Neurotrauma Clinical Practice Guideline

TITLE: Evaluation and Non-Operative Management of Acute Traumatic Brain Injury (TBI)

EFFECTIVE: Jan 31, 2013

DOCUMENT VERSION: 1.0

LAST REVISION: April 3, 2012

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PURPOSE: This is a clinical practice guideline for medical interventions to be used in monitoring and treating acute traumatic brain injury. The purpose of the guidelines is to help provide for uniform standards in monitoring and management of elevated intracranial pressure, and minimizing secondary injury after TBI/DAI. This does not constitute a standard of care or hospital policy.
This is a guideline only. Physician(s) may deviate from this guideline, but there must be a documented reason for deviation from this guideline in the medical record.

This guideline applies only to acute traumatic brain injury (injury within past 7 days).

I. Procedures

A. Resuscitation Guidelines and Therapeutic Goals in TBI

1. Systolic BP should be maintained at or above 100mmHg at all times.
2. CPP should be maintained at or above 60mmHg at all times.
3. ICP should be maintained less than 20 mmHg at all times.
4. Hypoxemia (PaO_2 < 100 mmHg or SaO_2 < 90%) should be avoided at all times.
5. Normocarbia ($PaCO_2$ 35-40mmHg) should be maintained except during hyperventilation maneuvers as a salvage technique for herniation syndromes.
6. Mild elevations in temperature (37 – 38.5C) should be treated with pharmacologics **–or–** cooling blanket. Fever > 38.5C should be treated aggressively with pharmacologics and active cooling.

B. Airway Management

1. All patients GCS < 9 should be intubated.
2. Short acting agents are preferred (etomidate, propofol, succinylcholine or rocuronium).

C. Cardiac and Hematologic Management

1. All patients with ventriculostomy or ICP monitor require invasive blood pressure monitoring to provide for CPP directed therapy.
2. Patients should be resuscitated to euvolemia with saline solutions and blood products.
3. Hemoglobin should be maintained at or above 8 gm/dL.
4. INR should be maintained below 1.4.
5. Platelet count should be maintained at or above 75,000 / mm^3.

D. Neuroimaging:

1. Non-contrast CT is the imaging modality of choice for initial assessment of all neuro-trauma patients.
2. Urgent non-contrast CT of the brain is indicated for changes in neurological status not attributable to identifiable metabolic or physiologic derangement.
3. CT Angiogram (Arch through Circle of Willis) should be considered for patients with neurological exam *not directly attributable* to diffuse TBI or non-operative intracranial mass lesion. Additionally, CTA should be considered in patients at high risk for traumatic neurovascular injury (cervical subluxation, cervical fracture through foramen transversarium, penetrating trauma, skull base fracture through carotid canal or occipital condyle).

4. MRI (Stroke/TBI protocol) should be considered (diagnostic/prognostic) once the patient is stable and intracranial monitors removed for patients with permanent decline in GCS and/or fixed neurological deficit.

E. Intracranial Pressure Monitoring:
1. ICP should be monitored in all 'salvageable' patients with GCS less than 9 not attributable to a metabolic cause.
2. External ventricular drain is considered the gold standard for monitoring of ICP.
3. ICP may be monitored by a "bolt" and strain gauge device.
4. ICP should be monitored in all patients who undergo operative decompression / evacuation of epidural, subdural or intraparenchymal hematoma *and* have (or are expected to have) a post-operative GCS of 8 or less (i.e. no neuro exam to follow) after emergence from anesthesia.
5. ICP should be monitored in all patients with TBI and GCS < 13 who require emergent surgery for trauma to other organ systems during the initial resuscitation period.

F. Multimodal Monitoring:
1. Brain tissue oxygenation ($PbtO_2$) should be considered in patients indicated for invasive intracranial monitoring.
2. $PbtO_2$ should be maintained at or above 15 mmHg (see Licox Protocol).

