

CRITICAL CARE ORDER SET • TIERED PROTOCOL

Increased Intracranial Pressure

ICU management of intracranial hypertension and herniation. Work the ladder in order — optimize universal neuroprotection (Tier 0) before escalating, treat sustained ICP > 22 mmHg, and protect cerebral perfusion at every step. Reserve hyperventilation and barbiturates for rescue. Adapt all thresholds to your protocol and the individual patient.

PATIENT _____	MRN _____	WEIGHT (KG) _____	ICP MONITOR / EVD _____
ALLERGIES _____	ETIOLOGY _____	ORDERING CLINICIAN _____	ATTENDING _____

Dx

Recognition & diagnosis

DEFINE Intracranial hypertension = sustained (> 5 min) ICP > 22 mmHg. Herniation and refractory ICP are neurological emergencies — recognize early and move down the ladder without delay.

CLINICAL SIGNS

- ☐ Headache, nausea / vomiting, pupillary changes, declining mental status
- ☐ **Cushing's triad** — hypertension, bradycardia, irregular respirations / apnea (often a late sign)
- ☐ Uncal (transtentorial) herniation — acute ↓ consciousness with **ipsilateral pupillary dilation** + contralateral hemiparesis
- ☐ Consider subfalcine, uncal, and tonsillar herniation patterns by location

CONFIRM

- ☐ Invasive ICP monitoring confirms the diagnosis; clinical / physiologic signs may precede instrumentation
- ☐ Noncontrast head CT when the patient can be positioned safely (if brain not yet imaged)

T0

Universal neuroprotection

FOR ALL Apply to any patient at risk of raised ICP. Optimize **every** Tier 0 measure before escalating.

MONITORING & NEURO CHECKS

- ☐ Neuro exam (GCS, pupils, motor) **q1 h**; increase frequency if deterioration
- ☐ Continuous cardiac monitoring and pulse oximetry
- ☐ Noninvasive BP **q15 min**, OR arterial line for continuous BP and sampling (preferred in high-risk ICP)

POSITIONING & NURSING

- ☐ Head of bed **> 30°**; neck midline to facilitate cerebral venous drainage
- ☐ Avoid jugular compression — no tight C-collar if not needed, avoid extreme neck rotation
- ☐ Minimize noxious stimuli — avoid Valsalva / coughing: stool softeners, adequate analgesia; suction only as necessary and preoxygenate

VENTILATION & OXYGENATION

- ☐ If not intubated — maintain **SpO₂ ≥ 94%**, supplemental O₂ as needed
- ☐ If intubated — maintain **PaO₂ > 80 mmHg**; target **PaCO₂ 35–40 mmHg** (avoid prophylactic hyperventilation)
- ☐ Avoid high PEEP unless needed for oxygenation; balance against venous return / ICP

HEMODYNAMICS / CPP

- ☐ If ICP monitored — target **CPP 60–70 mmHg**
- ☐ Avoid hypotension; resuscitate with isotonic fluid (**0.9% NaCl**)
- ☐ Norepinephrine infusion start **0.02–0.05 mcg/kg/min IV**, titrate to MAP / CPP goal

SEDATION & ANALGESIA (BASELINE)

- ☐ **Fentanyl** 25–50 mcg IV q15 min PRN, OR infusion 25–200 mcg/h IV
- ☐ **Propofol** infusion 5–20 mcg/kg/min IV, titrate to light–moderate sedation (RASS –2 to 0), avoiding agitation / coughing
- ☐ Triglycerides q48–72 h if propofol infusion > 24–48 h

SEIZURE PROPHYLAXIS — if indicated (TBI, cortical bleed, post-craniotomy)

- ☐ **Levetiracetam** 1000 mg IV q12h (adjust for renal function)
- ☐ Alt: **phenytoin** 15–20 mg/kg IV load (max 50 mg/min), then 3–5 mg/kg/day divided q8–12h

TEMPERATURE MANAGEMENT

- ☐ Target normothermia < 37.5 °C
- ☐ Acetaminophen 650–1000 mg PO/NG/PR q6h PRN (max 4 g/day; adjust for liver disease)
- ☐ Active surface cooling (blanket / device) if persistent fever despite antipyretics

FLUIDS, ELECTROLYTES, GLUCOSE

- ☐ Maintenance 0.9% NaCl at ___ mL/h (weight / volume-status based)
- ☐ Avoid hypotonic fluids (0.45% NaCl, D5W) unless specifically indicated and closely monitored
- ☐ Serum electrolytes q6–12 h; **avoid and correct hyponatremia** (Na < 135 mEq/L)
- ☐ Blood glucose target 140–180 mg/dL, insulin per ICU protocol

Corticosteroids — vasogenic edema only

ONLY IF High-dose steroids only for vasogenic edema from **tumor, abscess, bacterial / TB meningitis, or neuroinflammatory disease** — otherwise avoid (no benefit in TBI / ischemic / hemorrhagic stroke).

