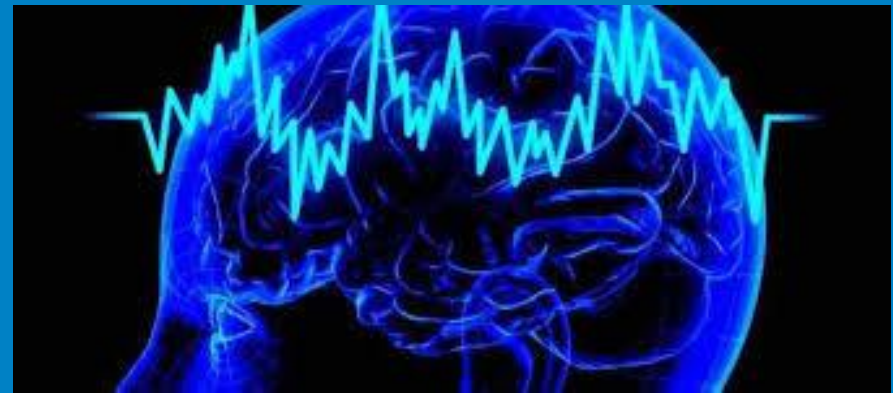
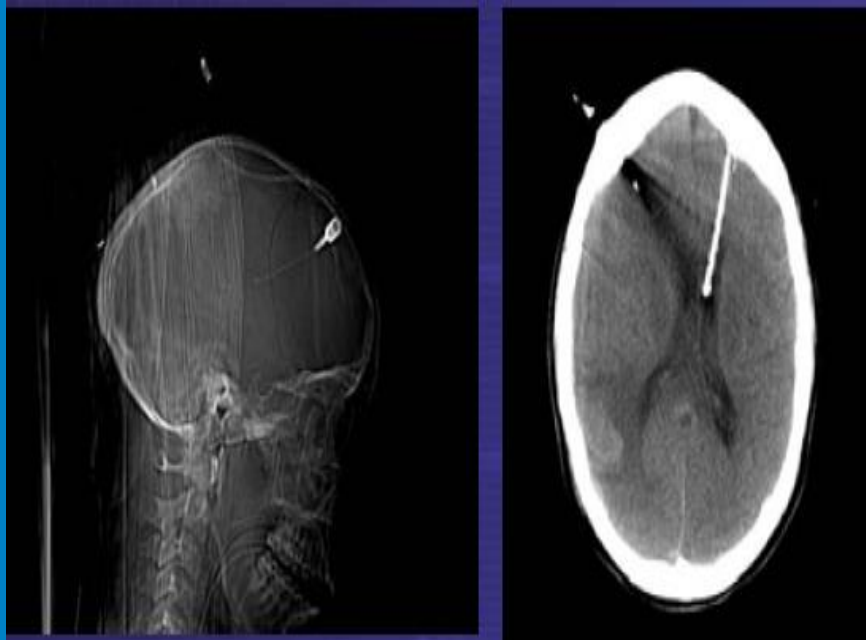


Care of the Pediatric Neuroscience Patient



Objectives

- Discuss assessment and plan of care for patients with hydrocephalus.
- Identify signs and symptoms of a shunt malfunction and increased intracranial pressure.
- Describe what a seizure is and different types of seizures.
- Explain seizure management in the pediatric population.

Hydrocephalus

- Results from underlying brain disorders
- Imbalance between production and absorption of CSF
- Congenital or acquired



Brain with normal ventricles



Brain with enlarged ventricles



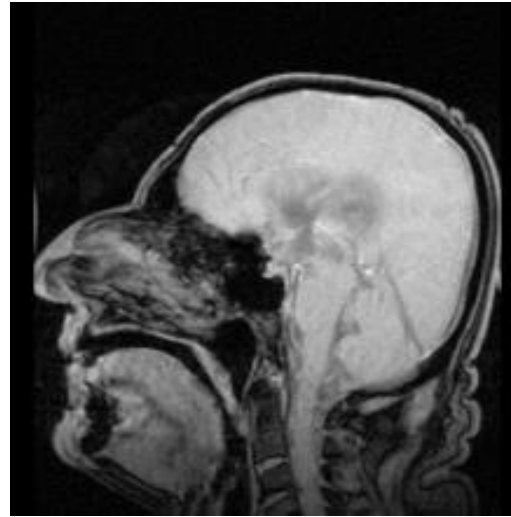
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Hydrocephalus

