primed

Pediatrics

NEUROLOGY

FIRST EDITION

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2025

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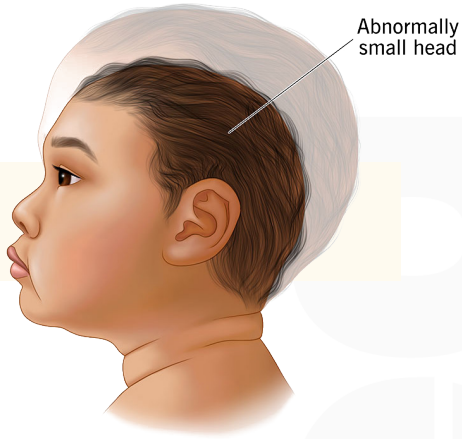
TABLE OF CONTENTS

“Two men looked out from prison bars, one saw the mud, the other saw stars.”

Which one will you be?

ABNORMAL SKULL GROWTH

Microcephaly



OFC *< than 2 standard deviations (SD)* below the mean for a given age, sex, and gestation (i.e., < 3rd percentile)

Causes

Primary or secondary

Congenital

Chromosomal / genetic

- Trisomies of 13, 18, and 21
- Cornelia de Lange syndrome
- Cri du Chat syndrome
- Smith-Lemli-Opitz syndrome

Postnatal

Chromosomal / genetic

- Inborn errors of metabolism
- Mitochondrial diseases
- Aminoacidopathies
- Defects in glucose transport

Acquired

Disruptive traumas

- Hypoxia or anoxia (insufficient placenta)
- Death of a twin (monochorionic)

Infections and protozooses

- Syphilis
- Toxoplasmosis
- Rubella
- Cytomegalovirus
- Herpes simplex
- Parvovirus B19
- Zika virus
- Other viruses

Teratogens/clinical conditions

- Alcohol
- Drugs (cocaine, crack, among others)
- Radiation
- Maternal diabetes mellitus without adequate control
- Maternal phenylketonuria
- Hydantoin

Deprivation

- Syphilis
- Toxoplasmosis
- Rubella
- Cytomegalovirus

Chromosomal / genetic

- Traumatic brain injury
- Parenchymal hemorrhage (more common in preterm children)
- Hypoxia or anoxia

Infections

- Meningitis
- Encephalitis

Toxins

- Copper poisoning
- Chronic renal failure

Deprivation

- Hypothyroidism
- Malnutrition
- Anemia
- Congenital cardiopathy

Classification

By time of onset:

Congenital, primary or genetic microcephaly: is present at birth or by 36 weeks' gestation.

Postnatal, secondary or acquired microcephaly: failure of normal growth in a brain that was of normal size at birth.

By association with other anomalies:

Isolated (or pure) microcephaly: is not associated with any other anomalies.

Syndromal (or complex) microcephaly: is associated with one or more additional anomalies.

Investigations

X ray skull: Determine suture patency, overriding, fusion and calcification.

MRI brain: Migrational defects - Malformation

TORCH serology

Karyotype: If dysmorphism

Metabolic screening: Phenylketonuria

Evaluation of Microcephaly

- Familial microcephaly needs exclusion
- Detailed birth history
- OFC of siblings and parents should be recorded
- Examine for associated dysmorphism
- Developmental assessment
- Detailed neurological evaluation - seizures, spasticity

Treatment and Prognosis

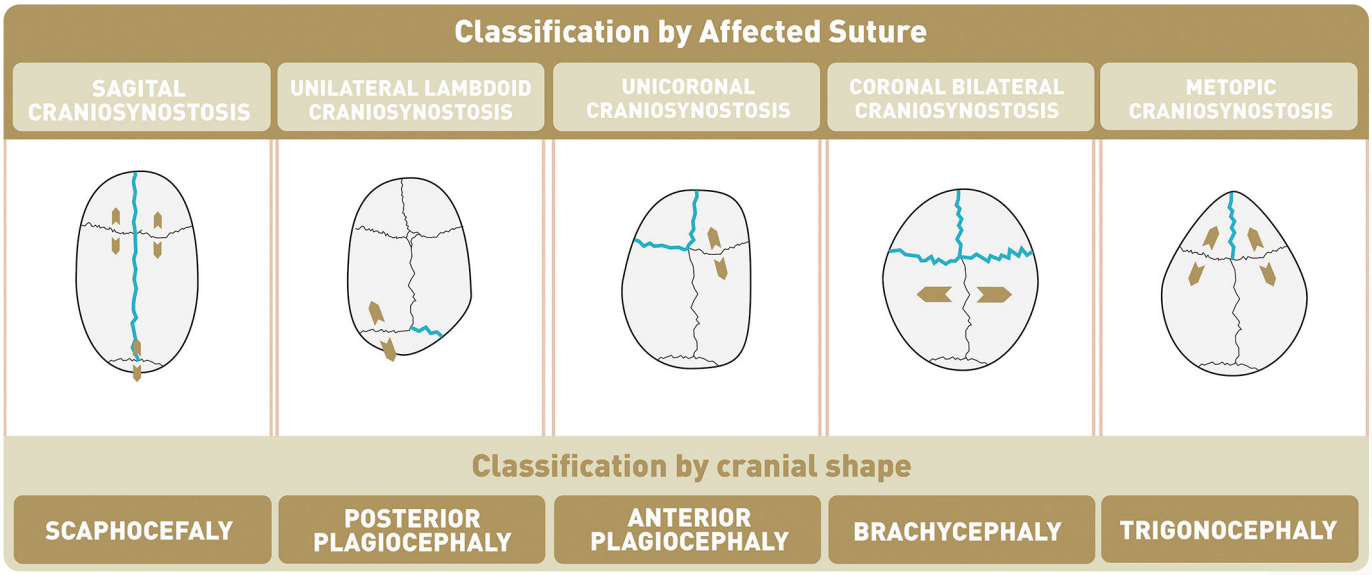
Usually supportive

- ***Treatable metabolic diseases:*** phenyl-free diet for PKU
- Treat neurological & sensory deficits
- Treat seizures
- Special schools
- Genetic counseling

Craniosynostosis

Craniosynostosis results from the early closure of cranial sutures, resulting in several other abnormal types of head shapes.

- Growth at suture lines is related to brain growth
- Sutures allow growth perpendicular to them, so ***early closure*** causes growth ***parallel to the suture***



Clinical presentation

Closure of a single suture is most common.

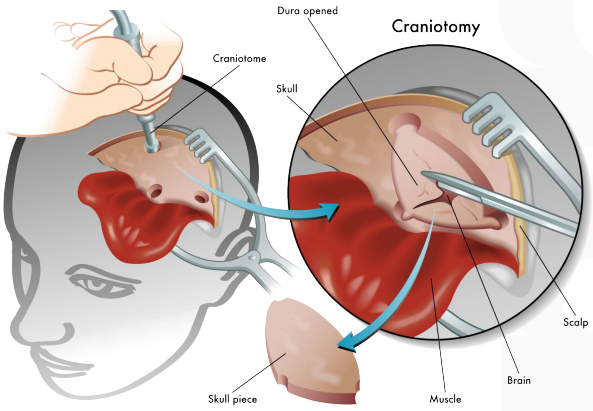
Depending on the severity, the child may have some or all of these problems:

- Abnormal skull shape
- Abnormal forehead
- Asymmetry of the eyes and/or ears
- ***Increased intracranial pressure*** which can possibly cause delays in development.
- ***Seizures and blindness*** may also occur.

Treatment

Either cosmetic or for ICP

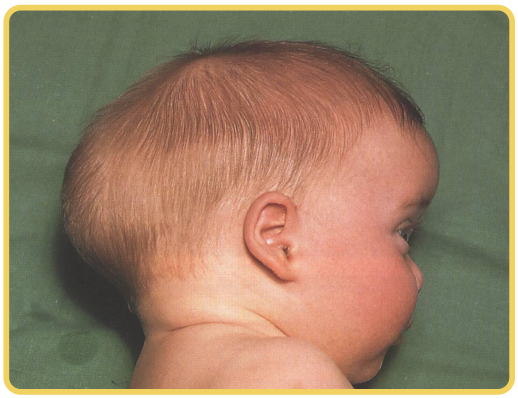
Craniotomy: opening suture line and insertion of polyethylene film to prevent reunion.

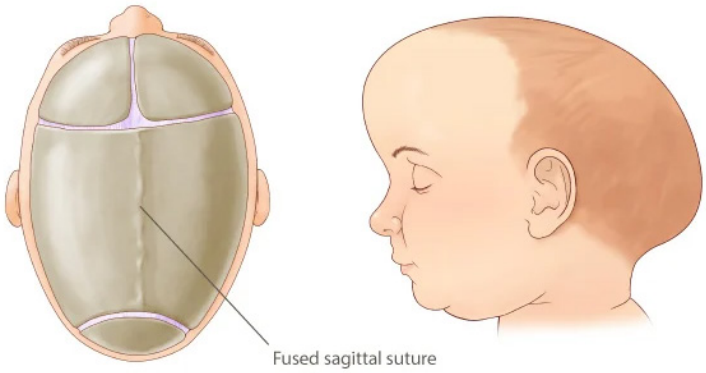


Types

Scaphocephaly

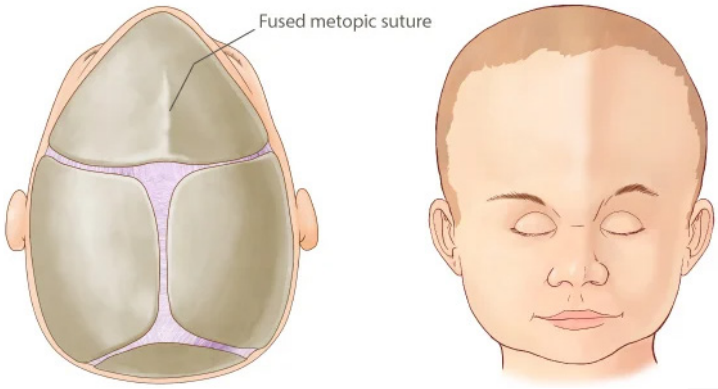
- ***Most common*** form of craniosynostosis
- Comes from the early closure of the **sagittal suture**, which has a clinical presentation of anterior-posterior elongation with bitemporal narrowing.





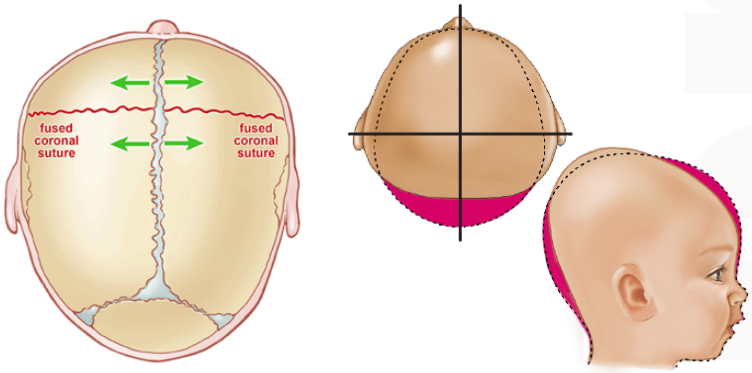
Trigonocephaly

- Result of premature closure of the **metopic suture** and gives the forehead a triangular appearance.



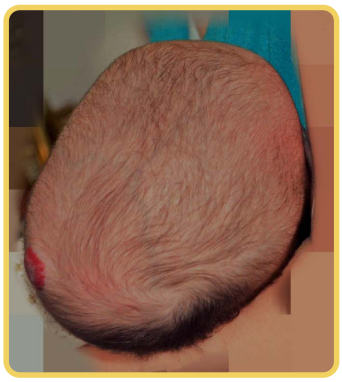
Brachycephaly

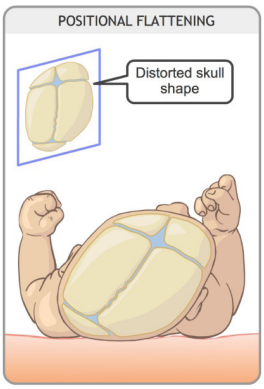
- Results from the premature closure of the **coronal suture** and results in a broad head with a recessed forehead.

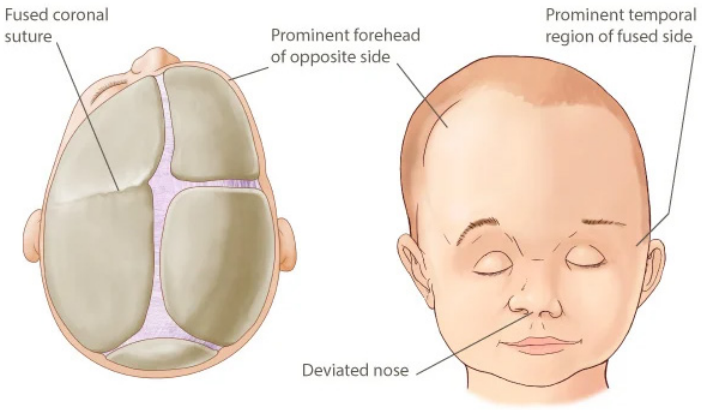


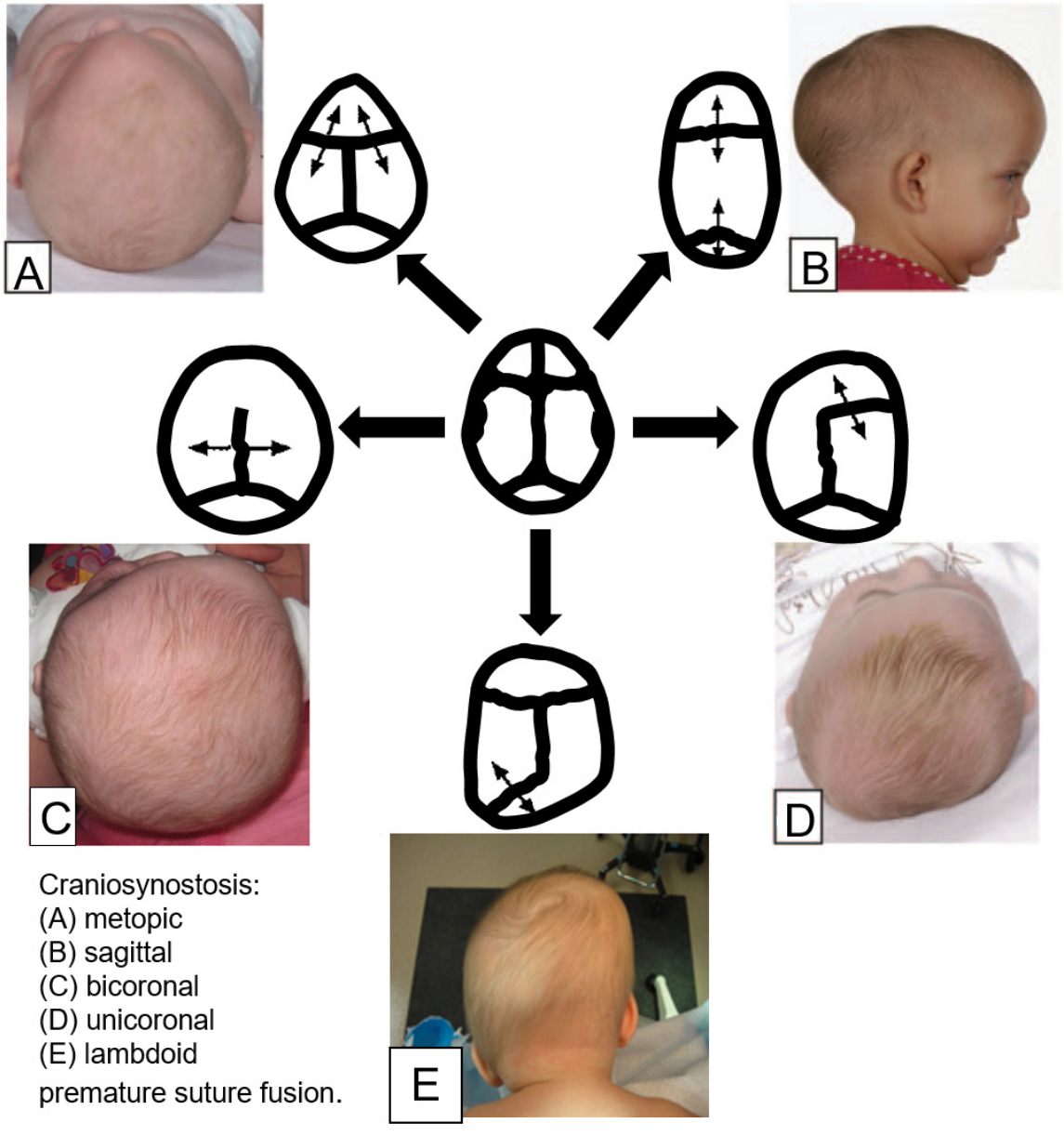
Plagiocephaly

- Results from **fused unilateral coronal** synostosis. It refers to a flattening of one area of the skull and is often seen in children with a history of lying with the head in one position.









Craniosynostosis:
(A) metopic
(B) sagittal
(C) bicoronal
(D) unicoronal
(E) lambdoid
premature suture fusion.

Macrocephaly

OFC > *than 2 standard deviations (SD)* below the mean for a given age, sex, and gestation (i.e., ≥ 97th percentile)

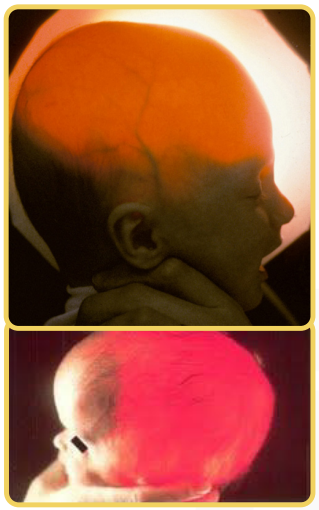
Causes

1. Extracranial causes: Cephalhematoma, subgalea hemorrhage.

2- Cranial causes:

- Chronic hemolytic anemia
- Osteopetrosis
- Hyperphosphatemia
- Osteogenesis imperfecta
- Rickets
- Achondroplasia

3-Intracranial causes: Megalencephaly , hydrocephalus.



