

Clinical Practice Guideline

Management of Patients with Severe Head Trauma

Introduction

Severely head injured patients are those comatose patients with Glasgow Coma Scores (GCS) of 3 to 8. The current Coalition referral center for patients with severe head injuries is the 332nd EMDG in Balad. All severely head injured Coalition and civilian patients are referred to Balad for definitive neurosurgical care. Several trends have been observed since 2003, warranting the standardization of care for these patients. The mortality of American service members with severe head injuries is 30% for GCS 3-5 and 10% for GCS 6-8. Of these survivors, progression to independent living in the United States is 30% for GCS 3-5 and 60% for GCS 6-8. These excellent outcomes are achieved through rapid evacuation from the battlefield, timely neurosurgical intervention, meticulous critical care, and team rehabilitation that often continues for months. On the contrary, many Iraqi patients cannot be afforded even basic critical care and rehabilitation. During the past four years, approximately 90% of severely head injured patients treated in Balad are Iraqi Nationals. After resuscitative surgery and initial critical care, all comatose Iraqi patients are transported to Baghdad. Those with isolated head injuries are treated at the “CNS” hospital. Those with multi-system injuries are treated at “Medical City”. Personal communication with staff neurosurgeons at these facilities confirms that patients who fail to quickly recover to independent or minimally-assisted living will not be aggressively treated. Given this standard of care, all Coalition patients with GCS 3-8 and Iraqi patients with GCS 6-8 should be referred to Balad for definitive neurosurgical care. Transfer of Iraqi patients with GCS 3-5 is optional, as these patients are likely to be treated expectantly.

JTTS CLINICAL PRACTICE GUIDELINES FOR SEVERE HEAD TRAUMA

MONITORING & LAB EVALUATION		INDICATIONS & GUIDELINES	
INTRACRANIAL PRESSURE (ICP)		Glasgow Coma Score 8 or less.	
ARTERIAL LINE		Any head trauma that requires tracheal intubation or other definitive airway.	
CENTRAL VENOUS PRESSURE		When ICP or CPP management requires mannitol (Osmitrol) or hypertonic saline.	
NEUROIMAGING		Non-contrast head CT upon admission then at 6-24 hours after admission.	
EEG		Continuously when barbiturates are employed to manage ICP.	
LABS		ABG, CBC, Chem 10, PT, PTT, and INR <i>at least</i> q12 hrs during the first 48 hours of care.	
GENERAL MANAGEMENT PRINCIPLES			
PHILOSOPHY		<ul style="list-style-type: none">• Maintain continuous communication between the care teams.• Aggressively avoid hypotension, hypoxemia, fever, and hyponatremia.• Remember, the longer the ICP is elevated and the MAP/CPP are low, the worse the outcome.	
RESUSCITATION FLUID		Prefer Normal Saline. (Beware of iatrogenic, hyperchloremic acidosis)	
MAINTENANCE FLUID		Prefer Normal Saline 1 cc/kg/hr. (Child use 4/2/1 rule X 80%)	
SEDATION		<ul style="list-style-type: none">• Prefer propofol (Diprivan) 10-50 mcg/kg/min IV.• Consider other short-acting agents such as fentanyl (Sublimaze) 1 mcg/kg/hr IV or midazolam (Versed) 1-2 mg/hr IV.	
ULCER PROPHYLAXIS		<ul style="list-style-type: none">• All patients should receive pantoprazole (Protonix) 40 mg QD.• Child dosing for pantoprazole (Protonix) is 1 mg/kg to maximum of 40 mg QD.	
DVT PROPHYLAXIS		<ul style="list-style-type: none">• Pneumatic stockings for all adults.• Consider enoxaparin (Lovenox) 30 mg SC bid 24 hours after injury.• DVT Prophylaxis is not indicated in children (age < 16 yrs).	
SEIZURE PROPHYLAXIS		<ul style="list-style-type: none">• For all patients with injuries penetrating the cortex or blunt injuries with abnormal CT.• Minimum treatment 7 days.• Fosphenytoin (Cerebyx) loading dose: 18 mg/kg IV over 10 minutes. Adult maintenance: 100 mg q8h (child 2 mg/kg q8h). Therapeutic level: 10-20 µg/ml: [Phy corrected] = [Phy measured]/(0.2 x [albumin]) + 0.1.• Phenytoin (Dilantin) causes irritation of peripheral veins; run IV bolus over 20 minutes.	
ANTIBIOTICS		Cefazolin (Ancef) 1 gm IV (child 25 mg/kg) q8h X 5 days for all open injuries.	
NURSING		Assess neurologic status hourly; document ICP/CPP ventriculostomy output.	
STEROIDS		<ul style="list-style-type: none">• Steroids are <i>not</i> recommended for head trauma.• High dose methylprednisolone (Solu-Medrol) is contraindicated in penetrating injuries.• Consider methylprednisolone (Solu-Medrol) in blunt trauma with incomplete cervical spinal cord injuries. This protocol is not recommended for thoracic and lumbar trauma.• The protocol for methylprednisolone (Solu-Medrol) is 30 mg/kg bolus IV, then 5.4 mg/kg/hr.	
NUTRITION		≈140% of basal energy expenditure by seventh day post injury. Give 15% of calories as protein.	
GENERAL MEDICAL MANAGEMENT GOALS			
NEUROLOGIC	Intracranial Pressure (ICP)	< 20 mm Hg	See page 2
	Cerebral Perfusion Pressure (CPP)	> 60 mm Hg	

