It’s Not Rocket Science, Just Brain Surgery!

Neurosurgical Emergencies
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Conflict of Interest Disclosure

- I do not have any conflict of interest
- I will not be discussing any off-label product use
- This class has no commercial support or sponsorship, nor is it co-sponsored
Objectives

• Identify early signs & symptoms of neurologic decline

• Identify late signs & symptoms of neurologic decline

• Discuss pertinent & concerning findings of case presentations
Shift Report

- 14 yo M  POD 7 Hemispherectomy
- Plan: DC to Rehab
- Patient on CR & SaO2 monitors
- Monitors alarming through report
- Interrupt report to check the monitor
- HR is 46
Urgent Assessment

• Asleep, try to wake him
• No response to painful stimuli
• Check pupils
  • Anisocoria
  • L pupil sluggish/ R pupil non-reactive
• Vital signs
  • HR 46
  • BP 152/95
  • RR 18
You call a CODE

NOW IT'S TIME TO PANIC
Pediatric Neuro Assessment

- Observe
- Know Baseline
- Age Dependent
- LOC
- Cranial Nerves
- Vitals
- Motor/ Sensory
- Reflexes
Assess Development

• Know **Normal** Development!!!!

• What should a child be able to do at this age?
• Loss of milestones/ skills?
  • Gross motor, Fine motor, Language
• Capable of following commands? (versus not cooperative)
Assess Post-Op Baseline

- What surgical procedure?
  - See Operative Report
- Are there new deficits?
- Is the deficit expected with the surgery?
  - Ask Neurosurg
  - Read Progress notes
- Concerning /pertinent findings in previous 8 hrs
- Is the team concerned??
Dig Deeper

• What happened in the last 2, 4, 12 hours?
  • Surgery?
  • How was the patient post op? (baseline, better, different)
  • Medications?
    • CNS depressants: Narcotics, Benzos
  • Personality changes?
  • Comorbid conditions?
  • Lab trends?
How are the parents?

- “This happens everyday at this time, I keep telling people.”

  vs.

- “Something doesn’t feel right.”
Reason for surgery/ admit
What did the patient look like BEFORE surgery?
  • Talk to parents!
Patient’s baseline: PreOp vs. PostOp
  • Neurologically intact?
  • Waxing & waning neuro exam?
  • Developmentally appropriate?
Changes can be subtle
Physical Exam

- Level Of Consciousness
- Cranial Nerves
- Motor
- Vitals
Elements That Affect Exam

- Narcotics
- Fluid & Electrolyte Imbalance
  - Hyponatremia → lethargy, seizures
  - Hypoglycemia → lethargy
- Infection
  - Meningitis → Irritability, lethargy, neck pain
Elements That Affect Exam

• Pain
  • PQRST
  • “Head Pain”
    • Incisional pain?
    • Worst headache ever?
    • Typical migraine?
• Pain → Nausea, Irritability, HTN, Tachycardia
Oh, Oh, Oh, To Take A Family Vacation! Go Vegas After Hours
Consciousness is the **earliest** & **most sensitive** indicator of neurologic decline.
How Will You Perform This Exam?
Applying stimuli

- Auditory (voice/other sounds):
  - Normal voice
  - Loud voice/other loud sounds

- Tactile (touch):
  - Light touch
  - Painful stimuli

Continuum

- Full consciousness
- Confusion
- Lethargy
- Obtundation
- Stupor
- Light coma
- Coma
- Deep coma
LOC Terminology

- **Awake & Alert**
  - Arouses to voice, has delayed response
  - May drift to sleep during exam

- **Lethargic**
  - Arouses with loud verbal or light tactile stimuli
  - Drifts to sleep if stimulus stops

- **Obtunded/ Somnolent**
  - Arouses to voice, has delayed response
  - May drift to sleep during exam

- **Stuporous**
  - Nearly unconscious, moans or withdraws to pain

- **Comatose**
  - Unresponsive
## Pupillary Changes

<table>
<thead>
<tr>
<th>Term</th>
<th>Findings</th>
</tr>
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<tbody>
<tr>
<td>Brisk</td>
<td>Normal finding</td>
</tr>
<tr>
<td>Sluggish</td>
<td>In conditions that compress oculomotor nerve; early transtentorial herniation, cerebral edema</td>
</tr>
<tr>
<td>Nonreactive or fixed</td>
<td>With midposition, nonreactive pupils, neither sympathetic not parasympathetic innervation in functions. Associated with midbrain infarction or transtentorial herniation</td>
</tr>
<tr>
<td>Small Pinpoint nonreactive</td>
<td>Focal damage of pons: hemorrhage or ischemia. Opiate drug overdose.</td>
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</table>
3rd Nerve Palsy

