This CPG provides guidelines and recommendations for the treatment and medical management of casualties with moderate to severe head injuries in an environment where personnel, resources and follow-on care may be limited.

This presentation is based on the Neurosurgery and Severe Head Injury CPG, 02 Mar 2017 (ID:30). It is a high-level review. Please refer to the complete CPG for detailed instructions. Information contained in this presentation is only a guideline and not a substitute for clinical judgment.
Agenda

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Combat casualties with severe head trauma have specific needs both medically and surgically that require neurosurgical involvement.

There are neurosurgical management decisions that depend on follow-on care resources.
Severe head trauma is a complicating injury in at least 1/3 of trauma-related deaths in the United States and is part of current combat operations.

Classification of injury has prognostic and care eligibility implications in the combat environment and is based on the Glasgow Coma Score (GCS).

- Mild: GCS 13-15
- Moderate: GCS 9-12
- Severe: GCS 3-8
A large percentage of patients have historically been host national patients and this impacts their care.

- Treatment of host nationals in military treatment facilities is dependent on medical rules of eligibility in a given area of responsibility (AOR) at that time.
- Neurosurgical resources are limited in the combat environment.
- Host national treatment will eventually occur in hospitals in the patient’s nation.
- Decisions made for host nation patients should be made with an understanding of the continuum of care of patients in their nation.

Two different general pathways based on whether patients are treated as U.S. personnel/coalition or host national patients.
Considerations

- **Coalition forces**
  - Mild head injuries that do not clear within 24 hours require evaluation by computed tomography (CT) and/or a neurosurgeon.
  - Any penetrating head injury, open skull fracture, or moderate or severe head injury should be evaluated by a neurosurgeon.
  - Patients with head trauma and unexplained neurologic deficits should be evaluated by a neurosurgeon.
Host National treatment is dependent on medical rules of eligibility in the AOR, but in general:

- Patients with mild head injury should be managed locally and not transferred to Role 3 facilities unless transfer is discussed and coordinated with the receiving neurosurgeon or chief of trauma.

- Moderate head injury may be referred to Role 3 facilities with neurosurgical capability for definitive care.

- Severe head injury is based on mission, tactical situation, and resource availability and must be preceded by direct communication and discussion with the neurosurgeon, as these casualties may need to be managed expectantly.
Positive outcomes are achieved through rapid evacuation from the battlefield, far forward medical management, timely neurosurgical intervention, meticulous critical care and a dedicated rehabilitative effort.

Initial management of patients with head trauma begins with addressing life-threatening injuries and resuscitation based on current trauma protocols.

During initial care, there are specific neurosurgical recommendations for the medical care of head injury patients.
Neurosurgical recommendations for initial resuscitation and treatment include:

- Blood products are preferred over other colloids.
- For patients not requiring blood products, normal saline is the preferred crystalloid solution.
- Normoventilation with a goal PaCO2 of 35-40 should be maintained.
- Prophylactic hyperventilation is not recommended except as a temporizing measure in the setting of suspected herniation.
- Routine prophylactic antibiotics are unnecessary for isolated closed head injuries, but open skull fractures, or pre-operative patients should be placed on antibiotics.
  - Cefazolin or Clindamycin are first line.
  - Add Metronidazole if grossly contaminated.
Neurosurgical recommendations for the initial resuscitation and treatment include (continued):

- Monitor glucose every 6 hours with goal glucose < 180 mg/dl, but avoid hypoglycemia.
- Steroids should be avoided.
- Maintain SBP ≥ 100 mm Hg for patients 50-69 years old or ≥ 110 mm Hg for patients 15 to 49 or over 70 years old.
- Manage hypoxemia with a goal SaO₂ of > 93-95 and a PaO₂ of > 80.
- Document serial neurological exams to include:
  - Glasgow Coma Score
  - Pupil size and reactivity
  - Presence of gross focal neurologic signs and/or deficits
Intracranial hypertension is medically treated with hyperosmotic therapy with one or more of the following:

- **3% saline**
  - Consider 250 mL bolus of 3% saline then infuse 3% saline at 50-100 mL/hr for resuscitation.
  - Goal serum Na level is 150-160.
  - Place central venous access to administer hypertonic saline and vasoactive medications.
- Monitor serum sodium on a frequent basis with all osmotic agents.
Intracranial hypertension is medically treated with hyperosmotic therapy with one or more of the following: *(continued)*

