DIVISION OF NEUROSURGERY
UNIVERSITY OF MALAYA
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Neurosurgery at its cutting edge

Traumatic Brain Injury

Masters of General Surgery

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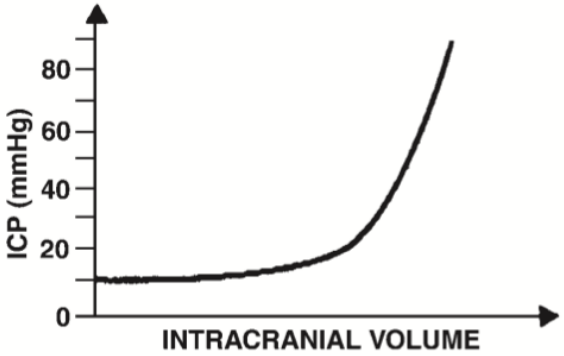
Monroe Kellie Doctrine

- The cranial vault is essentially a closed, fixed bony box.
- The volume in a skull is constant.
- An increase in one component will displace the other components.

$$Intracranial\ Volume = brain + CSF + blood \tag{1}$$



ICP Monitoring

ICP monitoring is appropriate in severe head injury patients (GCS 3-8) with an abnormal CT, or a normal CT scan if 2 or more of the following are noted on admission:

- SBP $<$ 90 mm Hg
- Age $>$ 40 years
- Uni or Bilateral motor posturing

Risk of intracranial hypertension (with normal CT) increased to 60% if two or more of the above.

Impact of ICP instability and hypotension on outcome in patients with severe head trauma. JNS November 1991;(75) No. 1, Pages S59-S66

Intracranial Pressure Monitoring

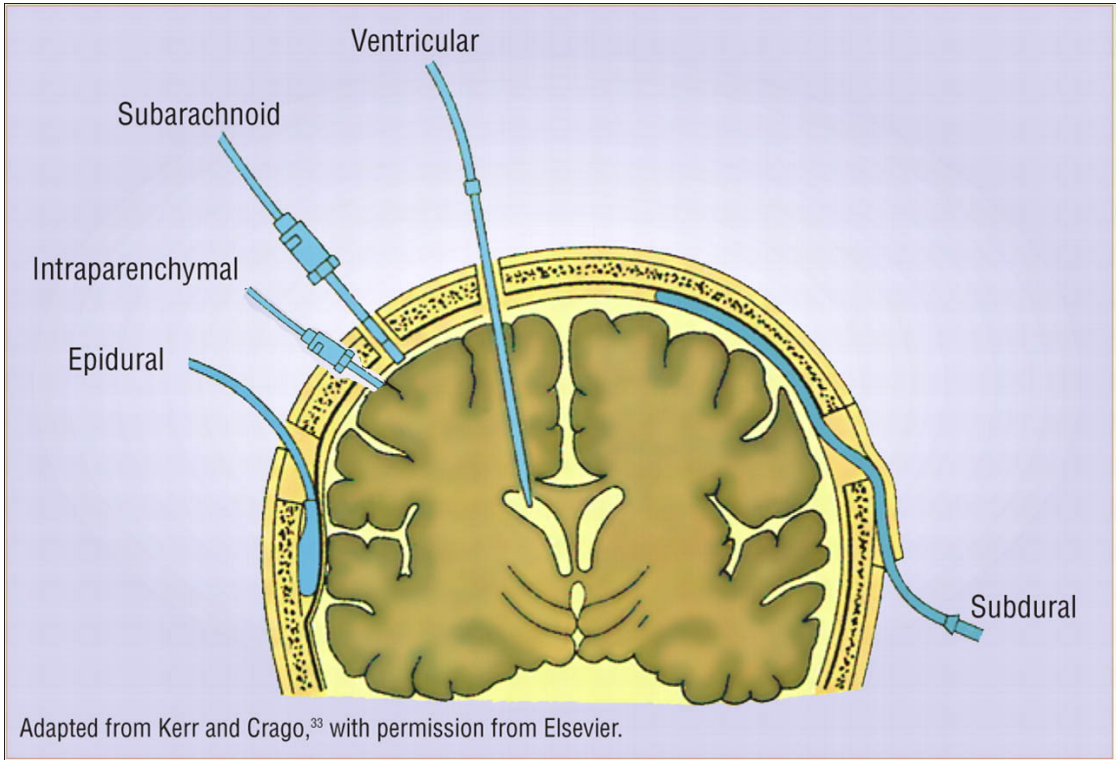
- The injured brain is extremely vulnerable to
  - hypotension
  - hypoxia
  - increased ICP
- Identification and prevention of secondary insult improved outcome results.
- Attempt to maintain Cerebral Perfusion Pressure between 50 to 70 mmHg

