MANAGEMENT OF PATIENTS WITH SEVERE HEAD TRAUMA

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X Minor Changes (*or)*		***Changes are substantial and require a thorough reading of this CPG***		***(or)***
Significant Changes				

1. **Goal.** To provide guidelines and recommendations for the treatment and management of combat casualties with severe head injuries.

2. **Background.**

   a. Severely head injured patients are those comatose patients with Glasgow Coma Scores (GCS) of < 9.

   b. Currently, definitive neurosurgical care is available at Level III facilities in both Iraq and Afghanistan.

   c. Multiple trends have been observed since 2003, warranting the standardization of care for these casualties.

   1) The mortality of American service members with severe head injuries is 65% for GCS from 3 to 5 and 10% for GCS from 6 to 8.

   2) Of the survivors, progression to independent stateside living is > 40% for GCS from 3 to 5 and 60% for GCS from 6 to 8.

   3) Positive outcomes are achieved through rapid evacuation from the battlefield, timely neurosurgical intervention, meticulous critical care, and a dedicative rehabilitative effort that often continues for months.

   4) In the CENTCOM AOR, a large percentage of patients who present with severe head injury are Host Nationals.

   5) Following Level III theater hospital treatment and transfer to a local host nation hospital, Host Nationals in Iraq and Afghanistan who fail to quickly recover to independent or minimally assisted living will typically not be aggressively treated thereafter.

   d. All Coalition casualties with any penetrating head injury, open skull fracture, moderate (GCS 9-13) or severe (GCS 3-8) head injury and Host Nationals with moderate head injury should be referred to Level III facilities with neurosurgical capability for definitive care. Transfer of Host Nationals with a GCS from 3 to 8 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 be managed expectantly. Coalition forces with mild (GCS 14-15) who do not clear within 24 hours may require transfer for formal evaluation by a neurosurgeon. Host National patients with mild head injury should be managed locally and should not be transferred to Level III facilities unless transfer is first discussed and coordinated with the receiving neurosurgeon or Chief of Trauma.

3. Evaluation and Treatment.

a. Address life-threatening injuries and begin resuscitation using ATLS protocols.

1) Normal saline is the preferred crystalloid solution for resuscitation of patients who do not require massive transfusion.

2) Blood products are preferred over albumin and Hespan if colloids are necessary.

3) Consider recombinant Factor VIIa for life threatening intracranial bleeding.

4) **Normoventilation with a goal PaCO2 of 35-40 should be maintained.**

5) Antibiotics are unnecessary for isolated closed head injuries. Casualties with open head injuries should receive one gram (children 50 mg/kg) Cefazolin (Ancef) IV on admission and then every 8 hours until wounds are closed.

6) **Do not use steroids**. Steroids provide no benefit to head injured patients and have been proven to worsen outcomes in patients with severe head injury.

b. Manage hypotension and hypoxemia.

1) Keep SBP > 90 mm Hg.

2) Keep SaO2 > 93%.

c. Document serial neurological examinations.

1) GCS

2) Pupil size and reactivity

3) Presence of gross unilateral weakness, paraplegia, or quadriplegia

d. If possible, for casualties transferring to Level III facilities with neurosurgical capability, avoid medications that cause long-lasting sedation or paralysis. Neurosurgeons at these sites will examine the casualty upon arrival. **However, at no time should medication selection override the need to safely transport the casualty.**

1) Vecuronium is preferred for paralysis.

2) Propofol is preferred for sedation.

3) <u>Intermittent administration of narcotics is preferred over continuous infusions.</u>

e. If treatment for intracranial hypertension is needed prior to transfer:

1) Typical signs of severe intracranial hypertension: asymmetric motor posturing, unilateral or bilateral fixed, dilated pupil, decreasing level of consciousness

2) Initiate 3% Saline Protocol (see Appendix B).

3) Optimize pO2/pCO2 (pO2 > 80 mm Hg, pCO2 35-40 mm Hg)

4) Avoid/rapidly treat hypotension

5) Elevate head of bed (may keep patient flat in the setting of suspected spine injury and use reverse Trendelenburg position.

