Management of traumatic brain injury

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Agenda

- Discuss injury types ranging from concussion to severe traumatic brain injury
- Review components of the neurologic examination
- Review management strategies for patients with TBI
Concussion

- Any traumatic alteration of consciousness
  - Usually results in a rapid onset of altered neurologic function, but symptoms may develop and evolve over minutes to hours following the initial insult
  - Neuropathologic changes may occur, but routine imaging studies are negative
Concussion

- 80-90% of concussions have symptoms that resolve within 7-10 days
  - Headache
  - Cognitive
  - Emotional lability, irritability
  - Amnesia, loss of consciousness
  - Balance disturbances
  - Insomnia
Concussion

- Initial investigation
  - Should be performed by a health care professional in a setting which is appropriate for assessment
  - Thorough Medical and Neurologic examination
    - Specific attention should be paid to evaluating the cervical spine
  - Important to assess whether the patient appears stable, declining, or improving
  - Patients should not be left alone for several hours following the injury
  - Determination whether the patient should undergo neuroimaging made at this time
http://physicians.catonline.com/scat/
Management of concussion

- Physical and cognitive rest
  - Generally 24-48h
- Stepwise return to activity
  - Rest for 24 hours
  - Light activity
  - Light exercise
  - Moderate to Heavy exercise
Return to play

- For athletes who have suffered a concussion, they should not be allowed to return to play on the same day.
- Each of the following stages should be given 24 hours.

<table>
<thead>
<tr>
<th>Rehabilitation Stage</th>
<th>Functional Exercise at Each Stage of Rehabilitation</th>
<th>Objective of Each Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No activity</td>
<td>Symptom limited physical and cognitive rest.</td>
<td>Recovery</td>
</tr>
<tr>
<td>2. Light aerobic exercise</td>
<td>Walking, swimming, or stationary cycling keeping intensity &lt;70% maximum permitted heart rate. No resistance training.</td>
<td>Increase heart rate</td>
</tr>
<tr>
<td>3. Sport-specific exercise</td>
<td>Skating drills in ice hockey, running drills in soccer. No head impact activities.</td>
<td>Add movement</td>
</tr>
<tr>
<td>4. Non-contact training drills</td>
<td>Progression to more complex training drills, eg. passing drills in football and ice hockey. May start progressive resistance training.</td>
<td>Exercise, coordination, and cognitive load</td>
</tr>
<tr>
<td>5. Full contact practice</td>
<td>Following medical clearance participate in normal training activities.</td>
<td>Restore confidence and assess functional skills by coaching staff</td>
</tr>
<tr>
<td>6. Return to play</td>
<td>Normal game play.</td>
<td></td>
</tr>
</tbody>
</table>
Other pioneering work in concussion

- Balance systems
- APO-E4
- fMRI
- DTI
- EEG
- Biomarkers
When the injury gets worse

- Now you’ve found something on a CT of the head
Intracranial hemorrhage

CT I D E S

- Cerebral contusion
- Traumatic subarachnoid hemorrhage
- Intraventricular hemorrhage
- Diffuse Axonal Injury
- Epidural Hematoma
- Subdural Hematoma
Severe Traumatic Injury

- What the patient really needs...
Acute traumatic brain injury—initial management

- ATLS protocol
  - A->B->C
  - Remember to perform a brief neurologic examination if time and circumstances permit

  - GCS 14-15 = mild injury
  - GCS 13 or less = moderate or severe injury
  - Observation versus head CT, NEXUS criteria for cervical spine management
  - CT head and cervical spine
NEXUS—Allows for clearance of the cervical spine without imaging

- Focal neurologic deficit
- Midline spinal tenderness
- Distracting injury
- Intoxication
- Altered level of consciousness
Goal: Prevent secondary injury

Brain swelling leads to decreased blood supply to the brain
What does the neurosurgeon want to know when you call?

