Hyperbaric Oxygen Brain Injury Treatment Trial: Clinical Standard Guidelines (CSG)

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OBTAINING AN ACCURATE ENROLLMENT GLASGOW COMA SCALE (GCS) SCALE

- The most accurate GCS is post resuscitation (off sedation) just prior to enrollment
- The degree of change in neurologic status from either pre-hospital or first hospital to enrollment is highly significant (p < 0.001)
- Patients with lower GCS scores and compromised pupil reactivity have a greater range of improvement over time, while patients less compromised have a greater range for deterioration

Marmarou et al.; J Neurotrauma 24:270-280, 2007

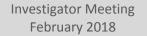




Obtaining an Accurate Enrollment GCS Score

- •Short-acting sedative and analgesic agents are recommended
- Propofol is drug of choice as it allows rapid titration and short half life







EVALUATION

- •GCS
 - -Eye opening
 - -Best motor response
 - -Verbal response
- Pupillary size, equality, reaction to light
- •Symmetry of motor strength



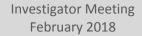




GCS Best Motor Response

Follow commands 6
Localizes to pain 5
Withdrawal to pain 4
Flexion posturing (decorticate) 3
Extensor posturing (decerebrate) 2
No response 1



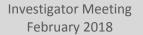




IMPACT SCORE

- •Age
- •Motor score
- Pupillary reactivity
- •CT Marshall score
- •The IMPACT score will be used in the predictive model of GOS-E outcome at 6 months



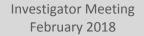




Clinical Standard Guidelines

- •CSGs formulated by a multidisciplinary standardization team
- •Treatment variability among sites can undermine a RCT
- •The guidelines do not preclude clinical judgement







Physiologic Goals

Pulse $Ox \ge 90\%$	ICP < 22 mmHg	Physiologic Na+ 135-145*
$PaO_{2} \ge 100 \text{ mmHg}$	$PbtO_2 \ge 20 \text{ mmHg}$	INR ≤ 1.4
PaCO ₂ 40-45 mmHg	$CPP \stackrel{2}{\geq} 60 \text{ mmHg}$	$PLTS \ge 75 \text{ x } 10^3 / \text{mm}^3$
$MAP \ge 70 \text{ mmHg}$	Temp 36.0-37.9° C	$Hgb \ge 8 \text{ gm/dl}$
SBP > 100 mmHg if 50 to 69		
years old or > 110 mmHg if 15		
to 49 or over 70 years old	Glucose 80-180 mg/dL	рН 7.35-7.45

*Hypertonic saline therapy: Na+ range: 145 mmol/L (minimum) to 160 mmol/L (maximum)





OXYGENATION / VENTILATION

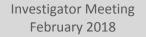
- •End tidal CO_2 (ETCO₂) should be monitored preclinical, ED, and during transport to and from HBO₂
- •Hyperventilation should be strictly avoided during resuscitation because it increases ischemia
- •Therapeutic hyperventilation may be necessary for brief periods for refractory ICP, herniation



BLOOD PRESSURE / VOLUME RESUSCITATION

- •Normal saline is initially recommended to maintain euvolemia
- •Blood transfusion as needed (Hgb \geq 8 gm/dl)
- •Vasopressors may be required to maintain SBP > 100-110 mmHg and/or to maintain CPP > 60 mmHg







NTRACRANIAL PRESSURE MONITORING

- A ventriculostomy is the preferred monitoring device for the HOBIT Trial
- The ventriculostomy is zeroed at the tragus of the ear (foramen of Monroe)
- Hypertonic saline (HTS) or mannitol should be used prior to ICP monitoring in patients undergoing uncal herniation or neurologic deterioration
- Intracranial hypertension is defined as \geq 22 mmHg
- Despite this being National Brain Injury Foundation Guidelines, 22 mmHg is high intraventricular pressure (equals 286 mm H_2O)





