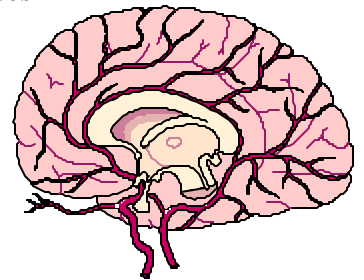


# STATE TRAUMA ADVISORY BOARD MANAGEMENT RECOMMENDATIONS

## SUBJECT: EVIDENCE-BASED MANAGEMENT OF SEVERE TRAUMATIC BRAIN INJURY

*These treatment recommendations are based on an evidence-based-medicine analysis of the literature performed by the Eastern Association for the Surgery of Trauma (EAST). The results of this analysis were published as a synopsis in the Journal of Trauma (J Trauma 44(6):941-57, 1998) and are available as a complete document at [www.east.org](http://www.east.org). Because they are based on a formal evidentiary analysis of the literature, the EAST guidelines represent what the authors present as the optimal management strategies based on available literature.*

*The recommendations contained below are an attempt to translate the EAST guidelines into evidence based practice. Although they attempt to follow the EAST guidelines as closely as possible, there may be equivalent methods of accomplishing any one given management goal. Individual steps in these recommendations, therefore, represent treatment suggestions. Substitution of any or all of these recommendations by equivalent approaches that are based on consideration of the evidence-based literature review as published by the EAST is a valid treatment option.*



**PURPOSE:** To facilitate management of the severe traumatic brain injury (TBI) patient based on evidence-based practice (as outlined in the Guidelines for the Management of Severe Brain Injury) whenever possible. This document serves only to integrate the Guidelines for the Management of Severe Brain Injury into practice where they are directly applicable. It is not an exhaustive guide to managing TBI.

### DEFINITIONS

Severe TBI	GCS $\leq$ 8
Hypotension	Systolic blood pressure 90 mmHg
Hypoxia	Oxygen saturation $<$ 90% or a PaO <sub>2</sub> $<$ 60 mmHg or apnea or cyanosis in the field
Hyperventilation	PaCO <sub>2</sub> 30-35 mmHg
Severe Hyperventilation	PaCO <sub>2</sub> $<$ 30 mmHg
ICP	Intracranial Pressure measured by ventriculostomy or intraparenchymal device

**I. IN THE FIELD****A. Monitoring**

1. Establish accurate GCS as soon as possible.
2. Measure blood pressure and, if possible, oxygenation (oxygen saturation) and tidal CO<sub>2</sub> using quantitative capnometry, as soon and as often as possible.

**B. Airway, Oxygenation, and Ventilation**

1. Perform endotracheal intubation in a patient with GCS 8, using rapid sequence intubation if necessary. Minimize response to intubation with Lidocaine or other appropriate medication whenever possible.
2. Oxygenate with 100% FiO<sub>2</sub>.
3. Ventilate normally (unless hyperventilation is indicated [vide infra]), attempting to keep PaCO<sub>2</sub> at the lower end of normal. Attempt to achieve a minute ventilation of 100-120cc/kg/min. For an Ambu bag volume of 500 cc and a 70 kg patient, this will require 14-16 assisted respirations per minute. Only in patients with evidence of intracranial hypertension (elevated ICP) as suggested by 1) unequal or dilated pupils; 2) posturing; 3) neurologic deterioration not explainable by other causes (ie medications), should hyperventilation be performed. This will involve an attempt to deliver 140-150 cc/kg/min. For an Ambu bag volume of 500 cc and a 70 kg patient, this will require 18-20 assisted respirations per minute.

**C. Blood pressure & Fluid resuscitation**

1. Full, unrestricted fluid resuscitation per ATLS protocols using isotonic fluids. No fluid restriction in TBI patients. 0.9% NS is generally the preferred resuscitation solution.
  - a. Consider administering 250 cc of 7.5% NS as the first resuscitation fluid (followed by isotonic solutions).
2. Keep systolic blood pressure >90 mmHg at all times. Any hypotension must be corrected vigorously and immediately.
  - a. Consideration should be given to maintaining a mean arterial pressure >90 mmHg.
  - b. Primary response to hypotension is fluid administration and prevention of blood loss.
  - c. Use of pressor solutions should be considered in hypotension refractory to above measures.

**D. Sedation or Neuromuscular Blockade**

1. May be used as required. Short-acting agents should be employed.

## II. AT THE HOSPITAL

### A. Continue ABCs as above

1. Adjust ventilator settings to achieve O<sub>2</sub> saturation > 94% and PaCO<sub>2</sub> of 35-37 mmHg. Only in patients with suspected intracranial hypertension (elevated ICP) should hyperventilation be initiated (vide infra). The target of such hyperventilation is a PaCO<sub>2</sub> of 30-35 mmHg. This will involve an attempt to deliver 140-150 cc/kg/min.
  - a. Arterial blood gases should be closely followed.
  - b. Capnography should be considered.
2. Hypotension must be immediately corrected using an escalating approach as described above.
  - a. Consideration should be given to maintaining a mean arterial pressure >90 mmHg.