$$CPP = MAP - ICP \tag{2}$$

- However, aggresive measures with fluids and pressors should be avoided because of the risk of ARDS

Guidelines for the management of severe traumatic brain injury.
Journal of Neurotrauma, Volume 24, Supplement 1, 2007

ICP Monitoring



Adapted from Kerr and Crago,[33] with permission from Elsevier.

Anaesthetics, Analgesia and Sedatives

High dose barbiturates is recommended to control elevated ICP refractory to maximum standard medical and surgical treatment.

Hemodynamic stability is essential before and during barbiturate therapy.

- Analgesia and Sedative
  - Propofol Vs Morphine: Less intensive ICP therapy at D3. Similar long term outcome.
  - Propofol 0.5 mg/kg bolus, 20-75 mcg/kg/min not exceeding 5 mg/kg/h
- Barbiturates
  - loading dose 10 mg/kg over 30 min, followed by 5mg/kg/H for 3 doses and maintenance dose of 1mg/kg/H
  - Serum pentobarbital level 3-4mg%
  - Burst suppression on EEG

Propofol in the treatment of moderate and severe head injury: a randomized, prospective double-blinded pilot trial.
J Neurosurg. 1999 Jun;90(6):1042-52

Hyperventilation

- Prophylactic hyperventilation (PaCO2 of 25 mmHg or less) is not recommended.
- Should be used sparingly as a temporising measures to control ICP
- Avoid hyperventilation within 24 Hrs of injury
- Deleterious effect of hyperventilation with $<$ 25 mmHg PaCO2 during first 5 days of injury at 6 months follow up.

Adverse effects of prolonged hyperventilation in patients with severe head injury: a randomized clinical trial.
J Neurosurg. 1991 Nov;75(5):731-9.

Hyperosmolar Therapy

- Mannitol is effective in controlling the ICP as a short term measures at doses of 0.25mg to 1g/kg body weight
  - peak onset 30 minutes after infusion
  - half life approximately 100 minutes
  - stays in the system within 6 to 8 hours
  - may cause diuresis and subsequently hypovolemia
- Arterial hypotension should be avoided.

Mannitol dose requirements in brain-injured patients.
J Neurosurg. 1978 Feb;48(2),169-72.

Anti Epileptic Prophylaxis

The use of phenytoin, carbamazepine, phenobarbital or valproate is not recommended for preventing late post traumatic seizures.

- Early PTS within 7 days of injury and late PTS after 7 days
- Reduced early PTS risk in first week

Indication for antiepileptic

- Penetrating brain injury
- ICB
- Depressed or compound skull fracture

Management of head injury. Posttraumatic seizures. Neurosurg Clin N Am. 1991 Apr;2(2):425-35.

Antibiotic Prophylaxis

The incidence of infection is increased with mechanical ventilation and invasive monitoring techniques (1-27%).

- Single study to support a short course of antibiotic at the time of intubation.
- No evidence to support prolonged antibiotic for systemic prophylaxis in intubated TBI patients.
- Early tracheostomy or extubation did not reduce the rate of pneumonia

A prospective study of tracheobronchial bacterial flora in acutely brain-injured patients with and without antibiotic prophylaxis.
J Neurosurg. 1977 Aug;47(2):228-35.