G. Management of Elevated Intracranial Pressure:
1. The threshold for initiation of treatment is sustained ICP > 20 mmHg for more than 5 minutes.
2. Sudden dramatic elevations in ICP should prompt CT scan to rule out hematoma, hydrocephalus, or other mass lesion.
3. Prior to initiating medical therapy, optimize patient positioning.
   a) Head of bed greater than 30 degrees.
   b) Loosen/remove cervical collar and maintain slight flexion of neck if possible.
4. Initial therapy shall consist of hyperosmolar therapy with hypertonic saline solutions.
   c) 3% and higher should be given in patients with central or PICC access. 3% may be given peripherally during initial resuscitation prior to obtaining central access.

d) 23.4% hypertonic saline (30mL bolus) is preferable to mannitol when central access is present.
e) Serum sodium is to be monitored every 6 hours while hyperosmolar therapy is instituted.
f) Goal is serum Na = 145-155 mEq/L.
g) Hypertonic saline should be withheld for Na > 159 mEq/L.

5. Mannitol may be used as a 'rescue' osmotherapy in patients with SBP > 90 mmHg, and serum Osmolarity < 320 mOsm.
   a) Initial dosing is 0.5-1g/kg IV Bolus.
   b) Lasix 40 mg IV bolus should be given concurrently with the initial dose of mannitol.
   c) Subsequent boluses may be given at 0.25-0.5 g/kg IV bolus while serum Osm < 320, or osmolar gap < 20, unless evidence of hypovolemia is present.
6. Concurrent therapy shall consist of adequate IV anesthesia and analgesia, including consideration for induced burst-suppression.
   a) Dexemetomedine is the anesthetic/anxiolytic of choice for TBI for the first 48 hours after injury.
   b) Propofol may be considered as a secondary / additional anesthetic for TBI.
   c) Shorter acting narcotics (fentanyl) should be considered for analgesia in TBI and polytrauma patients.
7. Second-line therapy for elevated ICP shall consist of neuromuscular blockade.
8. Decompressive craniectomy should be considered for 'salvageable' patients with initial GCS greater than 3 (including witnessed GCS > 3 in 60 minutes prior to admission) and medically refractory ICP > 20 mmHg.
9. Third-line therapy for refractory ICP shall consist of induced hypothermia (see hypothermia protocol).
10. Barbiturate coma is discouraged.
11. Glucocorticoids are contraindicated in TBI.

H. Seizure Prophylaxis
1. All TBI patients at risk for seizure should receive prophylaxis upon admission.
2. Seizure prophylaxis should be continued for no more than 7 days.
3. Keppra 500-1000mg BID is the preferred agent.
4. Dilantin may be used, and should be dosed based on therapeutic levels. If used, baseline and serial LFTs should be monitored.

I. Electroencephalography & Burst Suppression

1. EEG to rule out sub-clinical (non-convulsive) seizure activity should be considered for patients with neurological exam *not directly attributable* to diffuse TBI or non-operative intracranial mass lesion.
2. Continuous EEG is indicated for patients requiring pharmacologic burst suppression. Burst suppression is defined as an alternating pattern of <10 uV activity in all leads for at least 4 seconds (suppression) and with an intervening period of high electrical activity (burst). Over a window of measurement, the periods of suppression should be greater than bursts of activity.
3. Spectral Monitoring (BIS) is indicated for patients requiring pharmacologic burst suppression *only when continuous EEG is not available*. Burst suppression is defined as a BIS Index < 20 and/or a suppression ratio (SR) = 70-80%

J. DVT Prophylaxis

1. Chemoprophylaxis (LMWH) may be considered when:
   a) There is no evidence of intracranial hemorrhage.
   -or- Initial hemorrhage is stable on serial CT for more than 48 hours after coagulopathy has been corrected.
   b) The patient does not have indwelling ICP monitor, ventricular catheter or lumbar drain.
   c) There is no cranial or spinal surgery planned for at least the next 24 hours.

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1/31/2013
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