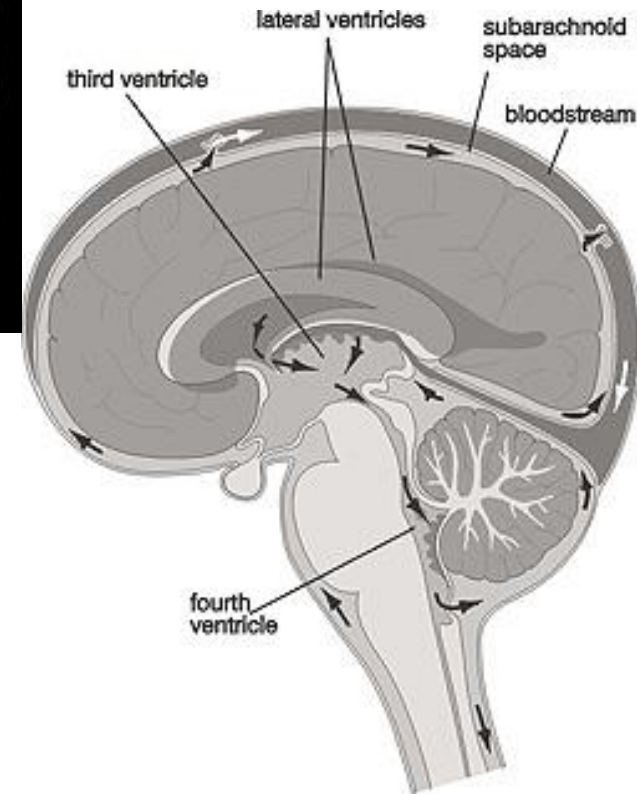
- Pathophysiology
 - CSF formed primarily in ventricular system by choroid plexus
 - Flows by pressure gradient between ventricular system and venous channels
 - CSF absorbed primarily by arachnoid villi
 - Imbalance between production and absorption results in hydrocephalus

CSF & Ventricular System

- Ventricles produce CSF
 - Provide a pathway for the effective circulation of CSF
- CSF main function = shock absorber
 - Protect the brain by providing cushioning
 - Minimizes the impact due to physical trauma



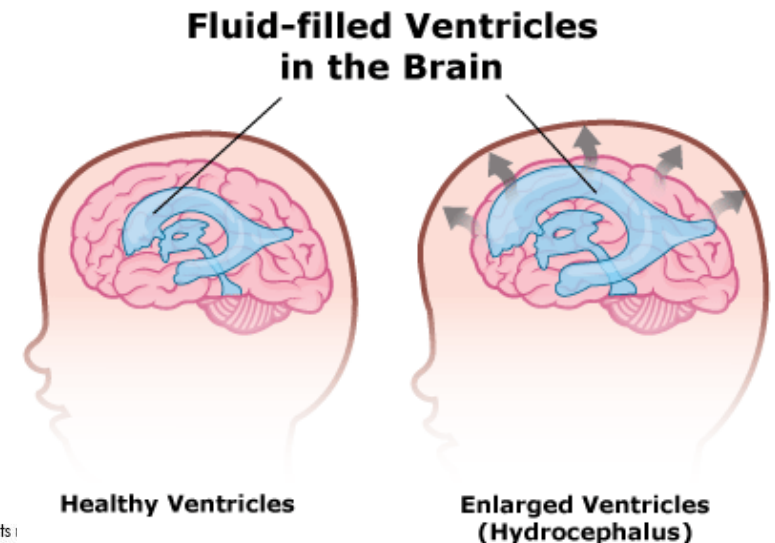
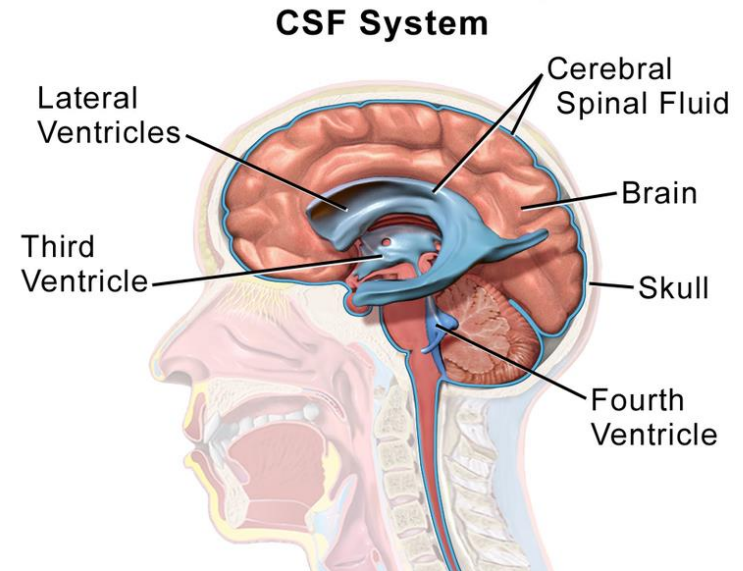
MRI showing pulsation of CSF