HEMODYNAMIC	Mean arterial pressure (MAP)	Maintain CPP	<ul style="list-style-type: none"> Hypotension (SBP < 90 mm Hg) worsens mortality and outcome Provide a rapid physiologic resuscitation utilizing Normal Saline, Hypertonic Saline, or colloids.
	Central venous pressure (CVP)	> 5 mm Hg	
	Cardiac index (CI)	> 2.5L/m/m²	
PULMONARY	Oxygen saturation (SpO ₂ %)	> 93%	Aggressively avoid hypoxemia
	PaCO ₂	30-35 mm Hg	First 24-48 hours of care
HEMATOLOGIC Consider titrating components using thromboelastography (TEG)	INR	< 1.5	Transfuse fresh frozen plasma
	Platelets	> 100,000/mm³	Transfuse platelets
	Hemoglobin	> 10 g/dL	Transfuse packed red blood cells
METABOLIC	Glucose	> 80 & < 150 mg/dl	Have low threshold for insulin drip
RENAL	Serum osmolality	> 280 & < 320 mOsm	<ul style="list-style-type: none"> sOsm = (2 x Na) + (Glucose/18) + (BUN/2.8) See sodium disorders on page 2
	Serum sodium	> 135 & < 150 mEq/L	

INTRACRANIAL PRESSURE MANAGEMENT

GENERAL MEASURES	Keep head in neutral position, avoid of tight cervical collars and circumferential ETT ties, elevate the head of the bed to 30-60 degrees.
SEDATION	<ul style="list-style-type: none"> Propofol (Diprivan) preferred during first 72 hours (see above for dosing). Confirm level of sedation when intracranial pressure increases.
TEMPERATURE	Consider cooling measures (Tylenol, cooling blanket) even for <i>modest</i> temperature elevations (100-101° F).
INTRACRANIAL HYPERTENSION MANAGEMENT	<ul style="list-style-type: none"> Treat elevations ≥ 20 mm Hg sustained for > 5 minutes. Always consider repeat CT scan with ICP elevations refractory to medical therapy.

TITRATE TO EFFECT GOAL: ICP < 20 mmHg	1. Deep sedation/analgesia	Propofol/fentanyl/midazolam (see above for dosing).
	2. Chemical paralysis	Cisatracurium (Vecuronium): Loading dose 0.2 mg/kg IV. Maintenance infusion 1-3 mcg/kg/hr IV.
	3. Modest hyperventilation	<ul style="list-style-type: none"> PaCO₂ 30-35 mmHg during evaluation or evacuation. Discontinue after 24-48 hours.
	4. Hypertonic saline	<ul style="list-style-type: none"> Recommended during the first 24-48 hours. 3% NS 250-500 cc bolus over 15 minutes (child 5 cc/kg). 3% NS infusion 40 cc/hr (child 0.5 cc/kg/hr).
	5. Mannitol	<ul style="list-style-type: none"> Avoid in dehydration and hypotension. 1 gm/kg IV fast push, then 0.25 gm/kg push q4h.
	6. Ventricular drainage	When open, ventriculostomy may drain as much as 10-20 cc/hr.
	7. Decompressive craniectomy	Discuss indications with neurosurgeon on call.

CEREBRAL PERFUSION PRESSURE MANAGEMENT (CPP = MAP – ICP)

GOAL > 60 mm Hg	1. Ensure euvoemia	Utilize endpoints of resuscitation (exam, vital signs, urine output, CVP, PCWP, CI).
	2. Control the ICP	Beware of mannitol use in hypovolemic patients.
	3. Consider pressors	Dopamine preferred, 0.5 mcg/kg/min IV.

