Anesthesia for the Head-Injured Patient

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Disclosures: None
Anesthesia for the Head Injured Patient

- Airway management
- Blood pressure
- Hyperventilation
- Pharmacotherapy
  - osmolar Rx
  - wonder drugs
  - barbiturates
  - glycemic control
- Hypothermia
• Teenage boy s/p surgery / radiation for astrocytoma
• Clinically stable, occasional seizures
• Fall b/o seizure.
• Trauma bay: GCS 3, fixed and dilated
• Intubated; mannitol 50 gm
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• Intubated; mannitol 50 gm
# Glasgow coma scale

<table>
<thead>
<tr>
<th>Eye opening</th>
<th>Score</th>
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<tbody>
<tr>
<td>spontaneously</td>
<td>4</td>
</tr>
<tr>
<td>to speech</td>
<td>3</td>
</tr>
<tr>
<td>to pain</td>
<td>2</td>
</tr>
<tr>
<td>none</td>
<td>1</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Verbal response</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>orientated</td>
<td>5</td>
</tr>
<tr>
<td>confused</td>
<td>4</td>
</tr>
<tr>
<td>inappropriate</td>
<td>3</td>
</tr>
<tr>
<td>incomprehensible</td>
<td>2</td>
</tr>
<tr>
<td>none</td>
<td>1</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Motor response</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>obeys commands</td>
<td>6</td>
</tr>
<tr>
<td>localises to pain</td>
<td>5</td>
</tr>
<tr>
<td>withdraws from pain</td>
<td>4</td>
</tr>
<tr>
<td>flexion to pain</td>
<td>3</td>
</tr>
<tr>
<td>extension to pain</td>
<td>2</td>
</tr>
<tr>
<td>none</td>
<td>1</td>
</tr>
</tbody>
</table>

**Maximum score** 15
• Teenage boy s/p surgery / radiation for astrocytoma
• Clinically stable, occasional seizures
• Fall b/o seizure.
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• Intubated; mannitol 50 gm
Intubating the Head Injured Patient

1. Increased ICP
2. Full stomach
3. Uncertain cervical spine
4. Uncertain airway
   - blood
   - airway injury
   - skull base fracture
5. Uncertain volume status
6. Uncooperative / combative
7. Hypoxemia
The Cervical Spine in Multiple Trauma

- Incidence of cervical fracture:
  - $\approx 2\%$ of blunt trauma survivors
  - $\approx 8\%$ of TBI survivors with GCS $< 8$

- Intubation often must occur before X-ray evaluation

- (Fortunately) The majority of fractures are not unstable

Morris & McCoy; Anaesthesia 59: 464-82, 2004
Crosby; Anesthesiology 104: 1293-318, 2006
Intubating the Head-Injured Patient

- Emergent: RSI, MIAS, Sellick man.
- How to proceed when it is less urgent?
Trauma Intubations and Neurologic Injury:

Trauma Center survey: 8 of 83 directors knew of cases

Case report: Paraplegia after intubation
Hastings et al. Anesthesiology 78: 580, 1993

Case report: Quadriplegia after intubation
Paraplegia after intubation
Muckart et al. Anesthesiology 87: 418, 1997

Rare - But not Non-existent
“Clearing” the cervical spine?
The Cervical Spine in Multiple Trauma

- GCS = 15
- No intoxicants or drugs
- Negative physical examination
  - No midline tenderness
  - No neurological deficit
  - Full active ROM
- No significant distracting* injuries

Clinical clearance of the cervical spine in patients with distracting injuries: It is time to dispel the myth


Melanie K. Rose, MD, Lindy M. Rosal, BS, Richard P. Gonzalez, MD, Jack W. Rostas, MD
What about the patient you can’t examine?
Modern CT alone is sufficient to detect unstable cervical spine injuries.

Results of this meta-analysis strongly show that the cervical collar may be removed from obtunded or intubated trauma patients if a modern CT scan is negative for acute injury.
Intubation "Plans"

• **Plan A:**
  Usually: RSI - MIAS - Sellick maneuver

• **Plan B:**
  Laryngeal mask
  Bougie
  Glidescope
  Combitube
  Cricothyrotomy *

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Intubating the Head Injured Patient

**Principle:** The recently injured brain is very intolerant of "second insults" (e.g., hypoxia, hypotension)

First: A. B. C.
Then: I. C. P.
• Teenage boy s/p surgery / radiation for astrocytoma
• Clinically stable with seizures
• Fall b/o seizure.
• Trauma bay: GCS 3, fixed and dilated
• Intubated; mannitol 50 gm; CT scan
Mannitol

1g/kg (infusion)

0.25 g/kg

Increments: 12.5 g

Limit: 320 mOsm/L

(Factitious hyponatremia)

HTS
Hypertonic Saline

• Might be advantageous in repeat dosing situations
  - less hypovolemia.