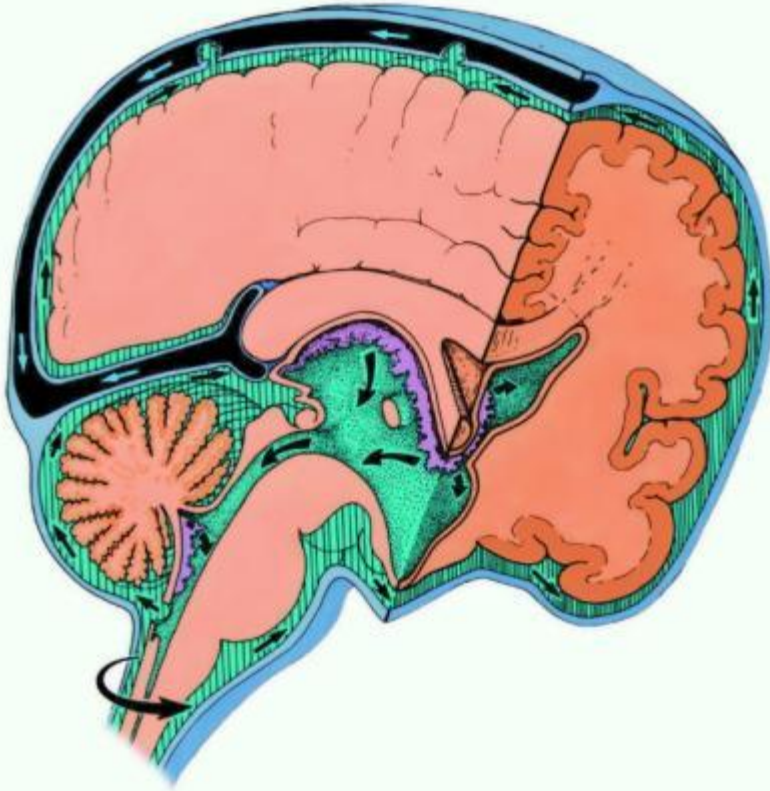
Cerebrospinal Fluid Flow

CSF Production & Volume

- Adult ventricles produce 500 ml of CSF/day but CSF is constantly reabsorbed so only some is stored
- CSF production:
 - 20-25 ml/hr in adults
 - 0.35 ml/kg/hr in children
 - Excessive CSF production leads to hydrocephalus
- Most CSF stored in spinal canal
- CSF Volume:
 - Infants: 40-60 ml
 - Young children: 60-100 ml
 - Older children: 100-120 ml
 - Adults: 100-160 ml
 - Average adult = 135 ml

