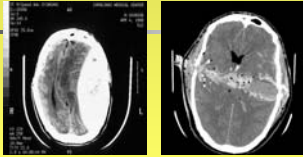


## Neuro-resuscitation: TBI



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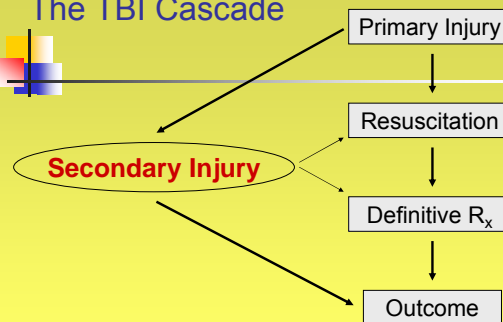
## Why talk about this?

- 150,000 trauma deaths in the US each year, 1/3 due to TBI
- 250,000 TBI survivors require hospitalization and inpatient care
- Prehospital and ED care is critical to improving outcomes
- \$40 billion spent each year

Brain Trauma Foundation, 2000  
[www.braintrauma.org](http://www.braintrauma.org)

- Guidelines for the prehospital management of TBI
- Guidelines for the management of severe TBI

## The TBI Cascade



## Secondary Injury In TBI


- Prospective study of 717 patients with severe TBI at 4 centers.
- A single episode of hypotension (BP <90 mmHg) or hypoxia (PaO<sub>2</sub> <60 mmHg) during the initial resuscitation was associated with a significant increase in morbidity and mortality.

Chestnut RM. *J Trauma* 1993; 34:216.

## 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.

???



Should the patient be intubated at the scene?

A. Yes?

B. No?

### EMS Airway Management

- Prospective study of 191 adult trauma patients with TBI (GCS  $\leq$  8).
- Intubation – 51% field/49% ED:
  - Field intubation mortality 23%.
  - ED intubation mortality 12%
  - Field intubation associated with longer ventilation, ICU and hospital stay
- Limitations: patient selection, transport time

Bochicchio GV. *J Trauma* 2003; 54:307.

### EMS Airway Management

- Prospective study of adult trauma patients:
  - GCS  $\leq$  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.

### EMS Airway Management

- Prospective adult TBI trial (GCS <8)
- RSI with midazolam & succinylcholine
- No more than 3 attempts were allowed
- A Combitube<sup>®</sup> was used when RSI failed
- PO<sub>2</sub>, end-tidal PCO<sub>2</sub>, HR were monitored
- Success rates and complications were tracked

Dunford JV. *Ann Emerg Med* 2003; 42:721.

### EMS Airway Management

- RSI was successful in 49/53 (89%).
- Thirty-one (57%) desaturated during RSI; 26 (84%) of these occurred in patients with a SaO<sub>2</sub> >90% prior to paralysis
- The median duration of desaturation was 160 seconds (max 270 seconds) and the median percent decline in oxygen saturation was 22%

Dunford JV. *Ann Emerg Med* 2003; 42:721.

???

Should the patient be given a sedative [eg: Haldol® vs Ativan®] to facilitate transport?

A. Yes?

B. No?

### Brain Targeted Therapy

- Sedation and analgesia:
  - benzodiazepines and neuroleptics
  - One study found droperidol, 5 mg IV, safe in the prehospital setting
- Glucose
  - One case series demonstrates difficulty identifying cause of altered mental status in suspected TBI patients
  - Prehospital glucose determination recommended
  - Limitations of testing and controversies of treatment

### Management of undifferentiated agitation in the ED. Acad Emerg Med 2005; 12:1167

- Prospective randomized double blind trial: im 5 mg droperidol, 20 mg ziprasidone, 5 mg midazolam
  - ETOH most common
- 144 patients; altered mental status score
- Midazolam was the fastest acting (< 15 min) but more frequently required rescue med and supplemental oxygen
- Ziprasidone had the slowest onset

### 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

???

Intubation technique [RSI vs other]?

A. RSI

B. Other

???

Your rescue technique if RSI is unsuccessful?

A. Trach light?

B. I-LMA?

C. Combitube?

D. Surgical?

E. Surgical?

### Rapid Sequence Intubation

**7 P's FOR RSI PROCEDURE**

- Preparation
- Preoxygenation
- Pretreatment
- Paralysis and sedation
- Protection and positioning
- Pass the tube
- Post intubation management

National Emergency Airway Course®

### Reflex Sympathetic Response To Laryngoscopy (RSRL)

- Results from manipulation of the airway
- Indirect and direct pathway
- Not eliminated by paralysis
- Response:
  - Hypertension, tachycardia
  - Increased ICP
  - Increased IOP

### Rapid Sequence Intubation

Pretreatment with **LOAD** drugs:

Lidocaine	1.0 mg/kg
Opiate (Fentanyl)	3-5 ug/kg
Atropine	0.02 mg/kg
Defasciculation	0.01 mg/kg

National Emergency Airway Course®

### Lidocaine: What Do We Know?

Does lidocaine suppress the RSRL?	<b>MAYBE</b>
Does lidocaine suppress the cough reflex (direct reflex response to laryngoscopy)?	<b>YES</b>
Is there any evidence that lidocaine improves outcome in patients with TBI?	<b>NO</b>

Robinson N. *Emerg Med J* 2001; 18:453.