- Mannitol should be considered if there is further deterioration in neurological status or as an alternative to 3% saline.
  - Mannitol 1 g/kg bolus IV followed by 0.25 g/kg IV push q4 hours.
  - Replace brisk urine output with isotonic fluids.
  - Avoid mannitol in hypotensive or under-resuscitated casualties.
Treatment: Moderate to Severe TBI

- Antileptic medications for seizure prophylaxis for the first 7 days after a moderate or severe TBI.
  - Seizures are not uncommon after severe brain trauma.
  - Reasonable options include phenytoin, fosphenytoin, or levetiracetam.

- DVT chemoprophylaxis with a moderate to severe head injury should be done in consultation with theater neurosurgeon.
  - Patients with moderate or severe head injury require sequential compression devices if able.
  - Enoxaparin 30 mg sq BID or SQ heparin may be used as chemoprophylaxis, providing patient does not have potential hemorrhagic issues.
Other specific medical treatment recommendations for the patient with severe head injury include:

- Avoid and treat hyperthermia.
- Elevate head of bed to 30-45° or use reverse Trendelenburg position if suspected spine/spinal cord injuries.
- Gastric ulcer prevention should be provided.
- Consider enteral nutrition.
Surgical intervention is often indicated in the management of patients with severe brain trauma.

Operative interventions likely to be required include: intracranial pressure (ICP) monitor placement, evacuation of hematoma, and decompression.

ICP monitoring and/or surgical intervention is not advised for patients with a GCS 3-5 and clinical and imaging evidence of diffuse anoxic injury, if long-term continuing care and rehabilitative capabilities are not available in the nation of origin.
**Intracranial Monitoring**

- Management of severe TBI using information from intracranial pressure (ICP) monitors reduces in-hospital and two week post-injury mortality.

- Should be considered in all salvageable patients with severe brain injury and an abnormal CT showing one or more: hematomas, contusions, swelling, herniation, or compressed basal cisterns.

- If a normal CT, ICP is indicated in severe TBI if two or more of the following are present: Age > 40, unilateral or bilateral posturing, systolic blood pressure < 90 mm Hg.
Treatment: Moderate to Severe TBI

- Options for ICP monitoring
  - External ventricular drain
  - Parenchymal ICP monitors. Currently Codman ICP monitors are the only approved device for USAF aeromedical evacuation.

- Goal intracranial pressure is < 22 mm Hg.

- Target cerebral perfusion pressure for survival and favorable outcomes is 60-70 mm Hg.
Treatment: Moderate to Severe TBI

- **Epidural Hematoma (EDH)**
  - All epidural hematomas > 30 cc should be surgically evacuated.
  - EDH < 30 cc with less than 15 mm thickness and less than 5 mm midline shift with a GCS > 8 without a focal deficit may be managed non-operatively.

- **Subdural Hematoma (SDH)**
  - An acute SDH with thickness > 10 mm or midline shift > 5 mm should be surgically evacuated.
  - An SDH with a thickness < 10 mm and shift < 5 mm if there is a decrease in GCS of 2 or more, worsening pupillary exam, and/or an ICP greater than 20 mm Hg, should be evacuated.
Treatment: Moderate to Severe TBI

- Traumatic Parenchymal Lesion
  - Hematoma should be evacuated in a patient with a GCS of 6-8 with frontal or temporal contusions greater than 20 cc in volume with midline shift or at least 5 mm and/or cisternal compression on CT.
  - Lesions that are greater than 50 cc in volume in a salvageable patient should be evacuated.

- Posterior fossa mass lesions with mass effect on non-contrast CT or with neurological dysfunction or deterioration referable to the lesion should have surgical intervention.

- Surgical decompression, or craniectomy, should be strongly considered following penetrating combat brain trauma.
Skull flap management

- U.S./Coalition Forces
  - Those who have penetrating brain trauma: do not save or send the calvarium.
  - Those who have blunt trauma: consider abdominal subcutaneous implantation if it can be done in a sterile fashion.