6) **Patients with moderate head injury who deteriorate and those with severe head injury should receive 250ml bolus of 3% saline and then infusion of 3% saline at 50-100ml/hr for resuscitation en route to the Level III center. If further deterioration occurs or if the patient shows signs of herniation (pupillary dilation, hypertension and bradycardia, progression to decerebrate posturing)** consider using Mannitol 1g/kg bolus IV, followed by 0.25g/kg rapid IV push q4hrs. **Note: Do not use Mannitol in hypotensive or under-resuscitated casualties.**

f. Antiepileptic medications for seizure prophylaxis:

1) Consider for all patients with intracranial hemorrhage, penetrating brain injury, and seizure activity following the injury, or a GCS < 9.

2) Phenytoin or fosphenytoin are the preferred parenteral (IV or IM) medications.

3) Discontinue after seven days if there is no penetrating brain injury, no prior seizure history, and no development of seizures following the injury.

g. See attached tables for a concise description of salient points for the management of severe head trauma patients.

h. NOTE: In the CENTCOM AOR, DO NOT implant skull flaps removed during craniectomy on US military patients into the abdominal wall or other structure. Skull reconstruction will be performed in CONUS facilities at the appropriate time using synthetic materials.

i. Neurosurgeons at Level III facilities should give strong consideration to placing ICP monitors or Ventriculostomy catheters in patients prior to CCATT movement out of theater when these patients are at risk for developing increased intracranial pressure and/or when their neurologic exam may be difficult to follow during transport.

4. Responsibilities. It is the trauma team leader's responsibility to ensure familiarity and appropriate with this CPG and to expeditiously coordinate transfer of severe head injury patients to one of the theaters' neurosurgical centers.

5. References.

[1]*Guidelines for Field Management of Combat-related head trauma, Emergency War Surgery Handbook, 2004*

[2]Brain Trauma Foundation Guidelines for Management of head injury, 2005 http://www.braintrauma.org/site/DocServer/btf_field_management_guidelines.pdf?docID=121

[3] Bell RS, Neal CJ, Armonda RA, et al. Military traumatic brain injury and spinal column injury: A 5-year study of the impact of blast and other military grade weaponry on the central nervous system. J Trauma 2009;66:S104-11.

Approved by CENTCOM JTTS Director and Deputy Director and CENTCOM SG

APPENDIX A

MONITORING & LABS	GENERAL INDICATIONS*
INTRACRANIAL PRESSURE (ICP)	Glasgow Coma Score of 3-8 with an abnormal CT scan (hematomas, contusions, edema, or compressed basal cisterns) ***or*** 2 or more of the following adverse features are present in a patient with severe head injury and a normal head CT scan: (Age > 40 yrs, Unilateral or bilateral motor posturing, systolic blood pressure, < 90 mmHg)
ARTERIAL LINE	Any head trauma that requires tracheal intubation and/or for other medical indications.
CENTRAL VENOUS PRESSURE	When ICP or CPP management requires anything beyond simple measures and/or for other medical indications***. Trendelenburg position will raise ICP. Line site of choice is SCV.***
EXHALED CO2	Desirable when active measures are required to control ICP. Correlate to PaC02 initially/periodically.
NEUROIMAGING	Non-contrast head CT upon admission then within 24 hours after admission (or earlier to document stability of the bleed). Additional scans obtained as indicated (e.g.; clinical deterioration).
LABS	ABG, CBC, Chem 10, TEG, PT, PTT, and INR *at least* q8 hrs during the acute phase.
GENERAL MANAGEMENT PRINCIPLES*	
PHILOSOPHY	Maintain continuous communication between the care teams. Maintain the patient in a "hyperosmolar-but-euvolemic" state with adequate oxygen carrying capacity and a constant substrate delivery via adequate cerebral perfusion pressure (CPP) of >60mm Hg. Aggressively avoid hypotension, hypoxemia, fever (>99 F), hyponatremia and other CNS insults. The longer the ICP is elevated (> 20), and the MAP & CPP are low (< 60), the worse the outcome! **Brain injury is heterogeneous amongst patients and the process is dynamic: Treatment and management goals must be tailored accordingly**
RESUCITATION FLUID	Normal or 3% saline.
MAINTENANCE FLUID	D_5 Normal saline (Dextrose in maintenance fluids mandatory if insulin is utilized)
SEDATION	Propofol 1st choice up to 72°. Other short-acting agents (Fentanyl, versed) upon discretion of SICU or neurosurgical staff. Typical ICU Propofol sedation dose range: **20-75 ugm/kg/min**
ULCER PROPHYLAXIS	All patients.
DVT PROPHYLAXIS	Recognize high DVT risk in traumatic brain injury patients. Intracranial neurosurgical procedures: Sequential Compression Device (SCD) with or without Graduated Compression Stocking (GCS); High Risk neurosurgery patients: SCD and/or GCS; OK to use Lovenox following stable CT scan in consultation with neurosurgeon.
SEIZURE PROPHYLAXIS	Prophylactic anti-epileptic treatment is optional and is maintained for 7 days if no seizure activity is documented. Treat acute seizure with Lorazepam 1-2 mg IV or Midazolam 5-10 mg IV followed by loading dose of Phenytoin 20 Mg/kg infused at <50 mg/min or Fosphenytoin 20 PE (Phenytoin equivalent)/kg infused at <150 PE/min. The daily dose thereafter is 300 mg Phenytoin or 300 PE Fosphenytoin q HS or may be divided TID.