Hydrancephaly

Conditions featuring macrocephaly

1. Hydrocephalus

a. Communicating e.g. Post-inflammatory, post-infectious

b. Non-Communicating e.g. Aqueductal stenosis, tumor, arachnoid cysts, malformations

2. Subdural Fluid Collection

a. Hematoma e.g. Trauma

b. Hygroma

c. Benign external hydrocephalus

3. Megalencephaly

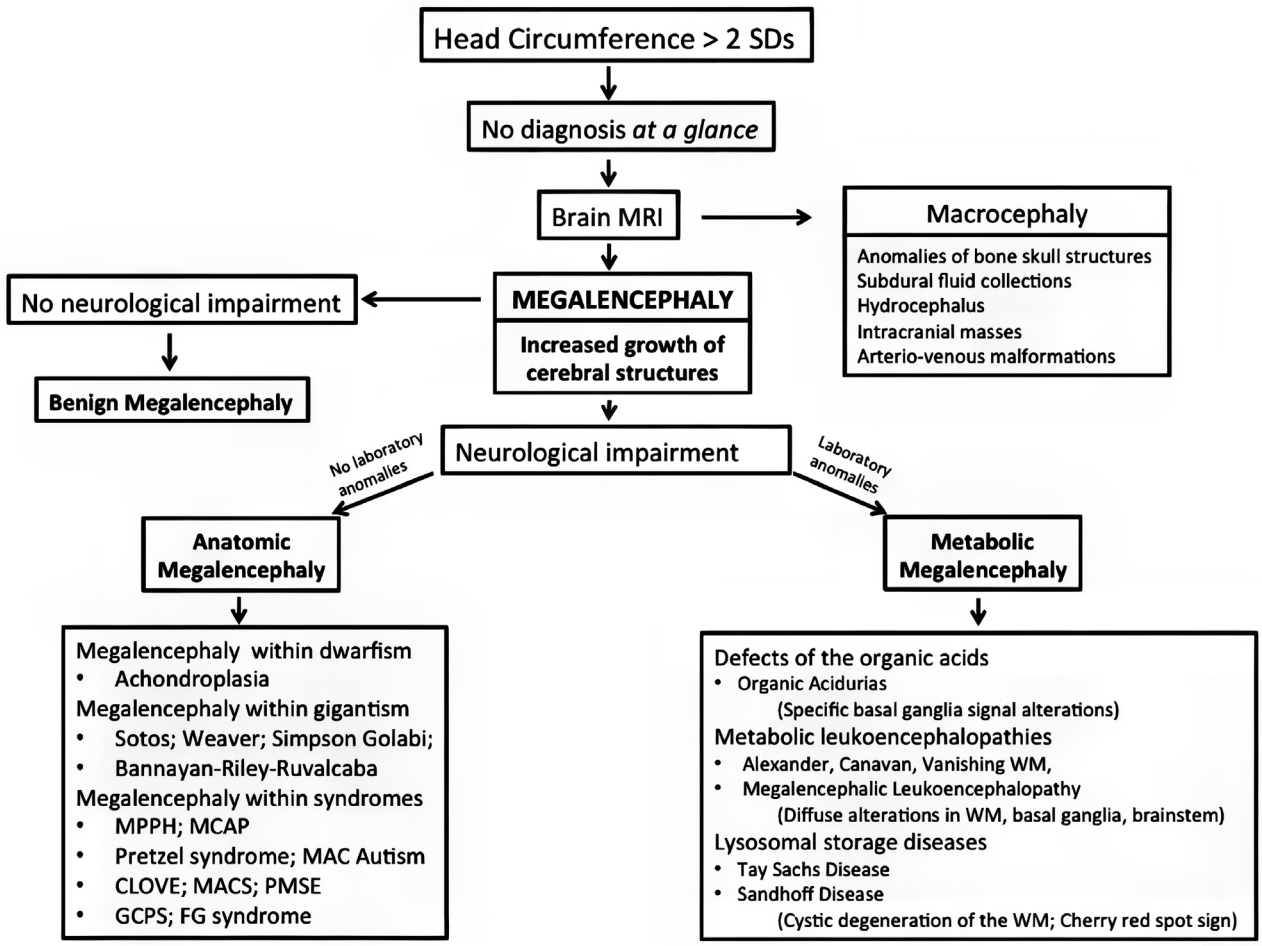
a. Anatomic e.g. Tuberous sclerosis complex, neurofibromatosis, polymicrogyria, fragile X syndrome, Sotos syndrome

b. Metabolic e.g. Mucopolysaccharidoses, gangliosidoses, Alexander disease, Canavan disease, glutaric aciduria

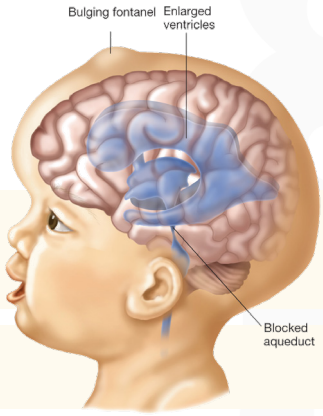
4. Abnormal Skull Growth e.g. Achondroplasia, craniofacial dysplasia syndrome

5. Familial Macrocephaly

Approach to a case of Macrocephaly



Hydrocephalus

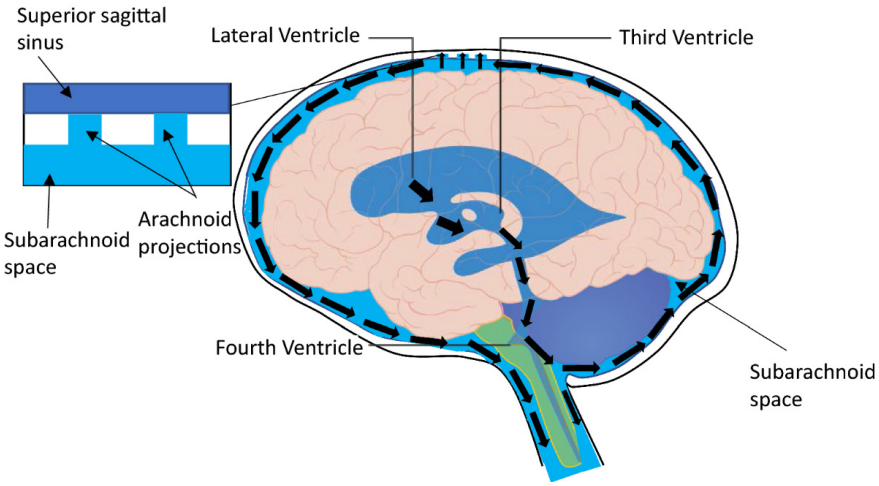


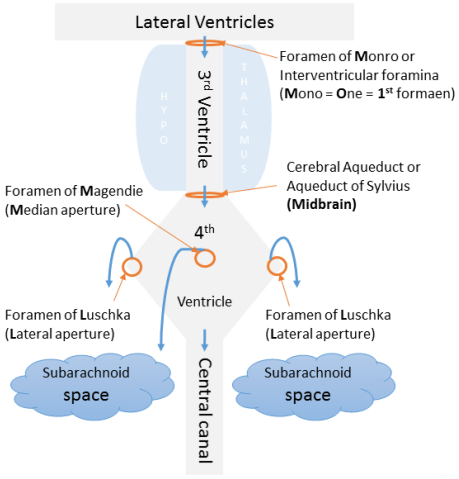
Excessive accumulation of CSF in the brain's ventricular system associated with progressive ventricular dilatation

Ventricular dilatation due to increased CSF volume

- **Cerebrospinal fluid (CSF)** is a clear, colorless plasma-like fluid that circulates through a system of cavities found within the brain and spinal cord; ventricles, subarachnoid space of the brain and spinal cord and the central canal of the spinal cord.
- Cerebrospinal fluid is produced by a specialized tissue called the ***choroid plexus.*** Choroid plexuses are located in the walls of the lateral ventricles and in the roofs of the third and fourth ventricles.
- ***The CSF passes from the lateral ventricles*** to the third ventricle through the interventricular foramen (of Monro).
- ***From the third ventricle,*** the CSF flows through the cerebral aqueduct (of Sylvius) to the fourth ventricle.

- ***From the fourth ventricle,*** some CSF flows to the central canal of the spinal cord. However, the majority of CSF passes through the apertures of the fourth ventricle; the median aperture (of Magendie) and two lateral apertures (of Luschka). ***From there,*** the CSF flows through the subarachnoid space of the brain and spinal cord. it is finally reabsorbed into the dural venous sinuses through arachnoid granulations.





Causes of hydrocephalus

Congenital vs. acquired

Acquired Hydrocephalus:

This is the type of hydrocephalus that develops at birth or in adulthood caused by:

- Tumor - Meningitis - Infection - Hemorrhage - Traumatic brain injury - Gliosis - Stenosis.

Congenital Hydrocephalus:

- It is ***present at birth*** and may be caused by events that occur during fetal development or as a result of genetic abnormalities e.g. aqueductal anomalies.

Obstructive vs. non-obstructive

1. Communicating Hydrocephalus (non-obstructive):

This type of hydrocephalus occurs when there is no obstruction to the flow of CSF within the ventricular system.

The condition arises either due to

a. Inadequate absorption by the arachnoid granulations
b. Abnormal increase in the quantity of CSF produced by the choroid plexus.
c. Impaired resorption in the subarachnoid spaces (results from meningeal inflammation, due to infection or to blood in the subarachnoid space).

2. Non-communication (Obstructive) Hydrocephalus:

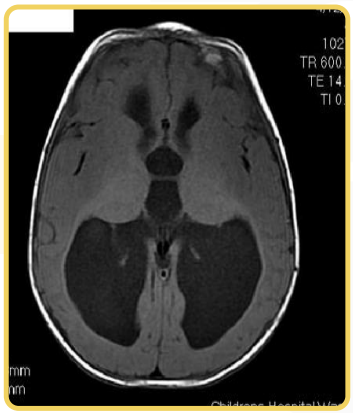
It occurs when the flow of CSF is blocked along one of more of the passages connecting the ventricles, causing enlargement of the pathways upstream of the block.

- Obstruction most often occurs in the aqueduct of Sylvius but sometimes at the outlets of the 4th ventricle (Luschka and Magendie foramina).

The most common causes of obstructive hydrocephalus are:

a. Aqueductal stenosis
b. Dandy-Walker malformation
c. Chiari II type malformation

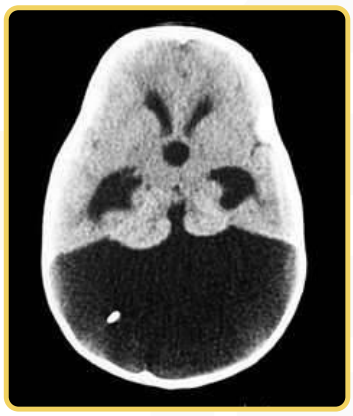
1. Aqueductal stenosis



Narrowing of the outflow pathway for CSF from the 3rd ventricle to the 4th ventricle.

- It may be either primary, or secondary to scarring or narrowing of the aqueduct resulting from a tumor, hemorrhage, or infection.
- Primary aqueductal stenosis may be X-linked.

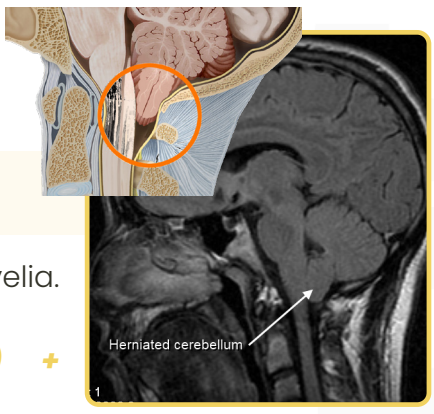
2. Dandy-Walker malformation



Progressive cystic enlargement of the 4th ventricle in fetal life, resulting in agenesis of the cerebellar vermis and hydrocephalus.

- Dandy-Walker malformation accounts for 5 to 10% of cases of congenital hydrocephalus.
- ***Hydrocephalus + prominent occiput.***

3. Chiari II (formerly Arnold-Chiari)



A series of hindbrain deformities.

- hydrocephalus occurs with spina bifida and syringomyelia. Cerebellar tonsils protrude through the foramen magnum.
- ***Hydrocephalus (obstruction of the 4th ventricle) + myelomeningocele.***

Clinical manifestations

The symptoms of hydrocephalus tend to vary across different age groups.

Infants	Children and Adolescents
• Unusually large head size • Rapidly increasing head circumference • Bulging and tense fontanelle or soft spot • Prominent scalp veins • Downward deviation of eyes (sunset sign) • Vomiting • Sleepiness • Irritability • Seizures	• Nausea and vomiting • Swelling of the optic disc or papilledema • Blurred or double vision • Balance and gait abnormalities • Slowing or loss of developmental progress • Changes in personality • Inability to concentrate. • Seizures • Poor appetite

In older children: ***Signs of increased ICP*** (vomiting, ataxia, progressive "increasing in severity" headache, 6 th N palsy) are common. whereas ***alteration in consciousness and papilloedema*** are late signs.

Diagnosis

Examination in infants may reveal the following findings:

- ***Head enlargement*** (head circumference ≥98th percentile for age), especially crossing percentiles on the growth chart
- Dysjunction/splaying ***of sutures***
- Dilated scalp ***veins***
- Tense/bulging ***fontanelle.***
- ***Setting-sun sign:*** Characteristic of increased intracranial pressure (ICP); downward deviation of the ocular globes, retracted upper lids, visible white sclerae above irises.
- Increased ***limb tone*** (spasticity preferentially affecting the lower limbs)

Children and adults may demonstrate the following findings on examination:

- ***Papilledema*** (optic nerve swelling) LATE SIGN
- Failure of upward ***gaze***
- Unsteady ***gait***
- ***Large head***
- Unilateral or bilateral ***sixth nerve palsy*** (secondary to increased ICP)
- Children may also exhibit the ***Macewen sign***, in which a "cracked pot" sound is noted on percussion of the head.

Work-up

A complete neurological examination

Imaging studies:

- ***Computed tomography scan*** (CT or CAT scan) ***radiation hazard***
- ***Magnetic resonance imaging*** (MRI) ***need sedation or anasthesia***
- ***Cranial ultrasonography*** (Fetal and infant)

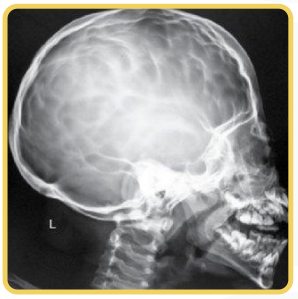
Diagnostic procedures:

- Lumbar puncture (spinal tap) or ventricular tap.
- Intracranial pressure monitoring

Hydrocephalus may be

Compensated:

- Clinically + dilated ventricular system without trans ependymal CSF permeation in the periventricular white matter.



Non-compensated:

- Clinically +dilated ventricular system with transependymal CSF permeation in theperiventricular white matter.
- ***Silver – beaten appearance*** in older children with increased intracranial pressure.

Treatment

1. Medical treatment:

Indications: in transient conditions, such as meningitis (positive CSF culture), or neonatal intraventricular hemorrhage.

Acetazolamide (25 mg/kg/d in 3 doses): Careful monitoring of respiratory status and electrolytes is crucial. Treatment beyond 6 months is not recommended.

Furosemide (1 mg/kg/d in 3 doses): Electrolyte balance and fluid balance need to be monitored carefully. may be acceptable for CSF fluid reduction

2. Repeat lumbar punctures (LPs).

3. Surgical treatment: The *preferred* therapeutic option

- Ventricular shunting (VP VA shunt): CSF diversion
- Endoscopic third ventriculostomy (E3V)
- Endoscopic aqueductoplasty (EA)

Shunts:

The principle of shunting is to establish a communication between the CSF and a drainage cavity (peritoneum, right atrium, pleura).

- ***A ventriculoperitoneal (VP) shunt*** is used most commonly.
- ***A ventriculoatrial (VA) shunt*** also is called a "vascular shunt." It shunts the cerebral ventricles through the jugular vein and superior vena cava into the right cardiac atrium.
- ***A ventriculopleural shunt*** is considered second line

Complications of shunts:

1. Shunt Obstruction or blockage
2. Shunt Infections
3. Shunt disconnection.
4. A shunt kinking or becoming compressed.
5. Shunt valve failure.
6. Under drainage
7. Over drainage
8. A subdural hematoma

Alternatives to shunting include the following:

1. Choroid plexectomy in cases of CSF over-production.
2. Cerebral aqueductoplasty.
3. In cases where a tumor is the cause, removal cures the hydrocephalus in 80%.
4. Endoscopic third ventriculostomy (ETV), involves the surgical creation of an opening in the floor of the third ventricle to enable the passage of CSF.

For rapid-onset hydrocephalus with increased intracranial pressure (ICP) is an emergency. The following can be done:

- Ventricular tap in infants
- Open ventricular drainage in children
- LP in posthemorrhagic and postmeningitic hydrocephalus

VP or VA shunt MDT (Ped Neuro, Neurosurgery, rehabilitation team):

- Rehabilitation (Physiotherapy, occupational / speech therapy, early intervention sessions)
- Muscle relaxant for spasticity (if present) Treatment of seizures
- Treatments for swallowing problems
- Treatment of recurrent UTI (in case of meningomyelocele)
- Psychological support of family

2 ENCEPHALOPATHY & CENTRAL MOTOR NEURON DISORDERS

Cerebral Palsy

Cerebral palsy may be defined as a disorder of tone, posture or movement, which is due to a static lesion affecting the developing nervous system (up to 3 years of age).

> ***Despite the unchanging nature of the causative lesion, its existence in a developing nervous system means that its manifestations may change over time.***

> ***It is not an etiologic diagnosis but a clinical syndrome (a manifestation of static encephalopathy) that refers only to Motor dysfunction.***

Causes of cerebral palsy

Prenatal insults:

- Intrauterine hypoxic–ischemic injury
- Intrauterine infection
- Toxins
- Chromosomal disorders

Perinatal insults:

- Hypoxic–ischaemic injury
- Intracranial haemorrhage
- Bilirubin encephalopathy

Postnatal insults:

- Trauma
- Bacterial meningitis
- Viral encephalitis
- Asphyxia

- **Preterm:** intracerebral hemorrhage/ periventricular leukomalacia
- **The immediate effect of asphyxia** is hypoxic ischemic encephalopathy (HIE)
- **The immediate effects of kernicterus** are lethargy, increased tone, decreased Moro and opisthotonos, long-term effect includes choreoathetoid cerebral palsy, sensorineural deafness.

Pathophysiological/systemic classification of CP

Pyramidal (Spastic) (77%):

Lesion is usually in the motor cortex

C/P:

1. Weakness or paralysis motor delay
2. Hypertonia with clasp knife spasticity.
3. ***Exaggerated tone, reflexes, and pathological reflexes, contractures.***
4. Positive Babinski sign (after 2 yrs).
5. Persistent neonatal reflexes
6. Abnormal postures: scissoring esp. on vertical suspension.
7. Pseudobulbar palsy in bilateral cases: Dysphagia, repeated chocking, nasal regurge

Extrapyramidal (Dyskinetic) (23%):

Lesion is usually in the basal ganglia.

C/P:

1. Hypertonia: ***Rigidity.***
2. Associated deafness
3. Extrapyramidal manifestations (involuntary movements)
4. ***Chorea*** (rapid jerky irregular, Proximal > Distal)
5. ***Athetosis*** (slow, coarse, repetitive distal movement)
6. ***Dystonia*** (hyperextension & tortion around an axis)

Cerebellar (Hypotonic) ataxic

C/P:

1. ***Hypotonia & hyperreflexia (?)***
2. ***Manifestations of cerebellar ataxia*** (uncoordinated movements)
3. Nystagmus, Intention tremors & Dysmetria
4. Stacatto speech, Dysdiadocokinesia & Zigzag gait (ataxic gait)

Atonic:

Lesion is in motor area 4

C/P:

1. Severe hypotonia (floppy baby)
2. Normal or slow reflexes

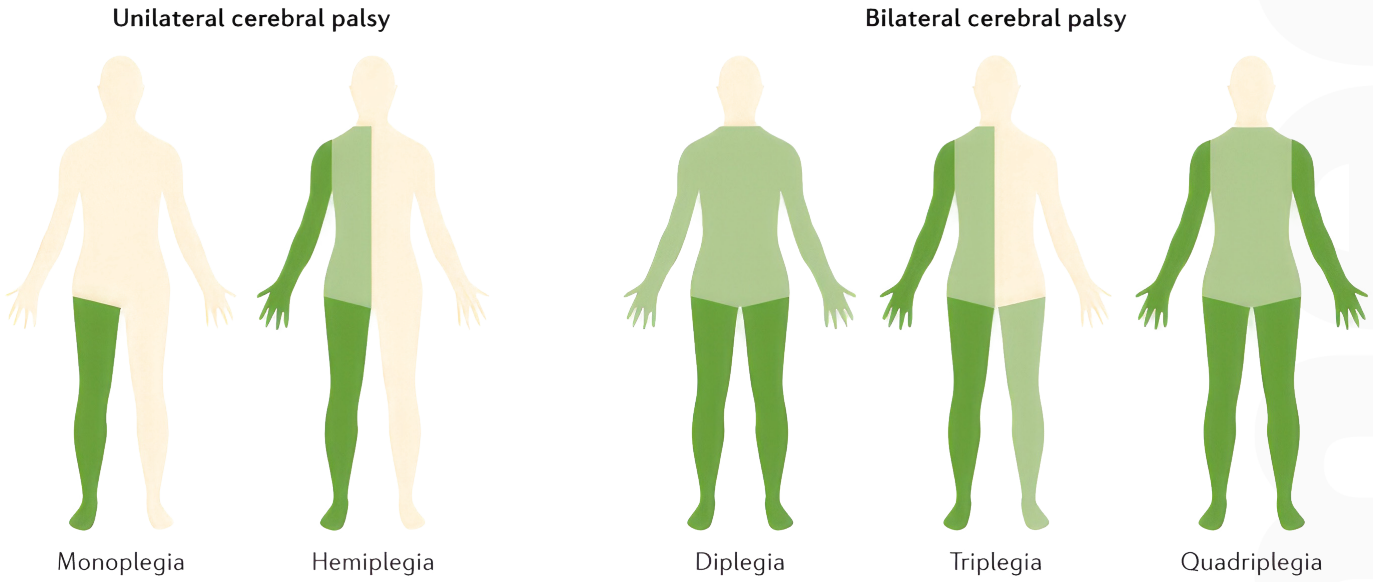
Mixed

Topographic classification of CP

(anatomical distribution of motor abnormalities)

- ***Quadriplegia:*** all 4 extremities
- ***Hemiplegia:*** one side of the body
- ***Diplegia:*** 4 limbs, legs worse than arms
- ***Paraplegia:*** legs only
- ***Monoplegia:*** one extremity

Spastic diplegia is most frequently seen as the result of periventricular leukomalacia in preterm infants.



Functional classification of CP

- ***Mild:*** impairment of only fine precision movement.
- ***Moderate:*** gross & fine movement and speech problems.
- ***Severe:*** inability to perform activities of daily living.

How can you diagnose CP clinically?

- Delay in motor development.
- Abnormal posture and gait
- Abnormal muscle tone
- Abnormal reflexes
- ***Persistence of some primitive reflexes*** (Moro).
- ***Delayed appearance of normal posture protective reflexes*** e.g., failure to do parachute reflex at 9 mo.

CP should be differentiated from progressive disorders of CNS including degenerative diseases, metabolic disorders, muscular dystrophies, so *MRI brain* should be done. Also, we may consider *metabolic screening* tests and *genetic studies* in some cases.

Associated disabilities / Complications

- Mental retardation, microcephaly, epilepsy, hearing and visual impairments and pseudobulbar palsy.
- Attention deficits, learning disabilities.
- Dysphagia causes malnutrition, poor growth.
- Gastroesophageal reflux, constipation.
- Recurrent chest infections
- Deformities, Joint contractures and scoliosis.