• Variations in concentrations (3%, 7.5%, 15%, 23.4%) and osmolar loads in the various studies, it is difficult to make specific recommendations.

• (Anecdotal support for hypertonic saline “rescue” after mannitol failure.)
"... data suggest that HTS can be more effective than mannitol."

"... low numbers, limited RCTs, inconsistent methods"

(Anecdotal support for hypertonic saline “rescue” after mannitol failure)
High quality data are still needed to define the most appropriate osmotherapeutic agent, the optimal dose, the safest and most effective mode of administration and to further elucidate the mechanism of action of 23.4% saline and of osmotherapy in general.
• Teenage boy s/p surgery / radiation for astrocytoma
• Clinically stable with seizures
• Fall b/o seizure.
• Trauma bay: GCS 3, fixed and dilated
• Intubated; mannitol 50 gm; CT scan
• Taken to OR
• Desflurane during vascular access (2 IVs, a-line)
• Then, fentanyl 150 ug, propofol 150 ug/kg/min
• Desflurane D/C’d
When ICP is out of control (or when you don’t know but you have reason to worry), omit all of the inhaled agents.
Propofol drip was started at 150 mcg/kg/min with a phenylephrine drip at 40 mcg/min. The patient received another 50 gm mannitol per surgery request and surgery commenced. He was bolused with 150 mcg of fentanyl.

Blood pressure averaged SBP’s of 140’s-150’s initially with HR 100-110 and minute ventilation was adjusted with goal ET-CO2 ~ 27.

Initial ABG on FiO2 50% 7.36 / 33 / 118 / 18 / -6.8/ Hb 12.2
Propofol drip was started at 150 mcg/kg/min with a phenylephrine drip at 40 mcg/min. The patient received another 50 gm mannitol per surgery request and surgery commenced. He was bolused with 150 mcg of fentanyl.

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Initial ABG on FiO2 50% 7.36 / 33 / 118 / 18 / -6.8/ Hb 12.2
How would you have managed BP & CO2?
Autoregulation is easily impaired
Insertion of a Tracheostomy Cannula

ICP (torr)

0

200

BP (torr)

0

Pentothal 150 mg
Cerebral circulation and metabolism after severe traumatic brain injury: The elusive role of ischemia

Bouma et al., (MCV / Neurosurg), J Neurosurg 75: 685-93, 1991

- During the first 6 hours after injury, CBF was low (23 ± 5)"
- Focal CBF was < 18 in 1/3 of patients studied within 6 hrs of injury
Systemic Hypotension / Outcome after TBI

The association of hypotension occurring early after TBI with poorer neurologic outcomes has been demonstrated in both adults and children.

Chesnut. J Trauma 34: 216, 1993
What should the target CPP* be in the adult head-injury patient?

* CPP = MAP - ICP
? CPP = 70 mmHg
"The appropriate guideline for maintenance of CPP is still controversial. It is inappropriate to argue that a CPP level below 60 mmHg is safe and appropriate in the adult [in the first 72 hours after TBI]."

\[80 - 20 = 60 \text{ mmHg}\]
"... a significant decrease until day 4 followed by an incomplete recovery. ..."
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Initial ABG on FiO2 50% 7.36 / 33 / 118 / 18 / -6.8 Hb 12.2
(It requires very severe injury to eliminate CO2 responsiveness)
In some cases ischemia was successfully treated by inducing arterial hypertension or by reducing hyperventilation. 

Bouma et al., (MCV/Neurosurg), J Neurosurg 75: 685-93, 1991
Adverse Effects of Prolonged Hyperventilation in Patients with Severe Head Injury (GCS ≤ 8)

Muizelaar et al., (MCV) J Neurosurg 75: 731-9, 1991

- Hypervent: (n = 36)  GCS: 5.6  PaCO2 25
  Normocap: (n = 41)  GCS: 5.7  PaCO2 35

Among patients with good admission motor scores (4 - 5) there were fewer favorable outcomes (p < 0.05) in the hyperventilation group three and six months post injury.
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Among patients with good admission motor scores (4 - 5) there were fewer favorable outcomes (P < 0.05) in the hyperventilation group three and six months post injury.