- ☐ Dexamethasone per indication (e.g., 10 mg IV load, then 4 mg IV q6h) for confirmed vasogenic edema

PROPHYLAXIS & SUPPORTIVE CARE

- ☐ DVT — SCDs continuous; pharmacologic (enoxaparin 40 mg SC daily or heparin 5,000 units SC q8–12h) when neurosurgery approves
- ☐ GI — pantoprazole 40 mg IV/PO daily (or equivalent)

- ☐ Bowel — senna **8.6–17.2 mg PO/NG qHS**; polyethylene glycol **17 g PO/NG daily**
- ☐ Nutrition — enteral feeding per ICU protocol as soon as safely feasible

T1 First-line ICP-lowering therapy

TRIGGER ICP > **20–22 mmHg** or clinical signs of elevated ICP despite optimized Tier 0.
Mannitol and hypertonic saline are equally effective — both need an intact blood–brain barrier and an osmotic gradient.

HYPEROSMOLAR THERAPY — CHOOSE ONE PRIMARY STRATEGY

A • Mannitol (bolus)

- ☐ Mannitol **0.5–1 g/kg IV** over 5–15 min STAT for ICP > threshold
- ☐ Repeat **0.25–0.5 g/kg IV q4–6h PRN** for ICP > threshold
- ☐ Serum Na, K, creatinine, osmolarity **q4–6h**; dose repeats by **osmolar gap** (goal $\approx$ **20–55 mOsm/kg**)
- ☐ Hold if serum osmolarity > **320 mOsm/kg** or rising osmolal gap; strict I/O + Foley for accurate urine output

CAUTION Use care with hypotension, renal failure, or hypovolemia.

B • Hypertonic saline (intermittent bolus)

- ☐ **3% NaCl 2–5 mL/kg IV** over 10–20 min STAT — or fixed **250–500 mL IV** over 10–20 min
- ☐ Repeat **q4–6h PRN** per serum Na and osm goals
- ☐ Serum Na + osmolarity **q4–6h**; avoid Na > **155–160 mEq/L** and rise > **8–10 mEq/L per 24 h**

CSF DRAINAGE

- ☐ Acute obstructive hydrocephalus on imaging → emergent **EVD** placement
- ☐ If EVD already in place — drain **5–10 mL CSF** for acute ICP rises; maintain CPP **60–70 mmHg**

SEDATION & HEMODYNAMIC TIGHTENING

- ☐ Increase propofol up to **50 mcg/kg/min IV** for ICP control (deeper sedation, e.g., RASS -4 to -5); ensure analgesia (fentanyl **50–200 mcg/h IV**)
- ☐ Maintain **CPP 60–70 mmHg** — norepinephrine **0.02–0.5 mcg/kg/min IV**; 0.9% NaCl **250–500 mL IV PRN** if hypotensive and not volume replete

SURGERY & ESCALATION

- ☐ Notify neurosurgery / neurocritical care when Tier 1 initiated
- ☐ If ICP uncontrolled or herniation signs persist — consider surgical evacuation (e.g., hemorrhagic contusion); if surgery not undertaken, proceed to Tier 2
- ☐ If ICP controlled — consider repeat head CT to rule out new processes

T2

Refractory ICP

TRIGGER ICP remains **> 20–22 mmHg** despite optimized Tier 0 + Tier 1 (adequate osmotherapy and sedation).

CONTINUOUS HYPERTONIC SALINE

- ☐ **3% NaCl infusion 0.5–1.5 mL/kg/h IV** via central line; titrate to ICP and serum Na
- ☐ Target Na **145–155 mEq/L** (avoid **> 160**); Na + osmolarity **q4h**, daily (or more) creatinine, strict I/O

DEEP SEDATION

- ☐ Propofol up to **80 mcg/kg/min IV**, titrate to deep sedation / burst suppression if neuro-guided
- ☐ Adjunct **midazolam 1–2 mg IV q5–10 min PRN**, or infusion **1–10 mg/h IV**

PRIS Propofol infusion syndrome (metabolic acidosis, cardiac dysfunction, rhabdomyolysis, hypertriglyceridemia) risk rises at **> 80 mcg/kg/min for > 48 h** — use extreme doses only temporarily while correcting; support circulation with fluids / pressors.