- 1 Pupil Dilated & Not Reactive
  - Oculomotor nerve compression
  - Will also have ↓ LOC, changes to motor & sensory function
- Ptosis
- Affected eye turns outward when the unaffected eye looks straight ahead
  - Causes double vision
- Affected eye can’t move ↑ or ↓

Anisocoria
Baseline in ~ 17% population
6th Nerve Palsy

- Diplopia
- Esotropia
  - Affected eye crosses inward toward the nose
Motor Response – Posturing

**DECORTICATE**
(Flexor)

Arms are like "C"s
Moves in toward the "Cord"

Problems With Cervical Spinal Tract or Cerebral Hemisphere.

**DECEREBRATE**
(Extensor)

Arms are like "e"s

Problems Within Midbrain or Pons.
Posturing

- **Decorticate Posturing**
  - Damaged cerebral hemisphere, internal capsule, thalamus or midbrain
  - The cortex is no longer able to suppress brainstem reflexes

- **Decerebrate Posturing**
  - Brainstem damage
  - The brainstem is no longer able to suppress spinal cord reflexes
Vital Signs: Cushing’s Triad

- Hypertension
- Bradycardia
- Abnormal Respirations

LATE & ominous sign of brainstem compression
Suggests impending herniation
Pathophysiology

• When arterial pressure < intracranial pressure
  • (Increased ICP)
  • Hypothalamus activates the sympathetic nervous system
  • Peripheral vasoconstriction + ↑ CO = ↑ arterial BP

• When arterial blood pressure > intracranial pressure, blood flow to the brain is restored 😊
  • The ↑ arterial BP caused by the CNS ischemic response stimulates the baroreceptors in the carotid bodies→ bradycardia
Neurosurgical Emergencies

- Inside the Calvarium
  - Brain
  - Cerebrospinal fluid
  - Veins
  - Arteries
- There’s little room for anything extra
  → PRESSURE
Monro-Kellie Hypothesis
Causes of ↑ ICP

• **Conditions that ↑ Brain Volume**
  - Space occupying masses
  - Cerebral edema

• **Conditions that ↑ Blood Volume**
  - Obstruction of venous outflow
  - Hypercapnea
  - Vasodilation

• **Conditions that ↑ CSF Volume**
  - Increased production
  - Decreased absorption
  - Obstruction to flow
Herniation

Supratentorial
1. Uncal (transtentorial)
2. Central
3. Cingulate (subfalcine)
4. Transcalvarial

Infratentorial
5. Upward
6. Tonsillar
Signs & Symptoms of Impending Herniation

- Decreased LOC
- Pupillary abnormalities
- Motor dysfunction
- Impaired brainstem reflexes
- Altered vital signs
Ways to ↓ ICP

1. Enhance venous drainage
2. Hyperosmolar therapy
3. Hyperventilation
4. CSF drainage
5. Surgical Decompression/ Resection
1. Enhance venous drainage
   • Elevate HOB ≥ 30°
   • Ensure c-collar isn’t impeding venous drainage

2. Administer Hyperosmolar Therapy
   • Mannitol vs. Hypertonic Saline
Mannitol vs. Hypertonic Saline

- ↓ Brain Volume
- Draws water from extra-cellular space
- Acts on distal tubules of kidney
- BBB must be intact to work
- Adverse Effects
  - Dehydration, Hypokalemia, Hyponatremia, Renal Failure

- ↓ Brain Volume
- Maintains efficacy with repeat dosing
- Less side effects
- Does not cause profound diuresis
- Less risk of hypovolemia
- Preferred agent over Mannitol
3. Hyperventilation

- Reserved for acute brain herniation & failed response to other therapies
- Not recommended for TBI
- Decreases cerebral blood flow, thus blood volume
- Can cause ischemia
Manage Increased ICP

4. CSF Drainage
   • Decreases CSF Volume
   • External Ventricular Drain
     • Catheter inserted into ventricle thru burr hole
     • Connected to drainage system
   • Shunt Tap

5. Surgery

**Steroids (Dexamethasone)**
Manage vasogenic edema associated with tumors
Use H2-blocker to protect against gastric ulcer
Things That Increase ICP

- Valsalva
- Constipation
- Fever
- Shivering
- Fighting the ventilator
- Noxious Stimuli/ Emotional Upset

- Avoid clustering nursing activities!
Let’s Play
Triage

- You: RN working in Seattle
- Call from mother re: 2 yo, Ryan
- Ventriculoperitoneal (VP) shunt
- Vomiting
- Sleepy
- Saw PCP & dx with Otitis
Symptoms of Shunt Malfunction

- Vomiting
- Headache
- Irritability
- Sleepiness
- Swelling along shunt tract
- Loss of skills/ Decline in school performance
- Personality change
- Difficulty waking or staying awake
Red Flags?