Treatment

Supportive

Children with cerebral palsy need the care of a multidisciplinary team directed toward maximizing functional abilities

- ***Managing concurrent medical problems*** e.g., seizures, GERD, constipation, and nutritional rehabilitation (some need feeding by gastrostomy tube)
- ***Physical and occupational therapy***, special education, psychology, audiology, & orthotics).

Treatment of spasticity:

- Physical therapy
- Orthoses
- Muscle relaxants e.g., baclofen (lioresal)
- Botulinum toxin (Botox)
- Orthopedic Surgery

Encephalopathy

A generalized disorder of cerebral function that may be acute or chronic, progressive or static.

- It is a **clinical state** characterized by an ***alteration of consciousness, behavior and/or cognition.***
- it can present with a range of focal neurological manifestations such as seizures, visual disturbances, speech abnormalities, motor weakness, and sensory and autonomic deficits.

Mental status

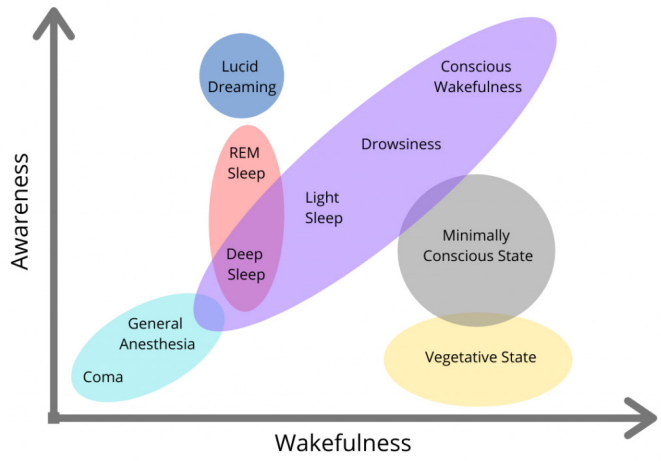
Consciousness is a cortical function that allows for awareness of self and environment (place, time).

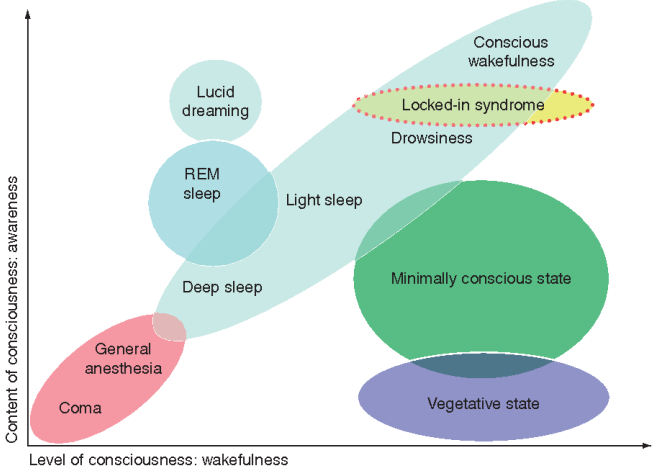
> ***Arousal*** represents the system that initiates and maintains consciousness and is mediated by the reticular activating system (RAS), which extends from the pons through the midbrain to the hypothalamus and thalamus.

> ***Awareness*** is based on an even more widely distributed network of connections between cortical and subcortical structures; cerebral hemispheres.

An alteration of consciousness in a person means that there is a defect in both, arousal and awareness states. Acute changes in consciousness vary in degree from mild lethargy and confusion to deep coma.

- ***Lethargic*** patients have difficulty maintaining an aroused state Patients who are obtunded have decreased arousal but are responsive to stimuli.
- ***Stupor*** is a state of responsiveness to pain but not to other stimuli.
- ***Coma*** is a state of unresponsive unconsciousness and is caused by dysfunction of the cerebral hemispheres bilaterally, the bilateral thalami, and/or the brainstem. It is the most profound degree to which the two components of consciousness, arousal and awareness, can be diminished





Causes of altered mental status

Infection

- Meningitis
- Encephalitis (e.g., herpes simplex virus, arboviruses)
- Brain abscess or subdural empyema
- Tuberculosis meningitis
- Toxic shock syndrome

Postinfectious (e.g., acute disseminated encephalomyelitis (ADEM))

Post immunization (e.g., whole cell pertussis vaccine)

Trauma

- Abusive head trauma
- Hemorrhage (e.g., epidural, subdural, subarachnoid)
- Brain contusion
- Concussion
- Toxins (Intoxication or Withdrawal)
- Ethanol
- Narcotics
- Barbiturates
- Aspirin (Reye syndrome)
- Illicit drugs
- Lead poisoning

Hypoxia-Ischemia

- Near-drowning
- Post-cardiopulmonary arrest (e.g, cardiac arrhythmia, obstructive
- cardiomyopathy)
- Carbon monoxide intoxication
- Perinatal asphyxia
- Strangulation

Epilepsy

- Subclinical (or nonconvulsive) status epilepticus
- Postictal states

Stroke

- Arterial ischemic stroke
- Cerebral sinovenous thrombosis
- Hemorrhage

Increased Intracranial Pressure

- Brain tumor
- Cerebral edema
- Hydrocephalus

Migraine

Systemic Disorders

- Gastrointestinal (e.g., intussusception)
- Vasculitis (e.g., systemic lupus erythematosus)
- Hepatic failure
- Hypertensive encephalopathy
- Reye syndrome
- Endocrine disorders (e.g., adrenal insufficiency, thyroid disorders)
- Renal disorders (e.g., uremia)

Demyelinating disorders e.g., multiple sclerosis, Acute disseminated encephalomyelitis (ADEM)

Metabolic Derangements

- Hypoglycemia
- Hyponatremia or rapid correction
- Hypernatremia or rapid correction
- Hyperosmolality or rapid correction
- Hypercapnia
- Hyperammonemia
- Inborn errors of metabolism e.g., mitochondrial disease, organic acidemias
- Diabetes mellitus ketoacidosis/ hypoglycemia

Thiamine deficiency (Wernicke encephalopathy)

Causes of altered conscious state/coma (alternate)

Coma with focal signs

- ***Intracranial hemorrhage***
- ***Stroke:*** arterial ischemic or sinovenous thrombosis
- ***Tumors***
- ***Focal infections:*** brain abscess
- ***Post seizure state:*** Todd' paralysis
- ***Acute disseminated encephalomylelitis***

Coma without focal signs and with meningeal irritation:

- ***Meningitis***
- ***Encephalitis***
- ***Subarachnoid hemorrhage***

Coma without focal signs and without meningial irritation:

- ***Hypoxic-ischemia:*** cardiac or pulmonary failure, shock, near drowning.
- ***Post infectious disorders:*** ADEM - Hemorrhagic shock and encephalopathy syndrome
- ***Post immunisation encephalopathy*** (Whole cell pertusis vaccine)
- ***Drugs and toxins***
- ***Cerebral malaria***
- ***Rickettsial:*** lyme disease, rocky mountain spotted fever
- ***Hypertensive encephalopathy***
- ***Post seizure states***
- ***Non-convulsive status epilepticus***
- ***Metabolic disorders:***
  - Hypoglycemia
  - Acidosis: Diabetic ketoacidsis, organic acidemis
  - Hyperammonemia: hepatic encephalopathy, urea cycle disorders, valproic acid encephlopathy, Reyes syndrome.
  - Uremia
  - Fluid and electrolyte disturbance (dehydration, hyponatremia, hypernatremia)
- ***Systemic infections:*** Gram negative sepsis, toxic shock syndrome, enteric encephalopathy, shigella encephlopathy

Diagnostic approach

Coma is a medical emergency, whose evaluation requires a rapid, comprehensive, and systematic approach. Early identification of the underlying cause of coma can be crucial for patient management and prognosis.

Evaluation and early therapeutic interventions should proceed simultaneously.

Rapid assessment and stabilization:

- ***Assessing vital signs and the ABC*** (airway patency, breathing [ventilation and oxygenation], and circulation) are crucial for initial stabilization, also provide clues about the underlying etiology.

History: laying stress on:

Known illness or injury

Onset:

- ***Abrupt and unexplained:*** intracranial hemorrhage, seizure, trauma, or intoxication.
- ***Acute:*** infectious process, metabolic abnormality.
- ***Gradual:*** slowly expanding intracranial mass lesion.
- ***Recurrent:*** metabolic.

Symptoms of increased intracranial pressure (ICP).

Vague or inconsistent history: nonaccidental trauma (child abuse)

Examination:

General examination: head or scalp injury, dysmorphic facies, color complexion, odor, skin for rash or petechia

Neurologic examination: focal signs, meningeal irritation signs Assessment of level of consciousness: Glasgow coma scale

Assessment of brain stem affection: pupillary examination, oculocephalic response and /or vestibulocephalic response, motor response

Early recognition of herniation syndromes

Rapid bed side test: blood glucose level

Investigations:

Routine laboratory testing:

- Glucose
- Sodium, potassium, calcium, magnesium, chloride, bicarbonate,
- BUN, creatinine, AST, ALT, blood gases, ammonia, TSH
- Blood, urine analyses for toxic substances
- Blood, urine cultures if infection suspected

Skeletal survey, ophthalmologic examination if child abuse suspected.

Neuroimaging

- Head CT
- Brain MRI, MRA, MRV

CSF analysis (if no evidence for increased intracranial pressure on neuroimaging):

- Opening pressure
- White and red blood cell counts, protein, glucose
- Culture (+viral PCR testing)
- EEG

Secondary laboratory testing (if cause remains unknown):

- Lead level, pyruvate, lactate, serum amino acids, urine organic acids, acylcarnitine prof

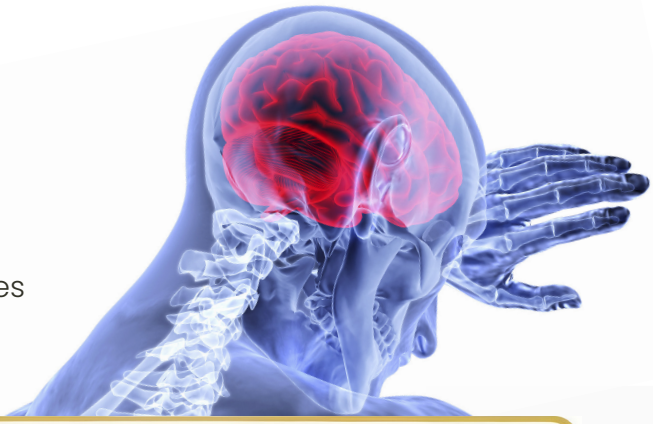
Treatment

Stabilize the patient (ABC, IV access, treat hypoglycemia and definite seizure),

Give empiric treatment till reaches the underlying cause then treat accordingly:

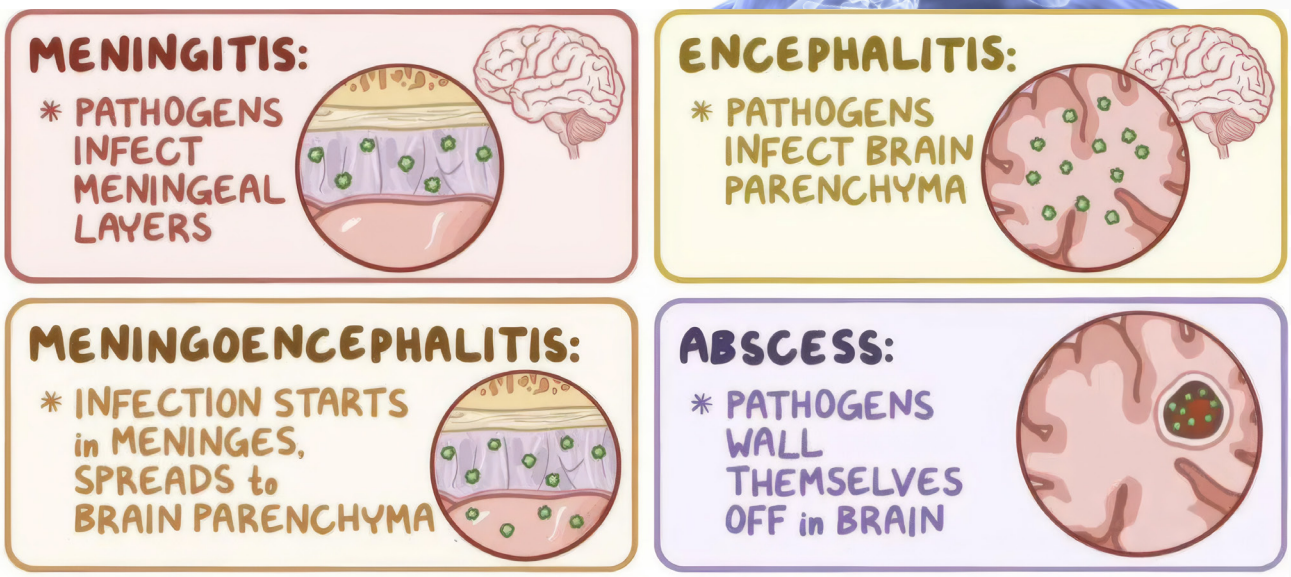
- ***For suspected infection:*** Ceftriaxone and vancomycin/ Acyclovir For suspected opioid ingestion: Naloxone
- ***For suspected increased ICP:*** Mannitol / Hypertonic saline 3% Also, elevate head and keep midline.
- ***For suspected nonconvulsive status epilepticus:*** treat as status epilepticus.

CNS infection



Histologically:

- ***Meningitis:*** infection of meninges
- ***Encephalitis:*** infection of brain parenchyma
- ***Meningoencephalitis:*** usually caused by viruses
- ***Focal infection:*** (brain abscess)



How to suspect CNS infection?

Common symptoms:

- Headache, photophobia
- Nausea, vomiting, anorexia
- Restlessness, altered state of consciousness

Common signs:

- Fever
- Neck pain and rigidity
- Focal neurologic deficits
- Seizures
- Obtundation and coma

Bacterial meningitis

It is one of the most serious pediatric infections that is associated with high risk of mortality and morbidity. However, deployment of antibiotics and vaccines altered the spectrum of the disease.

Streptococcus pneumoniae, Hemophilus influenzae, Neisseria meningitidis are the most frequent causative organisms.

Transmission through ***droplets*** of respiratory or ***throat secretions*** from carriers, ***hematogenous*** spread (through BBB) or ***direct inoculation*** from penetrating head injury.

Clinical manifestations:

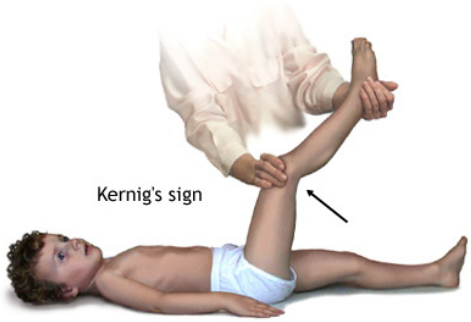
- Usually ***preceding upper respiratory tract symptoms.***
- ***Rapid onset*** is typical of S. pneumoniae and N.meningitidis.
- ***Fever*** usually is present

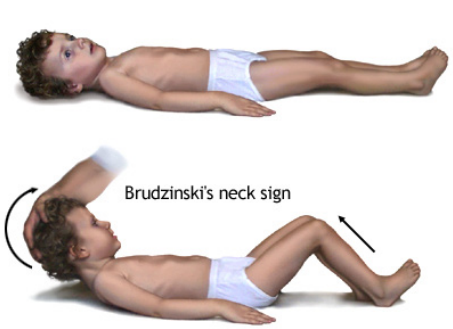
Manifestations of meningeal inflammation:

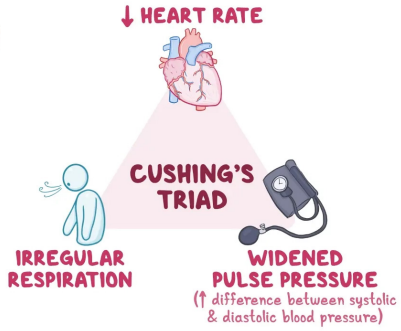
- Include headache, irritability, nausea, vomiting, nuchal rigidity, lethargy, photophobia.
- In ***young infants***, signs of meningeal inflammation may be ***minimal*** with only irritability, restlessness, depressed mental status, and poor feeding.
- ***Kernig and Brudzinski signs*** of meningeal irritation usually are positive in ***children older than 12 months of age.***
- Focal neurologic signs, seizures, petechial or purpuric lesions, sepsis, shock, and coma may occur.

Manifestations of increased intracranial pressure:

- Headache, diplopia, and vomiting. sixth nerve palsy.
- ***A bulging fontanel*** may be present in infants.
- ***Cushing triad:*** ***bradycardia*** with ***hypertension***, and ***apnea*** are signs of increased intracranial pressure with brain herniation.
- Papilledema is uncommon, unless there is occlusion of the venous sinuses, subdural empyema, or brain abscess.







Complications:

- Subdural effusion
- Intracranial infection (subdural empyema, brain abscess),
- Cerebral infarction
- Hydrocephalus
- Diabetes insipidus
- Disseminated infection (arthritis, pneumonia).

Neurologic sequelae include: focal deficits, seizures, hearing loss, and vision impairment.

The most common permanent neurologic sequel is hearing loss.

Diagnosis:

CT or MRI.

Lumber puncture:

- ***Cytology:*** cell count and type
- ***Chemistry:*** glucose and proteins
- ***Culture and sensitivity***

	Bacterial Meningitis	Viral Meningitis	Fungal Meningitis	Tuberculous Meningitis
WBCs	> 1000 cmm	< 1000 cmm	Variable	Variable
Predominant differential cell	PMNs	Lymphocytes	Lymphocytes	Lymphocytes
Protein	↑↑↑	Normal or ↑	↑	↑
Glucose (CSF/serum ratio)	↓	Normal	↓	↓

Treatment:

In infants and children outside of the neonatal age group, ***third-generation cephalosporin*** & ***Vancomycin.***

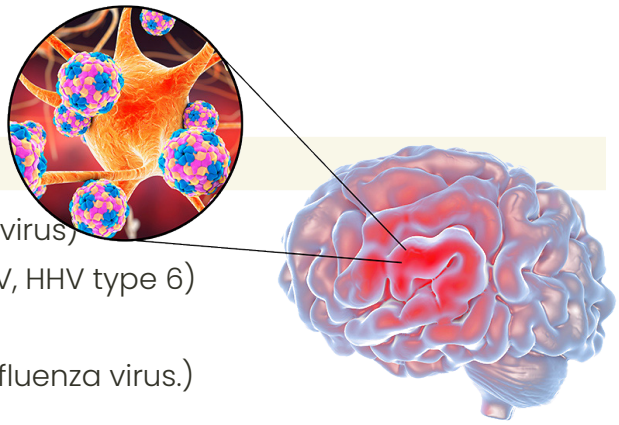
- Third-gen cephalosporin is generally used empirically, as it treats pathogens most likely recovered at this age, including S. pneumoniae, N. meningitidis & H. influenzae type b.
- Vancomycin is added for resistant S. pneumoniae.

Duration of treatment ranges between ***10 to 14 days.***

Dexamethasone shown to decrease hearing loss in those with meningitis due to H. influenzae type b (given before or concurrently with first dose of antibiotics).

Antibiotic prophylaxis of close contacts to those with meningococcal meningitis and H. influenzae type b meningitis is indicated.

Viral meningoencephalitis



Etiology:

- ***Enteroviruses*** (polio, echo, coxsackie and enterovirus)
- ***Herpesviridae*** (HSV-1, HSV-2, varicella zoster, CMV, HHV type 6)
- ***MMR*** (Mumps, measles, rubella)
- ***Respiratory viruses*** (adenovirus, corona virus, influenza virus.)
- ***Arboviruses*** (WNV, Japanese encephalitis virus)

Clinical picture:

- The **same as bacterial one.** BUT may find ***exanthems either precede or accompany CNS signs.***

Outcome:

- Quite variable, some pathogens are self limited, others cause significant long-term neurologic sequelae

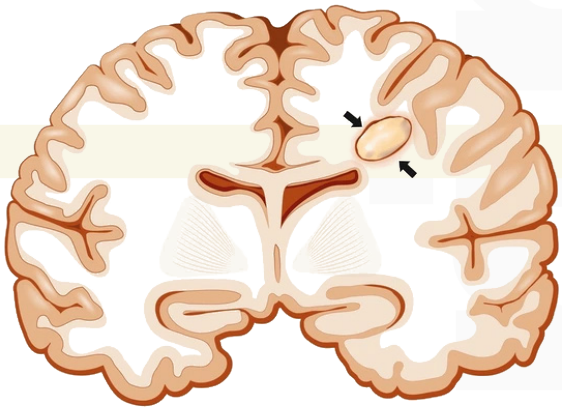
Diagnosis:

- Suspected by ***CSF*** cells are less than 1000/mm3, mononuclear
- Confirmed by ***PCR***

Treatment:

- For **most causes**, ***no effective*** antiviral agents except **herpes virus family:** ***Acyclovir, ganciclovir, others.***
- **Supportive management:** IV fluids, seizure control, treat cerebral edema.