NEUROMUSCULAR BLOCKADE — only after adequate sedation & analgesia

- ☐ **Cisatracurium 0.1–0.2 mg/kg IV bolus**, then **1–3 mcg/kg/min IV infusion** (prevents coughing / posturing / shivering / dyssynchrony)
- ☐ Train-of-four **q4h** and with dose changes; keep sedation/analgesia active; pressure-wound care, eye lubrication, limb positioning aids

MAP CHALLENGE – TEST AUTOREGULATION

- ☐ Perform a controlled MAP challenge correlating BP with ICP ($\pm$ TCD CBF velocity / brain-tissue PbtO₂) to derive an **individualized optimal CPP**

CSF DIVERSION, INVASIVE MONITORING & IMAGING

- ☐ Neurosurgery consult for EVD (CSF diversion + ICP monitoring); treat ICP > **20–22 mmHg**, maintain **CPP 60–70 mmHg**
- ☐ STAT noncontrast CT head for change in exam or refractory ICP; serial CT per neurosurgery / neurocritical care

T3 Rescue therapy

EMERGENCY Impending / ongoing herniation, or refractory ICP despite Tiers 0–2. Mobilize neurosurgery **now** – these are bridges to definitive care.

EMERGENT HIGH-DOSE HYPEROSMOLAR THERAPY

- ☐ **Mannitol 1 g/kg IV** over 10–20 min STAT for herniation signs (fixed pupil, acute decline)
- ☐ **23.4% NaCl 30 mL IV** over 10–20 min via central line STAT; check Na + osmolality 1–2 h post-bolus; no repeat without Na review and neurosurgical approval

SHORT-TERM CONTROLLED HYPERVENTILATION

- ☐ Temporarily hyperventilate to **PaCO₂ 30–35 mmHg** for impending herniation; ideally with cerebral oxygen monitoring (jugular venous / brain-tissue O₂)
- ☐ ABG within **15–30 min** of vent change; return to PaCO₂ 35–40 mmHg ASAP – avoid prolonged hypocapnia

Barbiturate coma – specialist oversight, continuous EEG

- ☐ **Pentobarbital 5–15 mg/kg IV** over 30 min–2 h load, then **1–4 mg/kg/h IV** maintenance; continue 24–96 h
- ☐ Alt: **thiopental 2–5 mg/kg IV** load over 10 min, then **1–3 mg/kg/h IV**
- ☐ Co-orders: continuous EEG (titrate to **burst suppression 5–20 s** or $\geq 50\%$), vasopressors for CPP, frequent ABG / lactate / electrolytes

CAUTION Hypotension, respiratory / immune suppression, paralytic ileus. High doses can mimic brain death (unreactive pupils even on pupillometry) – clearance takes days; exercise care in prognostication.

Moderate hypothermia (TTM)

- ☐ Target core temp **32–36 °C** (may lower ICP); use a temperature-feedback device, surface or intravascular / esophageal cooling

TBI In TBI, hypothermia may worsen outcomes — limit to **35–36 °C**. Watch shivering, arrhythmia, sepsis, electrolyte shifts; use induction / maintenance / rewarming protocols.

DEFINITIVE SURGICAL INTERVENTION

- ☐ STAT neurosurgery consult for refractory intracranial hypertension / herniation
- ☐ Potential procedures — decompressive craniectomy, hematoma evacuation (epidural / subdural / intraparenchymal), mass-lesion resection

! Hard "do-not" / caution list

- ☐ Do **not** perform lumbar puncture in suspected / known elevated ICP without explicit neurosurgical approval
- ☐ Do **not** use chronic prophylactic hyperventilation to $\text{PaCO}_2 < 35 \text{ mmHg}$ except as short-term Tier 3 rescue
- ☐ Avoid hypotonic IV fluids in patients with / at risk for raised ICP unless a specific controlled indication exists
- ☐ Avoid rapid / excessive BP reduction in ICP- or CPP-dependent patients
- ☐ Avoid inadequate sedation / analgesia — agitation, coughing, or shivering worsens ICP

EDUCATIONAL USE ONLY

Not a substitute for clinical judgement. Verify doses, allergies, renal/hepatic function, and contraindications. Adapt all agents, tiers, and thresholds to your institutional neurocritical-care protocol and the individual patient.

Spreading knowledge
Improving outcomes