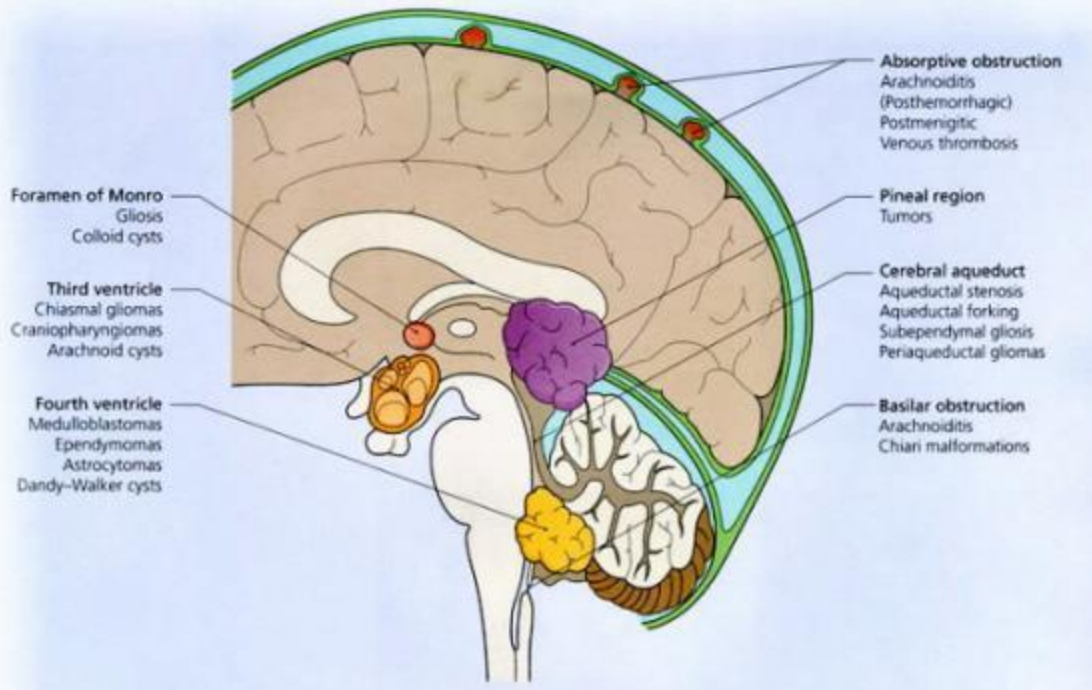


Hydrocephalus



- Non-communicating (obstructive)
 - CSF unable to pass from ventricles to spinal cord
 - NTDs, neonatal meningitis, trauma, tumors, Chiari malformation, aqueductal stenosis
- Communicating (non-obstructive)
 - CSF flows freely
 - Subarachnoid hemorrhage, intrauterine infections

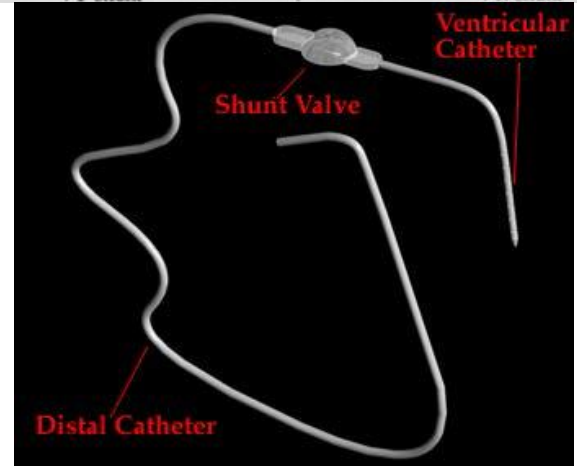
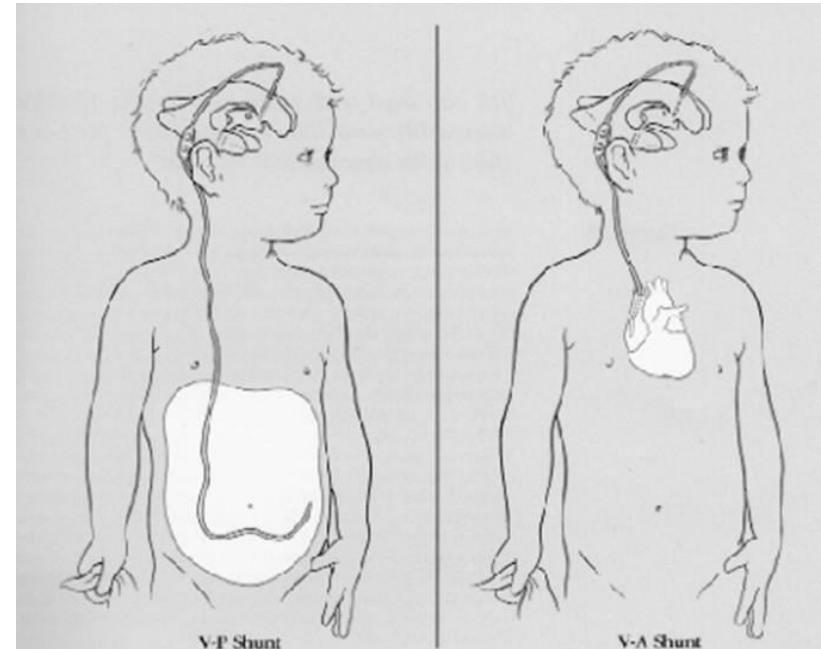
Hydrocephalus



- Common associated disorders/illnesses
 - IVH
 - Meningitis
 - Intrauterine viral infections (CMV, Rubella)
 - Lesions or malformations of brain
 - Chiari malformations
 - Non-accidental injury

