HEAD TRAUMA

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DISCLAIMER

• I speak Army…Sorry.

• My statements and views are based on peer reviewed journals, workshops, personal experience, and discussions with experts. If there is something more up-to-date that I have missed or left out, please don’t stone me in a public square.

• My experience with field medicine is primarily dismounted, aid bag medicine over 8 yrs as a PA with Airborne Infantry units and Special Operations teams.

• So if I say something that seems off base/Too ARMY please let me know during the questions portion and I will expand or elaborate for clarity sake.
OBJECTIVES

• Provide an overview of head injury patterns, mechanisms of injury, and patient presentations

• Discuss management of head injuries according to current guidelines
  • ATLS
  • Joint Trauma System
  • Neurocritical Care Society
  • Society of Critical Care Medicine

• Introduction to management of head injuries in the austere environment
  • PFC Clinical Practice Guidelines
AGENDA

• Anatomical Overview
• Injuries and Evaluation
• Austere Environments
• Summary
• Good Resources
ANATOMY

- Skin of scalp
- Periosteum
- Bone of skull
- Periosteal Meningeal
- Dura mater
- Arachnoid mater
- Pia mater
- Arachnoid villus
- Blood vessel
- Falx cerebri (in longitudinal fissure only)

Superior sagittal sinus
Subdural space
Subarachnoid space
INJURIES AND EVALUATION
WHY DO WE CARE?

- In the US: Approx. 2.5 million TBIs/yr.
  - 283,000 hospitalizations (~11%)
  - 52,000 do not survive (~2%)
- Worldwide: TBI is a leading cause of death in children and young adults
- Falls and motor vehicle collisions are the most common etiologies (civilian)

Neurocritical Care Society: enls.neurocriticalcare.org
CASE

• 25yo M flips over his handlebars while cycling to work. He was not wearing a helmet. Bystanders report the patient was unresponsive at the scene for less then a minute then got up for a bit walking around, mildly confused, with limited recall of the event. EMS is called and the patient is taken to the hospital. He arrives at your trauma bay, responds incoherently, opens eyes when asked, and localizes to pain (E3V4M5). What is our initial concern?
PRIMARY AND SECONDARY BRAIN INJURY

• Primary: Occurs at the time of impact, or point of injury (POI), and may result in altered mental status and/or level of consciousness
  • Typical Mechanisms of Injury (MOIs)
    • MVC
    • Falls
    • Blunt trauma
    • Penetrating Trauma
    • Explosions** (military primarily)

• Secondary: The sequelae resulting from the primary injury. All TBI interventions are aimed at preventing Secondary injury.
SECONDARY BRAIN INJURY

• Causes of secondary brain injury
  • Hypoxia
  • Ischemia
  • Hypotension
  • Hematoma expansion
  • Cerebral edema
  • Intracranial Hypertension
  • Seizure
  • Fever

• Tissue is the issue!
  • Maximize cerebral perfusion
  • Minimize oxygen consumption in the rest of the body
    • Hemorrhage
    • Fever
    • Pain
    • Exertion
    • Seizure
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PRIMARY SURVEY

- ATLS
  - A: Airway
  - B: Breathing
  - C: Circulation
  - D: Disability
  - E: Exposure/Environment

- TCCC
  - M: Massive Hemorrhage
  - A: Airway
  - R: Respirations
  - C: Circulation
  - H: Hypothermia
INITIAL EVALUATION

- Glasgow Coma Scale
  - Should be performed as part of your primary survey (“D”)
  - Motor score is best indicator of prognosis/severity
  - Good thing to **MEMORIZE**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Response</th>
<th>Score</th>
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<tr>
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<td>Open spontaneously</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Open to verbal command</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Open to pain</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>No eye opening</td>
<td>1</td>
</tr>
<tr>
<td>Best verbal response</td>
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<td>5</td>
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<tr>
<td></td>
<td>Confused</td>
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<td>Incomprehensible sounds</td>
<td>2</td>
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<tr>
<td></td>
<td>No verbal response</td>
<td>1</td>
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<tr>
<td>Best motor response</td>
<td>Obey commands</td>
<td>6</td>
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<tr>
<td></td>
<td>Localising pain</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Withdrawal from pain</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Flexion to pain</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Extension to pain</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>No motor response</td>
<td>1</td>
</tr>
</tbody>
</table>
DO YOU EVEN MACE?

