Patient Monitoring and Management

Case Report
- 64 y/o male awoke with:
  - Left gaze deviation
  - Aphasia
  - No movement in right arm or leg
  - Left facial droop
- Last normal: prior to going to bed
- Initial exam:
  - Mental status: answers simple yes / no questions; Unintelligible words intermittently
  - Cranial nerves: Left gaze preference, no blink to threat on right, right facial droop (forehead sparing)
  - Motor: No movement on right
  - Sensory: no response to pain on right

Day #1: Non-contrast Head CT

Dx: Acute Ischemic Stroke
- General Facts
  - “Time is Brain”
    - Alteplase within 3 hours of symptom onset
    - Embolectomy within 6 hours
- Early Risks
  - Hemorrhagic transformation
  - Cerebral edema:
    - Peak swelling period 24 to 96 hours
  - Propagation of clot

Case Report: Initial Interventions
- Is this patient a candidate for systemic tPA?
- Check for perfusion dependence
  - Antiplatelet and high dose statin therapy
  - Permissive Hypertension
  - ICU monitoring

Initial Workup
- Source control:
  - Echocardiogram with agitated saline test
  - Telemetry x 48 hours
  - Lipid profile
  - Hemoglobin a1c
  - +/- lower extremity imaging
  - 24 hour follow up scans
- MRI when feasible
24 hour repeat Head CT

Day #3
- More somnolent
- Bradycardic and hypertensive
  - Atropine???
- Extensor posturing with right arm and leg

Intracranial Hypertension

Repeat head CT

Dx: Intracranial Hypertension
- General Facts
  - Normal ICP
    - < 20 mmHg or < 25 cmH20
  - Goal of ICP monitoring
    - Cerebral Perfusion Pressure:
      - CPP = MAP – ICP
    - Cerebral Blood Flow:
      - CBF = CPP / CVR
    - Cerebral Metabolic rate of O2 Consumption
      - CMRO2 = CBF x AVjDO2

Intracranial Hypertension
- Symptomatology
  - Decreased responsiveness
- Cushing’s Triad
  - Bradycardia
  - Hypertension
  - Irregular respirations
- Anisocoria
- Posturing

Monro-Kellie Doctrine

<table>
<thead>
<tr>
<th>Skull</th>
<th>Brain</th>
<th>Blood</th>
<th>CSF</th>
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**Pressure-Volume Curve**

\[
\text{Compliance} = \frac{\Delta V}{\Delta P}
\]

**Autoregulation**

**Monitoring**

**ICP Monitoring — Indications**

**Level II Evidence**
- Salvageable patients
- Severe TBI (GCS 3-8)
- Abnormal head CT after resuscitation
  - Hematomas
  - Contusions
  - Edema
  - Hemiation
  - Compressed basal cisterns

**Level III Evidence**
- Severe TBI
- Normal head CT and (2 or more)
  - >40 years
  - Unilateral / bilateral motor posturing
  - SBP < 90 mmHg

**Pros**
- Diagnostic
- Therapeutic
- Accurate
- Low cost
- Prophylactic Abx not indicated

**Cons**
- Infection / ventriculitis
- More difficult procedure

**Intracranial Pressure Monitoring**

**Noninvasive**
- Bedside exam
- Optic nerve sheath diameter
- Pulsatile index (TCD)

**Invasive**
- Fluid-Coupled Monitoring
- Parenchymal Monitoring
- Brain tissue Oxygenation
- Microdialysis catheters
- Jugular venous saturation

**Fluid-Coupled Monitoring**

- Invasive
- Parenteral
- Parenchymal
- Brain tissue Oxygenation
- Microdialysis catheters
- Jugular venous saturation
**Pro**

- Reliable
- Simpler technique
- Fewer complications

**Con**

- Diagnostic only
- Variable values
- Regional pressure

**Parenchymal Monitors**

**Brain tissue oxygenation**

**Pro**

- Continuous PbtO2 monitoring
- Early signs of vasospasm
- Simultaneous ICP catheter

**Con**

- Experience
- Variable values

**SjvO2**

- CMRO2 = CBF x AVjDO2
- Continuous jugular oximetry
- SjvO2 < 50% x 10 minutes
- Calibrate every 8-24 hours

**Cerebral Microdialysis**
Case Report: Monitoring

- Ventriculostomy placed
  - Open at -10 cmH20
- Opening pressure estimated to be > 40 cmH20
- Drained ~ 200 mL in first 24 hours

Management

Basic Neuro-protective Steps

- Secure the Airway
- Hemodynamically stabilize
- Elevate HOB
- Neck Neutral
- Temp control
- Analgesia / sedation
- +/- Hyperventilation

Surgical – Definitive Therapy

- Evacuation of Mass lesions
- Decompressive Hemicraniectomy
- Bifrontal Cranietomy
- Skull fracture elevation/debridement

Reduce Blood / CSF Volume

- Positioning
  - HOB >30 degrees
  - Neck neutral
- Hyperventilation
  - Temporizing measure (signs of impending herniation)
  - PbtO2 monitoring recommended
  - Prophylactic – not recommended
- CSF drainage

Reduce Brain Volume

- Osmotic agents
- Hypertonic saline
- Steroids
**Mannitol**

- **Dose:**
  - 0.25 – 1 g/kg
- 1st phase effect: Rheological
- 2nd phase effect: Diuretic
- Special Considerations:
  - Renal injury
  - Reflection coefficient 0.9
  - Volume loss
  - ***Needs Filter

**Hypertonic Saline**

- **Bolus dosing preferred**
- 1st phase effect: Rheological
- 2nd phase effect: Volume expansion
- Special considerations:
  - Reflection coefficient 1.0
  - Careful with heart failure patients

**Reduce Brain Demand (CMRO₂)**

**Barbiturates**

- **Positive effects**
  - Reduce CMRO₂
  - Redistribute CBF to ischemic zones
  - Free radical scavenger
- **Adverse effects**
  - Hypotension
  - Negative inotrope
  - Vasodilator
  - Immunosuppressive
  - Ileus

**CMRO₂ Reduction - Other**

- **Anesthetic**
  - Propofol
- **Hypothermia**
- **Normothermia**
- **AED**
- **Mechanical Ventilation**

**Case Report: Interventions**

- **Medical:**
  - Intubated and hyperventilated x 2 hours
  - Sedated with Propofol and Fentanyl
  - Normothermia and anti-shivering protocol
  - Mannitol 75g IV every 6 hours x 24 hours – weaned over next few days
- **Surgical:**
  - Ventriculostomy
  - Decompressive Cranectomy on day 2
Outcome

- Day 7: Tracheostomy placed
- Day 13: weaned to Trach collar
- Day 15: Transferred to floor
- Active participation with PT / OT / SLP
- Day 17: Transferred to SNF rehab

References