- Vomiting with Zofran
- “Lethargy”
- Progression of symptoms
- Shunt –dependent hydrocephalus
Dig a Little Deeper

- Screen for viral illness
  - Diarrhea?
  - Sick Contacts?
  - Cough, Congestion?
  - Sore throat?
- Logistics/ Safety
- Consider Geography
Recommendations

- Local ER
- Head CT
Think Ahead

- Etiology of hydrocephalus?
- Programmable valve?
- Prior shunt revisions?
- Do ventricles change?
- NPO
Hospital Course

- Transported via EMS to Children’s Hospital
- Emergent OR (overnight)
  - VP Shunt Revision – Proximal catheter
POD 1 - VP Shunt Revision

07:00: AM rounds
  Rouses to light stimulation
  Recent anesthesia

10:00: Still sleeping

12:00: Vitals 36.8°C, 100, 24, 99% RA, 105/45 LLE

13:00: Page provider for Emesis x 1
  Parents are concerned
What’s Next?

• Lethargic → Obtunded/Somnolent
• Not improving
• Post op CT
  • Small area of intraventricular hemorrhage
• NPO
• Head CT
• Prepare for OR
Key Points

- Shunts can fail ANYTIME
- Your assessment skills got him to the OR while he was still compensating
Case Presentation

- 9 mo presents to outside ED
- 12 day hx of vomiting & 4 lb weight loss
- Previously treated for otitis
- Received Zofran for nausea & IVF for dehydration @ outside hospital
- Became lethargic & bradycardic

- Think about the puzzle, what would you do next?
Manage Increased ICP

- Exam, Vitals, Imaging show increased ICP
- Transfer to medical center with pediatric neurosurgery
- How to manage her ICP?
Treatment of Hydrocephalus

- Started on Dexamethasone
- Taken Emergently to OR for EVD
  - Opening pressure around 50 cm H$_2$O
- Stable now: Intubated & EVD
- What caused the hydrocephalus?
  - MRI Brain & Spine w/ & w/o contrast
Post Op EVD

- Awake & Alert
- Opening her eyes spontaneously
- Tracks with conjugate gaze
- PERRL
- Warm & well perfused, RRR
- Afebrile
- HR 91–137
- RR 18–36
- Systolic BP 84–123 / Diastolics 40–96
Consent for Tumor Resection

• Infection
• Bleeding
• CSF leak
• Permanent dysfunction of cerebellum
  • Vision
  • Coordination
  • Balance
  • Swallowing
• Posterior fossa syndrome
• Need for shunt
• Stroke, Coma, Death
Operative Course

- Hypertension (150/100)
  - Nicardipine
- EBL = 300 mL
  - 1 unit of PRBC’s
- Post op CT
  - Minimal expected hemorrhage at resection site
- PICU
POD 1

- VSS, Awake, Alert
- Incisions well approximated; Sites dry
- Labs
  - Na 136, K 3.7, Cl 107, Hct 34.3, WBC 23.1
- Pain well controlled – Tylenol & Oxycodone
- Post Op MRI
- Transfer to floor
You are RN caring for this 9 mo F
s/p EVD & Posterior fossa tumor resection
EVD @ 15, output clear & within parameters
Exam & Vitals have been stable
IV D$_5$NS + PO
3 hrs into your shift
  • Family calls you to bedside for rhythmic movement of RUE & R facial twitching
CODE is called
• Airway, Breathing, Circulation
  • Breathing spontaneously
  • Maintained SpO$_2$ > 90% with blow-by O2
• Lorazepam administered, no effect
• WHY??
• Electrolytes sent STAT
  • Na 117
• NS bolus
  • Seizures stopped after 30 mL NS
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Summary

- Hyponatremia → Cerebral Edema → ↑ ICP
- Just because the tumor is out, doesn’t mean the emergency is over!

- D$_5$NS for Neurosurg patients
- Check daily Na for patients with EVD
- Replace CSF output 1:1 with NS
Resources

Provider Consult Line 206-987-7777
Questions?

My brain before

My brain now

6/1/21
References


Thank You for Being...

The World Needs You