MONITORING & LABS	GENERAL INDICATIONS*		
ANTIBIOTICS	If using antibiotic impregnated ventriculostomy, then no IV prophylactic antibiotics required. Otherwise, Ancef 1 gm IV TID while ventriculostomy in place only (neurosurgeons' discretion). For all penetrating head trauma, use Ancef 1 gm IV TID.		
NURSING	Hourly neurologic assessments. Document ICP/CPP and ventriculostomy output. Notify physician of all pertinent changes.		
STEROIDS	Steroids are *not* recommended for head or spine trauma and should not be used.		
NUTRITION	Enteral feeding should be begun as soon as it is safe to do so. *Avoid agitation/ ICP during nasal or oral tube placement.* Full enteral nutritional goal ≤ 7 days.		
General management goals (Goals may be individualized / altered by faculty according to specific patient requirements)*			
NEUROLOGIC	ICP	**< 20 mm Hg**	See page 2
	CPP	**> 60 mm Hg**	
HEMODYNAMIC	Mean BP	**Maintain to avoid ↓BP**	Hypotension (SBP < 90mmHg) worsens mortality Provide a rapid physiologic resuscitation
	CVP	**> 5 mm Hg**	
PULMONARY	Sp02%	**> 93%**	Aggressive avoidance of hypoxemia
	PaC02	**35 – 40 mmHg in first 24 hrs/ 30-35 24 hrs to 7 days**	Avoid *routine* hyperventilation
HEMATOLOGIC	INR	**≤ 1.3**	Fresh frozen plasma
	Platelets	**≥ 100,000/mm^3**	Platelets
	Hemoglobin	**≥ 10 g/dL**	Packed red blood cells
	TEG	**Normalized values**	As indicated by results
METABOLIC	Glucose	**> 80 < 150 mg/dl**	Have low threshold for insulin drip
RENAL	Serum Osmolarity	**> 280 & < 320 mOsm**	See sodium disorders on next page
	Serum Sodium	**> 138 & < 165 meq/L**	
INTRACRANIAL PRESSURE MANAGEMENT*			
GENERAL MEASURES	Head in midline position, avoidance of tight cervical collars and tight circumferential ETT ties; elevate the head of the bed to 30 degrees. (Consider reverse Trendelenburg)		
SEDATION	Propofol 1st choice up to 72°. Other short-acting agents (Fentanyl, Versed) upon discretion of SICU or neurosurgical staff. Typical ICU Propofol sedation dose range: **20-75 ugm/kg/min.**		
TEMPERATURE	*Aggressive* temperature management. Consider cooling measures (Tylenol, cooling blanket) even for *modest* temperature elevations (>98.6° F).		
INTRACRANIAL DYNAMICS	Treat sustained ICP elevations >20 Always consider an expanding mass lesion with ICP elevations refractory to therapy.		
Treatment Paradigm for the Traumatic Brain Injury Patient*			
TITRATE	**Ensure sedation and analgesia are adequate**	Titrate lowest possible dose to achieve desired RASS score and/or BIS 60-80. Avoid routine over sedation.	