Hydrocephalus

- Therapeutic management
 - Early identification important to reduce complications from increased ICP
 - Goals of treatment
 - Relieving hydrocephalus
 - Managing complications associated with disorder
 - VP shunt, usually needed
 - Might need to be replaced with growth



Signs and Symptoms of Shunt Malfunction

Infant

- Have unexplained crabbiness.
- Throw up or not eat normally.
- Have a bulging or a rounded soft spot, even when not crying.
- Sleep more than normal.
- Have swelling around the shunt site or shunt tubing.
- Have an increase in head size.
- Be unable to look straight ahead and only look down.

Toddler

- Have changes in mood, personality or behavior.
- Throw up or not eat as well as normal.
- Have a headache. Look for pain behaviors if your child is not able to tell you they have a headache.
- Sleep more than normal.
- Have swelling around the shunt site or shunt tubing.

Signs and Symptoms of Shunt Malfunction

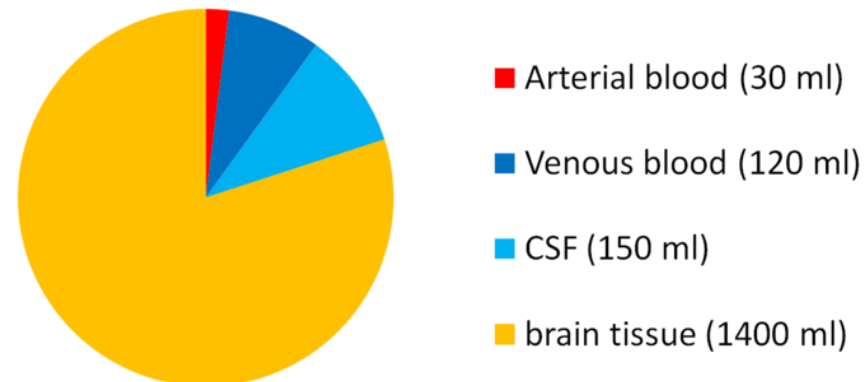
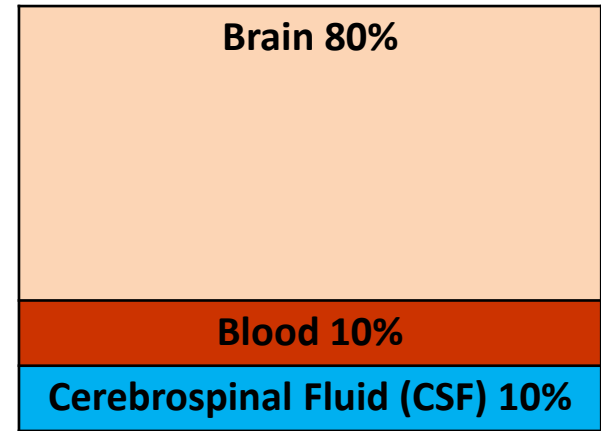
- School-age child:
 - Throw up or not eat as well as normal.
 - Have a headache or vision changes.
 - Sleep more than normal.
 - Have a hard time thinking or understanding.
 - Have changes in mood, personality or behavior.
 - Have lower grades in school.
 - Have swelling around the shunt site or shunt tubing.

General Signs & Symptoms

- Fever 101F (38.3C) or higher.
- Redness, drainage or increased swelling around incision(s).
- A headache that gets worse.

