Management of Catastrophic Brain Injury

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Acute Care Surgery/Surgical Critical Care
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Catastrophic Brain Injury

- Blunt, polytrauma patients
- Multiple injuries
- CT scan consistent with herniation or impending herniation
- Neurosurgery deems injury non-survivable
Catastrophic Brain Injury

- Protect the brain
- Early Intensive Care Management
Catastrophic Brain Injured

Improve

Does NOT Improve

Donor

Not a Donor
Catastrophic Brain Injury

**GOAL** is to decrease Intracranial Pressure

- HOB elevation
- C-collar too tight
- Pain control/sedation
- Intubation
- Hyperventilation

- Resuscitation.....
Catastrophic Brain Injury

Cerebral perfusion
Catastrophic Brain Injury

hyperventilation
  >> decrease pCOs
  >> vasoconstriction
  >> decrease arterial volume
  >> decrease ICP
Catastrophic Brain Injury

- Resuscitation fluid
- Isotonic vs. hypertonic saline
Hypertonic Saline

- 250-500 cc (4cc/Kg)
- 5 minute infusion
- 3 - 7.5%
- +/- Dextran 6%
Hypertonic Saline

- Animal studies support improved microcirculatory flow

- Increases
  - Intravascular volume
  - Osmolarity
  - Brain perfusion
Hypertonic Saline

- Decreases
  - Pro inflammatory cytokines
  - Capillary permeability
  - Brain edema

- Diminish biomarkers
  - Suggest mitigation of brain injury
  - S100, enolin

Hypertonic Saline
Human, Animal and Cell Studies

- Decreased *PRO* and increased *ANTI*-inflammatory cytokines
- Renders *Neutrophil* unable to adhere and cause injury
- Mediated by cell shrinkage

Hypertonic Saline Summary

- Safe
- Equivalent to isotonic crystalloid as volume expander
- Promising immunomodulatory role
Intensive Care Management
Catastrophic Brain Injured

- Improve
- Does NOT Improve

- Donor
- Not a Donor
Catastrophic Brain Injury Guidelines “CBIG”

- SBP > 90
- UOP > 1 ml/kg/hr
- PO$_2$ > 100
- pH 7.35-7.45
- Electrolytes
- Glucose
- Coagulation
- Normothermia
Hormone Depletion

- Herniation leads to CV deterioration
- Impaired cellular oxygen use
  - Aerobic to anaerobic metabolism
  - Increased lactate
- Depletion of energy stores
- Associated with hypothyroid state
Endocrine Deficiency

- Cortisol
- ADH
- Insulin
Hormone Replacement Protocol

- 1 amp D50
- 2g Solumedrol
- 20 units regular insulin
- 20 mcg Thyroxine
  - Start drip 10mcg/h, titrate up
  - Monitor K+
The role of thyroid hormone administration in potential organ donor

- Prospective study, N=19
- **Hypothesis**: T4 therapy will reverse the hemodynamic instability and prevent CV collapse in brain-dead patients who are potential organ donors
- Donors optimized on institution protocol and hormonal replacement after failure

The role of thyroid hormone administration in potential organ donor

T₄ administration

<table>
<thead>
<tr>
<th>Total Vasopressor Dose (mcg/kg/min)</th>
<th>Time interval in hours Time 0 is start of T₄</th>
</tr>
</thead>
</table>

Catastrophic Brain Injured

- Improve
- Does NOT Improve

- Donor
- Not a Donor
Organ Donation

- Remains a national crisis
- National call for improvement

- 128,562 waiting
- 18 deaths/day while waiting

UNOS database, 2013
Organ Donation

• Organ Donor Collaborative
• Public Education
• Registries
• 40% of adult population registered to donate
Organ Donor Collaborative

- 2003
- Health and Human Services recognized the organ shortage
- GOAL: dramatically increase access to transplantable organs
  - Increase number of donors
  - Increase organ transplanted per donor (OTPD)
<table>
<thead>
<tr>
<th>Table 8</th>
<th>Key leadership organizations involved in organ donation</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Society of Transplantation</td>
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<tr>
<td>Association of Organ Procurement Organizations</td>
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<tr>
<td>American Hospital Association</td>
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<tr>
<td>Institute for Healthcare Improvement</td>
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<tr>
<td>Neurocritical Care Society</td>
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<tr>
<td>National Kidney Foundation</td>
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<td>Society for Critical Care Medicine</td>
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<td>Quality Reality Checks, Inc</td>
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<td>Society for Critical Care</td>
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<tr>
<td>United Network for Organ Sharing</td>
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</tbody>
</table>
Organ Donor Collaborative

- Identified 80% donors in 20% hospitals in the US
  - Implemented best practice
  - OPO
## Collaborative Goals

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversion rate, %</td>
<td>75%</td>
</tr>
<tr>
<td>Medical examiner denials, #</td>
<td>0</td>
</tr>
<tr>
<td>Referral rate, %</td>
<td>100%</td>
</tr>
<tr>
<td>Timely notification rate, %</td>
<td>100%</td>
</tr>
<tr>
<td>Appropriate requester rate, %</td>
<td>100%</td>
</tr>
</tbody>
</table>
Organ Donation Conversion rate

Authorize / Approach

Increased
Organ Donation rates

Total Number Organs Donated: Increased
Collaboration
OPO and Intensivists
## Donor Management Goals (DMG)

<table>
<thead>
<tr>
<th>Donor Management Goals</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Arterial Pressure</td>
<td>60-110 mmHg</td>
</tr>
<tr>
<td>Central Venous Pressure</td>
<td>4-10 mmHg</td>
</tr>
<tr>
<td>Ejection Fraction</td>
<td>&gt;50%</td>
</tr>
<tr>
<td>Vasopressors</td>
<td>≤1 and low dose</td>
</tr>
<tr>
<td>Arterial blood gas pH</td>
<td>7.3-7.45</td>
</tr>
<tr>
<td>$\text{PaO}_2: \text{FiO}_2$</td>
<td>&gt;300</td>
</tr>
<tr>
<td>Serum Sodium</td>
<td>135-155 mEq/L</td>
</tr>
<tr>
<td>Blood Glucose</td>
<td>&lt;150 mg/dL</td>
</tr>
<tr>
<td>Urine Output</td>
<td>0.5-3 ml/kg/hr over 4 hours</td>
</tr>
</tbody>
</table>
The Impact of Meeting Donor Management Goals on the Number of Organs Transplanted per Donor: Results from the United Network for Organ Sharing Region 5 Prospective Donor Management Goals Study

Malinoski DJ, et al; on behalf of the UNOS Region 5 DMG workgroup
Crit Care Med 2012
Optimization of Donor Management Goals Yields Increased Organ Use

Donors

Stable
Catastrophic Brain Injured

Improve

Does NOT Improve

Donor

Not a Donor
Summary

• Recognition of Catastrophic Brain Injured patients
• Prompt ICU care
• Take care of the patient first
• Potential for Organ Donation
Cardiac Output
ICU Management

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