Increased Intracranial Pressure

Key Points:

- Common pathological condition common to many neurological disorders (trauma, tumors, bleeds, infection, metabolic disorders)
- **Hypoxia and hypercapnea** both produce vasodilatation and contribute in edema and increased intracranial pressure. (Autoregulation)
- Monro-Kellie hypothesis:
  The skull is a closed rigid container. Intracranial volume is composed of brain tissue (85%), intracranial blood volume (5%), and cerebrospinal fluid (10%). Conditions that increase one or more of the intracranial contents must cause a reciprocal change in the remaining contents or an increased ICP will occur. Compensatory mechanisms initially are able to accommodate a growing intracranial volume, but if contents continue to expand, compensatory mechanisms fail.
- When volume within the skull overwhelms the compensatory mechanisms, intracranial pressure begins to rise.

Normal ICP 0-10 mm Hg
Pressure > 20 mm Hg are considered increased

Cerebral Perfusion Pressure (CPP)

Parameter used to monitor the adequacy of blood flow to the brain. ICP increases; blood vessels become compressed reducing blood flow to the brain. Systemic blood pressure needs to be high enough to overcome the ICP to deliver O_2 and glucose to brain tissue.

CPP = MAP-ICP

An increase in ICP will result in a decrease in CPP, unless the MAP is also increased. Maintain CPP > 60-70 mmHg to decrease ischemia to the brain.

Signs and Symptoms of Increased ICP:

Early:

- Decreasing level of consciousness (earliest and most sensitive)
- Restlessness, changes in speech, loss of judgment, memory
- Headache that increases in intensity with coughing or straining
- Pupillary changes (oculomotor nerve)
  Dilation with slow constriction
  Diplopia
- Contralateral motor or sensory losses (monoparesis, hemiparesis)
- Nausea and vomiting

Later S/S

- Continuing deterioration in level of consciousness
- Changes in vital signs
  1. **Rise in systolic BP and decrease in diastolic BP, widened pulse pressure**
  2. **Slow pulse**
  3. **Respiratory dysrhythmias (shallow, slow irregular, apnea, hiccups)**
     Above bolded (1,2,3) referred to as **Cushing's response** and are classic indicators of increased intracranial pressures.
     Fever without a clear source of infection
- Possible vomiting (more common in children)
- Papilledema (pressure seen by visualizing the optic disc)
- Decerebrate or decorticate posturing, possibly flaccid
- Sluggish, non-reactive pupils

Interventions for ICP

Non-surgical

Respiratory Support (usually managed with airway and ventilator) to maintain O_2/CO_2 balance

Cerebral oxygenation: PaO2 must be kept between 90-100 mm Hg.

Hyperventilation: decrease the $PaCO_2$ to cause vasoconstriction of cerebral vessels without causing ischemia at the same time (30 – 35 mm Hg). **Not routinely used**

Drug Therapy

Osmotic diuretics: establish a high osmotic gradient to draw H_2O from extracellular space of the edematous cerebral tissue into the plasma. H_2O is drawn from the brain to decrease the bulk of the brain tissue.

Mannitol:

Small frequent bolus doses of 20%-25% solution given through a filter (crystallizes easily). Monitor lytes, osmolality, I&O. May follow with Lasix.

Nrsg: Renal function, electrolytes, serum osmolality (client can become dehydrated and hypotensive).

Corticosteroids:

- Dexamethasone - usually given with tumors or abscesses. Mechanism of action unknown.

Nrsg: Dosage should be tapered, watch the gut, usually give with pepcid, monitor blood glucose, and check SFOB.

Blood pressure control:

- Hypotension can cause ischemia
- Hypertension can increase cranial pressures

Muscle relaxants, muscle paralysis, sedation:

- Neuromuscular parlaysis helps prevent coughing, sneezing, bucking the ventilator and other activities that increase cranial pressures. (Pavulon)
- Sedation decreases anxiety and fear

Temperature control:

- Temp increase will increase metabolic rate. Tylenol, cooling blanket, watch for shivering as well. Metabolism increases 5 – 7% per degree of increased body temp.

Seizure control:

- Control seizures to decrease the risk of secondary ischemic assaults (Dilantin)

Barbituate coma:

- Only used is if patient does not respond to conventional management (pentobarbital) and will decrease overall metabolic rate and ICP

Antibiotics:

- Used primarily if ICP monitor is in place

Surgery:

- Decompressive surgery to remove brain tissue
- Craniotomy to allow brain tissue to expand
- Placement of a ventricular catheter

Cerebral spinal fluid drainage:

- Ventricular drainage: insertion of a catheter into the lateral ventricle**.**

Nutrition:

- Malnutrition can occur quickly with wasting of lean muscle mass.
- Nutritional support with jejunal feeding to avoid aspiration and regurgitation. Start within 7 days of injury.
- Monitor blood sugars to prevent hypoglycemia as glucose is primary fuel for the brain.

Control of Activity:

- Neck kept in alignment to promote venous drainage
- HOB elevated
- Prevent or avoid coughing
- Calculate CPP if monitor is in place

ICP monitoring

Intraventricular catheter (ventriculostomy)

- Inserted through a small hole in the skull and through the brain directly into one of the lateral ventricles. Catheter is connected to a sterile drainage system with three- way stop cock.
- Measures pressure, allows for drainage or sampling. Allows for instillation of contrast media
- Catheter can become occluded by a clot.

Subarachnoid Bolt

- Inserted through a burr hole in the skull into a small opening in the dura and into the subarachnoid space.
- No penetration of brain tissue. Connected to a transducer leveled around the lateral ventricles.

Epidural Probe

- Pressure sensitive cables are placed into the epidural space.
- Is least invasive but provides for no drainage or sampling.

Fiberoptic transducer- tipped catheter

- Measures changes in the amount of light reflected from a pressure-sensitive diaphragm in the catheter tip. This can be placed directly into brain tissue, subarachnoid space, epidural space or into a ventricle.
- These are fragile and break easily

REMEMBER INFECTION IS RISK OF ALL CATHETERS!!!!

Herniation Syndromes

Occur late in the course of increased ICP and are bodies last attempt to restore normal brain volume and pressures

Symptoms seen: unilateral or bilateral papillary dilation, asymmetric papillary reactivity, abnormal motor posturing.

Because of pressure on the pons and medulla, blood pressure changes, bradycardia and asystole can occur. When hypotension occurs, death may be imminent.