Hyperosmolar Therapy in Neurotrauma

Purpose: To reduce elevated intracranial pressure (ICP) and mitigate secondary brain injury in patients with traumatic brain injury (TBI), intracerebral hemorrhage, or other causes of cerebral edema.

Indications

- Sustained ICP > 20–22 mmHg despite sedation and positioning
- Clinical signs of herniation (e.g., unilateral mydriasis, decerebrate posturing)
- Radiologic evidence of cerebral edema, midline shift, or compressed ventricles

Mechanism of Action

- **Creates an osmotic gradient** across the blood-brain barrier (BBB), drawing water from brain parenchyma into the intravascular space
- **Reduces cerebral blood volume** via plasma expansion and decreased blood viscosity

Main Agents

1. Mannitol

- Concentration: 20% (0.25–1.0 g/kg IV bolus)
- Onset: 15–30 min | Duration: 2–6 h
- Requires intact BBB to be effective
- Monitor serum osmolality (< 320 mOsm/kg) and renal function
- Risk: hypovolemia, renal failure, rebound ICP increase with repeated doses

2. Hypertonic Saline (HTS)

- Available concentrations: 3%, 7.5%, 23.4%
- Dosing examples:
    1. 3%: 250 mL over 20–30 min
    2. 7.5%: 100–150 mL bolus
    3. 23.4%: 30 mL bolus over 10–15 min via central line only
- Preferred in patients with hypotension or polyuria
- Monitor serum sodium (target: 145–155 mmol/L) and chloride
- Can be used as continuous infusion (e.g., 3% NaCl at 30–70 mL/h)

Comparative Notes

Feature	Mannitol	Hypertonic Saline
Volume status	Diuretic effect (↓ volume)	Volume expansion (↑ MAP)
Use with hypotension	Contraindicated	Preferred
Risk of rebound ICP	Higher	Lower
Monitoring	Osmolality, Cr	Na+, Cl−, fluid balance

Monitoring and Safety

- Frequent ICP monitoring (EVD or intraparenchymal probe)
- Serum sodium/osmolality every 4–6 h
- Renal function and urine output
- Avoid prolonged or aggressive correction (>12 mEq/L/24h in chronic hyponatremia)

Clinical Pearls

- Combine with other ICP-lowering strategies: sedation, head elevation, normocapnia
- Avoid hypotonic fluids (e.g., D5W, 0.45% NaCl)
- HTS may be preferred in polytrauma or hypotensive patients
- Do not use empirically without signs of raised ICP

References

- Neurosurg Clin N Am. 2025 Jul;36(3):387–400. doi:10.1016/j.nec.2025.03.007.
- Brain Trauma Foundation Guidelines (2020 update)