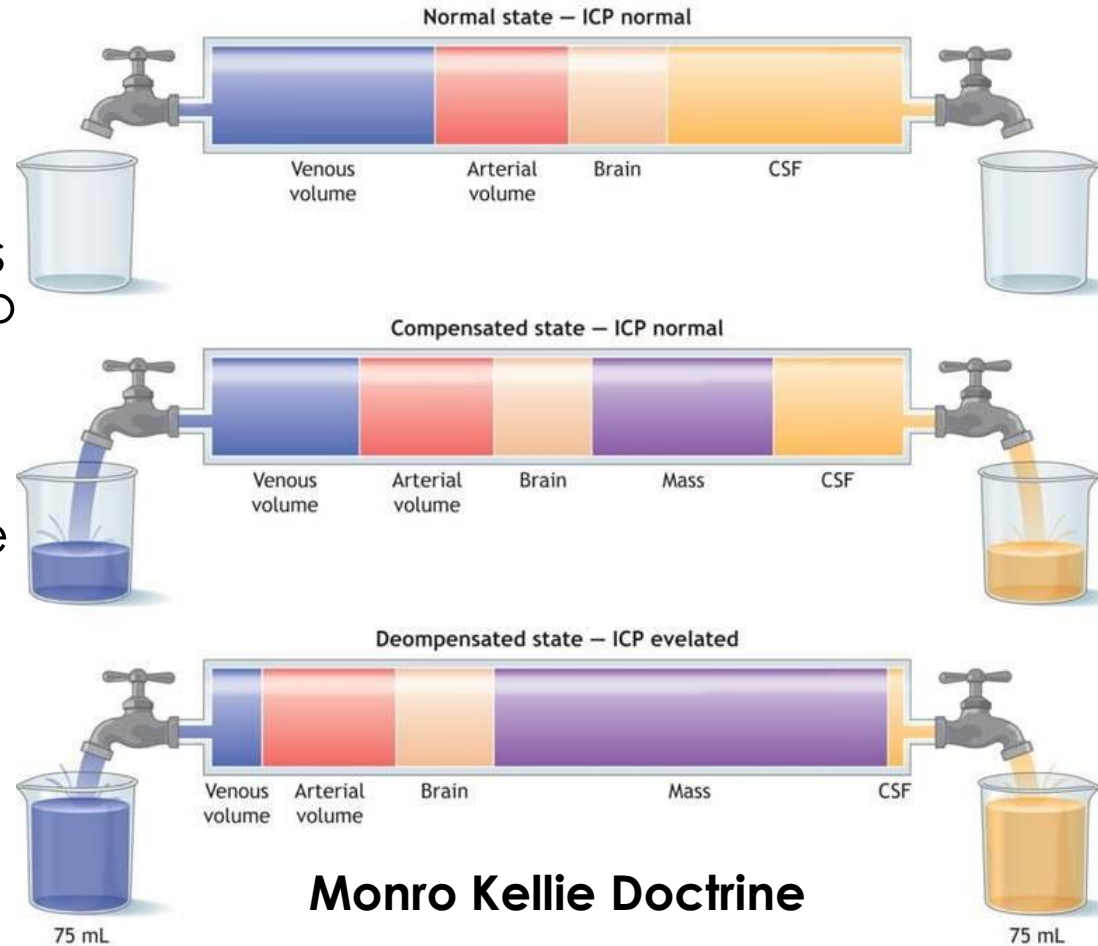
3 Main Components: Cranial Vault

- Fixed space with 3 main components:
 - Brain 80%
 - Blood 10%
 - Cerebrospinal Fluid (CSF) 10%
- Similar to a rigid box
- Volume of the three components within the skull must remain equal
- Increase in one must be accompanied by a decrease in another
 - Otherwise intracranial pressure (ICP) will increase
 - More ICP (Bad) = Less LOC (Also Bad)



Something's Got to Give

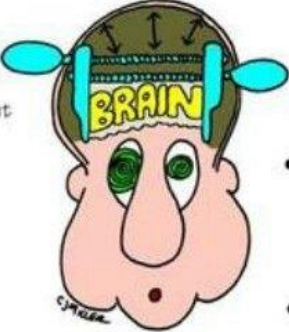
- Volume of one component increases, volumes of the others compensate to maintain ICP (0-15 mmHg)
- Intracranial mass increases in size, CSF is displaced into spinal canal
- Reduction of brain blood volume/flow = inadequate brain tissue oxygenation
- Displacement of brain tissue = herniation



Increased Intracranial Pressure (ICP)

- Normal ICP = 0-15 mm hg
- Increased ICP = above 20 mm hg (*CHW generally accepted*)
- Common clinical signs of **early** intracranial hypertension may include
 - Vomiting
 - Irritability
 - Headache
 - Seizures
 - Changes in LOC
 - Photophobia
 - Lethargy
 - Nystagmus
 - Double vision

INCREASED INTRACRANIAL PRESSURE

- 
- Changes in LOC
 - Eyes
 - Papilledema
 - Pupillary Changes
 - Impaired Eye Movement
 - Posturing
 - Decerebrate
 - Decorticate
 - Flaccid
 - Decreased Motor Function
 - Change in Motor Ability
 - Posturing
 - Headache
 - Seizures
 - Impaired Sensory & Motor Function
 - Changes in Vital Signs:
 - Cushing's Triad:
 - ↑ Systolic B/P
 - ↓ Pulse
 - Altered Resp Pattern
 - Vomiting
 - Changes in Speech
 - Infants:
 - Bulging Fontanels
 - Cranial Suture Separation
 - ↑ Head Circumference
 - High Pitched Cry