Brain abscess



Often associated with an underlying etiology;

Contiguous spread from nearby infection like:

- Meningitis
- OM
- Mastoiditis
- Sinusitis

Direct compromise of BBB due to penetrating head injury

Organisms:

- ***Streptococcus anginosus*** group is the most common.
- ***Staph. Aureus*** is the 2nd most common

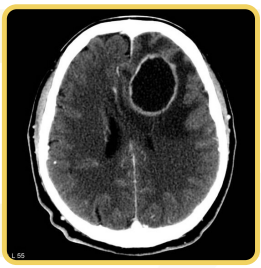
Clinical picture:

Early; asymptomatic or non specific e.g.low grade fever, headache…

Then, severe headache, vomiting, seizures, focal signs, papilledema, up to coma

If cerebellar, may present with nystagmus and ataxia

Diagnosis:

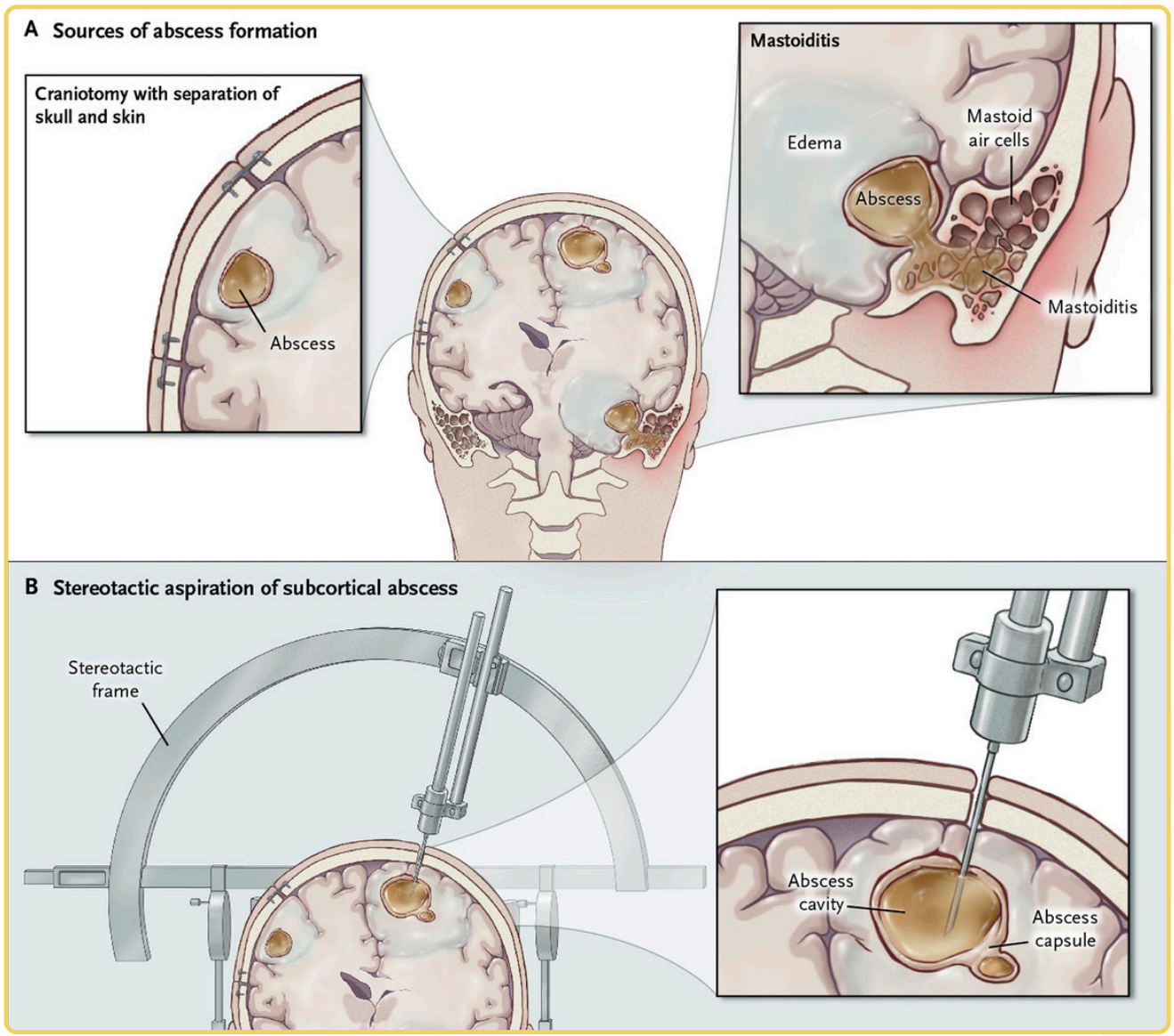


MRI is the best diagnostic tool as it can ***differentiate*** the abscess from cysts or necrotic tumors.

Treatment:

Antibiotc regimen: usually start empirically with: ***3rd generation cephalosporin + metronidazole + vancomycin.***

Aspiration of large abscess for ***diagnosis, culture and decompression.***



WEAKNESS AND HYPOTONIA IN PEDIATRICS

Hypotonia and Weakness are neurological findings that can be found due to central and peripheral motor neuron affection:

Central hypotonia:

- HIE (atonic type)
- Stroke (Hemorrhagic and thromboembolic)
- Genetic syndromes like Down syndrome and Prader-Willi syndrome.
- Metabolic disorders like lipid storage disease.
- Spinal cord lesions like shock stage of transverse myeitis, tumor, trauma and vascular injury.

Peripheral Hypotonia: Motor neuron unit disorders (see later).

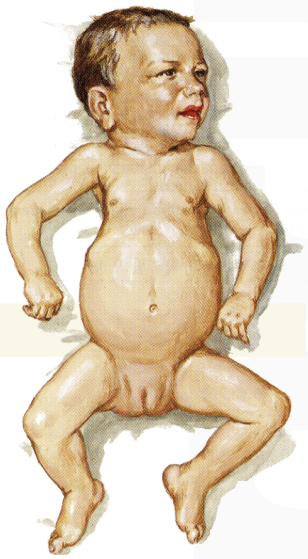
Hypotonia is about muscle tone. Weakness is about muscle power.

Hypotonia and weakness manifest as delayed motor development if early in life and primary/Secondary inability of motor function later on.

Demonstrating Hypotonia

In neonates and infants:

- *Supine position*
- *Head lag or traction response*
- *Ventral/ horizontal suspension*
- *Vertical suspension.*
- *Passive tone around the joints*



1. Frog Position:

- ***In the Supine position;*** frog's leg position, spontaneous movements are lacking & the arms lie either extended at the sides of the body or flexed at the elbow with the hand beside the head.

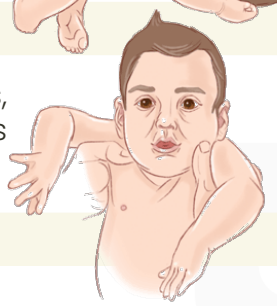
2. Traction response:

- Shoulders don't raise promptly and there is marked head lag.

3. Ventral suspension:

- More marked back curve, his head drops well below 45° from the horizontal and head & legs are hanging limply.

4. Vertical suspension:



- When a hypotonic infant is suspended vertically, the head falls forwards, the legs dangle and the infant may slip \through the examiner's hands because of weakness in shoulders.

5. Passive tone

- Shows marked decrease in resistance to stretch.

- **Tone is the resistance of a muscle to stretch.**
- **The muscle is said to be hypotonic or flaccid when it offers little resistance to stretch.**
- **Tone vs. Power?**

Motor Examination in LMNL vs LMNL

	UMNL	LMNL
Tone	Increased (spasticity or rigidity)	Decreased
Reflexes	Increased	Decreased
Babinski reflex	Present	Absent
Atrophy	Possible (disuse)	Possible (denervation)
Fasciculations	Absent	Possible (nerve disease?)
Muscle Weakness	Quadriplegia - Diplegia Paraplegia - Hemiplegia	Proximal (myopathy) Distal (Neuropathy)

Causes of pediatric hypotonia & weakness

Neuron	Cause of Hypotonia and weakness
	UMNL
Cortex	• Hypoxic-ischemic encephalopathy • Intracranial hemorrhage • Stroke (thrombotic or embolic) • Genetic syndromes (Down syndrome and Prader-Willi) • Inborn errors of metabolism (Folate deficiency states) • Storage diseases (Lipid storage Diseases)
Corticospinal tract	• Cervical spine injury • Paraspinal infections and tumors • Postinfectious Transverse Myelitis
	LMNL
Anterior Horn Cell	• Spinal muscular atrophy type 1 (Werding-Hoffman disease) • Poliomyelitis
Peripheral nerve root/nerve	• Hereditary sensory motor neuropathy • Gulilian Bacre syndrome • Other autoimmune and inflammatory neuropathies • Heavy metals, toxins and drugs intoxication
Neuromuscular junction	• Congenital myasthenic Syndromes • Transient acquired neonatal myasthenia • Myasthenia Gravis • Aminoglycosides and organophosphorus toxicity • Infantile botulism
Muscle	• Congenital myopathies • Congenital muscular dystrophy • Hypokalemic periodic paralysis

Causes of Cerebral Hypotonia

1) Hypoxic Ischemic Encephalopathy (Atonic CP)
2) Intracranial Hemorrhage and Thromboembolic stroke
3) Genetic Syndromes e.g., Down syndrome and Prader-Willi.
4) Metabolic disorders e.g. Lipid storage, etc.

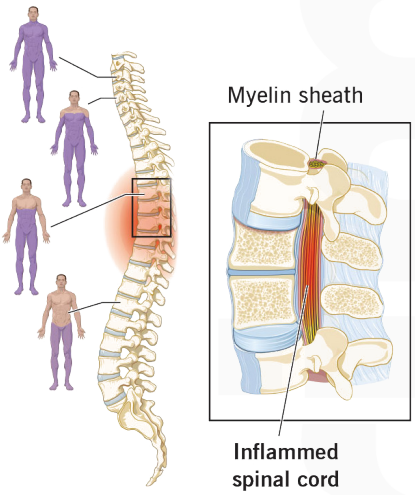
Causes of Spinal Cord Hypotonia

1) Shock stage of Transverse Myelitis
2) Spinal cord infections and inflammation
3) Spinal cord trauma
4) Spinal cord tumors
5) Spinal cord vascular lesions.

Transverse Myelitis

Acute demyelinating spinal cord disorder evolving in *hours or days.*

- Attributed or preceded by **viral infection or immunization.**
- Usually thoracic and demarcated by the **sensory loss (sensory level).**
- Usually presented as symmetric leg weakness, asymmetric presentation is common.
- **No voluntary bladder emptying.**
- Tendon reflexes may be high or low
- Recovery begins after approximately a ***week***
  - 10% do not recover
  - 40% have incomplete recovery.



Diagnosis:

- ***MRI*** to exclude acute cord compression and show swelling and signs of inflammation at level of myelitis.

Treatment:

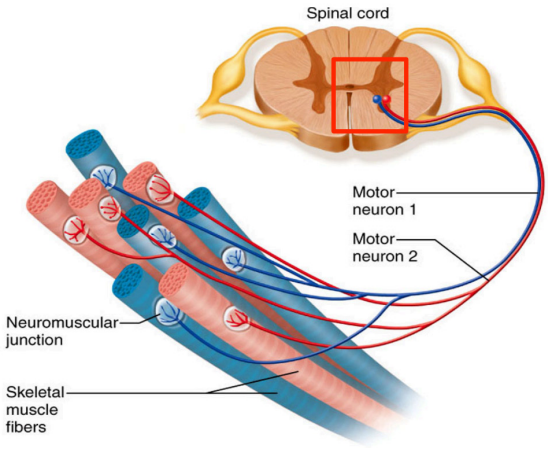
- ***Steroids:*** methyl prednisolone
- ***IVIG/plasmapheresis*** are also used.

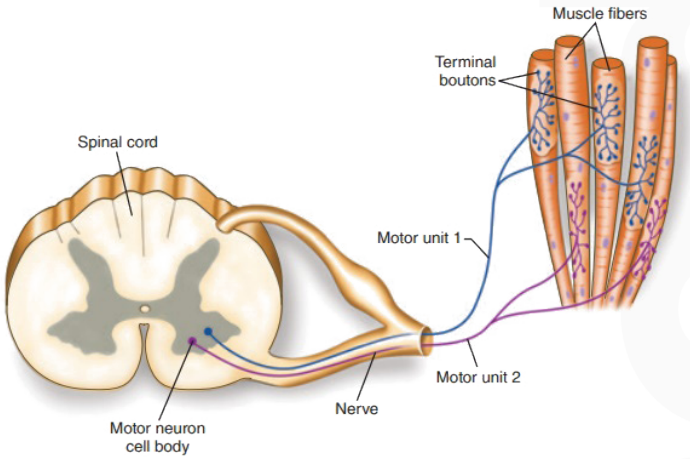
Motor Neuron Diseases in Pediatrics

Anatomical background of the motor neuron unit

Disorders of the motor neuron unit (lower motor neuron lesion) include four components:

1) A motor neuron in the ventral horn of the spinal cord (AHC).
2) Axons of motor neurons (efferent nerve) which form the peripheral nerve.
3) Neuromuscular junction.
4) Muscle fiber innervated by a single motor unit.





Clinical manifestation of motor unit disease

- ***Hypotonia***
- ***Muscle weakness*** which is proximal > distal in ***myopathies*** and the reverse in ***neuropathy.***
- ***Tendon stretch reflexes*** are lost or diminished.
- ***Fasciculations*** as a sign of denervation.

Fasciculations; brief contraction of small number of muscle fibres leading to flicker under the skin (eg. tongue).

- ***Contractures*** occur at birth or later whether in neuropathic or myopathic disorders.
- ***Funnel shape thorax*** usually encountered in congenital neuromuscular disorders.

I. Anterior Horn Cell disorders

1) Spinal Muscle Atrophy (SMA)
2) Poliomyelitis
3) Non polio Enteroviral infections

Spinal Muscular Atrophies (SMA)

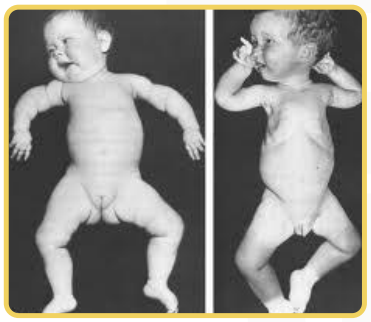
It is an autosomal recessive genetic defect in SMN gene which encodes for a protein which is necessary for survival of motor neurons; low level of this protein leads to dysfunction of LMN (A.H.C.) of the spinal cord and brain stem.

It may begin in intrauterine life or any time thereafter.

Broad phenotype spectrum ranging in age of onset.

Types of SMA:

SMA Type I: Werding-Hoffman (severe infantile form) (2 – 6m):



- Starts ***in utero*** or may be delayed to the ***1st 24 hours of life.***
- ***Generalized hypotonia and weakness*** more proximal and distal with characteristic fasciculations (best seen in the tongue)
- ***Fasciculations*** of the tongue (denervation).
- With progression, breathing becomes rapid, shallow, and predominantly abdominal.
- Extraocular muscles, sphincters and diaphragm are spared.
- **The heart isn't involved and the IQ is normal.**
- ***Cause of death*:** bronchopneumonia and respiratory failure.

***SMA Type II*:**

- It is the ***more slowly progressive*** late infantile form (6 – 18 months).
- Reach sitting position and live till adolescence.

***SMA Type III*:** It is a more chronic or juvenile form (onset > 18 months).

***SMA type IV*:** Adult-onset form.

Diagnosis of SMA:

1) Nerve Conduction Velocity (NCV)
2) Genetic studies for SMA gene
3) Prenatal and pre-implantation diagnosis by genetic testing.

Treatment by Multidisciplinary team:

Orthopedics, Physiotherapy and orthotics, Nutrition, Respiratory care, etc.

***Gene therapy*:**

- The FDA has approved three medications to treat SMA:
- All are forms of gene therapy that affect the genes involved in SMA.

II. Peripheral Neuropathy

1) Hereditary Sensory-Motor Neuropathy.

2) Gullain-Barrè Syndrome.

3) Other autoimmune and inflammatory neuropathies.

4) Tumors

5) Toxins and Heavy metals.

6) Drug intoxication.

Hereditary Sensory-Motor Neuropathy (HSMN)

They are group of progressive diseases of peripheral nerves genetically determined.

Motor components generally dominate but sensory involvement (hypothesia) can be present.

Autonomic involvement can happen.

Diagnosis:

- Genetic testing

Guillain Barre Syndrome (Post-infectious Polyneuropathy)

Demyelination (loss of myelin) of mainly motor nerves sometimes also sensory and autonomic, affect all ages and isn't hereditary.

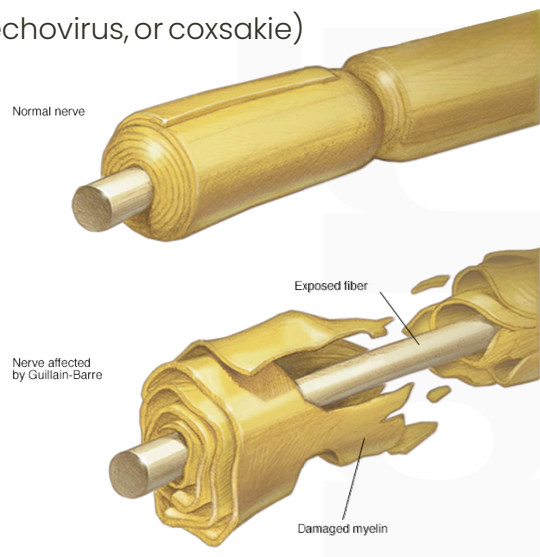
Preceded by **vaccination, or viral infection** (measles, mumps, echovirus, or coxsakie) by ***1-2 weeks.***

Autoimmune in nature.

Starts as **ascending paralysis to ultimately cause bilateral symmetrical hypotonia with areflexia.**

Ocular affection: Millter-Fisher syndrome (acute external ophthalmoplegia, ataxia and areflexia).

The course is either regressive, progressive or follows a chronic neuropathy causing flaccid tetraplegia with bulbar and respiratory muscle involvement and ventilation may be needed.



Diagnosis:

a) Nerve conduction velocity.
b) CSF examination (Cyto-albuminous dissociation?).
c) MRI.

Management:

- ***Plasmapheresis/Intravenous Immunoglobulin*** are the mainstay kind of treatment.

III. Disorders of neuromuscular transmission

1) Congenital myasthenic Syndromes
2) Transient acquired neonatal myasthenia.
3) Myasthenia Gravis
4) Aminoglycosides and organophosphorus toxicity
5) infantile botulism

Myasthenia Gravis

It is characterized by progressive fatigability of striated muscle throughout the day

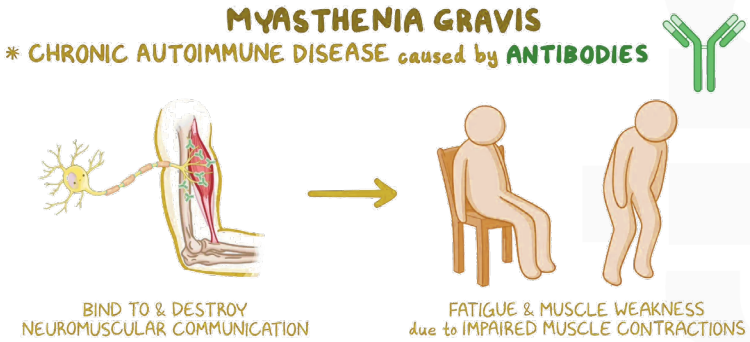
The cause is an **immune-mediated neuromuscular blockade** (Antibodies to the Acetyl Choline receptors and others).

Diagnosis:

- ***EMG*** with repetitive stimulation
- ***Antibodies*** detection in blood
- ***Edrophonium*** Test.

TTT:

- ***Anticholinesterase*** medications.



Infants born to myasthenic mothers can have transient neonatal myasthenic syndrome.

IV. Disorders of muscle

1) Congenital myopathies (non-progressive genetic)

2) Muscular dystrophy (1ry progressive genetic causing progressive weakness and degeneration of skeletal muscles)

3) Metabolic myopathy (due to error or defective metabolic problem)

4) Hypokalemia, Hypophosphatemia.

5) Inflammatory myopathy

6) Acute rhabdomyolysis

Congenital Myopathies

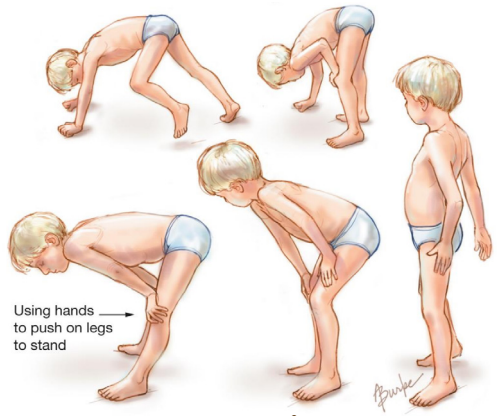
It is non-progressive, genetically determined disorders; the definitive diagnosis of each type is determined by histopathological finding in muscle biopsy.

Note: Congenital myopathy vs Muscular dystrophy?