1. Findings on CT scan
2. Neurologic examination
3. Hemodynamics and ability to transfer
Neurologic examination: GCS

<table>
<thead>
<tr>
<th>Eye opening</th>
<th>Verbal response</th>
<th>Motor response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = None</td>
<td>1 = None</td>
<td>1 = None</td>
</tr>
<tr>
<td>2 = To Pain</td>
<td>2 = Incomprehensible groaning</td>
<td>2 = Extensor posturing</td>
</tr>
<tr>
<td>3 = To verbal command</td>
<td>3 = Non-contextual speech</td>
<td>3 = Flexor posturing</td>
</tr>
<tr>
<td>4 = Spontaneous</td>
<td>4 = Confusion</td>
<td>4 = Withdrawal from pain</td>
</tr>
<tr>
<td></td>
<td>5 = Oriented and conversant</td>
<td>5 = Localizing movements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 = Following commands</td>
</tr>
</tbody>
</table>
Acute care management of traumatic brain injury: what you can do without a neurosurgeon

- Positioning
  - Keep the head of the bed elevated—use reverse trendelenberg positioning when spine fractures have not been ruled out
- Hyperventilation—OK to use in the short term PCO2 25-35
- Ensure neutral cervical spine positioning
- Mannitol 1g/kg up to 100 g
- Hypertonic Saline 23.4% 15-30cc slow infusion (10-15 minutes)
- Antiepileptic medications (Phenytoin or Levetiracetam)
- Sedation
- Paralytics
Stepwise protocol for management of intracranial hypertension

1. Position patient
2. Normalize vitals and metabolic factors
3. Sedation
4. Hyperosmolar therapy
5. CSF Diversion
6. Pharmacologic paralysis
7. Barbiturate coma
8. Hypothermia
9. Decompressive craniectomy
10. Intubation
Guiding Principle: Preserve viable brain tissue

Prevent secondary brain injury

Management of Intracranial Pressure and perfusion to the brain

- Intracranial pressure monitoring
  - Patients who remain a GCS of 8 or less after resuscitation and who have a brain injury meet criteria for intracranial pressure monitoring
  - EVD or Fiber optic monitor (bolt)
A Trial of Intracranial-Pressure Monitoring in Traumatic Brain Injury

Randall M. Chesnut, M.D., Nancy Temkin, Ph.D., Nancy Carney, Ph.D., Sureyya Dikmen, Ph.D., Carlos Rondina, M.D., Walter Videtta, M.D., Gustavo Petroni, M.D., Silvia Lujan, M.D., Jim Pridgenon, M.H.A, Jason Barber, M.S., Joan Machamer, M.A., Kelley Chaddovik, B.A., Juanita M. Celia, M.D., Marianna Chernov, Ph.D., and Terence Hendrix, B.A.
Decompressive Craniectomy in Diffuse Traumatic Brain Injury


**Figure 1. Intracranial Pressure before and after Randomization.**

Shown are the mean measurements of intracranial pressure in the two study groups during the 12 hours before and the 36 hours after randomization. The I bars indicate standard errors.
Intracranial pressure monitoring in severe head injury: compliance with Brain Trauma Foundation guidelines and effect on outcomes: a prospective study