- Host nationals have 3 options.
  1. Clean and replace.
  2. Clean and replace with hinge craniectomy.
  3. Craniectomy with potentially limited chances for cranioplasty in the future depending on rules of eligibility.
General Guidelines

- Exploratory burr holes have limited practical utility and should only be performed under very specific conditions after consultation with a neurosurgeon if possible and at a location where CT scan is not available.

- High index of suspicion for traumatic aneurysms is required if there is a penetrating injury at the base of the skull or across a known major vascular territory.

- Removal of devitalized brain tissue is an option in penetrating head injury and select cases of open skull fractures.

- Routine pursuit of individual foreign bodies within the brain is not advisable, but should be left to the discretion of the neurosurgeon.

- Primary dural closure or limited duroplasty should be done cautiously at the initial operation.
Early and safe transport of severe head injury patients is important, but it requires multiple considerations.

- **Sedation**
  
  Avoid long lasting sedation or paralysis, but this should not override safe transport.
  
  - Vecuronium is preferred for paralysis.
  - Propofol is preferred for sedation.
  - Intermittent narcotics preferred over continuous infusion.
Transport Considerations

- Patients who have ongoing resuscitative requirements and an intracranial lesion or the potential for development of cerebral edema may require delayed evacuation.

- Intracranial pressure can be affected by the stresses of flight, and observation in flight can be warranted in patients with borderline ICP measurements.

- Aeromedical evacuation can potentially expand any pneumocephalus, which is particularly important in patients that have not undergone a decompressive craniectomy.

- Consider loading the TBI patient head first rather than feet first into an aircraft, to maintain head elevation.
**Population of Interest**

1. All patients with a diagnosis of traumatic brain injury and an initial GCS of 3-8.
2. All patients who receive a cranial procedure (ICP monitor, craniectomy, craniotomy).

**Intent (Expected Outcomes)**

1. All patients in population of interest avoid hypotension and hypoxia: SBP never < 100 mmHg, MAP never < 60, SaO2 never < 93%.
2. All patients in population of interest have PaCO2 monitored at every role of care.
3. All patients in population of interest have a head CT performed within 4 hours of injury.
4. All patients with a ventriculostomy have hourly documentation of ICP/CPP and ventriculostomy output.
5. Patients in population of interest unable to be monitored clinically (e.g., unable to hold sedation for Q1 hour neuro exam) have an ICP monitor or ventriculostomy placed prior to transport out of theater.
**Performance/Adherence Measures**

1. Number and percentage of patients in the population of interest with lowest SBP<100 within first 3 days after injury.

2. Number and percentage of patients in the population of interest with MAP<60 within first 3 days after injury.

3. Number and percentage of patients in the population of interest with SaO2<93% within first 3 days after injury.

4. Number and percentage of patients in population of interest who have PaCO2 documented at every role of care (POI, POI MEDEVAC, ROLE 2-4, interfacility MEDEVAC).

5. Number and percentage of patients in the population of interest who maintain PaCO2=35-40

6. Number and percentage of patients who had a head CT performed within 4 hours of injury.

7. Number and percentage of patients with a ventriculostomy who had hourly documentation of ICP/CPP and ventriculostomy output.

8. Number and percentage of patients in the population of interest unable to be monitored clinically (eg. unable to hold sedation for Q1 hour neuro exam) who have an ICP monitor or ventriculostomy placed prior to transport out of theater.

**Data Source**

- Patient Record
- Department of Defense Trauma Registry (DoDTR)
- ICU flow sheet
- Neurologic assessment flow sheet
References


References


List of Appendices in CPG

Appendix A: General Indications
Appendix B: 3% Saline Protocol
Appendix C: Additional Information Regarding Off-Label Uses in CPGs
Contributors

- Col Randall McCafferty, USAF, MC
- CDR Chris Neal, MC, USN
- LTC Scott Marshall, MC, USA
- LTC Jeremy Pamplin, MC, USA
- CDR Randy Bell, MC, USN
- CDR Dennis Rivert, MC, USN
- Maj Brian Hood, USAF, MC
- LTC (ret) Patrick Cooper, MC, USA
- CAPT Zsolt Stockinger, MC, USN

Slides: Maj Andrew Hall, USAF, MC
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