Nutrition

There were significantly more deaths in the group that did not receive full caloric replacement by the 7th day after injury.

- Replacement of 140% of Resting Metabolic Expenditure in non-paralysed patients
- 100% Resting Metabolic Expenditure in paralysed patients
- using enteral or parenteral formulas containing at least 15% of calories as protein by the seventh day after injury.

The favorable effect of early parenteral feeding on survival in head-injured patients.
J Neurosurg. 1983 Jun;58(6):906-12.

DVT Prophylaxis

20% risks of developing DVT without prophylaxis after severe TBI.

- Graduated pressure stockings are recommended
- No sufficient data to support the benefit of LMWH

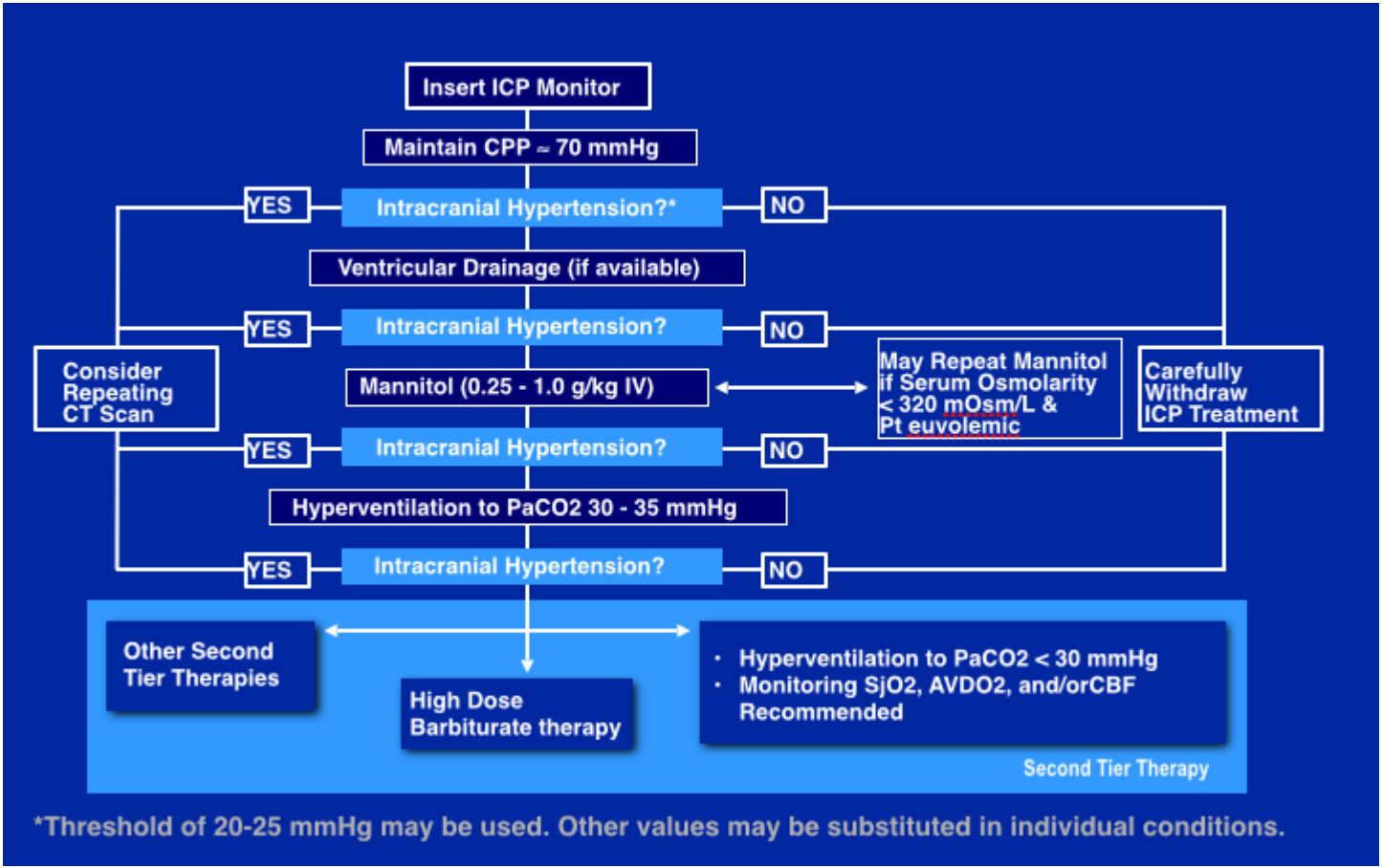
Deep vein thrombosis and pulmonary embolism in head injured patients. Angiology. 1983 Oct;34(10):627-38.