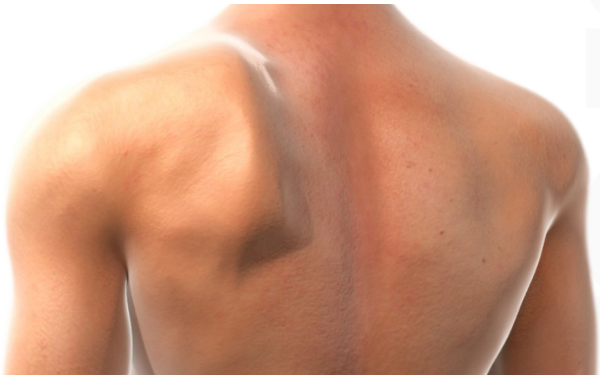
Duchenne Muscular Dystrophy (Muscle Dystrophies)

A muscular dystrophy is a primary myopathy, genetic basis, progressive.

- Degeneration and death of muscle fibers occur at some stage in the disease. **XLR disease.**
- ***Dystrophin*** (a muscle protein) is deficient causing functional abnormalities in skeletal muscles, cardiac muscles and brain.
- **In infancy:** mild ***hypotonia*** may be present. mild delay in ***motor*** development.
- Proximal weakness with **pseudohypertrophy** of ***calf muscles, tongue*** due to proliferation of connective tissue in muscle. and **sparing** of ***hand*** muscles as well as ***extraocular*** muscles and uretheral ***sphincter.***
- An early **Gowers sign** is often evident by age 3 yr and is fully expressed by age 5 or 6 years.



Gower sign



Winging of scapula

The length of time a patient remains ambulatory varies greatly ***7-10 years.***

Contractures most often involve the ankles, knees, hips, and elbows. Scoliosis is common.

The thoracic deformity further compromises pulmonary capacity and compresses the heart.

Cardiomyopathy is a constant finding.

IQ affection occurs in 25%.

Milder form = Becker's.

Diagnosis:

- ***EMG.***
- ***CPK Enzyme assay.***
- ***Genetic studies*** For dystrophin gene in blood and muscle.
- ***Echo and ECG.***
- ***Pulmonary Functions.***

Management:

Treatment of cardiorespiratory complications.

Non exhausting physiotherapy.

Orthopedic choices (bracing and tendon lengthening surgery)

Use of Steroids in DMD:

- Glucocorticoids can decelerate the myofiber necrosis in muscular dystrophy.
- DMD treated early with steroids appear to have an improved long-term prognosis in muscle and myocardial outcome, as well as short-term improvement in muscle strength, and steroids can help keep patients ambulatory for more years than expected without treatment

Heart medications, such as angiotensin-converting enzyme (ACE) inhibitors or beta blockers, if muscular dystrophy damages the heart.

Gene therapy: Gene therapy is already established and was approved by FDA in certain mutations

Causes of Death in DMD

- ***Respiratory muscle involvement*** is expressed as a weak and ineffective cough, frequent pulmonary infections, and decreasing respiratory reserve.
- The ***thoracic deformity*** further compromises pulmonary capacity and compresses the heart.
- ***Pharyngeal weakness*** can lead to episodes of aspiration, nasal regurgitation of liquids, and an airy or nasal voice quality.
- ***Cardiac failure.***

How do you investigate a motor unit disease or lower motor neuron disease to localize the lesion and determine its etiology?

Where is the lesion?

What is the lesion?

I. Laboratory Findings:

- Several ***Lysosomal enzymes*** are released by damaged or degeneration of muscle fibers and could be measured in serum. The most useful is **Creatine Phosphokinase (CPK).**
- ***CPK level*** is characteristically elevated in muscular dystrophies and breakdown.
- ***Molecular genetic marker:*** DNA markers from samples .

II. Nerve conduction velocity (NCV):

- Motor and sensory nerve conduction velocity (NCV) electro-physiologically determined through surface electrodes by which we can ***localize the site of lesion anterior horn cell (A.H.S.), peripheral nerve.***

III. Electromyography (EMG):

- Electrophysiological studies through inserting electrodes in the muscle. It is used mainly to diagnose ***myasthenic decremental response and myopathic involvement.***

IV. Imaging of Neuromuscular Disorders:

- ***MRI*** (image of choice) in muscle dystrophy, dermatomyositis and spinal cord or nerve roots (Transverse Myleitis) or plexues (Brachial plexues lesions) injuries.

V. Muscle Biopsy:

- The ***most important and specific diagnosis*** (Quadriceps femoralis) to be examined by light and electron microscopy and immuno-histochemistry and genetic studies.

VI. Nerve Biopsy:

- ***Sural nerve*** is a pure sensory nerve, the mostly sampled nerve (90% involved in all neurons) electron microscopy and special stain for specific disease.

VII. Echocardiography & ECG:

- ***Cardiac evaluation*** in myopathies

Not all causes of inability to walk is due to CNS disorder whether central or peripheral.

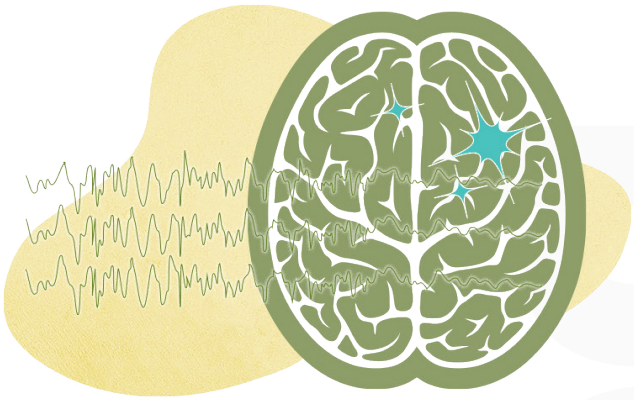
Non-paralytic causes especially bone disease rickets, arthritis and congenital hip dislocation, systemic illness or even physiological delay must be considered.

Hypotonia and motor developmental delay may be an expression of other diseases as endocrine, rickets, systemic metabolic or non- specific expression of chronic systemic illness or malnutrition.

Type	Common Presenting features	Site of Lesion	Cause	Clues to Diagnosis
UMNL	• AFP and hypotonia are the initial presentations for UMNL. • AFP occurs on the opposite side of the CNS. • Spacticity develops later. • Hyperreflexia and positive Babiniski.	Cerebral Cortex	1. Intracranial Hge. 2. Brain Tumor. 3. Seizures. 4. HIE	1. History of trauma – Signs of increase ICT and signs of lateralization. 2. Known Tumor and signs of increased ICT. 3. Todds paralysis following seizure activity. 4. History of Perinatal asphyxia.
		Spinal Cord (UMN below the lesion)	1. S.C. Trauma. 2. S.C. Tumor. 3. Paraspinal infections and inflammations. 4. Transverse Myelitis.	1. History of trauma – Sensory level/loss – Bowel/bladder involvement – Pain spine and movement. 2. Sensory level/loss – Bowel/Bladder involvement – Painful spine and movement. 3. Fever – Sensory level/loss – Bowel/Bladder involvement - Pain spine and movement. 4. Fever – Neck stiffness – Sensory level/loss – Bowel/Bladder involvement – Pain spine and movement.
LMNL	• AFP and hypotonia are persistant presentations of LMNL. • Muscle weakness • Hypotonia • Fasciculations in nerve disease. • Decreased spinal cord reflexes	AHC disease.	• Poliomyelitis and non polio Enteroviruses.	• Fever, etc.
		Peripheral Nerve diseases.	1. Guillian Barre 2. Peripheral nerve Toxins.	1. Preceeding viral infections/vaccination – Acending weakness – Autonomic manifestations – vague sensory symptoms and pain. 2. Exposure.
		NMJ disorders	1. Botulism 2. Mysthenia Gravis	1. Exposure constipation – descending weakness facial weakness. 2. Prominent and early ptosis – facial weakness – fluctuating symptoms – fatiguability.
		Muscle disorder	• Rabdomyolysis	• Rabdomyolysis

4 SEIZURE DISORDERS

Definitions



Seizures: a transient occurrence of signs and/or symptoms due to abnormal excessive or synchronous neuronal activity in the brain (cerebral dysrhythmia).

It is abnormal paroxysmal electrical brain activity manifested as ***abnormal motor, sensory, psychiatric or autonomic behavior.***

Acute symptomatic seizures: occur secondary to an acute problem affecting brain excitability such as electrolyte imbalance, structural, inflammatory, acute stroke, or metabolic disorders of the brain.

- The prognosis depends on the underlying disorder, including its reversibility and likelihood of developing epilepsy.

Epilepsy: is a disorder of the brain characterized by an enduring predisposition to generate seizures and by the neurobiologic, cognitive, psychological, and social consequences of this condition.

For epidemiologic purposes, epilepsy is considered to be present when at least *two unprovoked* seizures occur in a time frame of *more than 24 hours.*

Seizure disorder is a general term that is usually used to include any one of several disorders including epilepsy, febrile seizures, single seizures and seizures secondary to metabolic, infectious, or other etiologies (hypocalcemia, meningitis, etc).

The term ***"unprovoked"*** implies absence of a temporary or reversible factor producing a seizure at that point in time.

Convulsion: motor seizure

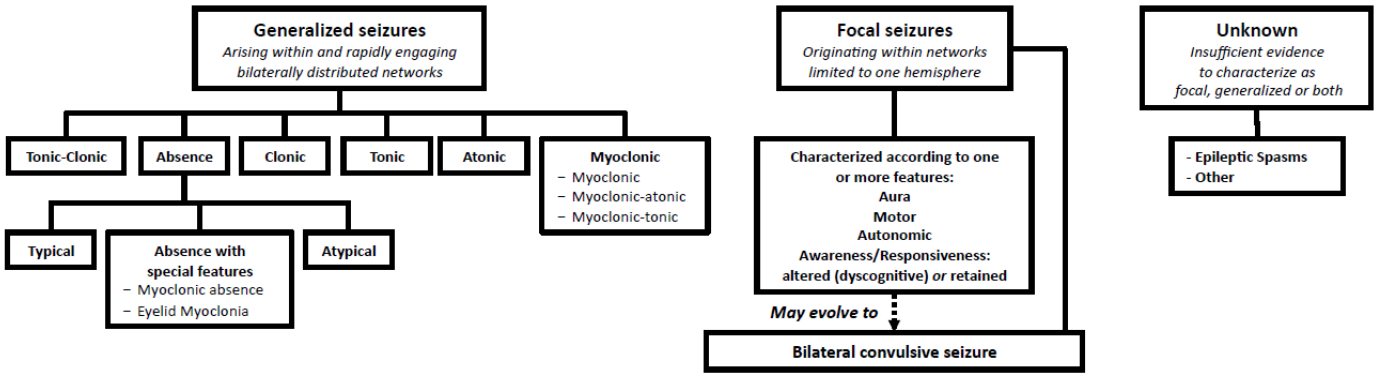
Fit: One attack

Aura: The portion of seizure which occurs before consciousness is lost and for which memory is retained after-wards. In simple partial convulsion, it is the whole seizure.

Postictal: The transient clinical and / or electrophysiologic brain dysfunction that results from the seizure and appears when it has ended, featured by drowsiness, confusion, sleep or automatism.

Classification of seizure types

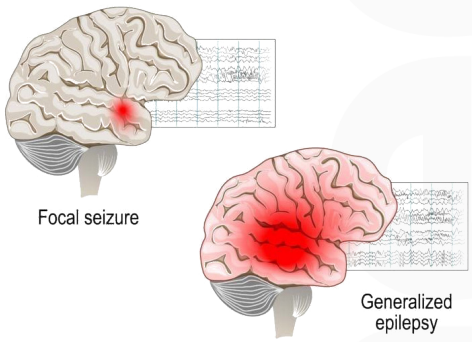
ILAE Proposal for Revised Terminology for Organization of Seizures and Epilepsies 2010:



Mode of seizure onset and classification of seizures:

Generalized epileptic seizures are regarded as arising in and rapidly engaging bilaterally distributed networks.

Focal (partial) epileptic seizures as originating within networks limited to one hemisphere.



I. Partial (focal, local) seizures

The seizure is first classified according to level of awareness. If awareness is impaired at any point in the seizure, the seizure is a focal impaired awareness seizure.

Because the first symptom/sign of the seizure is the most useful feature for identification of the regional brain network in which the seizure arises.

The following seizure types are therefore recognized for classifying focal seizures:

- ***Aware*** or ***impaired awareness***
- ***Motor onset*** or ***non motor onset***

Non motor includes:

- Focal sensory seizure
- Focal cognitive seizure
- Focal emotional seizure
- Focal autonomic seizure
- Focal behavioural arrest seizure

Focal seizures can spread widely in the brain to engage bilateral networks, including cortical and subcortical structures, resulting in a tonic-clonic seizure with loss of consciousness.

This seizure type is known as a *focal with secondary bilateral tonic-clonic seizure.*

Phenomena include:

Motor phenomenon: Localized jerk - spasms.

Sensory phenomenon: Localized parasthesia or numbness.

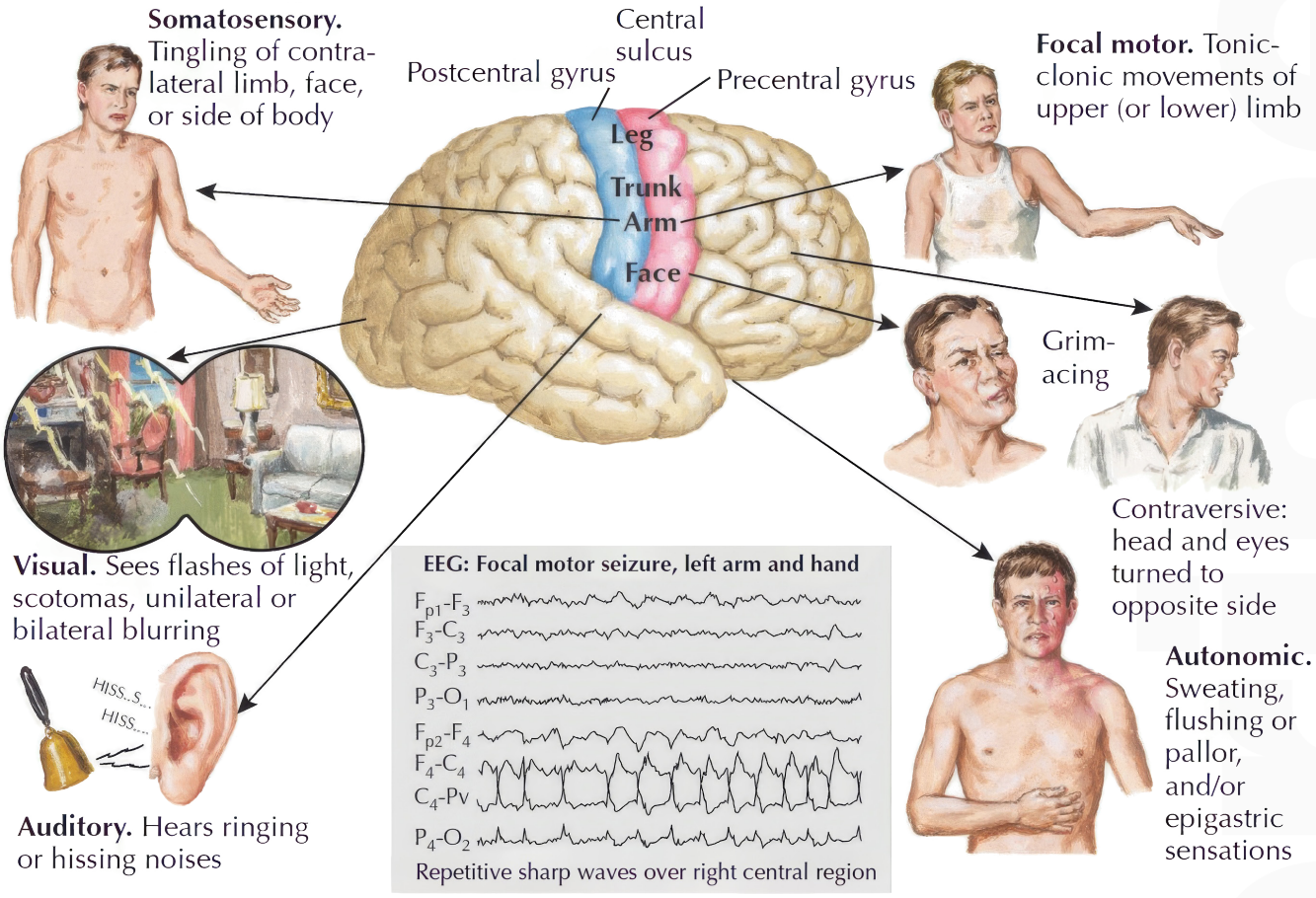
Special sensory:

- ***Visual:*** flashes of light.
- ***Auditory:*** sounds - hissing.
- ***Gustatory:*** paraguesia.
- ***Olfactory:*** parasomnia.
- ***Vestibular seizure.***

Emotional: anger - fear - anxiety - panic.

Cognitive:

- ***Dysmensia:*** deja vu (sense of familiarity).
- ***Illusion:*** macrospia - microspia.
- ***Structured hallucinations.***



II. Generalized seizures

Motor onset: Tonic clonic - Clonic - Tonic - Atonic - Myoclonic.

Non motor onset: Typical absence.

Tonic Seizures:

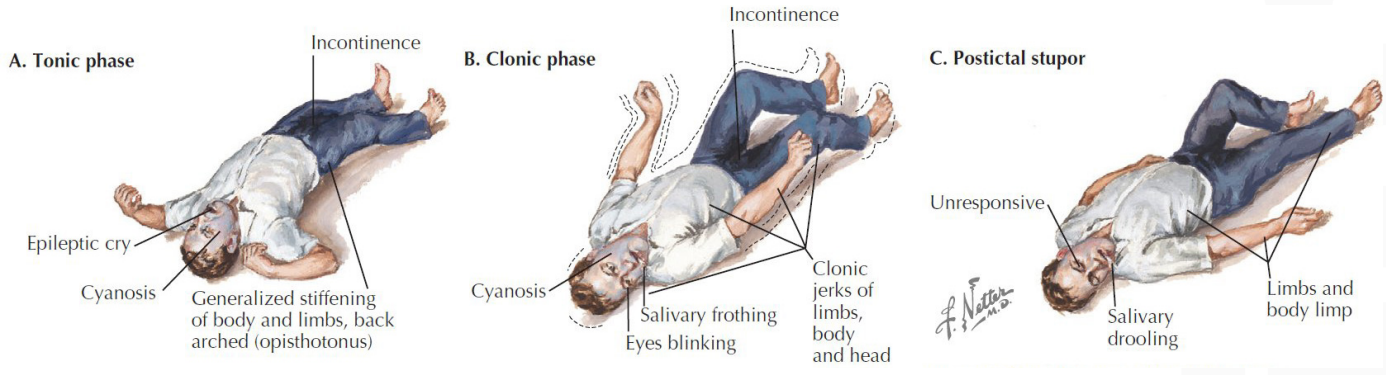
- ***No clonic phase***
- A generalized tonic seizure involves ***bilaterally increased tone*** of the limbs typically lasting ***3 seconds to 2 minutes.***

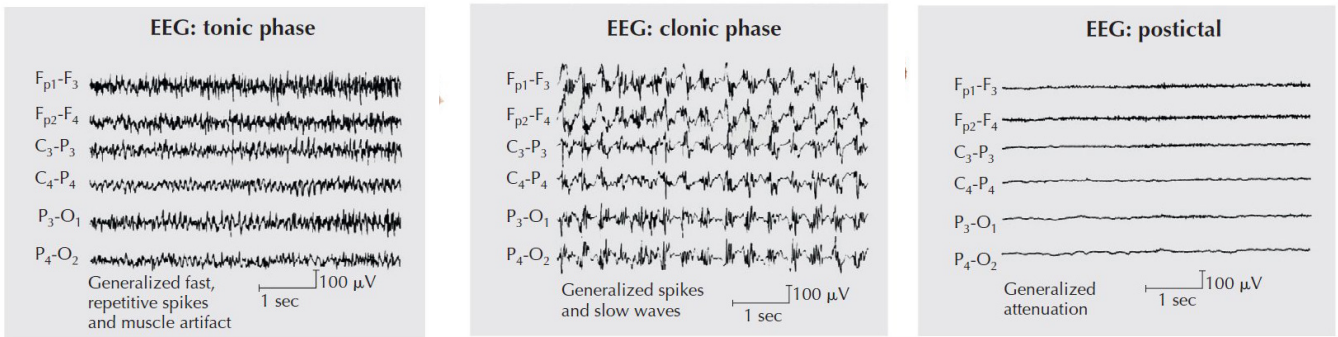
Clonic Seizures:

- ***Not preceded by tonic phase.***
- A clonic seizure is a seizure with ***bilateral, sustained rhythmic jerking*** and ***loss of consciousness.***
- It is distinguished from repetitive serial myoclonic seizures by the ***rhythmicity*** of the jerking and that it occurs in the setting of loss of consciousness

Tonic-Clonic Seizures:

- Generalized tonic-clonic seizures are ***bilateral and symmetric generalized motor seizures***, that occur in an individual with ***loss of consciousness.***
- The tonic-clonic seizure consists of a **tonic** (bilateral increased tone, lasting seconds to minutes) and then a **clonic** (bilateral sustained rhythmic jerking) phase, typically in this order.





