



Pediatric
Critical Care
Learning



PCCL Session: Summary Report and Resources

PCCL session topic: “A Case of tree-matic Brain Injury”

Date: April 11, 2025

Learning objectives:

1. Discuss the pitfalls of using the Glasgow Coma Score to assess head trauma patients.
2. Examine the signs and evolution of intercranial bleeds.
3. Considerations for when making a transfer without a pediatric team, including contingency planning while in transit.

Case:

- 13yr old male was struck on the back of head by a very large tree, knocking him to the ground. Loss of consciousness of approximately 1 min. He was transported with C-spine precautions, R arm splinted, and a hematoma was noted to back right of head.
- Primary Survey demonstrated **BP 98/71, HR 55, RR 18, 100% RA, 35.8C, 35 Kg. GCS E:3, V:4, M:6 = 13**, with equal and reactive pupils. No concerns were identified in ABCD assessment
- Secondary Survey demonstrated a large boggy hematoma to R parietal region of head, low volume hemotympanum to R ear and pain to right elbow without deficits.
- Pt Evolution (2.5 hours post injury)
 - Patient is coherent but confused. **GCS 14, Pupils 4mm PERRL, BP 118/83, HR 57, RR 20**
 - CT report summary: depressed skull fracture, blood in subdural & sub arachnoid, gas/air trapped in cranial cavity, swelling present making hard to differentiate between folds in the brain, midline barrier between cerebral hemispheres not straight, but curved, but not enough for midline shift
- Pt Evolution (4-5 hours post injury)
 - Gravol for nausea. **GCS 15, BP 130/78, HR 51, RR 18**. In the next hour patient has increasing agitation, nausea and vomiting. Significant concerns of worsening headache, not responsive to fentanyl. Vital: **130/95, HR 48, RR 16, 96%**.
 - Subsequently the Pt became somnolent, opens eyes only briefly, R pupil 4-5mm sluggish, L 3mm brisk. Reconsult peds neuro surgery and repeat CT scan of head
- CT (6 hours post injury)
 - Right sided epidural hematoma, increased from previous. Midline shift with subfalcine herniation and early right uncal herniation.
- Herniating
 - **BP 120/95, HR 44, RR 22, 99%** - 3%NS bolus started and airway secured by ETT. **BP 140/83, HR 125, 95% Vented @ 18 BPM**. Decision for RN, RT and MD – LLTO transfer
- In Ambulance



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- Dose of mannitol, Increased resp rate to hyperventilate (RR to 28). Pupils – R 7mm fixed, L 3mm fixed. Additional dose of 3% NS for relative brady cardia low 80's from 120's with widening pulse pressure. NS boluses for decreasing peripheral perfusion and weak pulses. Had worsening brady cardia and hypertension so increased sedation and paralyzed pt, settling HR and decreasing SBP
- Hand over directly to OR team as getting pt onto OR table.

Learnings:

Increased Intracranial Pressure

Recognition: Early recognition is crucial. Healthcare providers use a combination of history, physical exam, imaging, and monitoring:

- **History:** Recent head trauma, infection (like meningitis), brain tumor, or hydrocephalus.
- **Vital signs:** Monitor for signs of Cushing's triad (late sign):
 1. Hypertension with widened pulse pressure
 2. Bradycardia
 3. Irregular respirations
- **Neurological exam:** Changes in level of consciousness, cranial nerve deficits, papilledema

Symptoms: can be subtle or dramatic and may include

- **General:**
 - Headache (especially worse in the morning or with coughing/sneezing)
 - Nausea and vomiting (often without preceding nausea)
 - Blurred or double vision
 - Drowsiness or difficulty waking up
 - Seizures
- **Neurological:**
 - Altered mental status (confusion, irritability, lethargy)
 - Pupillary changes (dilated, non-reactive, or unequal pupils)
 - Motor dysfunction (weakness, posturing)
 - Cranial nerve palsies (especially CN VI)
- **Late signs:**
 - Coma
 - Posturing (decorticate or decerebrate)
 - Fixed and dilated pupils

Physiology: ICP is the pressure exerted by the contents of the skull (brain tissue, blood, and cerebrospinal fluid).