Cushing's Triad

- Indicates pre-morbid high level of ICP

- Increased Systolic BP
- Decreased HR
- Decreased RR

INCREASED INTRACRANIAL PRESSURE (IICP) -
CUSHING'S TRIAD
(Symptoms Of IICP Are Opposite Of Shock)

* IICP *
↑ Systolic B/P
↓ Pulse
↓ Respirations



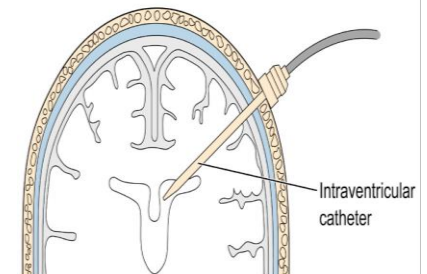
* Shock *
↓ B/P
↑ Pulse
↑ Respirations

Management of Increased ICP

- Decrease stimulation
- Turn lights down
- Limit visitors
- Use soft voices.
- Assess response to positioning.
- Raise HOB no more than 30 degrees.
- Check a bedside ICP using EVD.

Management of Increased ICP

- Endoscopic Third Ventriculosomy (ETV)
 - A small perforation in the thinned floor of the third ventricle, allowing movement of cerebrospinal fluid (CSF) out of the blocked ventricular system and into the normal CSF space.
- External Ventricular Drain Placement
 - Drains CSF (and sometimes blood) to collection bag
 - Monitors intracranial pressure
 - Used to decrease swelling and ICP
 - When CSF outflow is obstructed due to trauma or other abnormality

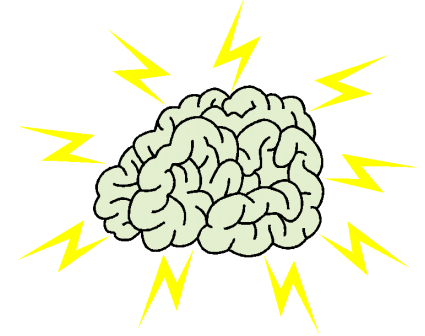


What is a Seizure?

- A seizure is a kind of electrical short circuit
 - A typical brain has about 10 billion cells called “neurons.”
 - These neurons are all bunched up side-by-side, and communicate with each other with electrical charges.
 - Certain chemicals in the brain help put brakes on all of this electrical activity.
 - In a seizure, a “short circuit” occurs, during which the neurons keep firing. The clinical manifestations of this short circuit vary, but can include twitching, full body shaking or staring.
 - Seizures may also include cyanosis, excessive secretions or incontinence
- ❖ **Most seizures are self-limiting – less than 5 minutes**

What is Epilepsy?

- History of 2 or more seizures
- Epilepsy has many causes
 - Illness
 - Brain damage
 - Abnormal brain development
 - ❖ 70% are idiopathic – no known cause
- Refractory Epilepsy
 - Seizures have failed to respond to several antiepileptic medications (AEDs)
 - Ketogenic diet
 - Epilepsy surgery



(National Institute of Neurological Disorders and Stroke, 2008)

Seizure Types

- Generalized
 - Involves both cerebral hemispheres
 - Convulsive: tonic-clonic seizures
 - Tonic clonic phase occurs first
 - May have postictal tonic phase for up to 4 minutes
 - Non-convulsive:
 - Absence seizures (eye blinking, staring, repetitive swallowing)
 - Atonic: sudden loss of tone and consciousness – “drop attacks”
 - Myoclonic: abrupt muscle contraction

Generalized Seizures

- Tonic-Clonic (formally “grand mal” or “convulsive”)
 - May start focal with an aura, but then generalize to the entire brain
 - All muscles of the body are involved
 - Unconsciousness
 - Tonic activity (stiffness)
 - Clonic activity (jerking)
 - May be sleepy post-ictal
 - May have temporary paralysis after (Todd's paralysis)



Seizure Types

- Simple focal (partial) seizure
 - Originates in one hemisphere of the brain and can spread.
- Complex focal (partial) seizure
 - Originates in one hemisphere and involves a change in awareness.
- Febrile Seizures
 - Seizure brought on by high fever due to illness
 - Occur in children 6 months to 5 years of age
 - Typically not started on an antiepileptic medication (AED).

