Severe Traumatic Brain Injury

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Objectives

- Discuss the key elements of the neurologic exam in patients with severe traumatic brain injury
- Present the controversy surrounding prehospital airway management of patients with severe TBI
- Discuss indications for ICP monitoring
- Discuss strategies in managing increased ICP

Case

- 18 year-old male assaulted with a lead pipe and beaten several times on the back of the head. Unconscious upon EMS arrival, now intermittently agitated.
- GCS score 8: Eyes open to pain (2), verbal inappropriate words (3), motor flexion abnormal (3). Pupils equal and reactive.
- The on-scene paramedic calls in requesting orders for sedative-assisted intubation. Their anticipated transport time to your ED is 15-20 minutes.

EMS Airway Management

- Prospective study of adult trauma patients:
  - GCS ≤ 8
  - Transport time > 10 minutes, and
  - Inability to intubate without RSI
- Midazolam and succinylcholine was used for RSI; rocuronium was given after ETT confirmation.

Davis DP. *J Trauma* 2003; 54:444

EMS Airway Management

- 209 patients were enrolled and compared to 627 controls.
- The two groups were similar.

	Mortality	Good Outcome
Field RSI group	33%	45%
ED RSI group	24%	57%

Davis DP. *J Trauma* 2003; 54:444

Case continued

- Patient was given lorazepam 2 mg in the field; arrives in the ED backboarded and collared with bag-valve-mask assisted ventilations
- BP is 90 / 60, P 110, RR 24, Pulse Ox 92%, blood glucose 100.
- GCS score 5 (nonverbal 1, eyes open to pain 2, extension posturing 2)
- Right pupil dilated and fixed

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Clinical Indicators of Increased ICP/ Herniation

- Unilateral or bilateral unreactive, dilated pupil
- Extensor posturing (decerebrate)
- In patients with a GCS score <9, a 2 point decrease in GCS score

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Airway Management in Severe TBI

- Premedicate:
  - Minimize reflex sympathetic response
    - Lidocaine, fentanyl, defasciculating dose of ndp
- Induction:
  - Avoid hypotension
    - Etimodate
- Paralyze:
  - Succinylcholine

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Severe TBI Guidelines (BTF / AANS)

- Standards
  - Prophylactic hyperventilation should be avoided
  - Use of glucocosteriods is not recommended
  - Prophylactic phenytoin is not recommended for late sz
- Guidelines:
  - Hypotension and hypoxia must be avoided
  - ICP monitoring is appropriate
  - Mannitol is effective for controlling raised ICP
- Options
  - Hyperventilation may be necessary for brief periods when there is acute neurologic deterioration
  - AEDs may be used to prevent early posttraumatic sz

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ICP Management

CPP = MAP – ICP

ICP : < 20 mm Hg
MAP: 100 – 110
CPP: near 70 mm Hg

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Hyperventilation

- Aggressive hyperventilation has been the cornerstone of ICP management for the past 20 years
- Hyperventilation reduces ICP by causing cerebral vasoconstriction
- Focal/regional reduction in cerebral perfusion the consequence

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Hyperventilation

- Hyperventilation [PCO2 from 36 to 29 mmHg] in 33 patients with severe TBI increased the volume on PET scanning of severely hypoperfused tissue within the injured brain, despite improvements in cerebral perfusion pressure and intracranial pressure.
- Hypoperfusion associated with accumulation of cytotoxic byproducts including glutamate, pyruvate, and lactate
- Prospective, randomized trial of 77 patients with severe TBI. 5 days of prophylactic hyperventilation [versus eucapnea]. At 3 and 6 months – outcome was significantly better in the control group.

Marion DW. *CCM* 2002; 30:2774 Muizelaar JP. *J Neurosurg* 2001; 75:731

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BTF Recommendations

- Endpoint = 30 mmHg with careful end-tidal PCO_2 monitoring
- In conjunction with other measures, for:
  - Asymmetric pupil response
  - Unilateral or bilateral pupil dilatation
  - Motor posturing
  - Rapid neurologic decline

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Mannitol

- Immediate plasma-expanding effect
  - Benefits CPP
  - Decrease hematocrit and blood viscosity
- Delayed osmotic effect, with onset in 15-30 minutes and duration from 1 to 6 hours
  - The later is responsible for ICP reduction

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Hypertonic Saline

- Plasma volume expander
- Increases MAP without increasing ICP thus results in improved CPP
- Dehydrates tissue simultaneously improving perfusion and decreasing edema
- Does not cause osmotic diuresis
- Human studies using 7.5% - 29% concentrations report 20 – 50% decreases in ICP
- Not first line at this time

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Hypertonic Saline

- Prospective, randomized, double-blind trial comparing outcome in 229 patient with severe TBI and hypotension in the field
- Hypertonic saline 250 cc 7.5% LR vs LR
- Results - No baseline differences between groups
  - Mean GCS = 4, ISS = 38, fluid = 1250
  - No difference in BP on ED arrival
  - No difference in survival or outcomes

Cooper DJ. *JAMA* 2004; 291:1350.

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Future Directions

- Induced hypothermia
- Neuroprotectants
- Neurogenesis

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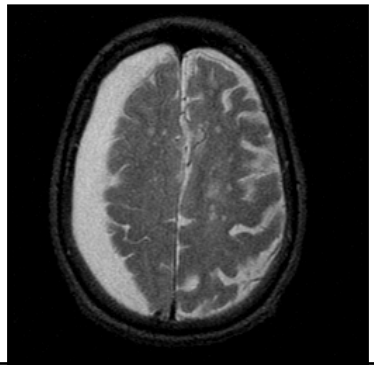
Case Continued



Conclusions

- Hypoxia and hypotension must be carefully assessed for and corrected in severe TBI patients
- Prehospital intubation has been associated with worse outcomes in severe TBI patients and its indications must be reassessed
- Patients with severe TBI should have an ICP monitor placed in the emergency department / trauma center
- Hyperventilation is a temporizing measure in the management of elevated ICP
- Mannitol is the first line agent for managing elevated ICP; the indications for hypertonic saline are yet to be clearly defined

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Questions??

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