Updates and Future Directions in the Management of Severe Traumatic Brain Injury

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Putting the Pieces Back Together
Severe Traumatic Brain Injury

- Severe TBI kills 50,000 people yearly
- Rates are highest among age groups of 15-24 and those >65 years old
- Lifetime costs of care for severe TBI >$3M/person
- Lifelong functional, behavioral, and cognitive disabilities

Definition of Severe TBI

• Glasgow Coma Scale score of 3-8
• Additional criteria used to categorize as severe TBI
  – Loss of consciousness for longer than 6 hours
  – Posttraumatic amnesia for >1 week
• Traumatic Coma Data Bank revealed that severe TBI is indicated by a GCS <9 within 48 hours of injury

TBI Pathophysiology

• Primary injury results in skull fractures, brain tissue disruption and torn cerebral vessels

• Secondary injury – interruption of blood flow and oxygen result in anaerobic metabolism, inadequate synthesis of adenosine triphosphate, and cellular acidosis. Cytotoxic edema follows from loss of energy-dependent ion transportation.
Biomarkers of TBI

- Ubiquitin carboxy-terminal hydrolase (UCH-L1) is involved in the addition or removal of ubiquitin from abnormal proteins destined for proteasomal degradation; serum levels high in diffuse injury

- Glial fibrillary acidic protein (GFAP) released by astrocytes during injury; serum levels high in focal mass lesions

Monro-Kellie Hypothesis

- Skull is a fixed compartment containing brain tissue, blood and CSF
- The sum of these three components must remain constant
- An increase in any one of these components must be offset by an equal decrease in one or more components otherwise an increase in ICP will result
Redefining Hypotension

• In a retrospective analysis of 15,733 patients with severe TBI admitted between 1998-2005 the optimal threshold of hypotension was:
  • 15-49 years old: 110 mm Hg
  • 50-69 years old: 100 mm Hg
  • 70 or older: 110 mm Hg

Intracranial Pressure Monitoring

- Assess cerebral perfusion to avoid secondary injury
- Placed directly into the ventricle (anterior horn of the lateral ventricle)
- External ventricular device (EVD) may be used to allow for therapeutic drainage of CSF
ICP Waveform

- Amplitude varies with changes in physiologic state and influenced by intracranial compliance and CBF
- Rise in P2 signifies decrease in cerebral compliance and predicts rise in ICP with stimulation
Nursing Interventions to maintain or decrease ICP

• Maintaining ICP at <20 mm Hg improves outcomes
• Draining CSF decreases ICP
• Do not induce hyperventilation to decrease ICP
• Sedation prevents ICP increases
• Mannitol is effective in decreasing ICP
Nursing Interventions to maintain or decrease ICP

- Elevate the HOB 30 degrees
- Remove/loosen rigid cervical collar
- Insulin therapy for management of blood glucose levels
- Maintain normothermia
Refractory Intracranial Hypertension

• *Induce moderate hypothermia (33-36°C)
  – Admission hypothermia associated with increased mortality (Bakur et al., 2011; Konstantinidis et al., 2011)

• Administer hypertonic saline
  – Bolus followed by continuous infusion
  – Close monitoring of Na level and urine output

• High dose barbiturates
  – Continuous EEG or bispectral index monitor

• Hyperventilation for emergent ICP
  – PbtO2 monitoring recommended
Nursing Interventions to maintain or increase CPP

• CPP = MAP – ICP
• Maintaining CPP between 50-70 mm Hg optimizes cerebral perfusion
• Norepinephrine may maintain or increase CPP
Continuous ICP/CPP Monitoring

- The number of brief episodes (5 min) of ICH are correlated with poor functional outcomes and mortality (Stein et al., 2011)
- Continuous monitoring of CPP has been associated with better outcomes (Kirkness, Burr, Cain, Newell, & Mitchell, 2006)
- Intraparenchymal pressure monitoring provides equivalent measurements when compared to intraventricular monitors (Vender et al., 2011)
Monitoring Brain Hypoxia

- Brain hypoxia is independently associated with poor outcome (Oddo et al., 2011)
- Continuous brain tissue oxygen (PbtO2) monitoring can help guide nursing interventions
Other Monitoring Strategies

• Monitoring brain temperature can help guide therapies
  – Antipyretic therapy alone or in combination with traditional cooling blankets only effective 40-50% of the time
  – Newer cooling systems can cause shivering

• EEG monitoring can help identify patients at risk for seizures
References

- American Association of Neuroscience Nurses (2011). Care of the patient undergoing intracranial pressure monitoring/external ventricular drainage or lumbar drainage. Glenview, IL: AANN.


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