- **Military Acute Concussion Evaluation**
  - Used as close to POI as possible
  - Can be repeated to assess progression/recovery

- **Issues**
  - GCS score is best tool for assessment of head injury and can be performed as serial exams
  - Right after an explosion people tend to be confused and anxious leading to false positives
  - Best used by medics 12 hours after injury to assess for late onset symptoms (HA, Dizziness, Memory loss etc.)
SECONDARY SURVEY

• Main priority is to prevent secondary brain injury
  • Avoid fever, seizures, anxiety, pain, shivering etc.

• As complete a neurologic exam as possible; look for worsening defects and/or new symptoms.

• Key features for head injury:
  • Level of consciousness
  • Cranial nerves
  • Repeat GCS
WHAT IS A “GOOD” NEUROEXAM?

• Primarily Neurosurgeons and Neurocritical care providers will care about a few key items
  • Motor Response
  • Pupillary response and EOMs
  • Check sensation and motor in all extremities (patient may move one side only and be GCS M6, but if you don’t assess the other extremities you may miss a deficit)

• Have a quick Cranial Nerve exam process. It is easy to evaluate and requires little to no tools.

• Can’t find an exam you Like?
  • The Navy’s Dive Manual has a good overall exam that can be completed in 10 mins or less
  • The Prolonged Field Care CPG on TBI has another decent example
CONCERNING “EASY TO SEE” EXAM FINDINGS
CASE

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INDICATIONS FOR IMAGING

• CT Head and Neck without Contrast
  • “Stable patient” – do not delay operative intervention to obtain a CT
    • Especially in poly-traumas
  • Most Head injury patients who are operative candidates will need a CT before the OR to show where the injury is and help with surgical planning
  • A positive CT scan does not mandate surgery; it all about the exam findings

• CT Angiography
  • Not acutely indicated; Reserved for penetrating traumas and post operative evaluation

• MRI Brain
  • Not Acutely indicate; Primarily used to evaluate acute ischemic events, axonal injuries, or hypoxic brain injury severity
WHAT ARE WE LOOKING FOR?

• “BLOOD CAN BE VERY BAD”
  • Blood
  • Cysterns
  • Bone
  • Ventricles
  • Brain
INTRACRANIAL HEMORRHAGE

• Epidural Hematoma
• Subdural Hematoma
• Subarachnoid Hemorrhage
• Intraparenchymal Hemorrhage

**Side Note**
• Though not intracranial, Scalp Lacerations bleed profusely and should not be ignored.
**EPIDURAL**
- Arise in the space between dura and skull
- Typically from head trauma (falls, MVC, assaults)
- Does not cross suture margins; lenticular appearance on CT

**SUBDURAL**
- Between Dura and Arachnoid membranes
- Traumatic or from intracranial hypotension
- Can cross suture margins; crescent shaped on CT

**SUBARACHNOID**
- Between the arachnoid and pia mater
- Ruptured intracranial aneurysm, vascular malformations, or trauma
- “worst headache” or “thunderclap”
- Amorphous appearance on CT
CASE

• Patient is stable and taken for a CT head/neck.

• What does the CT show?

