Objectives

- Describe the five components of the neurologic assessment.
- Discuss the neurologic changes associated with intracranial hypertension.
- Perform a basic neurologic examination in a conscious patient

Extracerebral Structures

- Scalp
  - Skin, cutaneous and adipose tissue
- Skull
  - Cranium minus the mandible
  - 8 bones
- Meninges
  - Three membranes covering the entire brain surface, spinal cord and spinal canal
    - Dura mater (Tough Mother)
    - Arachnoid Layer (spider web)
    - Pia mater (Tender Mother)
Cranial Protective Mechanisms

• **Dura Mater** – outermost layer of meninges directly beneath skull (tough fibrous layer)
  - Includes venous sinuses that collect blood from intracranial and meningeal veins for drainage into the IJ veins
  - Main blood supply is the middle meningeal artery and lies within the epidural space
  - Damage to this artery will result in an [epidural hematoma](#)

• A potential space exists between the dura mater and the arachnoid space

Cranial Protective Mechanisms

• **Arachnoid Mater** – fragile membrane that loosely surrounds the brain and fine threads of trabeculae connect the arachnoid to the pia mater.
  - Spongy space called the arachnoid space with CSF fluid circulating freely.
  - Large brain arteries originate here and divide into anterior and posterior circulatory branches

Cranial Protective Mechanisms

• **Pia Mater** – adheres directly to the brain tissue. Rich in small blood vessels that supply a large volume of arterial and follows the folds along the brains surface to form the lateral, third and fourth ventricles
Cerebral Spinal Fluid

- 4 Ventricles
  - 2 lateral ventricles are largest located in cerebral hemispheres
  - Third ventricle — connected to lateral ventricles at the Foramen of Monroe, cerebral aqueduct of Sylvius connects to 4th ventricle
  - Fourth ventricle — connects to central canal of spinal cord

Cerebral Spinal Fluid

- Produced from arterial blood in the lateral and fourth ventricles
- Absorbed by the arachnoid villi across the venous system and drains into the lymph system
- Normally clear and colorless
- Cushions the brain and structures
- Compensates for pressure changes
- Produces about 120-150 mL of volume that circulates at a rate of 20 mL/hr

Blood Supply to the Brain

- Two arterial systems supply blood
  - Carotid Arteries
  - Vertebral Arteries
- Circle of Willis connects two systems
  - 50% of population have “classic” shape
- CO₂ is the primary regulator for CNS blood flow
- Venous circulation runs parallel to many arteries
  - Important in aneurysms and anatomical landmarks
Cerebral Circulation

More O₂ needs than any other organ, even during sleep!

- Cerebral perfusion pressure (CPP) is equal to the MAP minus Intracranial Pressure (ICP)
  \[ \text{CPP} = \text{MAP} - \text{ICP} \]
- Cerebral blood flow is determined by activity, disease, fever, injury and other factors.
Autoregulation of Cerebral Blood Flow

- **Hypercapnia** (\(\text{PaCO}_2 > 45\text{mmHg}\)) and to a lesser extent hypoxia (\(\text{PaO}_2 < 60\text{mmHg}\)) cause dilation of cerebral arteries thus increasing the amount of blood flow into the brain, regardless of needs. **This causes increased Intracranial Pressure (ICP)!**

- **Hypocapnia** (\(\text{PaCO}_2 < 35\text{mmHg}\)) causes vasoconstriction that decreases \(O_2\) to brain to harmful level.

Cerebral Blood Flow

- Brain works best with a MAP between 70-105 mmHg
- Normal intracranial pressure is 5-15 mmHg
- Normal cerebral perfusion pressure 60-100 mmHg
- Beyond certain point, autoregulation fails...
  - **Increased ICP** causes decrease in perfusion to brain due to compression of arteries, veins and brain mass.

Monro-Kellie Doctrine

- **Sum of brain volume is constant**
  - Brain tissue
  - Cerebral spinal fluid
  - Intracranial blood volume
- An increase in one should cause a decrease in one or both of the remaining two
- Cerebral hypotension will cause traction or pulling on the vascular structures
  - Too much can cause dural tears = subdural hematomas
- Cerebral hypertension will cause compression to vascular structures
  - Too much can cause structures to become compressed into spinal canal opening = herniation
Intracranial Hypertension

- Cerebral edema is the most common cause!!
  - Extracellular such as blood
  - Intracellular or "metabolic" or "cytotoxic" edema
    - Cyanide poisoning
    - Trauma or cold
  - Combination of both by
    - Changing the osmotic pressure of blood with dialysis
    - Water intoxication (hyponatremia)
  - Obstruction of the venous outflow tracts
  - Rapid reduction of serum glucose (hypoglycemia) causing fluid influx into the cells
  - Mechanical failure for sodium, potassium and water regulation

Treatment of Increased ICP

- Maintain the patient's head midline to facilitate blood flow
- Maintain HOB at 30-45 degrees to facilitate venous drainage
- Avoid activities that increase ICP such as suctioning or gagging
- Treat fevers
- Decrease environmental stimuli
- Transfer to ICU for continuous monitoring

Maintain MAP and Cerebral Perfusion Pressure (CCP)

- Vasopressors or antihypertensives
  - Labetalol, calcium channel blockers
- Decrease metabolic requirements
  - Anticonvulsants, reduce fevers, barbituate coma
- Corticosteroids to reduce CSF production, reduce brain tumor blood flow
  - Dexamethasone