Myoclonic Seizures:

- A myoclonic seizure is a ***single or series of jerks*** (brief muscle contractions). Each jerk is typically milliseconds in duration. Brief jerks with ***sudden onset & offset.***
- May occur singly or in series.

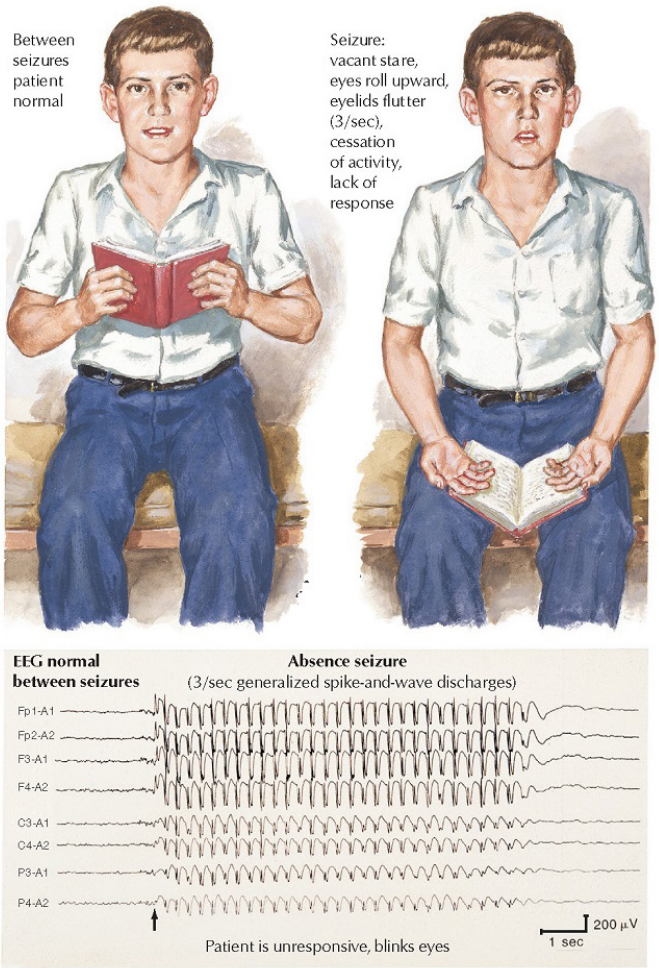
Atonic Seizures:

- An atonic seizure involves ***sudden loss or diminution of muscle tone*** **without apparent preceding myoclonic or tonic features.**
- Classically ***drops to floor.***
- May be limited to head nodding / knee sagging.

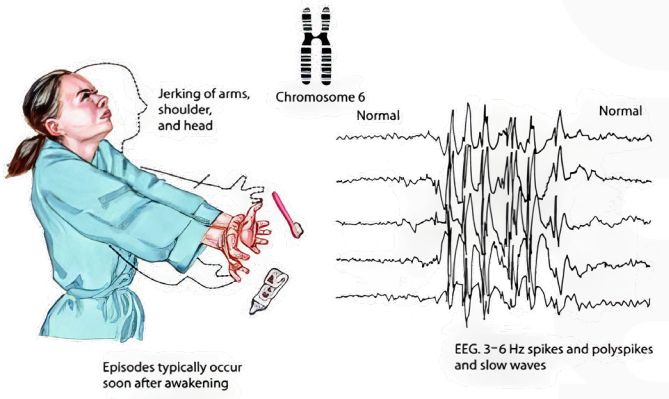
Absence seizures:

- Absence seizures with ***impairment of consciousness only***, mild clonic components, atonic components, tonic components, automatisms, autonomic components.

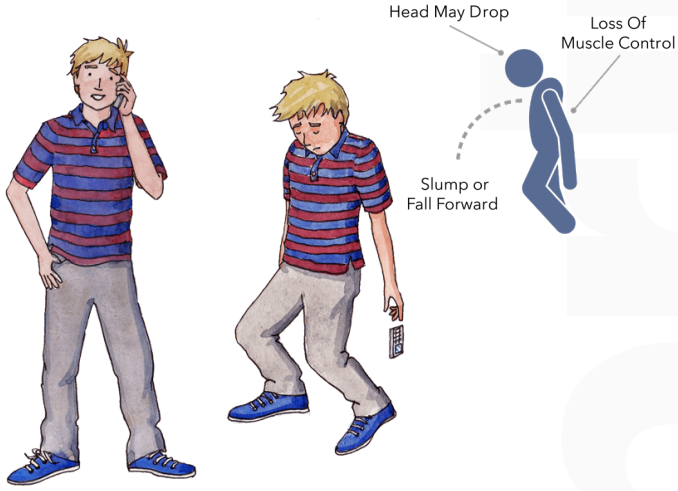
Please note: The EEG should not be used in isolation to make a diagnosis of epilepsy or exclude it when the clinical presentation supports a diagnosis of a non-epileptic event.



Absence seizures



Myoclonic seizures



Atonic seizures

III. Unclassified seizures

A seizure may be unclassified due to inadequate information to allow it to be placed in the focal, generalized or unknown onset categories

This may occur if it was not witnessed at onset, and if results of investigations (such as EEG and imaging) are not yet available

Epileptic spasm

- An epileptic spasm is a ***sudden*** flexion, extension or mixed flexion-extension of proximal and truncal muscles, lasting 1-2 seconds i.e. ***longer than a myoclonic jerk*** (which lasts milliseconds) but ***not as long as a tonic seizure*** (which lasts > 2 seconds).
- Spasms typically occur in a series, usually on wakening.

Infantile spasm:

- Infantile spasms are brief contractions of the neck, trunk, and arm muscles, followed by a phase of sustained muscle contraction lasting less than 2 seconds.
- Each jerk is followed by a brief period of relaxation with repeated spasms in clusters of variable duration.
- The peak age at onset of infantile spasms is ***3-8 months.***
- Infantile spasms are a neurological emergency since rapid initiation of effective therapy offers the best chance for favorable neurodevelopmental outcomes.

Etiology of seizures

1. ***Infection:*** Meningitis, encephalitis (herpes simplex or other viruses), brain abscesses, parasitic infections.
2. ***Metabolic derangements:*** Hypoglycemia, hypocalcemia, hyponatremia, inborn errors of metabolism, pyridoxine deficiency, uremia.
3. ***Vascular:*** Cerebrovascular accident, hypertensive encephalopathy, intra-cranial hemorrhage.
4. ***Toxicological:*** Ingestion, inhalation, exposure or withdrawal of substances of abuse.
5. ***Trauma:*** Non-accidental trauma, closed head injury. Oncoogical Brain tumor, metastatic disease.
6. ***Oncological:*** Brain tumor, metastatic disease.
7. ***Neurological:*** epilepsy, febrile seizure.

1 - 6: Etiology of acute symptomatic seizures

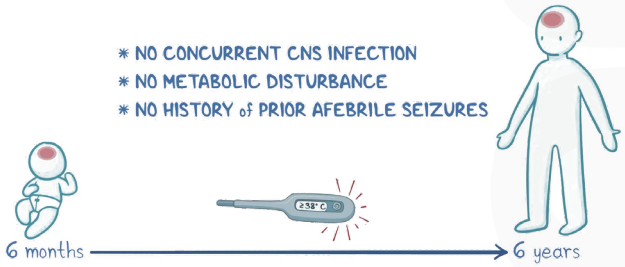
Acute symptomatic seizures

Acute symptomatic seizures occur secondary to an acute problem affecting brain excitability such as electrolyte imbalance, structural, inflammatory as meningitis and encephalitis, acute stroke, or metabolic disorders of the brain.

The prognosis depends on the underlying disorder, including its reversibility and likelihood of developing epilepsy.

Febrile seizures

Febrile seizures are the **most common seizures of childhood.**



They occur in **2 to 5 % of children:**

- Between the ages of ***6 months and 6 years*** (peak 12 - 18m)
- With a temperature of ***38°C or higher.***

As defined by the American Academy of Pediatrics (AAP), febrile seizures occur in the absence of:

- Intracranial infection
- Metabolic disturbance
- History of afebrile seizures.

Classification

A simple febrile seizure is a primary ***generalized***, usually tonic-clonic attack, lasting for a ***maximum of 15 min***, and ***not recurrent within a 24-hour period.*** They represent 65 to 90% of febrile seizures.

A complex febrile seizure is more prolonged (> 15 min), is focal, and/or recurs within 24 hr.

Febrile status epilepticus is a febrile seizure lasting >30 min.

Work-up

Each child who presents with a febrile seizure requires a ***detailed history*** and a ***thorough general and neurologic examination.***

Febrile seizures often occur in the context of otitis media, roseola, or similar infections, making the evaluation more demanding.

- In a typical febrile seizure, the **examination usually is normal**, other than symptoms of the illness causing the fever
- Typically, the child **will not need a full seizure workup**, which includes an EEG head CT, and lumbar puncture

Lumbar puncture:

- ***Recommended in children < 12 months*** of age and possibly up to 18 months after their first febrile seizure to rule out meningitis because clinical symptoms of meningitis may be subtle in this age group.
- ***For children >18 months*** of age, a lumbar puncture is indicated if the history and/or physical examination otherwise suggest intracranial infection.

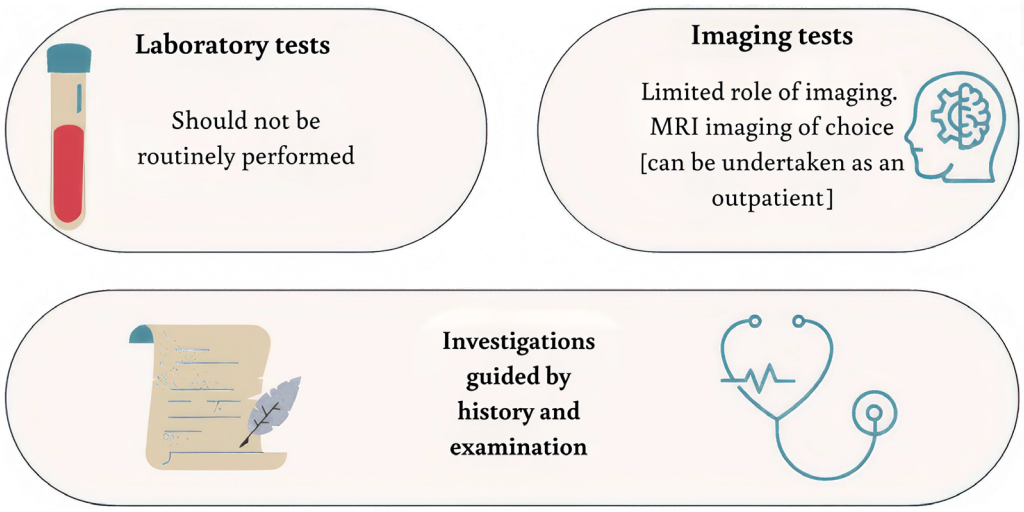
Blood glucose: Should be determined in children with ***prolonged postictal obtundation*** or those with ***poor oral intake*** (prolonged fasting).

Serum electrolyte essay: may be indicated ***If clinically suggestive*** (e.g., in a history or physical examination suggesting dehydration).

A CT or MRI is not recommended in evaluating the child after a first simple febrile seizure.

The work-up of children with **complex febrile seizures** needs to be ***individualized.*** This can include EEG and neuroimaging, particularly if the child is neurologically abnormal

Not all seizures associated with fever are febrile seizures. It can be due to CNS infection or a metabolic abnormality.



Treatment

In general, *antiepileptic therapy*, continuous or intermittent, is *not recommended* for children with febrile seizures.

Ensure saftey:

- Do NOT try to give anything by mouth to prevent him from biting the tongue, as this increases the risk of injury.
- During the seizure, leave your child on the floor.
- You may want to slide a blanket under the child if the floor is hard.
- Remove objects that may injure him.
- Loosen any tight clothing, especially around the neck.
- If possible, open or remove clothes from the waist up.
- If he vomits, or if saliva and mucus build up in the mouth, turn him on his side.

Focus your attention on bringing the fever down:

- Insert an ***acetaminophen suppository*** (if you have some) into the child's rectum.
- Apply cool washcloths to the forehead and neck. Sponge the rest of the body with lukewarm (not cold) water.
- ***Rectal diazepam*** is often prescribed to be given at the time of recurrence of febrile seizure **if lasting > 5 min.**
- Alternatively, ***buccal or intranasal midazolam or diazepam*** may be used
- **In cases of frequently recurring febrile seizures,** intermittent ***oral clonazepam*** (0.01 mg/kg every 8-12 hours up to a maximum dose of 1.5 mg/day) or ***oral diazepam*** (0.33 mg/kg every 8 hours) can be given during febrile illnesses.
- ***TTT the cause*** & ***rule out meningitis.***

Prognosis

The following is associated with an increased risk of subsequent epilepsy:

- Presence of a neurodevelopmental abnormality.
- Occurrence of a family history of epilepsy.
- Occurrence of complex febrile seizures.

Epilepsy

Epilepsy is a disorder of the brain characterized by an *enduring predisposition* to generate epileptic seizures and by the neurobiologic, cognitive, psychological, and social consequences of this condition.

Epilepsy is considered present when ***≥ 2 unprovoked*** seizures occur ***> 24 hours apart.***

- A seizure that is provoked by a transient factor acting on an otherwise normal brain to temporarily lower the seizure threshold does not count toward a diagnosis of epilepsy.
- Unprovoked seizures clustering in a 24 h period be considered to be a single unprovoked seizure for purposes of predicting recurrence risk.

Syndromic classification of epilepsy

Classification is undertaken using a multi-level classification framework, involving classification at three levels: The seizure type - epilepsy type - epilepsy syndrome.

Imaging, EEG and other investigations, where available, contribute to optimized classification at all three levels.

Etiology of epilepsy

Can be categorised into three major groups:

Genetic

- The epilepsy is the ***direct result of a known or presumed genetic defect(s)*** in which seizures are the core symptom of the disorder and in which there is no gross neuroanatomic or neuropathologic abnormality.

Structural/Metabolic

- There is a distinct ***other structural or metabolic condition or disease*** that has been demonstrated to be associated with a substantially increased risk of developing epilepsy.

Any condition that affect the grey matter can lead to seizures:

Post trauma or surgery - Post stroke e.g. A V malformation - Previous Cerebral infections - Cerebral malformation - Tumors (1ry/2ry) - Past history of Perinatal problems - Neurodegenerative diseases - Neurocutaneous syndromes - Inborn error of metabolism - Toxins (exogenous / endogenous) - Drugs i.e. Analeptics, Antihistaminics etc.

Unknown cause

- Unknown is meant to be viewed neutrally and to designate that the nature of the underlying cause is as yet unknown.
- it may have a fundamental genetic defect at its core or it may be the consequence of a separate as yet unrecognized disorder.

Frequently associated conditions & disorders

Neurocutaneous syndromes: Tuberous sclerosis; neurofibromatosis

Disorders of metabolism: Organic acidurias; pyridoxine-dependent epilepsy; Urea cycle disorders; disorders of cobalamin and folate metabolism

Chromosomal and genetic disorders: Down syndrome; Fragile X syndrome

Developmental anomalies of cerebral structure: Hemimegalencephaly; focal cortical dysplasia; arachnoid cyst

Perinatal and infantile causes: In utero infection; ischemic insult

Cerebral trauma: Open head injury; closed head injury; epilepsy after epilepsy surgery

Cerebral tumor: Glioma; ganglioglioma and hamartoma

Cerebral infection: Viral meningitis and encephalitis; bacterial meningitis and abscess

Cerebrovascular disorders: Cerebral hemorrhage; cerebral infarction; arteriovenous malformation

Cerebral immunologic disorders: SLE and collagen vascular disorders

Degenerative and other neurologic conditions: Neurodegenerative; hydrocephalus; porencephaly

These examples are not comprehensive, and in every category there are other causes.

Differential diagnosis of epileptic events

- All causes of episodic impairment of awareness
- Aberrations of mental function
- Falls
- Sensory/motor phenomena
- Psychic phenomena

Non epileptic paroxysmal events have been misdiagnosed as epileptic seizures in 20 30 % of patients diagnosed with epilepsy.

Pseudo seizures:

	Epileptic Seizures	Psychogenic Seizures
Precipitant	Usually non	Often an emotional one
In sleep	Common	Rare
When alone	Common	Less common
Motor phenomena	Stereotyped, usually both tonic & clonic movements slows as seizure continues.	Variable. Often tonic or clonic only. Pelvic thrusting.
Injury	Common	Rare
Incontinence	Common	Rare
Duration	May be short	Prolonged

In pseudo seizures:

- ***Attempts to open eyes passively*** ➔ tightening of the eye lids.
- Can be induced in response to ***suggestion.***

Disorders that may mimic epilepsy

1. Breath-holding attacks:

- They typically affect pre-school children.
- The child will begin crying after some form of upset and then stop breathing in expiration with what appears a silent cry or a series of expiratory grunts.
- With this prolonged expiratory apnea the child's face becomes ***blue with deep cyanosis.***
- They may recover at this point and breathe in, or go on to a syncope with transient loss of consciousness.

2. Night terrors:

- The onset usually occurs by 4 years of age and always by age 6.
- Two hours after falling asleep, the child awakens in a terrified state, does not recognize people, and is inconsolable.
- An episode usually lasts for 5 to 15 minutes but can last for an hour.

3. Collapsing attacks with cardiac dysrhythmias

4. Behavioral staring attacks

5. Self-stimulatory behavior, especially in children with autistic spectrum disorders

Investigations

Electroencephalogram (EEG)

"EEG does not diagnose and does not exclude epilepsy"

- Should be performed to ***support*** a diagnosis of epilepsy. EEG may help determine ***seizure type*** and ***epilepsy syndrome*** and thus provide the most suitable therapy.

The EEG should not be used in isolation to make a diagnosis of epilepsy or exclude it when the clinical presentation supports a diagnosis of a non-epileptic event.

- 10-18% of epileptics have normal EEG
- 2% of normal subjects have abnormal EEG
- Sleep EEG increases the yield of 50% of cases with unhelpful wake EEG.
- Serial EEGs will increase the yield of abnormalities

Use of EEG:

- Classify epileptic syndromes.
- Evidence of photosensitivity.
- Hyperventilation may provoke absence seizures
- To identify individuals with non-convulsive status epilepticus
- Guide for likelihood of relapse on ASM withdrawal

Video-EEG monitoring:

- Can help characterize the type of seizure and thus optimize pharmacologic treatment and for presurgical workup.
- Can differentiate seizures from other Mimickers.

Neuroimaging

Should be used to identify structural abnormalities that cause certain epilepsies.

MRI should be the imaging investigation of choice.

CT should be used to identify underlying gross pathology if MRI is not available or is contraindicated.

Indications:

1. Partial seizures (history/EEG)
2. Fixed or progressive neurological deficit.
3. Difficult seizure control.
4. Unexplained secondary loss of seizure control.
5. Acutely after a significant trauma or in case of coagulation disorder.

Other investigations

- including blood, CSF and urine biochemistry, genetic testing, advanced radiologic imaging should be undertaken at the discretion of the specialist to exclude other diagnoses, and to determine an underlying cause of epilepsy.

Evaluation of the first seizure

Initial evaluation of an infant or child during or shortly after a suspected seizure:

- Assessment of the adequacy of the airway, ventilation, and cardiac function
- Measurement of temperature, blood pressure, and glucose concentration.

For acute evaluation of the first seizure, the physician should search for potentially life-threatening causes of seizures:

- Meningitis, systemic sepsis, unintentional and intentional head trauma, and ingestion of drugs of abuse and other toxins.
- The history should attempt to define factors that might have promoted the convulsion and to provide a detailed description of the seizure.

Differential diagnosis for a patient being evaluated in the ER for first seizure should include: [Etiology pg. 44]

At least initial workup should include:

- Blood glucose
- CBC
- Electrolytes
- Urine analysis
- CSF analysis
- + Possibly neuroimaging.

Glucose abnormalities **and** ***hyponatremia*** **are the most common abnormalities associated with seizures.**

Therapy of epilepsy

Antiseizure Medication (ASM)

It is worth noting that initiation of ASM is a major event in the patient's life; Patients must take ASM for a long time, all ASM have side effects, and social problems.

The goal of antiepileptic therapy is: to achieve maximum normal function by balancing seizure control against drug toxicity to prevent recurrence of seizures.

Principles of drug treatment in newly diagnosed patients:

- ***Choice of drug*** depends on seizure type.
- ***Single is better than Multiple*** drug therapy
  - Better tolerance and compliance.
  - Less adverse effect & long-term toxicity.
  - No risk of interactions.
- Drug should be ***introduced gradually.***
- Maintenance dose should be the ***lowest dose*** which controls seizures.
- ***Compliance*** should be emphasized.
- If control is poor on the first drug at the ***highest tolerated dose;***
  - Treatment should be then changed to monotherapy with another first line drug.
  - If failed, treat with a maximum of two anti-convulsants.
- ***The reduction of dosage or withdrawal*** of anticonvulsant drugs should always be performed ***slowly.***
- ***Avoid sedative drugs***, unless they confer definite benefit.
- ***Avoid epileptogenic stimuli*** i.e.: fever, fatigue, photosensitivity.