### Fentanyl: What Do We Know?

Does laryngoscopy precipitate a rise in blood pressure and pulse?	<b>YES</b>
Can this be deleterious in patients with acute CNS or cardiovascular disease?	<b>YES</b>
Does intravenous fentanyl blunt the blood pressure/pulse response?	<b>YES</b>
Can fentanyl cause hypotension & apnea in the compromised patient?	<b>YES</b>

### Defasciculation: What Do We Know?

Do SCH-associated fasciculations increase ICP in certain at-risk patients?	<b>YES</b>
Does pretreatment with a non-depolarizer reduce this phenomena?	<b>YES</b>
Is there any evidence that SCH increases ICP in patients with TBI?	<b>NO</b>
Is there any evidence that SCH worsens outcome in patients with TBI?	<b>NO</b>

### RSI Induction Agents

- Midazolam
- Thiopental
- Etomidate
- Propofol
- Ketamine

### Succinylcholine

- 'Quick on quick off' a significant benefit
- Paralysis in 45 sec, duration 6-8 min
- No evidence of clinically important increases in intracranial pressure in TBI
- Relevant side-effects:
  - Hyperkalemia
  - Bradycardia [children; 2<sup>nd</sup> dose]

???

Best strategy for managing acute herniation:  
Decerebrate posturing, "blown pupil"



- A. Hyperventilate
- B. Mannitol
- C. Hypertonic saline
- D. Barbituate coma

???

Best strategy for managing increased ICP?

- A. Hyperventilate
- B. Mannitol
- C. Hypertonic saline
- D. Barbituate coma
- E. Hypothermia

### ICP Management



CPP = MAP - ICP

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

### 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

### Hyperventilation

Hyperventilation [PCO<sub>2</sub> 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

Coles JP. *CCM* 2002; 30:1950-9.  
 Marion DW. *CCM* 2002; 30:2774-5

### Hyperventilation

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.

Muizelaar JP. *J Neurosurg* 2001; 75:731-9

### Hyperventilation: What Do We Know?

Does <u>chronic</u> hyperventilation worsen outcome in severe TBI?	YES
Does <u>acute</u> hyperventilation worsen outcome in severe TBI?	MAYBE
Is there a role for hyperventilation in acute severe TBI?	???

### BTF Recommendations

- **Endpoint = 30 mmHg** with careful end-tidal PCO<sub>2</sub> monitoring
- In conjunction with other measures, for:
  - Asymmetric pupillary response
  - Unilateral or bilateral pupillary dilatation
  - Motor posturing
  - Rapid neurologic decline

[www.braintrauma.org](http://www.braintrauma.org) - 2000

### Hyperventilation

Prospective analysis of 37 intubated TBI patients without clinical herniation undergoing air transport to a Level I Trauma Center:

Assisted RR >14 bpm	60%
PaCO <sub>2</sub> < 30 mm Hg	70%

Thomas S. *J Trauma* 2002; 52:47-53.

### 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

### Mannitol

Prospective, randomized trial comparing mannitol to barbiturates for ICP control in 59 patients with severe brain injury

- Improved CPP control
- Lower mortality = 41% (M) vs. 77% (B)

Schwartz ML. *Can J Neurol Sci* 1984; 11:434

### Mannitol: What Do We Know?

Does mannitol effectively reduce ICP in patients with severe TBI?	YES
Do we know the right dose?	NO
Bolus dosing better than infusion?	YES
BP 'floor' for safe administration?	???

Schierhout G. *Cochrane Systematic Reviews* 2000.

### 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

### Hypertonic Saline

Prospective, randomized, double-blind trial comparing outcome in 229 patient with severe TBI and hypotension in the field:

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    graph TD
      A[Prospective, randomized, double-blind trial comparing outcome in 229 patient with severe TBI and hypotension in the field:] --> B[Hypertonic Saline  
250 cc 7.5%  
Lactated Ringers]
      A --> C[Control  
Lactated Ringers]
    
```

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

### Hypertonic Saline

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.

Huizenga et al. Guidelines for the management of severe head injury: Are emergency physicians following them? *Acad Emerg Med* 2002; 9:806-812

- 319 / 566 survey responses (56%) to 3 cases
  - 78% corrected hypotension
  - 46% used prophylactic hyperventilation
  - 14% used glucocorticoids
  - 8% used prophylactic mannitol
- Authors conclusion: A majority of emergency physicians are managing TBI according to the guidelines
- My conclusion: 7 years post publication, a significant number of emergency physicians are not correctly managing severe TBI



### Future Directions

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- Induced hypothermia
- Neuroprotectants
- Neurogenesis



### Conclusions

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- Hypoxia and hypotension must be carefully assessed for and corrected in severe TBI patients
- Prehospital RSI intubation has been associated with worse outcomes in severe TBI patients and its indications must be reassessed
- 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