

Increased Intracranial Pressure

Definition: Intracranial hypertension is an ICP ≥ 20 mm Hg for ≥ 5 minutes.

Normal ICP	=	5 - 15 mm Hg
If ICP	>	20 mm Hg, time to treat
If sustained ICP	>	40 mm Hg, prognosis is poor
If sustained ICP	>	60 mm Hg, almost always fatal

Causes of \uparrow ICP:

- Inadequate oxygen delivery to the brain due to O₂ deprivation, reduced cerebral blood flow, or direct injury.
- Interstitial edema due to increased capillary permeability.
- Mass effect, due to intracranial hematoma or hydrocephalus.

Patho-physiology: When ICP \uparrow , compensatory responses include (in this order):

1. reduction of CSF volume by contraction of the ventricles.
2. reduction of blood volume in the cranium. by:
 - a. hyperventilating to \downarrow PaCO₂ \rightarrow cerebral vasoconstriction
 - b. triggering Cushing's reflex (a late development) which initiates bradycardia and hypertension.
3. displacement of brain matter (herniation).

Treatment of \uparrow ICP:

No 2nd hit: Hypotension, hypoxemia, decreased cerebral perfusion pressure, are important causes of secondary brain injury.

O₂: Endotracheal intubation and mechanical ventilation. If possible, void PEEP. Maintain DO₂ at least 600 mL/min/m².

PaCO₂: Maintain PaCO₂ = 35 - 40 mm Hg. Reserve aggressive hyperventilation (PaCO₂ = 30) for treatment-resistant episodes of intracranial hypertension, since sustained hyperventilation causes cerebral ischemia. Aggressive hyperventilation should be guided by jugular vein O₂ saturation (SjvO₂) monitoring.

Fluids: Maintain SBP > 90 mm Hg. Do not use D₅W. There is controversy over fluid type: NS (0.89%), Hypertonic Saline (3.5% or 7%), Albumin, Hespan, FFP, 7% Saline in 6% Dextran 70.

Sedation: Sedation with Propofol is recommended, to lessen the \uparrow in ICP caused by agitation, suctioning, coughing, fighting ventilator. Sedation also reduces cerebral metabolic rate and O₂ demand. Propofol has short half-life, allowing frequent neuro assessment. Avoid opioids due to their hypotensive effect.

Suction: Careful suctioning technique. Some give Lidocaine to prevent further \uparrow in ICP. Preoxygenate with 4 breaths of 100% O₂, limit suction to ≤ 10 seconds, make only 1 or 2 suction passes.

CPP: Think CPP = MAP - ICP at all times. Keep CPP $> 60 - 70$ mm Hg by keeping SBP > 90 mm Hg, supporting with inotrope if needed, and minimizing increases in ICP.

HOB: Elevate head of bed 30 - 45° (beware of hypotension), prevent neck or hip flexion, avoid tight trach ties, beware tight cervical collar.

Careful: Minimize noxious stimuli. Prevent \uparrow intra-abdominal pressure. Allow ICP to recover from positioning, stimulation, procedures.

Mannitol: 0.25 - 1 g/kg IV. Monitor serum osmolality, maintaining at 305 - 320 mOsm/L (normal = 270 - 290).

Lasix: 0.5 - 1 mg/kg is sometimes given to decrease CSF production.

PaCO₂: If there are signs of herniation, begin hyperventilation to reduce PaCO₂ to 30 - 35 mm Hg. Then hyperventilate to achieve a reduction in ICP. Use ventilator, avoid using ambu bag, which may inadvertently apply PEEP.

β -blocker: For MAP > 150 mm Hg. Avoid Nitroglycerin or Nipride, which \uparrow venous capacitance (75% of cranial blood volume is venous).

Pentobarb: Barbiturates are considered if \uparrow ICP is refractory to treatment; monitor EEG, cardiac output (may need inotropes) and SjvO₂.

Temp: Aggressively treat fever. Do not allow shivering. May use controlled hypothermia to reduce core temp of 92° F (reduces cerebral metabolic rate and cerebral O₂ demand).

Albumin: Maintain colloid osmotic pressure by maintaining serum albumin = 4 g/dL (may help control one cause of cellular edema).