Which drug and in what dose? It is the identification of the **seizure type** (Table) and **safety profile** of the drug that determines the choice of anticonvulsant.

Most children with epilepsy achieve complete seizure control with monotherapy when using the correct drug for the seizure type.

Example of ASM according to seizure type:

Seizure type	Anti-seizure medications
Generalised tonic–clonic	***Sodium valproate*** (not in a female in a child bearing period) Lamotrigine
Tonic or atonic	***Sodium valproate***
Absence	***Ethosuximide***
Myoclonic	***Sodium valproate***
Focal	***Lamotrigine***

Epilepsy surgery:

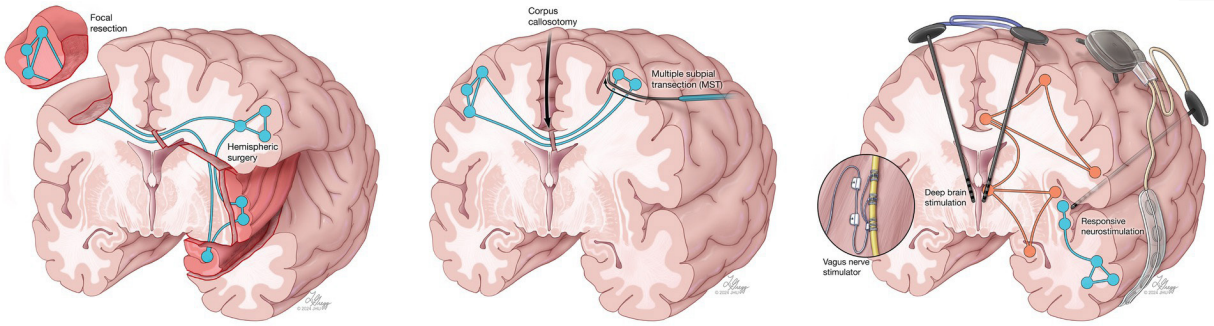
5 – 10% of chronic medically refractory epileptics may be surgery candidates.

Candidates for surgery:

- Confirmed diagnosis.
- Disabling seizures.
- Resectable focus
- No progressive underlying disease.
- Medical intractability; adequate trial of 2-3 first choice drugs with no acceptable control (1;2y).

Surgical approach:

1. ***Focal cerebral resection:***
   - Temporal lobectomy and amygdalo-hippocampectomy
   - Non temporal lobe resection
2. ***Hemispherectomy***
3. ***Corpus callosotomy***



Resective surgery | Disconnective surgery | Neuromodulation

Ketogenic diet

- The 'classic' ketogenic diet is a **high-fat, moderate protein, low carbohydrate** diet designed to mimic the biochemical changes associated with prolonged starvation, which had been reported to produce a ***dramatic decrease in uncontrollable seizures.***
- As the diet provides minimal carbohydrate, the fats are incompletely metabolized and ketone bodies result. The diet provides adequate protein for growth.
- The classic ketogenic diet is determined by a ratio of grams of fat to grams of protein plus carbohydrate combined. A 4:1 ratio (90% calories from fat) is typically used for children
- There was no clear influence of age, seizure type, or etiology on seizure reduction overall.

Vagal nerve stimulation:

- VNS may prevent or lessen seizures by sending regular, mild pulses of electrical energy to the brain via the vagus nerve.
- **Unclear mechanism of action**
- VNS seems to improve seizures in ***children*** and patients with both ***focal and generalized*** epilepsy.

Status Epilepticus

The definition of status epilepticus is refined to reflect:

- The time at which treatment should be initiated ***(t1)***
- Time at which continuous seizure activity leads to long-term sequelae ***(t2)*** such as neuronal injury, depending on the type of SE.

For generalized tonic-clonic seizures: SE is defined as continuous convulsive activity or recurrent generalized convulsive seizure activity without regaining of consciousness ***(t1 = 5 min, t2 ≥ 30 min).***

There is a 10-fold increase in mortality for seizure lasting < 30 min compared to those lasting 10 - 29 min.

In established epilepsy, status may be precipitated by:

1. Sudden drug withdrawal,
2. Intercurrent Febrile illness,
3. Metabolic disturbances, or
4. The progression of the underlying disease, and is commoner in symptomatic epilepsy.
5. Acute cerebral insult e.g: CNS infection or trauma

Most episodes of SE, however, *develop de novo* due to acute cerebral disturbances; e.g. cerebral infection, trauma, tumour, acute toxic or metabolic disturbances and febrile illness.

Management of status epilepticus

0-5 Minutes
Stabilization

1. **Stabilize patient** (airway, breathing, circulation, disability)
2. **Time seizure** from its onset, **monitor vital signs.**
3. **Assess oxygenation**, give oxygen via nasal cannula/mask, consider intubation if needed
4. **Initiate ECG monitoring**
5. **Collect finger stick blood glucose:**
   - ***If glucose < 60 mg/dl*** then administer 2 mL/kg of 25% dextrose water (D25W) via central line, or 5 mL/kg of 10% dextrose water (D10W) by peripheral IV.
   - When the patient is hypoglycemic, glucose level should be rechecked 3 to 5 minutes post-bolus, and a repeat bolus administered if necessary.
6. **Attempt IV access** and collect ***electrolytes*** (Na, Ca & Mg), ***hematology***, ***toxicology*** screen, (if appropriate, do anticonvulsant drug levels).

At 5 Minutes
initial therapy
(Repeat at 10 min if persisted)

- **Choose ONE of:**
  - ***Intravenous diazepam*** (0.15-0.2 mg/kg/dose, max: 10 mg/dose, may repeat dose once)
  - ***Intramuscular midazolam*** 0.3mg/kg OR 5mg (if the child weighs 13-40Kg), 10mg (>40Kg), single dose.
- **If none of the above available/ no IV access/ prehospital setting:**
  - ***Rectal diazepam*** (0.2-0.5 mg/kg/dose, max: 20 mg/dose, single dose)
  - ***Intranasal or buccal midazolam*** (0.3 mg/kg per dose via the buccal route, max single dose 10mg)

20-40 Minutes
Second phase

- **Choose one of the following second line options and give as a single dose:**
  - ***Intravenous levetiracetam*** (60 mg/kg, max: 4500 mg/dose, single dose)
  - ***Intravenous phenytoin*** (20 mg/kg, max: 1500 mg/dose, single dose)
- **If none of the above available, give:**
  - ***Intravenous phenobarbital*** (15 mg/kg, max: 1000mg, single dose)

40-60 Minutes
Third phase

- **There is no clear evidence to guide therapy in this phase:** ***TRANSFER to PICU:***
- ***Options include:***
  - Use of another (different) second-line medication
  - Proceeding to the use of anesthetic doses of either thiopental, midazolam, pentobarbital, or propofol (all with continuous EEG monitoring)

5 MISCELLANEOUS NEUROLOGY CASES

Benign Increase Tension

(Idiopathic intracranial hypertension) (pseudotumor cerebrii)

Headache syndrome characterized by elevated ICP in the absence of ventricular dilatation, intracranial mass lesion, or CSF abnormalities.

Most common in obese females between 15 and 44 years of age

Secondary Causes of Intracranial Hypertension in Childhood

1. CNS infection
2. Cerebral sinus venous thrombosis
3. Malnutrition
4. Head trauma
5. Endocrine abnormalities (hypoparathyroidism, hypothyroidism)
6. Obesity
7. Medications (Corticosteroids, Lithium, Vitamin A, Tetracyclines, Cis-retinoic acid, Levothyroxine, Growth hormone)

Diagnosis

The diagnosis requires:

- ***ICP greater than 25 cm of water*** as measured on LP.
- ***Normal neuroimaging*** and ***CSF*** studies.

Management

1. An appropriate amount of spinal fluid should be removed by LP to lower the closing pressure to less than 20 cm of water.
2. Potentially causative medications should be stopped
3. Weight loss and exercise should be recommended in the case of obesity
4. Underlying medical conditions should be treated appropriately
5. Medical treatment with carbonic anhydrase inhibitors (acetazolamide)
6. Surgery is reserved for patients with rapidly deteriorating vision due to papilledema.
7. CSF shunting: ventriculoperitoneal shunt

Acute disseminated encephalomyelitis (ADEM)

An immune-mediated inflammatory demyelinating disease of the CNS, which is typically transient and self-limiting.

It is characterized by an acute or sub-acute encephalopathy with polyfocal neurological deficits, typically presents as a monophasic illness.

Most of the case are reported **post-viral infection or vaccination.**

Characteristic clinical features

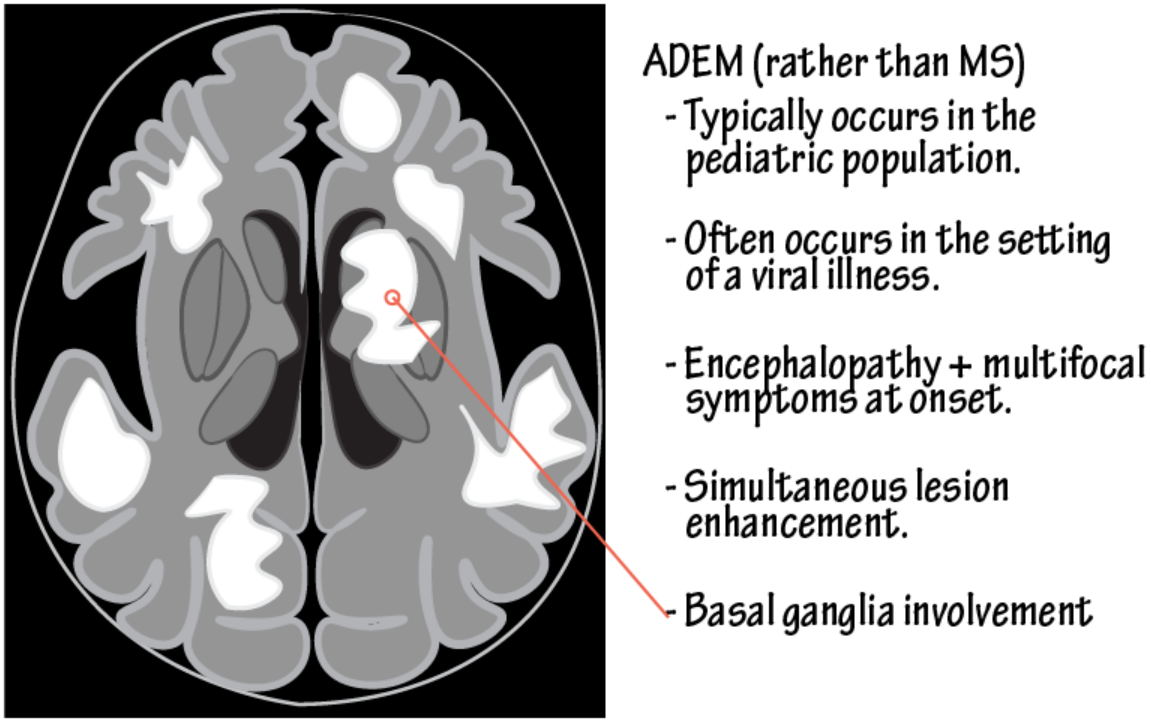
- Depressed level of consciousness, change in behaviour and psychosis with multifocal neurologic disturbances such as visual field defects, aphasia, motor and sensory deficits, ataxia, movement disorders, focal or generalized seizures,

Diagnosis

Neuroimaging is crucial in diagnosing ADEM: ***MRI*** shows multiple hyperintense lesions in both white and gray matter

Treatment

- Because of its presumed autoimmune basis, the most widely used therapy is ***immunosuppression.***



Questions

1. Hydrocephalus is most associated with:

A. Head size two standard deviations below mean
B. Head size one standard deviation below mean
C. Head size one standard deviations above mean
D. Head size two standard deviations above mean
E. Head size three standard deviations above mean

D

2. Lower motor neuron lesion is caused by all the following except:

A. Congenital myopathy
B. Neuropathy
C. Spinal muscle atrophy
D. Hereditary sensory motor neuropathy
E. Cerebral palsy

E

3. The mother of a previously normal 5-year-old girl rushes her to the emergency department because she woke up "swaying" in bed, and when she tried to walk she was very unsteady. On examination you found an alert and interactive, afebrile, non-toxic child with clearly unsteady gait, and hand tremors whenever she tried to reach out for your stethoscope, as well as nystagmus. Her neurological exam was otherwise unremarkable. The mother tells you that she recently recovered a febrile illness with a vesicular rash. What is the most appropriate course of action?

A. Send the child for an urgent MRI of the brain
B. Lumbar puncture
C. Electromyography and nerve conduction velocities.
D. Reassurance and follow up
E. Electroencephalogram

D

4. Which of the following is least likely to be found in the history of a child with a diagnosis of post anoxic cerebral palsy?

F. Placenta previa with antepartum hemorrhage
G. History of two previously affected sibs
H. Prolonged forceps assisted vaginal delivery
I. A need for endotracheal epinephrine in the delivery room
J. A bad CTG

B

5. The parents of a 3 months old boy bring him to the ER with obtundation, vomiting and seizures. They tell you he is an ex premature with a prolonged NICU admission when he developed intraventricular hemorrhage and meningitis, but was discharged at the age of 45 days. The parents have noticed his head to be getting larger with time. Over the past week the boy was crying excessively, with a gradual decrease in his feeding tolerance.

What is the DIRECT explanation of his current symptoms?

A. Dilated ventricular system
B. Increased intracranial pressure
C. An extension of his intraventricular hemorrhage
D. A recurrence of his meningitis
E. An episode of gastroenteritis.

B

6. The mother of a 5 years old boy presents to you complaining that her son has not yet started to walk. She tells you that he sat unsupported at the age of 8 months. He says 50 intentional words and can understand many more, but can not yet say 2 word sentences. She tells you that both of her own brothers were late walkers and died at the ages of 15 and 18 years, when they were both wheel-chair bound.

What is the DIRECT explanation of his current symptoms?

A. Absent ankle reflexes
B. Hypertrophied calves
C. Sphincteric affection
D. Positive patellar and adductor reflexes
E. Squint

B

What is the most relevant initial investigation?

A. Electromyography
B. Muscle biopsy
C. Total CPK
D. Muscle MRI
E. Genetic Mutation analysis

C

7. Which of the following is least likely to be seen on the lumbar puncture result of a patient with Guillain Barre Syndrome?

A. A CSF opening pressure of 45 cmH2O (normal up to 20)
B. A normal lumbar puncture analysis in the first week of illness
C. A CSF protein level of 105 mg/dl (normal 15-45)
D. A CSF glucose is normal
E. No cells in CSF

A

8. The parents of a 2-year-old bring her to the emergency center after she had a seizure. Although the parents report she was in a good state of health, the vital signs in the emergency center reveal a temperature of 39°C (102.2°F). She is now running around the room. Which part of the story would suggest the best outcome in this condition?

A. A CSF white count of 100/μL.
B. Otitis media on examination.
C. The seizure lasted 30 minutes.
D. The child was born prematurely with an intraventricular hemorrhage.
E. The family reports the child to have had right-sided tonic-clonic activity only.

B

9. About 12 days after a mild upper respiratory infection, a 12-year-old boy complains of weakness in his lower extremities. Over several days, the weakness progresses to include his trunk. On physical examination, he has the weakness described and no lower extremity deep tendon reflexes, muscle atrophy, or pain. Spinal fluid studies are notable for elevated protein only. Which of the following is the most likely diagnosis in this patient?

A. Bell palsy
B. Muscular dystrophy
C. Guillain-Barré syndrome
D. Charcot-Marie-Tooth disease
E. Werding-Hoffmann disease

C

10. A 10 months old girl presents to the ER after she had just had a febrile seizure. All of the following support the diagnosis of a simple febrile seizure EXCEPT:

A. The seizure was focal
B. The girl is now fully conscious with a normal neurological examination
C. The seizure lasted for 5 minutes
D. There is bilaterally enlarged tonsils with pus follicles
E. The seizure aborted spontaneously

A

11. A 3-year-old boy's parents complain that their child has difficulty walking. The child rolled, sat, and first stood at essentially normal ages and first walked at 13 months of age. Over the past several months, however, the family has noticed an increased inward curvature of the lower spine as he walks and that his gait has become more "waddling" in nature. On examination, you confirm these findings and also notice that he has enlargement of his calves.

Which of the following is the most likely diagnosis?

A. Occult spina bifida
B. Muscular dystrophy
C. Brain tumor
D. Guillain-Barré syndrome
E. Botulism

B

12. The following is expected to be found in the assessment of a child with CP:

A. Regression in previously acquired milestones
B. Seizures
C. A macular cherry red spot on fundus examination
D. Persistent metabolic acidosis
E. Lens dislocation.

B

13. You are called in to see a 12-month-old boy with clear motor developmental delay, who was admitted for bronchopneumonia. 2 days into his admission the boy developed respiratory failure and was intubated. All attempts at weaning him off mechanical ventilation have failed. On examination you find a floppy child with a bell shaped chest and alert look. His deep tendon reflexes are completely absent.

Choose the most likely investigation result for this patient:

A. A total CPK of 10,000 (normal up to 300 iu/ml)
B. Cataract and microphthalmia on ophthalmological evaluation
C. Electromyography showing diffuse anterior horn cell affection.
D. Pelvi-abdominal ultrasound showing huge hepatosplenomegaly.
E. Microcephaly and periventricular calcifications on brain CT.

C

1. *Shahd, 15 yrs*

You are contacted by the emergency room to see a previously healthy girl who presents with complaints of worsening headache for 3 weeks and blurred vision for 2 days.

The headache began several weeks ago and has gotten more severe over the last several days.

She now describes it as a constant, pounding sensation all over her head.

Two days ago she also developed blurred vision.

She does not have a prior history of headaches or migraines. She denies photophobia, phonophobia, nausea, and vomiting. She has not had any recent fever, cough, or congestion.

Vital Signs: afebrile

General Examination: The patient appears to be in moderate discomfort. There is no nuchal rigidity or back pain to palpation.

Neurologic examination:

- Mental Status: Alert.
- Language: She has normal naming, repetition, and comprehension
- Motor: She has normal bulk and tone with 5/5 strength throughout
- Coordination: There is no dysmetria
- Sensory: No deficits are noted
- Gait: She has a normal heel, toe, flat, and tandem gait
- Reflexes: 2+ throughout with bilateral plantar flexor responses
- Cranial Nerves: Her pupils are equal, round, and reactive to light. Her extraocular muscles are intact except for difficulty completely abducting her left eye. Diplopia is reported on left lateral gaze.
- Facial sensation and expression are intact symmetrically. Her gag is present. The tongue and uvula are midline.
- Visual field testing demonstrates enlarged blind spots bilaterally but is otherwise normal.
- Funduscopic examination reveals elevation of optic disc margins, absence of venous pulsations and tortuous vessels bilaterally.

Summary

The patient is a previously healthy 15-year-old girl who presents with a 3-week history of worsening headaches and a 2-day history of blurred vision.

On neurologic exam, she is found to have bilateral papilledema, and a left abducens nerve palsy, and enlarged blind spots on visual field testing.

Localization:

- Bilateral papilledema indicates increased ICP.
- Progressive headache is likely caused by the displacement of the intracranial pain sensitive structures (cerebral and dural arteries, large veins, venous sinuses) by elevated ICP. Pain sensation in the supratentorial intracranial blood vessels is mediated through the trigeminal nerve.
- Enlarged blind spots localize to the retinal cells adjacent to the optic disc and can occur with any cause of optic disc swelling.
- Isolated left abducens nerve palsy is a nonspecific sign often seen with elevated ICP
- Increased ICP: downward displacement of the brainstem..... stretches the abducens nerve as it passes out of the brainstem and through the subarachnoid space.
- Produces weakness of the ipsilateral lateral rectus muscle, causing diplopia on left lateral gaze

DD: Worsening headache with blurry vision

- Primary headache syndrome such as a migraine, tension headache, or cluster headache.
- Infectious process such as meningitis or encephalitis. No fever, photophobia, or nuchal rigidity
- Trauma could lead to headache and elevated ICP with a subdural hematoma but no history of head injury.
- Hydrocephalus from a brain tumor could cause this clinical picture but might be expected to cause more neurologic deficits.
- A slowly progressive subarachnoid bleed or sinus venous thrombosis should be considered.

2. *Selim, 17 months*

is seen in the neurology office for evaluation of spells. The patient has experienced two stereotypic episodes in which he abruptly stopped breathing, lost consciousness, and had shaking of all four extremities.

Both episodes occurred after his older brother took away a favorite toy. After a few cries, he stopped breathing, turned blue, and went limp.

As his mother went to pick him up during the spells, he became stiff and had jerking of his extremities for a few seconds.

The child then quickly responded to his mother's voice and his color returned to normal. Both spells lasted less than 1 minute.

The boy was the product of a normal pregnancy and delivery. He has no significant past medical history and his development is age appropriate. His father had similar episodes at similar age.

