

# Clinical Practice Management Guidelines

## Traumatic Brain Injury Pre-Hospital

### I. Assessment

#### A. Oxygenation and Blood Pressure

##### 1. Adult

- a. Patients with suspected TBI should be monitored for hypoxemia with continuous pulse oximetry and oxygen levels should be maintained at >90% saturation.
- b. Patients with suspected TBI should have blood pressure monitored as often as possible with the most accurate method available under the circumstances.
- c. Systolic blood pressure should be maintained at >90 mmHg.
- d. Three percent Normal saline should be considered as the initial resuscitative fluid for patients with suspected severe TBI who are hypotensive (<90 mmHg)

##### 2. Pediatric

- a. Systolic blood pressure should be maintained above age-specific minimums.
  - i. 0-28 days - >60 mmHg
  - ii. 1-12 months - >70 mmHg
  - iii. 1-5 years - >80 mmHg
  - iv. >5 years - >90 mmHg
- b. Blood pressure should be measured with the appropriate sized pediatric cuff. When blood pressure is difficult to obtain, documentation of the child's mental status, quality of the peripheral pulses, and the capillary refill time may be used as surrogate measures.
- c. 3% Normal saline (5 mg/kg bolus over 5 minutes) should be considered as the initial resuscitative fluid for children with suspected TBI who are hypotensive.
- d. Oxygen saturations should be measured continuously and levels maintained at >95%.

## B. Glasgow Coma Scale

## 1. Adults and Pediatrics

- a. Pre-hospital providers should be familiar with and accurately assess the Glasgow Coma Scale in patients with suspected TBI.
- b. GCS should be documented prior to the administration of paralytics, sedatives or narcotics.
- c. The GCS should be measured repeatedly over time to identify improvement with interventions or deterioration.

Pediatric Glasgow Coma Scale						
	1	2	3	4	5	6
<b>Eyes</b>	Does not open eyes	Opens eyes in response to stimuli	Opens eyes in response to speech	Opens eyes spontaneously	N/A	N/A
<b>Verbal</b>	No verbal response	Inconsolable, agitated	Inconsistently inconsolable, moaning	Cries but consolable, inappropriate interactions	Smiles, orients to sounds, follows objects, interacts	N/A
<b>Motor</b>	No motor response	Extension to pain ( <u>decerebrate response</u> )	Abnormal flexion to pain for an infant ( <u>decorticate response</u> )	Infant withdraws from pain	Infant withdraws from touch	Infant moves spontaneously or purposefully

Adult Glasgow Coma Scale						
	1	2	3	4	5	6
<b>Eyes</b>	Does not open eyes	Opens eyes in response to <u>painful stimuli</u>	Opens eyes in response to voice	Opens eyes spontaneously	N/A	N/A
<b>Verbal</b>	Makes no sounds	Incomprehensible sounds	Utters inappropriate words	Confused, disoriented	Oriented, converses normally	N/A
<b>Motor</b>	Makes no movements	Extension to painful stimuli ( <u>decerebrate response</u> )	Abnormal flexion to painful stimuli ( <u>decorticate response</u> )	Flexion/withdrawal to painful stimuli	Localizes painful stimuli	Obeys commands

## C. Pupils

### 1. Adults and Pediatrics

- a. Pupils should be measured after the patient has been resuscitated and stabilized.
- b. Asymmetry – defined as  $>1$  mm difference between right and left should be noted.
- c. Fixed pupils are  $<1$  mm - response to bright light should be noted.
- d. Evidence of orbital trauma should be noted.

## II. Treatment

### A. Adult and Pediatrics

1. Hypoxia should be corrected immediately.
2. An airway should be established by the most appropriate means available for:
  - a. Patients with GCS  $<9$ .
  - b. Inability to maintain an adequate airway.
  - c. Hypoxemia not corrected with supplemental oxygen.
3. When endotracheal intubation is used to establish an airway, confirmation of placement of the tube in the trachea should include lung auscultation and end-tidal CO<sub>2</sub> determination.
4. Patients should be maintained at normal breathing rates (ETCO<sub>2</sub> – 35-40 mmHg).
  - a. Continuous ETCO<sub>2</sub> is encouraged.
  - b. Hyperventilation should be avoided unless authorized to do so by on-line medical control for impending herniation.
    - i. Goal of hyperventilation is 30-35 mmHg.
    - ii. Continuous ETCO<sub>2</sub> is recommended.
5. Positioning
  - a. Head of bed should be elevated, if possible.
  - b. Head should be maintained in a midline position.
  - c. Cervical collars should be checked to ensure they are not too tight.

### III. Transportation and Destination

#### A. Adult

1. Patients with severe TBI (GCS <9) should be transported directly to a facility with immediately available CT scanning, prompt neurosurgical care, and the ability to monitor intracranial pressure and treat intracranial hypertension.
2. Mode of transport should be selected so as to minimize the total pre-definitive care hospital time for the patient. This would include the use of air transport from the scene and rendezvous with ground services at determined landing zones
3. Patients with minor head injuries but on anticoagulants should be triaged to a level of care capable of treating a severe TBI.

