs PbtO₂-based therapy
- 70 pts with severe TBI managed with Licox to keep PbtO₂ > 20mmHg as well as ICP/CPP
- Compared with 53 historical controls with goal of ICP <20 and CPP >60
- Lower mortality and more favorable short term outcomes

**How do we treat low PbtO₂?**

- Increase oxygenation
- Increase MAP
- Change PCO₂

**Early Management of TBI**

- ABC’s
- Imaging
- Emergent treatment

**ABC’s**

- Airway
  - Avoiding hypoxia
  - RSI
  - Post-intubation sedation
- Breathing
  - Normocarbia
- Circulation
  - Avoiding hypotension
### Treating ICP

- Keeping things “normal”
- Sedation
- Positioning
- Mannitol/Hypertonic saline

### Mannitol vs Hypertonic Saline

- Mannitol
  - Rheologic effects
  - Osmotic effects
  - Crosses BBB
  - Contraindicated in hypovolemic pts

- HTS
  - Osmotic effect
  - Can be used in hypovolemic pts
  - Can cause hyperchloremic acidosis, decreased platelet aggregation

### Emergent Treatment

- Hyperventilation
- Decompressive Hemicraniectomy

### Hyperventilation

- Decreased PaCO2 \( \rightarrow \) alkalinizing CSF \( \rightarrow \) cerebral vasoconstriction
- Decreased CBV \( \rightarrow \) decreased ICP, BUT........
- Effects last around 6 hours until CSF pH equilibrates
- Then there is re-dilation of cerebral arteries \( \rightarrow \) rebound ICP

### Decompressive Hemicraniectomy

- Most often a rescue procedure
- Data equivocal on whether outcomes improved

### Outcomes

- Difficult to make early predictions on outcome
  - Initial GCS
  - Pupils/Motor Score
  - Other injuries
  - MR spectroscopy
  - Specialty care in neuro-ICU's improve outcomes
Mild TBI

Study by Bazarian et al looked at mild TBI in the ED

- Used the NHAMCS for isolated mild TBI
- Less than ½ of patients were asked about pain
- Only half of those were treated
- Only 34% of those discharged from level I trauma centers were referred for further follow-up

Help for Mild TBI

- Educate patients on the possible symptoms from mild TBI
- Ensure follow-up

Summary

- TBI is a serious healthcare issue, especially in the elderly
- There are many different ways to classify TBI
- Prevention of secondary injury is key
- Educate patients with mild TBI

References