Steroids

- There use of steroid is not recommended for improving outcome or reducing ICP.
- High dose methylprednisolone is associated with increase mortality and therefore contraindicated.

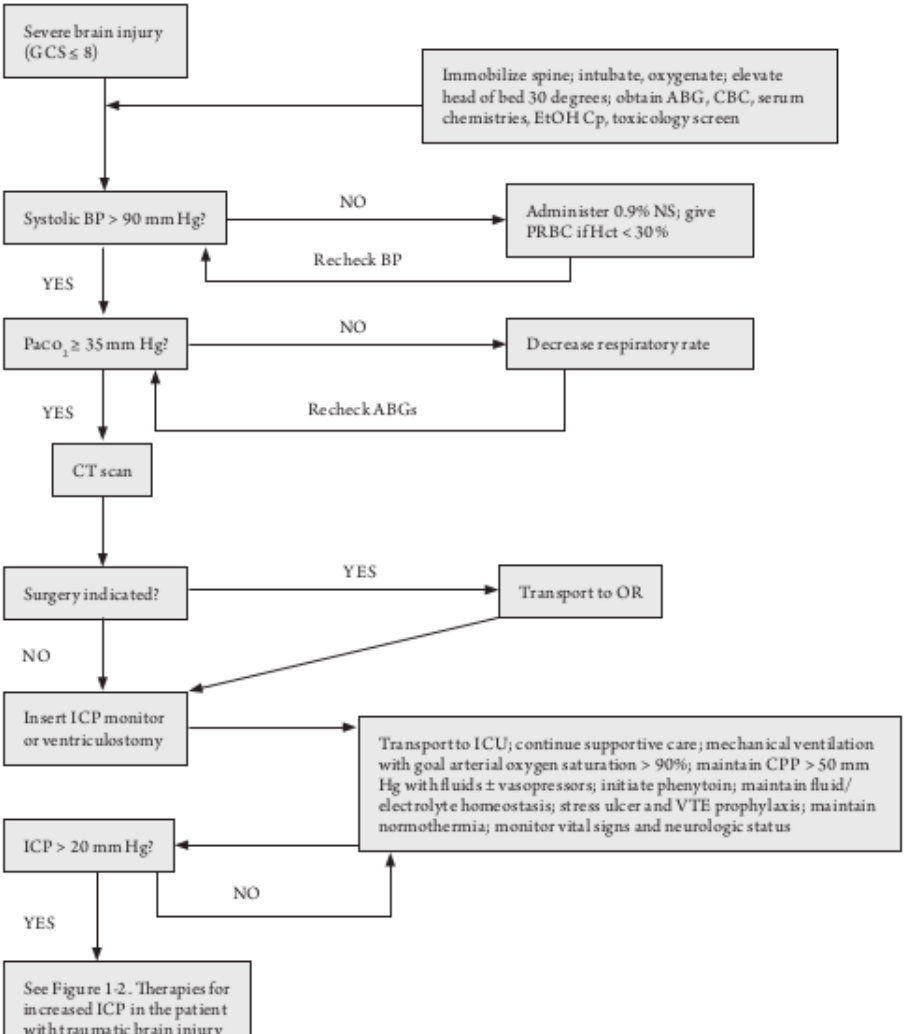
Effect of intravenous corticosteroids on death within 14 days in 10008 adults with clinically significant head injury (MRC CRASH trial): randomised placebo-controlled trial. Lancet. 2004 Oct 9-15;364(9442):1321-8.