#### B. Pediatric

1. Patients with severe TBI should be treated at a designated pediatric trauma center.

## Traumatic Brain Injury Hospital

- I. Stabilizing Hospitals (Level IV and some Level III)
  - A. Should perform Tier I therapy in the ED for all patients with suspected severe TBI (GCS <9).
  - B. Should rapidly triage, assess, and consider transfer of any patient with injury to the head while taking anti-coagulants.
- II. Definitive Care Hospitals
  - A. Should begin Tier I therapy while the patient is in the ED.
  - B. Should make, adopt, disseminate, and monitor compliance with a comprehensive TBI pathway.
  - C. Should expedite the triage, imaging, and assessment of any patient with injury to the head while taking anti-coagulants.
  - D. Should adopt a protocol for the rapid reversal of anti-coagulants for patients with documented TBI.
- III. Tier 1
  - A. Elevation of the head of bed 15 degrees with reverse Trendelenburg position.
  - B. Head positioned mid-line.
  - C. Ensure cervical collar is not so tight as to impede venous return.
  - D. Blood pressure should be monitored and hypotension avoided.
    1. 0-28 days - >60 mmHg
    2. 1-12 months - >70 mmHg
    3. 1-5 years - >80 mmHg
    4. >5 years - >90 mmHg
  - E. 3% Normal saline 250cc adult and 5cc/kg for pediatrics over five minutes.
  - F. Oxygen levels should be monitored and hypoxia (SaO<sub>2</sub> <90%) avoided.

1. Adult and Pediatric
    - a. Hypoxia should be corrected immediately.
    - b. An airway should be established by the most appropriate means available for:
      - i. Patients with GS <9.
      - ii. Inability to maintain an adequate airway.
      - iii. Hypoxemia not corrected with supplemental oxygen.
    - c. Following endotracheal intubation, confirmation of placement of the tube in the trachea should include lung auscultation and end-tidal CO<sub>2</sub>.
    - d. Patients should be maintained at normal breathing rates (ETCO<sub>2</sub> 35-40 mmHg).
      - i. Continuous ETCO<sub>2</sub> is encouraged.
      - ii. Hyperventilation should be avoided except in situations of impending herniation.
        - Goal of hyperventilation is 30-35 mmHg.
        - Continuous ETCO<sub>2</sub> is recommended.
  - G. Pain should be adequately treated with appropriate doses of narcotic.
  - H. Sedation should be accomplished without compromising systolic blood pressure or oxygenation.
  - I. Place Foley catheter and monitor fluid balance carefully.
  - J. Anti-convulsants should be given for early post-traumatic seizure and considered for prophylaxis in patients with:
    1. GCS <10
    2. Cortical contusion
    3. Depressed skull fracture
    4. Penetration of the dura
- IV. Tier 2
- A. CT scanning should be performed without contrast for the identification of operative injuries.

- B. Patients with persistent GCS <9 after initial stabilization and resuscitation should have ICP monitors placed.
  - C. ICP monitors should be maintained less than 20 mmHg.
    - 1. Sedatives and narcotics should be used to avoid intracranial hypertension, as well as hypoxia and systemic hypotension.
    - 2. Paralytics should be used if sedation and pain management are not controlling ICP.
  - D. Cerebral perfusion pressure (CPP) should be maintained between 50-70 mmHg.
  - E. Aggressive attempts to maintain CPP >70 with fluid and pressors should be avoided.
  - F. Temperature should be maintained 36.5-37.5 with antipyretics and cooling measures.
  - G. Shivering should be avoided and paralytics begun if active cooling is necessary to maintain body temperature.
  - H. Enteral nutritional support should be started and full nutritional support should be attained by day #7.
  - I. Stress ulcer prophylaxis should be started.
  - J. Implement DVT prophylaxis protocol.
  - K. Check serum glucose, electrolytes, and osmolality.
    - 1. Maintain serum glucose in a target range of 80 -20 mg/dl.
    - 2. Maintain serum sodium 140-150 mEq/L.
    - 3. Maintain serum osmolality >320 MOsm/L.
  - L. Cluster care interventions and consider blousing with narcotic or sedative when turning is required.
- V. Tier 3
- A. Consider repeating imaging to identify surgically corrected lesions.
  - B. Barbiturates should be considered first as a single test dose and as a continuous drip.
  - C. Continuous EEG monitoring is required for patients entering Tier 3. Suppression of bursts to <4 minutes are suggested.
  - D. Increase serum osmolality to 350-360 MOsm/L.

- E. Consider decompressive craniectomy.
- F. Consider hypothermia under a protocol with careful rewarming.
- G. Consider hyperventilation with brain tissue oxygen monitoring or other advanced monitoring.