### B. Facilitate rapid, safe transport to CT

1. Patient must be accompanied by medical personnel capable of directing a systemic and neurological resuscitation in the CT scanning suite.

### C. Monitoring (to be established as soon as possible)

1. Oxygen saturation
2. Arterial blood pressure (systolic, diastolic, and mean)
3. Pulse
4. EKG trace
5. Capnography
6. Urinary output
7. Central venous pressure
  - a. Consider PA line
8. ICP (vide infra)
9. Consider jugular venous saturation, particularly when hyperventilating.

### D. Treatment of suspected intracranial hypertension

1. Suspect intracranial hypertension when the patient exhibits:
  - a. Unequal or dilated pupils
  - b. Posturing
  - c. Neurologic deterioration not explainable by other causes (ie medications).
2. Treat suspected intracranial hypertension with:
  - a. Hyperventilation to a PaCO<sub>2</sub> of 30-35 mHg
  - b. Mannitol (0.25-1.0 g/kg IV bolus) ONLY if patient is normotensive and appears to be fully fluid resuscitated.

**E. ICP Monitoring (by ventriculostomy or intraparenchymal device) is indicated in the following severe TBI patients (at a minimum)**

1. Severe TBI patients with intracranial or calvarial abnormality on their CT
2. Severe TBI patients with normal CT and 2 or more of the following:
  - a. Age over 40 years
  - b. Unilateral or bilateral motor posturing
  - c. Present or past occurrence of systolic blood pressure <90 mmHg.

**III. TREATMENT OF INTRACRANIAL HYPERTENSION**

**A. Treatment threshold**

1. Intracranial pressure treatment should be initiated at an upper threshold of 20-25 mmHg.
  - a. Interpretation and treatment of ICP based on any threshold should be corroborated by frequent clinical examination and cerebral perfusion pressure (CPP) data.
2. CPP should be maintained at a minimum of 70 mmHg.

**B. Treatment algorithm**

1. A critical pathway for managing intracranial hypertension is presented in Figure 1. The order of steps is determined by the risk: benefit ratio of individual treatment maneuvers. This critical pathway is a consensus document, developed by the authors of the Guidelines for the Management of Severe Head Injury. Therefore, it must be viewed as Class III (“expert opinion”) evidence. As such, it should be interpreted as a framework that may be useful in guiding an approach to treating intracranial hypertension. It can and should be modified in an individual case by any circumstances unique to the patient as well as by the response of the ICP to individual treatment steps.

**C. NOTES**

1. The use of prophylactic hyperventilation (PaCO<sub>2</sub> 35 mmHg) therapy should be avoided.
2. Jugular venous oxygen saturation (SjO<sub>2</sub>), arterial-jugular venous oxygen content differences (AVdO<sub>2</sub>), and CBF monitoring may help to identify cerebral ischemia if hyperventilation is necessary.
3. Vigorous hyperventilation therapy may be necessary for brief periods when there is acute neurologic deterioration (eg acute pupillary dilation). Such hyperventilation should be terminated whenever possible as soon as the etiology has been determined and corrected.

4. Euvolemia must be maintained when mannitol is being administered.
5. High-dose barbiturate therapy may be considered in hemodynamically stable salvageable severe head injury patients with intracranial hypertension refractory to maximal medical and surgical ICP lower therapy.
6. The use of glucocorticoids is not recommended for improving outcome or reducing ICP in patients with severe TBI.

#### **IV. ANCILLARY CARE OF THE SEVERE TBI PATIENT**

##### **A. Nutrition**

1. Replace 140% of resting metabolism expenditure in non-paralyzed patients and 100% resting metabolism expenditure in paralyzed patients using enteral or parenteral formulas continuing at least 15% of calories as protein within 48 to 72 hours after injury.
  - a. The preferable option is use of jejunal feeding by gastrojejunostomy due to ease of use and avoidance of gastric intolerance.

##### **B. Anticonvulsants**

1. Prophylactic use of pheytoin, carbamazepine, or phenobarbital is not recommended for preventing *late* posttraumatic seizures. It is a treatment option to use anticonvulsants to prevent *early* posttraumatic seizures in patients at high risk for seizures following head injury. Phenytoin and carbamazepine have been demonstrated to be effective in preventing early posttraumatic seizures. The available evidence, however, does not indicate that prevention of early posttraumatic seizures improves outcome following head injury.

---

Information received from:

Randall Chesnut, MD

Division of Neurosurgery, Oregon Health Sciences University, Portland, Oregon