ACUTE CLINICAL DETERIORATION

(e.g. Mental status change, unilateral dilated pupil, new focal neurological deficit, progressive or refractory ICP elevation)

1. Confirm level of sedation	UNCAL HERNIATION SYNDROME (Commonly seen in head trauma) <ul style="list-style-type: none"> Unilateral dilating pupil → progression to fixed and dilated Altered mental status → progression to comatose Contralateral babinski → contralateral weakness → bilateral flexor or extensor posturing Tachycardia/hypertension → bradycardia/hypertension → bradycardia/hypotension
2. Verify oxygenation and ventilation	
3. Hyperventilate bag with 100% O ₂ ; goal PaCO ₂ 20-30 mmHg	
4. Re-bolus 3% saline or mannitol	
5. Repeat CT/call neurosurgery	
6. Consider damage control crani	

GLASGOW COMA SCORE		Eye Opening	Best Verbal Effort	Best Motor Effort
1		None	None	No response to pain
2		To Pain	Nonspecific sounds	Extensor posturing
3		To verbal stimuli	Inappropriate words	Flexor posturing
4		Spontaneously	Confused	Withdraws to pain
5		-	Oriented	Localizes pain
6		-	-	Follows commands
COMMON SODIUM DISORDERS SEEN IN HEAD TRAUMA				
Disorder	Na+	Diagnostic Clues	Treatment	
SIADH	↓	Low Sosm, usually euvolemic, ↑ Uosm	Restrict free water, administer hypertonic saline if severe	
Cerebral salt wasting	↓	Sosm may be normal, ↑ UOP, signs of volume depletion & hemoconcentration, very high U Na	Replace volume with Normal Saline or hypertonic saline. Administer oral sodium. Beware of rapid sodium correction.	
Mannitol use	↑	Polyuria, ↑ [Na+] & Sosm	Hold mannitol if Sosm > 320.	
Diabetes Insipidus	↑	Polyuria (> 250 cc/hr), ↑ [Na+] & Sosm, U Sp Gr <1.005	DDAVP ≈ 2-4 µg SQ bid.	
BRAIN DEATH DETERMINATION – Adhere to separate “Guidelines for Diagnosing Brain Death.”				

Clinical Practice Guideline

Recommendations

1. Always address immediate life-threatening injuries and begin resuscitation using ATLS protocols.
 - a. Normal saline is the preferred crystalloid solution.
 - b. Blood products are preferred over albumin and hespan if colloids are necessary.
 - c. Consider recombinant Factor VIIa for life threatening intracranial bleeding.
 - d. Consider hyperventilation (goal PaCO₂ 30-35 mm Hg) to decrease ICP.
 - e. Antibiotics are unnecessary for isolated closed head injuries. Patients with open head injuries should receive 2 grams (child 50 mg/kg) cefazolin (Ancef) IV on admission and every 8 hours until wounds are closed.
 - f. Steroids provide no benefit to head injured patients.
2. Two most important factors to manage:
 - a. Hypotension: keep SBP > 90 mm Hg
 - b. Hypoxemia: keep SpO₂ Sat > 93%
3. Document neurological examinations. These should include:
 - a. Glasgow Coma Score (GCS)
 - b. Size and reactivity of pupils
 - c. Presence of gross unilateral weakness, paraplegia, or quadriplegia
 - d. Interval changes while at your facility
4. Neurosurgeons in Balad prefer to examine patients when they arrive. Avoid medications which cause long lasting sedation or paralysis.

at no time should these preferences override the need for safe transport

 - a. Vecuronium (Norcuron) 5-10 mg (child 0.1 mg/kg) IV is preferred for paralysis. Avoid redosing within one hour of arrival in Balad.
 - b. Propofol (Diprivan) 5-10 mcg/kg/min IV is preferred for sedation.
 - c. Intermittent administration of narcotics is preferred over continuous intravenous drips for pain control.
5. If therapy for intracranial hypertension is needed prior to transfer:
 - a. Consider 23% NS 30 cc one time bolus IV over 15 minutes (child 0.5 cc/kg).
 - b. If 23% sodium chloride is unavailable, consider 3% NS 250-500 cc IV bolus (child 5 cc/kg) followed by continuous infusion 40 cc/h (child 5 cc/kg/hr).
 - c. If signs of herniation or severe edema are present, consider Mannitol 1 g/kg bolus IV, followed by 0.5 g/kg rapid IV push q4h.

do not use mannitol in hypotensive or under-resuscitated patients
6. Antiepileptic medications for seizure prophylaxis:
 - a. Consider for all patients with intracranial hemorrhage, penetrating brain injury, seizure following the injury, or GCS 3-8.
 - b. Fosphenytoin (Cerebyx) is the preferred parenteral (IV or IM) medication:
 - i. Adults: load 1 gram IV over 10 minutes, followed by 100 mg IV q8h.
 - ii. Children: load 20 mg/kg over 10 minutes, followed by 2 mg/kg IV q8h.
 - c. Discontinue after 7 days if no penetrating brain injury, no prior seizure history, and no development of seizures since the injury.