• What is a major worry in this patient?
CASE

• You properly diagnose the patient with an SDH, you position the HOB at 30deg to help with ICP, get the patient a bed in the ICU and page Neurosurgery. While transitioning from the CT scanner the patient becomes unresponsive, E1V1M4. His left pupil is larger than his right with sluggish to no reaction to light. Vital signs: HR 60, BP 145/95, RR 30 and irregular. What is happening and what should you do next?
HERNIATION
INTRACRANIAL PRESSURE

• Monroe-Kellie Doctrine, 1783
  • The Skull is **Non-distensible**
  • The Brain is **Non-Compressible**
  • An increase in the volume of one component of the intracranial cavity will cause a decrease in the volume of the other components, an increase in pressure within the intracranial cavity, or a combination of the two.
    • “Non-compressible” components
      • Brain (1300-1500ml, ~80%)
      • CSF (75ml, ~10%)
      • Cerebral Blood Volume (75ml, ~10%)
INTRACRANIAL PRESSURE
HERNIATION

• Presentation
  • Sudden decline in mental status or decrease in GCS (usually 2 or more points)
  • Non-reactive pupil
  • Extensor Posturing
  • Cushing’s response
    • HTN
    • Bradycardia
    • Irregular Respirations
CASE

- GCS <8 Intubate!
- Vitals demonstrate Cushing’s response (typically a late finding)
- Elevate HOB to 30deg
- Check neck positioning and adjust C-Collar to help with venous return
- HTS bolus or mannitol if no HTS available
- Emergent NSGY consult, they need to see the patient and evaluate surgical options
INITIAL MANAGEMENT OF ICP

• HOB >30deg (venous return)
• C-Collar positioning (venous return)
• Hypertonic Saline (3%) bolus over 10mins
  • Ok through a peripheral line for short duration
  • Central Line is preferred.
• Mannitol 1g/kg IV or IO
  • Non-selective, will cause systemic diuresis
CASE

• Patient is now intubated, GCS 3T. He received a 250ml bolus of 3% HTS. NSGY has seen the patient and are preparing the OR for emergent Hemicraniectomy to decompress the cranium and evacuate the hematoma.

• If the patient hadn’t shown signs of herniation and went to the ICU how would it change their care?
ICP MONITORING

• Subdural/Intraparenchymal
  • “Bolt” Monitor
    • Diagnostic only

• Intraventricular
  • Ventriculostomy
  • External Ventricular Drain
    • Diagnostic and therapeutic
KEY TAKE AWAYS

• Remember your Primary and Secondary surveys, don’t just assume the head injury is the only issue

• PREVENT SECONDARY BRAIN INJURIES

• Have a go to neuro exam and know the GCS scores

• Serial exams (Q1-2hrs) will help the provider identify progression

• Consult early! Brain is tissue and tissue is the issue; Protect it
AUSTERE MANAGEMENT

NO SUPPLIES? NO EVAC? NO PROBLEM!
PROLONGED FIELD CARE

• Last decade (+)
  • Linear medical protocols with robust evac systems and Role 3s
  • The Medic/PA’s Job: POI-60mins
    • Keep the red stuff inside: Tourniquets, Dressings
    • Optimize breathing: Nasal airways, chest seals, needle decompression
    • Short term pain control
  • Surgeon’s Job: patient arrival-Days
    • Stop Bleeding, Resuscitate, Stabilize
    • Manage Critical injury sequelae
      • Diagnose and manage the complications of polytrauma patients
    • Nursing care
    • Optimizing patient for transport to next echelon of care.
SO WHAT DOES THIS MEAN?

• Capabilities in our previously developed theaters are limited
• Role 1 providers have more responsibility to fill the gaps with drastically less equipment
  • ICU in a Ruck concept
• Understanding injury/illness progression is essential to do the most good with the least amount of support and supplies.
HEMODYNAMIC CONTROL

• Goal Systolic BP: >110; keep MAP high so CPP is preserved.

• Best: active hemorrhage = transfuse Whole blood or blood products; target >110 SBP

• Better: administer 1L 0.9% NaCl (NS)

• Minimum: control external bleeds. Administer TXA, Avoid meds that will lower BP
AIRWAY, OXYGENATION/VENTILATION

• GCS <8 Intubate

• Avoid hypoxia, hypo/hypercapnia

• Best:/Better Definitive airway per provider (cric/ET) target SPO2 >95% and EtCO2 35-40mmHg.

