Chapter 7

Managing Intracranial Pressure

Signs of Increased Intracranial Pressure

- Decreased level of consciousness
- Papilledema
- Tachycardia
- Hypotension
- Vomiting
- Irritability
- Photophobia
- Bulging fontanelle
- Split sutures
- Sunset eyes (chronic)
- Irregular respirations or apnea
- Widened pulse pressures
- **Cushing's triad (hypertension, bradycardia, abnormal respirations) is a preterminal event!**

Etiologies of Increased Intracranial Pressure

- Meningitis
- Encephalitis
- Head trauma
- Intracranial mass lesions
- Child abuse (eg, shaken baby)
- Status epilepticus
- Shock leading to hypoxic-ischemic encephalopathy

Treatment

- Assess and maintain airway, breathing, and circulation (ABCs)
  - Rapid sequence induction/intubation therapy may be necessary if airway protection is needed (eg, Glasgow Coma Scale score ≤ 8)
- Maintain **cerebral perfusion pressure (CPP) = mean arterial pressure – intracranial pressure (ICP)**

$$\text{mean arterial pressure (MAP)} = \frac{\text{systolic} + 2(\text{diastolic})}{3}$$

$$\text{Normal ICP} = < 20 \text{ mmHg}$$

Appropriate CPP is age dependent, as follows:

- **< 2 years**: 50 mmHg
- **2–6 years**: 55 mmHg
- **7–10 years**: 65 mmHg
- **11–16 years**: 70 mmHg
- **> 16 years**: 70–90 mmHg

  - If ICP monitoring is unavailable, use goal CPP as the minimally acceptable value for mean arterial pressure
- Avoid hypercarbia
  - Keep partial pressure of carbon dioxide (PCO_2) between 30 and 35 mmHg
  - Hyperventilation to PCO_2 below mid-30s mmHg should be reserved for temporary treatment of major ICP spikes
- Keep the partial pressure of oxygen in arterial blood (PaO_2) at 100 mmHg, or saturations at 97%–100%
- Keep patient's head midline and elevated to 30°
- Avoid free water; use isotonic fluid (normal saline) as the base solution for intravenous (IV) hydration
- Anticipate norepinephrine, dopamine, or epinephrine needs to maintain CPP once patient is euvolemic
- If patient is anxious and agitated while intubated, sedate with midazolam and fentanyl
  - Use paralysis if patient is persistently agitated
  - Sedation will alter neurological examination
- Avoid excess noise, vibration, light, and noxious stimulation that may increase ICP
  - Sedate with midazolam IV, fentanyl IV, or lidocaine IV, or via endotracheal tube before suctioning
- Treat seizures aggressively
  - Muscle relaxants will mask seizure activity
  - Consider prophylactic phenytoin for penetrating head injuries
- Keep patient cool and treat hyperthermia aggressively
  - Patient may need neuromuscular blockade to avoid shivering

- Monitor blood glucose
  - Add dextrose to IV fluids only after serum glucose ranges between 80 and 110 mmHg
- Place Foley catheter
- Monitor central venous pressure if available or indicated; maintain at 5–8 mmHg
- If increasing signs of ICP appear or if pupils suddenly dilate, administer hypertonic saline or mannitol (3% saline is preferred because it does not create an osmotic diuresis or result in hypovolemia)
  - **3% saline**: 2–4 mL/kg IV bolus for increased ICP
    - 10 mL/kg for herniation
    - 0.5 mL/kg/h for continuous infusion (range 0.1–1 mL/kg/h)
    - Patients will tolerate serum sodium rising to the 160 range, as long as the rise and eventual decline occurs gradually
  - **Mannitol**: 0.5–1 g/kg IV given over 20 minutes ; use in-line 5-μm filter for concentrations ≥ 20%
  - Consider **furosemide** 0.5–1 mg/kg IV slow push if patient is hypervolemic (maximum of 40 mg/dose)
  - Thiopental (3 mg/kg IV) may be given for continued evidence of increased ICP
    - Barbiturates are negative inotropes and vasodilators; watch for hypotension