Advantages of HTS Compared to Mannitol as an Osmotic Agent

- •HTS has a more prolonged effect
- •HTS expands vascular volume utilizing small volumes while mannitol causes a diuresis and volume/electrolyte depletion with risk of hypotension
- •HTS administration results in decreased ICP, increased MAP, increased CPP, with improved $P_{bt}O_2$

Rockswold et al, Neurosurg 65:1035-1042, 2009





Advantages of HTS Compared to Mannitol as an Osmotic Agent

- •HTS use can be continued despite elevated Na (~ 160) and serum osmolarities (340)
- •Mannitol use has to be restricted to serum mOsm > 320 or acute renal failure can result
- •HTS has less "rebound" due to a higher reflection coefficient (1.0 vs 0.9)

Rockswold et al, Neurosurg 65:1035-1042, 2009

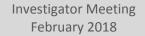






Management of Increased Intracranial Pressure







General Recommendations

- Adjust cervical collar placement if applicable
- Repeat CT
 - A repeat CT scan of the brain should be done at 6-12 hours post admission to rule out the evolution or development of a surgical mass or unexpected intracranial lesion and to check for the correct placement of monitors
- Craniotomy for surgical lesions
 - To be discussed later in presentation





TIER

- •Head of patient's bed to be placed at \geq 30 degrees
- Sedation and analgesia using recommended agents (propofol, fentanyl, and versed)
- •Ventriculostomy extraventricular drain; drain to 10 mmHg for ICP \geq 22 mmHg sustained for \geq 5 minutes
- •Mannitol: 0.25-1.0 g/kg; IV bolus x 1 dose *OR*
- •Hypertonic saline: 30 cc of 23.4% for 30 minutes x 1 dose
- Mild hyperventilation with a PCO_2 goal of 35-40 mmHg

Tier 1 completed within 30-60 minutes, if $ICP \ge 22$ mmHg proceed to Tier 2



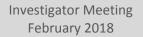




TIER 2

- •HyperOsmolar Therapy
 - -Mannitol: Intermittent boluses of mannitol (0.25-1 gm/kg body weight) should be administered. The serum sodium and osmolality must be assessed frequently (every 6 hours) and additional doses should be held if the serum osmolality exceeds 320 mOsm/L.
 - -Hypertonic saline: Boluses of 30 cc of 23.4% over 30 minutes may be used. Serum sodium and osmolality must be assessed frequently (every 6 hours) and additional doses should be held if serum sodium exceeds 160 mEq/L.





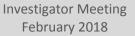


TIER 2

- •PCO₂ goal 30-35 mmHg, as long as brain hypoxia is not encountered
- •Neuromuscular paralysis: Pharmacologic paralysis with a continuous infusion of a neuromuscular blocking agent should be employed if the above measures fail to adequately lower the ICP and restore CPP. Adequate sedation must be utilized if pharmacologic paralysis is employed.

Tier 2 completed within 30-60 minutes, if ICP \geq 22 mmHg proceed to Tier 3





TIER 3 (INCLUDES POTENTIAL SALVAGE THERAPIES)

- •Decompressive hemi-craniectomy or bilateral craniectomy should only be performed if Tiers 1 and 2 are not sufficient. Procedure per site surgical protocol. This procedure is <u>NOT</u> a contraindication for HBO₂.
- •Barbiturate or propofol (anesthesia dosage) coma: It should only be instituted if a test-dose of barbiturates or propofol results in a decrease in ICP. Hypotension is a frequent side effect of high dose therapy.



Antiseizure Prophylaxis

- •TBI and HBO₂ can both cause seizures
- •All HOBIT patients are intravenously loaded with phenytoin (Dilantin) or levetiracetam (Keppra) and therapeutic levels maintained for 7 days







SURGICAL MANAGEMENT OF TB

- •In general, mass lesions should be evacuated for the following or a combination of indications
 - -Midline shift to > 5 mm, especially if the mass is in the temporal lobe
 - -Deterioration in the GCS motor score of one level
 - -ICP \geq 22 mmHg
 - -Compressed/absent circumcephalic cisterns
 - -Clinical judgement is required