• Minimum: NPA and Bag Valve Mask with supplemental O2 if available.
ICP MANAGEMENT

• Expect in all GCS 8 or less and worsening neurologic exam.
• Best: Hypertonic Saline 250ml Bolus (over 10mins); repeat Q3 PRN . Mannitol if no 3% saline at 1g/kg IV or IO
• Better: stop possible causes; Pain, Anxiety.
  • Ketamine 20mg IV
  • Fentanyl 25-50 ug IV
• Minimum: general measures
  • Elevate HOB
  • Neck in midline position
  • Properly position C-Collar
• **If Herniation is imminent consider hyperventilating the patient for no more than 20 mins to decrease ICP
ICP: CAN WE MEASURE THIS OUTSIDE THE HOSPITAL?

• No “reliable” test for ICP measurement in the field

• Optic Nerve Sheath diameter
  • Can serve as an adjunct to the neuro exam
  • Can identify if ICP is increasing or decreasing
  • About 10-20 reps for most to become proficient
  • Make this a new vital sign in all Head injury patients (Serial Exams)
OPTIC NERVE SHEATH US
INFECTION CONTROL

- ABX are mandatory if penetrating or open injury.
- Best:
  - Ceftriaxone 2g IV/IO Q8
  - Metronidazole 500mg IV/IO Q8
- Better: Ancef 2g IV QD
- Minimum: Clean and Dress all wounds to prevent further introduction of potentially infectious materials
SEIZURE PROPHYLAXIS/MANAGEMENT

• Any witnessed seizure requires rapid response
• Best: Keppra 2g IV/IO; 500mg Q12
• Better: Phenytoin 1.5g for 1 hr then 100mg/day; or phenobarbital 1.5g for 1 hr then then 100mg/day
• Minimum: Midazolam 5mg q5 mins (Max 10-15mg) or alternate benzodiazepine if versed is not available. (lorazepam/diazepam)
FEVER CONTROL

• Fever increases cerebral metabolism and can increase ICP. It also increases O2 demand elsewhere in the body

• Goal: 96F – 99.5F

• Best: Acetaminophen 650mg PO/PR Q4
• Better: Apply cold packs to axillary regions, posterior cervical region, and groin
• Minimum: remove unnecessary heat sources, place patient in a cool area
SODIUM MANAGEMENT

• Goal: Avoid Hyponatremia, target serum sodium between 145mmol/L and 160mmol/L
• Best: monitor serum sodium; in stable patients: Q6, Unstable: Q3
• Minimum: Avoid use of hypotonic solutions and restrict free water intake
WHO YOU GONNA CALL?

• Know when you have reached your limits and where to get help
• ADvanced VIrtual Support for OpeRational forces (ADVISOR)
  • DoD telemedicine network
  • Use during training so you can better interact with the program while deployed
  • Crucial in underdeveloped theaters
WRAP THIS UP ALREADY...ITS LUNCH TIME.

• Head injuries are significant medical issues and should be closely monitored
• Memorize a basic neurologic exam and the GCS scores
• Prevent secondary brain injury; the key to all head injury patients
• If your resources are limited or you are intellectually maxed out use telemedicine to bridge the gaps
GOOD REFERENCES

• Deployed Medicine App (JTS CPGs and best practices)
  • https://www.Pfcare.org
  • https://www.enls.neurocriticalcare.org

• Feel free to email me with questions:
  • brian.c.smedick.mil@mail.mil
QUESTIONS?

DISCLAIMER: “MAJ BRIAN SMEDICK HAS NO FINANCIAL INTERESTS TO DISCLOSE WITH REGARD TO THIS SUBJECT OR THE CONTENTS OF THE PRESENTATION.”