Typical AED's

Generic Name

- Topiramate
- Lamotrigine
- Carbamazepine
- Oxcarbazepine
- Divalproex
- Dilantin
- Clonazepam
- Lacosamide
- Levetiracetam
- Phenobarbital

Brand Name

- Topamax
- Lamictal
- Tegretol
- Trileptal
- Depakote/Valproic Acid
- Phenytoin
- Klonopin
- Vimpat
- Keppra

Rescue Medications

Lorazepam

- Preferred choice inpatient because of its prolonged effects
- Rapid onset (1-5 minutes)
- Long half-life (12-24 hours)

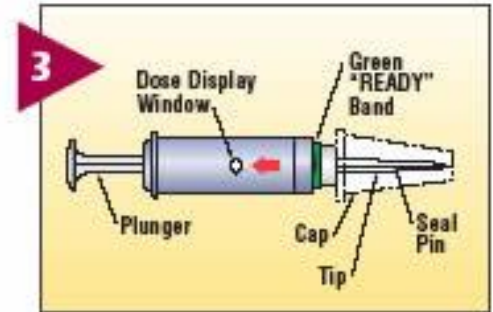
- Dosing: 0.1 mg/kg up to **maximum dose of 2mg**
- Administration: diluted 1:1 with NS and give over 1-2 minutes for GTC greater than 5 minutes
 - May repeat once within 5 minutes

Rescue Medications

Diazepam Rectal Gel

- Used as an anticonvulsant for acute treatment:
- Onset of action: 2-5 minutes
- Children <2 years: Not recommended

- Dosing: 0.5mg/kg
 - **Note:** Round dose to 2.5, 5, 7.5, 10, 12.5, 15, 17.5, and 20 mg/dose. Round to nearest available
 - Given for GTC greater than 5 minutes



Rescue Medications

Intranasal Midazolam

- Used as an anticonvulsant for acute treatment:
- Onset of action:
- Can be used in any age group

- Dosing: 0.5mg/kg
 - Infants 1 to 5 months: 0.2 mg/kg (single dose)
 - Infants ≥ 6 months, Children, and Adolescents: 0.2 to 0.3 mg/kg (maximum single dose: 10 mg); may repeat in 5 to 15 minutes
 - Given for GTC greater than 5 minutes



What do I need to know?

- Know your patient's seizure history
 - What do they look like? How long do they typically last?
 - Being hospitalized for fever, other illnesses, surgery, trauma, etc. puts them at increased risk to seize
 - Establish a neurological baseline upon admission – developmental delay, motor functioning, level of consciousness

What to do next?

- Communicate with the physician
 - Ask for the Seizure Rescue Order Set to be initiated (different name in Epic)
 - If the patient has IV access, lorazepam is the preferred medication
 - If no IV access or hard to obtain, Diastat can be ordered for children >2 years of age
 - Intranasal versed can be ordered for any age
 - Seizure Precautions: seizure pads, suction and oxygen at bedside
 - Fall risk order set placed
 - Includes being observed in bathroom at all times

Seizure Precautions

- Safety, Safety, Safety!!!
 - Verify seizure precautions
 - Ensure rescue meds are ordered
 - Suction set-up
 - Soft tip suction catheter and suction canister
 - O2 mask
 - Seizure bed pads – on all rails of bed but NOT in cribs
 - Emergency equipment (for all patients)
 - Helmet safety
 - Fall precautions

Seizure Management

1. Stay with the patient & call for help.
2. Note time seizure started.
3. Place patient in **side lying position**.
4. Notify MD of seizure activity.
5. Guide movements to prevent injury, but do not restrain the patient.

Seizure Management

6. Suction as needed
7. Apply oxygen as needed
8. Do not attempt to open the mouth or place anything in the mouth
9. Administer rescue medications according to order set
 - **RN assigned to pt will draw up & give medications**

Seizure Management

- Monitor oxygen level and apply 10-15 liters of oxygen as needed.
- Note the time the seizure began & what is occurring during seizure.
 - Extremity involvement
 - Eye involvement
 - Cyanosis
- ❖ Most seizures are self-limiting – less than 5 minutes.

Seizure Management

- Patients typically undergo an electroencephalogram (EEG) to monitor brain activity.
 - An **EEG** tracks and records brain wave patterns over defined duration.
- Patients typically also undergo an MRI to check for any brain abnormality that could be causing seizure activity.

Questions?