<table>
<thead>
<tr>
<th>Variable</th>
<th>ICP Monitoring (n = 101)</th>
<th>No ICP Monitoring (n = 115)</th>
<th>OR (95% CI)</th>
<th>p Value</th>
<th>AOR (95% CI)*</th>
<th>Adjusted p Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>overall in-hospital mortality</td>
<td>33 (32.7%)</td>
<td>62 (53.9%)</td>
<td>0.42 (0.24 to 0.72)</td>
<td>0.002</td>
<td>0.15 (0.03 to 0.74)</td>
<td>0.019</td>
</tr>
<tr>
<td>mortality due to brain herniation</td>
<td>13 (12.9%)</td>
<td>25 (21.7%)</td>
<td>0.53 (0.26 to 1.11)</td>
<td>0.107</td>
<td>0.34 (0.10 to 0.87)</td>
<td>0.046</td>
</tr>
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<table>
<thead>
<tr>
<th>Variable</th>
<th>ICP Monitoring (n = 101)</th>
<th>No ICP Monitoring (n = 115)</th>
<th>Mean Difference (95% CI)</th>
<th>p Value</th>
<th>Adjusted Mean Difference (95% CI)*</th>
<th>Adjusted p Value*</th>
</tr>
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<tbody>
<tr>
<td>mean ICU LOS in days</td>
<td>16.8 ± 1.3</td>
<td>8.2 ± 1.0</td>
<td>-8.62 (-11.83 to -5.41)</td>
<td>&lt;0.001</td>
<td>-6.04 (-9.46 to -1.69)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>mean hospital LOS in days</td>
<td>19.4 ± 1.6</td>
<td>10.1 ± 1.2</td>
<td>-9.26 (-13.10 to -5.42)</td>
<td>&lt;0.001</td>
<td>-7.14 (-11.14 to -2.08)</td>
<td>0.001</td>
</tr>
<tr>
<td>after exclusion of deaths</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean ICU LOS in days</td>
<td>21.7 ± 1.5</td>
<td>13.0 ± 1.8</td>
<td>-8.74 (-13.36 to -4.13)</td>
<td>&lt;0.001</td>
<td>-2.78 (-11.58 to -2.78)</td>
<td>0.007</td>
</tr>
<tr>
<td>mean hospital LOS in days</td>
<td>25.8 ± 1.8</td>
<td>18.2 ± 2.1</td>
<td>-7.61 (-13.13 to -2.09)</td>
<td>&lt;0.001</td>
<td>-2.34 (-9.56 to -2.34)</td>
<td>0.022</td>
</tr>
</tbody>
</table>
The neurosurgical arsenal
26 YO woman in a team roping accident. Never regained consciousness

- Patient arrives to your facility in a cervical collar, intubated by the flight team en route
- Vital signs are stable
- Neurologic exam demonstrates anisocoria L (8mm and fixed) > R (3mm and reactive), no movement in the extremities and the presence of an endotracheal tube
  - What's the GCS?
    - 3T
- Next step?
Next steps

- Cervical collar?
  - CT cervical spine is negative
- Should you investigate for blunt carotid/vertebral injury?
  - Do you have the capabilities to handle the injury if you find it?
  - When do we administer IV contrast?
- MRI?
A 70-year-old man was struck by a car at 40 mph. At the scene, the patient was GCS 3. Upon arrival at Billings Clinic, he was intubated and mechanically ventilated. The workup included CT head, cervical spine, CTA/P with contrast, CT maxillofacial, CT angiogram of the head and neck, and CT T/L spines.

- Open Tib/Fib fracture on the left
- Left shoulder dislocation
- Open elbow fracture
- Multiple skull and facial fractures
- Hemodynamically stable, no injury to internal organs
What next?
Conclusions

- Concussion is a traumatic alteration of consciousness
- People who are suspected to have a concussion should not return to play on the day of the injury, should be evaluated by a medical professional, and should ideally undergo a graduated return to activity prior to returning to play
- Management of acute traumatic brain injury in the field and emergency department should follow ATLS guidelines
- Obtain a neurologic examination
- Empiric management of presumed intracranial hypertension can be enacted in the absence of neurosurgical care with close attention paid to the clinical scenario
References

- Anthony Marmarou, Ph.D., Randy L. Anderson, Ph.D., John D. Ward, M.D., Sung C. Choi, Ph.D., and Harold F. Young, M.D. Howard M. Eisenberg, M.D. Mary A. Foulkes, Ph.D. Lawrence F. Marshall, M.D. John A. Jane, M.D. Impact of ICP instability and hypotension on outcome in patients with severe head trauma. Special Supplements Nov 1991 / Vol. 75 / No. 1s, Pages S59-S66