MONITORING & LABS		GENERAL INDICATIONS*
TO EFFECT Goal of ICP < 20	**Initiate CSF drainage via ventriculostomy**	Consider ventriculostomy drainage to control ICP to < 20 mm Hg
	Initiate osmotic therapy Hold if [Na+] is >159 and/or the Sosm is >329	**Hypertonic Saline (3%): Bolus therapy is 100-250 ml over 10 min and/or infusion rates range between 25-100 ml/hr.** (see Appendix B). As optional or adjunctive therapy consider **Mannitol:** 0.25–1 gm/kg over < 20 minutes then H 0.25 gm/kg q 6 h.
	Initiate paralysis	**Vecuronium:** 10 mg IVP or 0.1 mg/kg**. Cisatracurium (if available)**: Loading dose 0.2 mg/kg/Maint infusion rates: 1-3 mcg/kg/min
	Titrate EtCO2	PaC02 >/= 35
CEREBRAL PERFUSION PRESSURE MANAGEMENT (CPP = MAP – ICP)*		
CPP GOAL >60 mm Hg	**1. Ensure euvolemia**	Utilize endpoints of resuscitation (exam, vitals, Art. Line, CVP, PAC)
	Control the ICP First line: 3% saline; Second line: Mannitol. **Do Not use Mannitol in hypovolemic patients.**	
	2. Consider vasoactive drugs	Consider patient physiology. Vasopressin is agent of choice, followed by Phenlepherine or Norepinephrine.

ACUTE CLINICAL DETERIORATION (e.g. Acute mental status change, blown pupil or other obvious signs of cerebral herniation, new focal neurological symptoms, progressive and refractory ICP elevation)*

1. Verify oxygenation and ventilation

2. Hyperventilate (PaC02 30-35 mmHg) **to temporize only**

3. Re-dose osmotic agent

4. Call Neurosurgery

5. Arrange for emergent CT scan

UNCAL HERNIATION SYNDROME

- Unilaterally dilating pupil Progression to fixed and dilated
- Progressive impairment of consciousness → comatose
- Contralateral Babinski → contralateral weakness → bilateral decerebrate rigidity

GLASGOW COMA SCORE	Eye Opening	Best Verbal Effort	Best Motor Effort
1	None	None	Flaccid
2	To Pain	Nonspecific sounds	Decerebrates to pain
3	To verbal stimuli	Inappropriate words	Decorticates to pain
4	Spontaneous	Confused	Withdraws to pain
5	-	Oriented	Localizes to pain
6	-	-	Follows commands

COMMON SODIUM DISORDERS SEEN IN HEAD TRAUMA (Discuss therapy with staff prior to initiation)

Disorder	Na+	Diagnostic clues	Treatment
SIADH		Low Sosm, usually euvolemic, Uosm	Free water restriction, hypertonic saline if severe
Cerebral salt wasting		Sosm may be nl, uop, signs of volume depletion & hemoconcentration, very high U_{Na}	Volume replacement with NS or hypertonic saline. Oral sodium. Beware of rapid Na+ correction.
Mannitol use		Polyuria, $[Na^+]$ & Sosm	Hold Mannitol if Sosm > 329 mosm / [Na+] > 159
Diabetes Insipidus		Polyuria (>250cc/hr), $[Na^+]$ & Sosm, U_{SpGr} <1.005	DDAVP 2-4 mcg SQ/IV BID as permitted by staff neurosurgeon

** Individualized patient management in consultation with Neurosurgeon*

3% Saline Protocol

Hypertonic (3% saline) may be delivered via peripheral IV or intraosseous access

1. Give 250cc 3% NaCl bolus IV (children 5 cc/kg) over 10-15 minutes
2. Follow bolus with infusion of 3% NaCl at 50 cc/hour
3. If awaiting transport; check serum Na+ levels every hour:
   a.. If Na < 150 mEq/L re-bolus 150 cc over 1 hour then resume previous rate
   b. If Na 150-154, increase NaCl infusion 10 cc/hr
   c. If Na 155-160, continue infusion at current rate
   d. If Na >160, hold infusion, recheck in 1 hour

APPENDIX B

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGs

A. Purpose.

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

B. Background.

Unapproved (i.e., "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

C. Additional Information Regarding Off-Label Uses in CPGs.

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

D. Additional Procedures.

1. Balanced Discussion. Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

2. Quality Assurance Monitoring. With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

3. Information to Patients. Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.