Conclude: Prophylactic hyperventilation is deleterious

4 = withdraws from pain; 5 = localizes to pain
But when an ICP crisis occurs, hyperventilation is still an appropriate technique!
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Initial ABG on FiO2 50% 7.36 / 33 / 118 / 18 / -6.8 Hb 12.2
At 12:20, the surgeon opened the dura. Systolic pressure dropped to 90’s and stabilized after a crystalloid bolus, decreasing the propofol drip and increasing the phenylephrine drip to 60 mcg/min. At 12:25 the SBP dropped to 60’s, HR increased to 120’s, and ETCO2 was noted to be 22. Surgeons noted blood loss at operative site and empirically 2 units prbcs were hung and bolused in. Propofol drip was stopped and FiO2 was increased to 100%. Phenylephrine and vasopressin were bolused without improvement. [Call for help.] (Coagulopathy)

The SBPs dropped to and remained in the 50’s despite fluids and boluses of dilute epinephrine, vasopressin and phenylephrine.
Two more units prbcs were hung and the patient was placed in the head down position. With initial attempts with IV therapy being ineffective, chest compressions were initiated. Despite effective chest compressions and multiple rounds of epinephrine /vasopressin / calcium chloride / bicarb the patient progressed to asystole.

CPR was stopped and time of death was pronounced at 13:03. Preliminary autopsy results showed no gross cardiovascular findings. Surgeons estimated total blood loss at 300 – 500 cc.
What on earth happened?
Cushing’s Reflex?
Anesthesia for the Head Injured Patient

- Airway management
- Blood pressure
- Hyperventilation
- Pharmacotherapy
  - osmolar Rx
  - wonder drugs
  - barbiturates
  - glucose control
- Hypothermia

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Pharmacologic Treatment of Head Injury

- NMDA antagonists
  - Selfotel
  - Aptiganel
  - ACEA-102
  - CP-101,606
- Superoxide dismutase; tirilazad
- Triamcinolone; methylprednisolone
- Nimodipine
- Etomidate
- Bradycor
- Barbiturates
Pharmacologic Treatment of Head Injury

- NMDA antagonists
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- Superoxide dismutase; tirilazad
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- Barbiturates
"Barb Coma" for Head Injury

- Clinical trials: Outcome benefits have been inconsistent

- Theme 1: ICP responders have improved survival  
  (Marshall et al., 1979)

- Theme 2: Not everyone responds  
  - ? focal injury better than diffuse  
  - poor CO2 response = poor barb resp.  
  (Nordstrom et al., 1988)
Flow / Metabolism Coupling

CBF (ml/100 gm/min)

100

75

50

25

Cerebral Metabolic Rate (ml O₂/100 gm/min)

1

2

3

4

5

6

7

Seizure

Pain

Anxiety

Awake

Anesthetized

Carb coma

(CBF nadir reached at complete EEG suppression)
I. RECOMMENDATIONS

A. Level I

There are insufficient data to support a Level I recommendation for this topic.

B. Level II

Prophylactic administration of barbiturates to induce burst suppression EEG is not recommended.

High-dose barbiturate administration is recommended to control elevated ICP refractory to maximum standard medical and surgical treatment. Hemodynamic stability is essential before and during barbiturate therapy.

Propofol is recommended for the control of ICP, but not for improvement in mortality or 6 month outcome. High-dose propofol can produce significant morbidity.
Anesthesia for the Head Injured Patient

**Airway:**
Hypnotic-relaxant-tube usually OK;
Watch for high risk situations with time latitude

**BP:**
CPP target 60 mmHg

**Hypocapnia:**
Only when you must

**Drugs:**
Barbs for ICP control

**Hypothermia:**
Not supported (for now)

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Head Injury - Anesthetic Technique

- RSI (etomidate, sux) / Sellick / MIAS
- Assure cerebral venous drainage
- Anesthetics q.s. prevent sympathetic response
- Avoid cerebral vasodilators

- Mannitol: initial ≈ 1.0 gm / kg; increments 0.25 gm / kg
- CPP 60 mmHg (A-line)
- Normovolemia
- Iso/hyperosmolarity
- ↓ PaCO₂ p.r.n.
- Paralysis
- Anticonvulsants (7 days)
- (CSF drainage)
- (↓ CMR / Hemicraniectomy)