- **Normal ICP:** Teens: typically < 15 mmHg
- **Causes of increased ICP:**



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1. Mass effect: Tumor, hematoma, abscess
2. CSF issues: Hydrocephalus, meningitis
3. Cerebral edema: Trauma, stroke, hypoxia
4. Obstruction of venous outflow

Treatment:

- **Immediate/Acute Management:**

- Elevate head of bed (30°): Promotes venous outflow.
- Maintain head midline: Prevents jugular vein compression
 - Loosen or remove the c-spine collar to help promote venous drainage
- Oxygenation & ventilation: Prevent hypoxia and hypercapnia.
- Hyperventilation (**temporary**): $\downarrow \text{CO}_2 \rightarrow \text{vasoconstriction} \rightarrow \downarrow \text{cerebral blood volume}$.
 - Ventilate to low normal CO_2 (35-40mmHG)
 - Give oxygen for normoxemia (80-100mmhg) – avoid hyperoxemia – can cause vasoconstriction
 - Avoid high PEEP or high mean airway pressure – would impede venous drainage from the head
- Osmotic agents:
 - Mannitol (0.25–1 g/kg IV): Draws fluid out of brain tissue.
 - Hypertonic saline (3%): Reduces cerebral edema.
- Sedation and analgesia: Reduce metabolic demand.
- Anticonvulsants: Prevent or treat seizures.
- CSF drainage: Via external ventricular drain if hydrocephalus is present.

- **Definitive treatment (based on cause):**

- Surgical intervention: Craniotomy, tumor resection, hematoma evacuation
- Antibiotics: If caused by infection (e.g., meningitis, abscess)
- VP shunt or EVD: For hydrocephalus
- Steroids: If due to mass lesion like tumor (not in trauma)

3% NS vs Mannitol

FEATURE	3% Hypertonic Saline	Mannitol
Mechanism of Action	Increases serum osmolality, drawing water out of brain tissue into the intravascular space. Also expands plasma volume and improves cerebral perfusion.	Osmotic diuretic: draws water from brain parenchyma into vasculature, then promotes diuresis via kidneys.
Onset of Action	Rapid (within minutes)	Rapid (within 15–30 minutes)
Duration of Effect	Longer than mannitol (4–6 hours)	Shorter duration (2–4 hours)
Route of Administration	IV infusion (bolus or continuous)	IV bolus



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Common Doses	2–5 mL/kg bolus of 3% NS or continuous infusion (e.g., 0.1–1 mL/kg/hr)	0.25–1 g/kg IV bolus (can repeat)
Monitoring Parameters	Sodium levels, serum osmolality, central line preferred for $\geq 3\%$	Renal function, serum osmolality, urine output

****Careful electrolyte and volume status monitoring is crucial.**

Resources:

- TBI protocol – <https://www.childhealthbc.ca/pcc/hurry/severe-tbi>
 - o Head injury summary - <https://www.childhealthbc.ca/pcc/hurry/head-injury-summary>
 - o Severe head trauma - https://cms.trekk.ca/wp-content/uploads/2023/11/2022-10-12SevereHeadInjuryBLR_FINAL_v3.0.pdf
 - o Management of intracranial hypertension/cerebral herniation - https://shop.healthcarebc.ca/phsa/BCWH_2/Pharmacy,%20Therapeutics%20and%20Nutrition/C-05-07-62754.pdf
 - o CPS Position Statement on Management of Pediatric Patient with Acute Head Trauma - [Management of the paediatric patient with acute head trauma | Canadian Paediatric Society](#)
- Provincial Pediatric Trauma Team Activation - [Pediatric_Horizontal.pdf](#)
 - o Learning Hub Course - [PHSA - TSBC - Provincial Trauma Team Activation Criteria - LearningHub](#)
- Trauma Services BC Trauma Team Activation Standard - [Provincial Trauma Team Activation Standard.pdf](#)
- Intubation in trauma & Epi spritzer - <https://www.childhealthbc.ca/pcc/hurry/intubation-trauma>
- C- Spine clearance - https://shop.healthcarebc.ca/phsa/BCWH_2/BC%20Children%27s%20Hospital/C-05-07-60737.pdf
- Weight based dosing of medications – <https://www.childhealthbc.ca/pcc/hurry#term-359>
- Virtual Support Pathways - <https://www.childhealthbc.ca/pcc/hurry#term-429>

The resources shared throughout this session are for reference purposes only. Please consult your health authority leaders for guidance on adoption and use of these resources within your local context. The advice provided during the PCCL sessions is not intended to replace the clinical judgment of the healthcare providers who are with the patient. While PCCL sessions may suggest recommendations, the final decisions regarding a child's care and treatment should always rest with the healthcare professionals involved in their care at both the referring and receiving centres. If you need additional in the moment support refer to the Provincial Real Time Virtual Support Pathways: If you need additional in the moment support refer to the Provincial Pediatric Virtual Support Pathways: <https://childhealthbc.ca/pcc/provincial-pediatric-virtual-support-pathways>