Treatment Algorithm

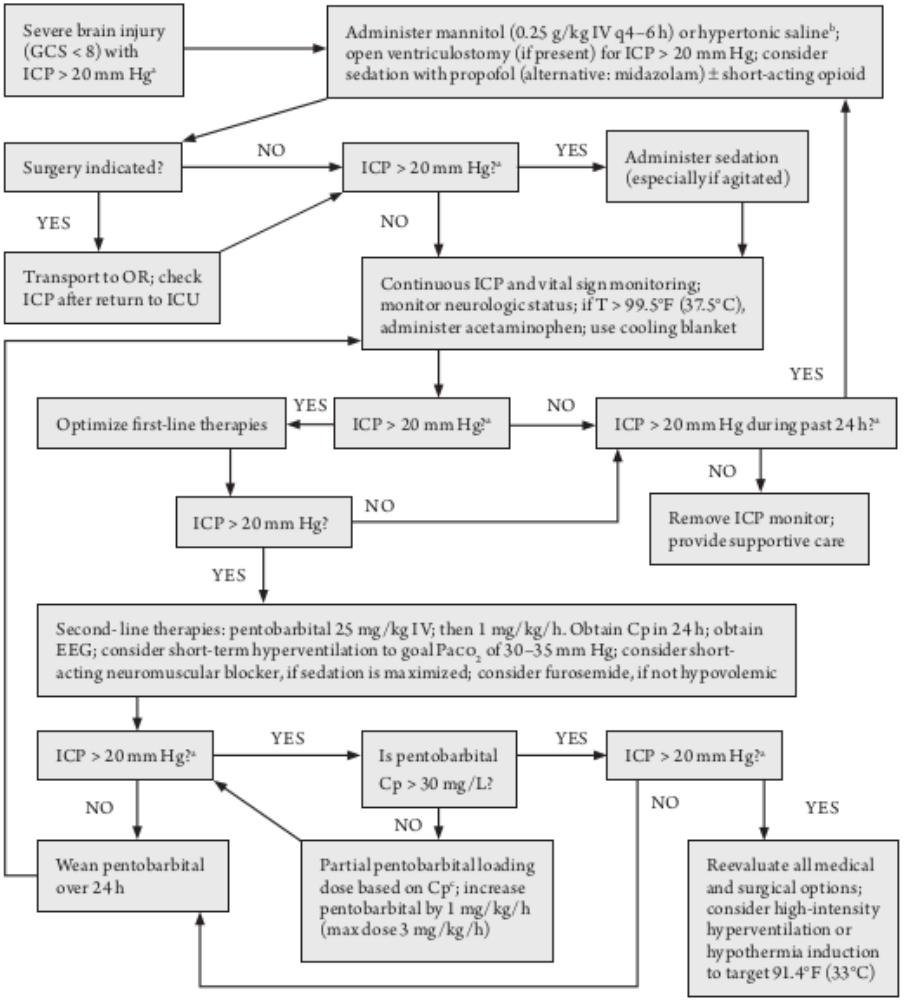


*Threshold of 20-25 mmHg may be used. Other values may be substituted in individual conditions.

Treatment Algorithm



Treatment Algorithm



Take Home Message

- Brain damage does not occur at the moment of impact, but evolves over the ensuing hours and days.
- The injured brain is extremely vulnerable to:
  - hypotension
  - hypoxia
  - increased intracranial pressure.
- Identification and prevention of secondary insult improved outcome results.
  - Statification
  - Identify Risks
  - Prevent Secondary Brain Injury
  - CPP Driven Management