***General Examination*:** Unremarkable

***Neurologic examination*:**

- Awake, alert, and playful
- Language: He babbles and says several words
- Cranial Nerves: II through XII are intact
- Motor: He has normal bulk and tone. He moves all four extremities equally against gravity
- Coordination: There is no dysmetria grabbing for toys
- Gait: He has a normal toddler gait
- Reflexes: 2+ throughout with bilateral plantar flexor responses

Summary

The patient is a healthy, developmentally normal 17-month-old boy who presents after two provoked episodes of crying, apnea with cyanosis,loss of consciousness, and brief jerking of the extremities.

His neurologic exam is normal.

Localization:

- There are no focal findings on the child's neurologic exam.
- Both spells were provoked by anger were associated with a brief cry followed by apnea and cyanosis.
- The stiffness and generalized jerking of the extremities likely represent a brief anoxic reflex seizure.
- Immediately there after he returned to his usual state of good health.

3. *Adham, 5yrs*

is brought to your office because his mother has noted that he has difficulty with activities that other children in his kindergarten class can do well.

The patient sat up at 10 months and began to walk independently at 18 months. He is now unable to stand or hop on one foot.

His mother complains that he runs very awkwardly and fatigues easily. He also has difficulty walking up stairs.

In addition, he seems to be behind his peers in learning the alphabet, colors, and numbers.

He was a FT infant and his mother did not experience any pregnancy complications.

General Examination: There is a mild spinal lordosis and tightness of the heel cords.

Neurologic examination:

- Mental Status: Alert. Language: He speaks in full sentences.
- Cranial Nerves: His pupils are equal, round, and reactive to light.
- His extraocular muscles are intact.
- His face is symmetric without weakness.
- His palate elevates symmetrically and his tongue is midline without fasciculations.
- Motor: He has mildly enlarged calves and mild diffuse hypotonia. Formal testing is difficult given his age but demonstrates lower more than upper extremity proximal weakness.
- Coordination: There is no dysmetria.
- Sensory: No deficits are noted.
- Reflexes: 1+ throughout with bilateral plantar flexor responses.
- When lying on the examination table, he has trouble flexing his neck against gravity.
- He places one hand on his knee to stabilize himself when arising from the floor.
- Gait: He has a mildly waddling gait with toe walking and lordosis.

Summary

The patient is a healthy 5-year-old boy who presents with progressive proximal weakness, fatigability, and mild cognitive delay.

His general exam demonstrates lordosis and his neurologic exam shows proximal more than distal weakness,

Hypotonia, hyporeflexia,

Calf pseudohypertrophy,

Gower's sign and an abnormal gait (waddling, toe walking).

Localization:

- ***Progressive proximal weakness*** appears the cause of his difficulties with tasks such as hopping, climbing stairs, and rising from the floor without support
- It also explains his lordosis, which is caused by weakness of pelvic girdle, abdominal, and back musculature

DD:

- The differential diagnosis of a child with progressive proximal weakness is broad, includes diseases of: AHC - PN - NMJ - MS
- Myopathies, however, are the most common culprit.

- ***Tight heel cords and toe walking*** are caused by weakness of the more distal anterior tibial and peroneal musculature
- ***Calf hypertrophy*** is relatively specific for a myopathic process, in particular DMD
- ***Mild cognitive delay*** is suggestive of a global cortical process and is likely related to the patient's underlying disorder
- ***Positive family history***

4. *Fadia, 9yrs*

Presented at our pediatric epilepsy clinic for assessment of episodes of altered mental status which first occurred three months earlier.

Episodes of "blanks out" for a few seconds and sometimes stops writing for 10 seconds during her lessons. Her teacher calls her name, but she doesn't seem to hear her. She usually blinks a few times and her eyes may roll up a bit, and sometimes she just stares. Then she is right back where she left off in her writing.

Some days she has more than 50 of these spells. Each staring episode lasted a few seconds and was of sudden onset and offset without any postevent confusion.

Past medical and Family history were uneventful.

Her neurological examination was normal.

5. *Zeina, 2years 5 months*

Presents to the emergency room for evaluation of fevers and lethargy. The patient was in her usual state of health until 7 days ago when she began having fevers up to 40°C. She was seen by the pediatrician 2 days after her fevers began and was diagnosed with a viral syndrome.

Over the last 2 days she has become less energetic and playful. Her oral intake has also decreased. Over the last day her parents have noticed episodes of unresponsiveness, body stiffening, and left-sided jerking lasting up to 1 minute.

There are no known sick contacts but she is in daycare.

Vital Signs: Tachycardic and febrile.

General Examination: Ill-appearing, nondysmorphic. Her general exam is otherwise unremarkable.

Neurologic examination:

- Neurologic Examination:
- Mental Status: She is irritable and lethargic but can be aroused.
- Cranial Nerves: Her pupils are equal, round, and reactive to light. Her extraocular movements appear intact without gaze preference. Her face is symmetric. Her tongue is midline.
- Motor: She has normal bulk and tone. She withdraws her extremities purposefully with antigravity strength to minimal pain stimuli.
- Coordination: No abnormal movements are noted.
- Reflexes: 2+ symmetrically with bilateral plantar extensor responses.

Summary

Previously healthy 2-years, 5-month-old girl. 1 week of fever, lethargy, and left focal seizures.

Her examination demonstrates tachycardia, fever, altered mental status and bilateral plantar extensor responses.

Localization:

- ***Lethargy:*** nonspecific sign and usually indicates diffuse cerebral dysfunction.
- ***Bilateral plantar extensor responses:*** ?? localize to the corticospinal tracts and given her lethargy, are most likely a result of the process involving her cortex.
- ***Left focal seizures:*** localize to the right cortex.
- Many processes can account for this patient's signs and symptoms
- But the triad of ***fever, lethargy, and seizure*** is most consistent with an acute CNS infection
- Focal neurologic signs, such as focal seizures in this clinical setting, are suggestive of ***HSV encephalitis.***

6. *Ahmed, 6 years*

Was brought to our Hospital with complaints of slurring of speech, difficulty in swallowing, left hand weakness and fever for 2 days.

Prior to this he had fever for 5 days, 2 weeks back along with mild cough and cold.

On Day 4 of fever child had one episode of seizure. He was admitted in the intensive care unit of a local hospital and managed.

MRI of brain was done which was unremarkable

CSF cytobiochemistry was normal.

He was managed with IV Ceftriaxione and IV Acyclovir IV Phenytoin and other supportive measures. Gradually he improved and was discharge in a stable condition after 6 days.

Two days later patient developed slurring of speech and difficulty in swallowing with fever for which he was admitted in our hospital.

He was evaluated at emergency and his GCS was 10/15.

On examination, he was in altered sensorium; tone was increased in upper and lower limb with brisk deep tendon reflexes. Plantars were upgowing and cranial nerve examination was normal. No meningeal sign was present.

He was started on with IV antibiotic (ceftriaxone), acyclovir and supportive measures.

Investigations:

- Initial investigations revealed: CBC, RFT and LFT were normal.
- CRP was 17 mg/L, Typhi dot, Widal test, Blood C/S and Malarial antigen test was negative.
- Fundoscopy was normal.
- Lumbar puncture revealed: CSF cell count was 3 cells (100% lymphocytes), Protein - 32 mg/dl and Glucose - 56 mg/dl (capillary blood glucose was 86 mg/dl) LDH - 12 U/L. CSF Bacterial antigen test causing encephalitis (Streptococcus Group B, H. influenzae b , S. pneumoniae , N. meningitidis , E. coli K1), herpes IgM test and herpes PCR were negative.
- EEG revealed generalized cerebral dysfunction with no definitive irritable foci.

Summary

Previously healthy 6-years-old boy

Recent history of a non-specific viral infection couple of week ago

Presenting with fever and altered sensorium;

Sudden onset multifocal neurologic disturbances; slurred speech, motor deficits, seizures

7. Mahmoud, 11yrs

Presenting with seizures lasting for about 50-60 seconds with increased tonicity, recurrent every few days to few weeks and associated with salivation, fecal and urine incontinence... since 1 year of age.

With inability to gain weight and perform activities of daily living.

He was on liquid diet since then along with persistent spasticity in body.

At the age of 10 years, treatment was initiated for seizures. Since then, improvement has been observed in the patient with decrease in frequency of seizures, and improvement in diet intake (started on solid food as well)

PH: The patient was born FT, NVD, unattended prolonged delivery at home. The patient had delayed first cry, distressed, cyanosed and spent a few hours till he was admitted to a NICU. He stayed for 22 days, and was on MV for 9 days.

DH: History of impaired development; motor, mental and speech.

Currently, the patient could hardly hold his neck, can't sit without support can't stand/walk

He could not pay attention to sound and had monosyllable speech

He could not recognize his parents, nor his family members

He had no civil senses, toilet demand and gender recognition

And his condition is stationary

General Examination:

- Patient is conscious, uncooperative and unable to respond to commands.
- Weight 15 kgs, height 118cm (Both below 3 percentile)
- Head circumference – 43 cm

Neurologic examination:

- Scissoring on holding the patient below his arms.
- Flexion deformity at most of his joints (elbows, wrist)
- Generalized spasticity
- Brisk Deep tendon reflexes
- +ve Babniski sign

Summary

Anoxic insult at birth

Developmental delay

Stationary UMNL

Seizures

Failure to thrive

8. *Radwa, 9 days*

A term female infant of 9 days old was born with a big head that was not noticed earlier in-utero.

Natal history, emergency lower segment cesarean section was made because of failure of progression of delivery even after induction with oxytocin.

On delivery the baby didn't cry immediately nor did she suck. She was just found to be a small baby with a big head.

After birth the APGAR score was 2 and 4 at first and fifth minutes respectively, indicating severe birth asphyxia.

Resuscitation was done by mask and then at neonatal ward kept under Oxygen therapy for few hours, then was discharged when started feeding on expressed breast milk.

***General Examination*:**

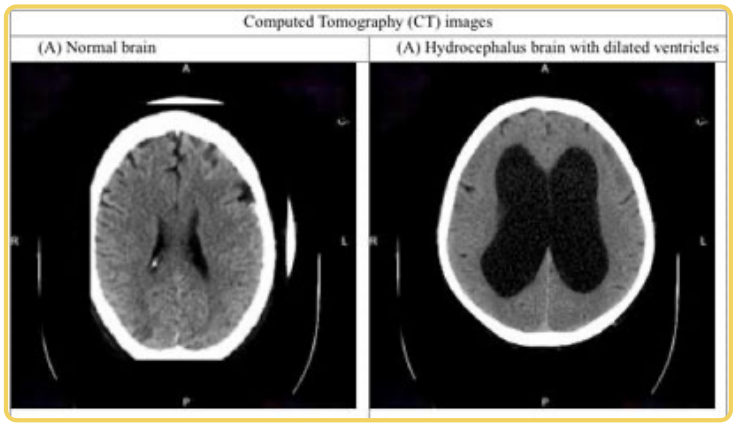
- Anterior and posterior fontanelle had widen
- Impaired up gaze (setting sun signs)
- Dilation of scalp veins
- Hypertonic lower extremities
- Occipitofrontal Circumference 49.5cm, (normal 32-35cm conclusion, ***Hydrocephalus***)
- Length 49cm
- Weight 3.9kg

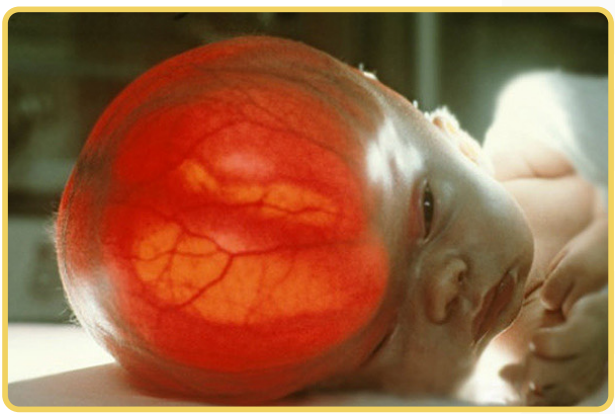
***Neurologic examination*:**

- The baby was alert with partial sucking reflex
- Exaggerated reflexes
- The muscle tone was hypertonic

***Investigations*:**

- Ultra-Sound scan was repeated showing the restriction of brain cortical growth due to fluid compression
- Bilateral ventriculomegally merging into one probably due to atresia of the aqueduct of Sylvius





9. *Ahmed, 13 years*

Is seen in your office on an urgent basis for complaints of lower extremity weakness.

The patient was in his usual state of good health until that morning when he noticed that his legs were weak when getting out of bed.

His symptoms seem to be getting worse because now he is having difficulty walking and difficulty standing from sitting position.

The patient does not have any medical problems.

He had an URT infection like all of his friends about 2 weeks ago but he did not experience any fevers.

He plays football but denies any recent trauma.

General Examination: Afebrile and no nuchal rigidity or papilledema.

Neurologic examination:

- Mental Status: Alert.
- Language: He has fluent speech without dysarthria.
- Cranial Nerves: His pupils are equal, round, and reactive to light. His extraocular muscles are intact. His facial movements are symmetric and without weakness. There is a strong gag and his tongue is midline without fasciculations.
- Motor:
  - He has normal bulk with mild hypotonia in the lower extremities.
  - Strength in the upper extremities is 5/5 and there is no pronator drift.
  - Lower-extremity strength is 3/5.
- Coordination: No dysmetria is noted
- Sensory: Intact to light touch, temperature, vibration, and proprioception.
- Gait: Unable to walk unassisted
- Reflexes: Absent in the lower extremities. Trace at the biceps and triceps. Bilateral plantar flexor responses are appreciated

Summary:

- The patient is a previously healthy 13-year-old boy who presents with an acute, progressive, ascending paralysis in the setting of a recent viral illness.
- His neurologic examination demonstrates proximal and distal lowerextremity weakness with areflexia and without apparent sensory abnormalities.

Localization:

- The lower extremity weakness and areflexia in this case most likely localizes to (LMNL)
- The other primary consideration might be a central process involving the spinal cord (TM although UMNL but shock stage is hypotonia and reflexia but extensor planter)
- Although there is no comment in the vignette regarding a sensory level or sphincter tone, the sensory examination is normal. There is no history of bowel/bladder incontinence or back pain that would be more suggestive of a spinal cord process.
- The plantar responses are flexor and no long tract signs. Thus, a disorder of the peripheral nerves seems more likely.

10. *Ahmed, 3 yrs*

A healthy boy, brought to the ER after waking up in the morning with a wobbly gait.

He had been fine the night before but is now having difficulty sitting up. He is also unable to walk independently.

There is no history of trauma.

He is not in any apparent pain.

PH: Approximately 2 weeks ago he had a low grade fever with cold symptoms but has been well since.

DH: He has a good appetite and is not irritable.

PH: He was born FT by SVD without complications.

DH: His development has been normal.

FH: There is no family history of neurologic disease.

General Examination:

- Vital Signs: Afebrile.
- General Examination: There are no dysmorphic facial features.
- Fundi could not be visualized.

Neurologic examination:

- Mental Status: Alert and playful.
- Language: He uses short phrases pronunciation. with age-appropriate
- Motor: He has normal bulk and tone. He moves all extremities against gravity.
- Gait: he supports himself on his legs but is unable to walk unassisted due to ataxia
- Reflexes: 2+ throughout with bilateral plantar flexor responses.
- Cranial Nerves: His pupils are equal, round, and reactive to light. He tracks objects in all directions. Nystagmus is noted on lateral gaze bilaterally. His face is symmetric. The tongue is midline.
- Coordination: Significant truncal ataxia is noted when he is in a sitting position. Dysmetria is appreciated bilaterally when he tries to pick up a pencil from the examiner's hand.

Localization:

- The neurologic findings on this patient's exam localize to the cerebellum diffusely as he has nystagmus, appendicular, as well as truncal/gait, ataxia.
- No focal features.

11. *Hassan, 2yrs*

ER notifies you that 2-year-old boy was in his normal state of good health until this morning when he complained of a headache and then fell to the floor. His mother saw jerking of both arms and legs, lasted for less than 5 min

He has had normal development.

His family history is significant for a single seizure of unknown etiology in his father at 4 years of age.

General Examination:

- HR was 108 bpm
- respiratory rate 16 breaths/min
- blood pressure 90/60 mm Hg
- temperature 40°C
- His blood sugar level was 135 mg/dL.
- By the time the child arrived to the ER, he was awake and he recognized his parents.
- His physical examination in the ER is significant only for a red bulging immobile tympanic membrane.
- CBC and urinalysis are normal.

Summary:

- An otherwise normal 2-year-old boy, with a family history of a single seizure in his father at 4 years of age, has a brief, generalized, self-limited seizure associated with an elevated temperature
- His examination is nonfocal
- He has completely recovered within 1 to 2 hours of the seizure

12. *Hussein, 3.5yrs*

Hussein is a three and a half year old boy whose mother brought him in to your clinic for evaluation. Her chief concern is that the boy was a rather late walker. he walked alone at the age of 2 years old and fell frequently. She tells you that over the past six months things have gotten even worse. He falls even more often than before. His walk has gotten very “funny”, resembling that of a duck. He is having more and more difficulty climbing stairs, though he can descend stairs fairly well. Holding a cup full of water is also more difficult than scribbling on paper, which he really enjoys at his nursery. his teacher told the mother that he has great difficulty getting up after playing of the floor with his friends, and has a funny way of ‘climbing upon himself ’ to get off the floor. He can talk in long sentences, obeys complex commands and knows 6 colors.

a) What other points do you want to ask about in history?

- Perinatal history: of decreased fetal kicks and/or polyhradamnios: more with congenital myopathies than with later onset muscle dystrophies.
- Course of weakness: stationary or progressive. Congenital myopathies tend to be non progressive, whereas muscle dystrophies are progressive diseases.
- Family history of similar conditions.

Here the mother tells you that her brother and her uncle were both afflicted with a similar condition. They both became wheel chair bound at the ages of 14 and 16 respectively, and died in their early twenties from a heart condition.

b) What is the name of the gait the mother is describing? What does it signify?

- Waddling Gait. Signifies muscle disease.

c) What is the name of the sign his nursery teacher is describing? what is its significance?

- Gower Sign; Signifies non specific Proximal muscle weakness.
- A positive Gower sign is NOT SPECIFIC for muscle disease and can be seen in any other condition with proximal muscle weakness such as spinal muscle atrophy.

d) What would you look for during examination?

- Distribution of weakness: Proximal more than distal. can also be inferred from the given history (going up stairs more difficult than going down, holding a heavy cup more difficult than holding the pen).
- The presence of facial muscle weakness: usually seen in congenital myopathies and not in Duchenne Muscle dystrophy.
- Tone: slight hypotonia. Maybe contractures with tendon Achilles shortening in advanced cases (unlikely in this child as still very young).
- Deep tendon reflexes: In muscle disease reflexes are diminished but not absent. Absent reflexes would alternatively suggest a peripheral nerve disease such as HSMN.
- Calf muscle pseudo hypertrophy
- Scapular winging (less prominent and later in DMD)

e) What is the first investigation you would order?

- Total CPK.

Total CPK comes back and it is remarkably elevated at 18,560 (upper limit of normal 250 IU/L).

f) What other investigations would you then order?

- This high CPK suggests a muscle dystrophy. The family history suggests an x linked recessive pattern of inheritance. The ages at which the uncle and mother's uncle were crippled and died favors Duchenne Muscle dystrophy as opposed to Becker (milder form, same genetic mutation).
- ***You ask for:***
  - EMG: myopathic pattern
  - Muscle biopsy: with staining for muscle dystrophin. The advent in genetic testing has recently obviated the need for muscle biopsy in DMD. It is now standard practice to proceed for genetic testing.
  - Genetic testing for Dystrophin gene mutation.
  - Baseline echo and ECG: for evaluation for cardiac function.

The results of genetic testing come out confirming a missense-mutation in the Dystrophin gene. The patient is diagnosed as a case of Duchenne Muscle dystrophy.

g) How will you manage this child?

***Multidisciplinary approach*:**

- ***Pediatric Neurologist*:**
  - Regular developmental assessment.
  - Low dose steroids with follow up (prolongs time to wheel chair need).
  - Consideration for novel therapies for DMD: based on mutation.
- ***Physiotherapist*:**
  - Regular muscle strengthening exercises
  - Stretching of tendon Achilles to prevent shortening.
  - May need ankle foot orthoses
- ***Cardiologist*:**
  - Serial echoes.
  - ACE inhibitors for cardiomyopathy.
- ***Pulmonologist*:** Serial pulmonary function tests (may develop respiratory muscle weakness later)
- ***Orthopedic surgeon*:** for contractures/ deformities/ scoliosis.
- ***Geneticist*:** for counselling and carrier testing of sibs (CPK) and future children.

13. *Ahmed, 10 months*

Ahmed is a 10 month old boy who is the 1st in order of birth to non related parents. He has a non remarkable perinatal history and has been meeting developmental milestones for his age. His family has been adopting an 'anti vaccination policy' and so he has not received any vaccines to date. His family history is significant for febrile seizures in his father and 2 uncles, as well as a maternal cousin.

Ahmad is brought to the ER having a 'fit'. Upon arrival, Ahmad is dusky, drooling, with his eyes rolled up, his back arched and stiff and his 4 limbs are spread out with rhythmic clonic jerking. The mother tells you that he has been like this for 35 minutes. She tells you that he has had a fever for the past few days. Today he vomited twice but was otherwise okay. His temperature has shot up to 39.5 degrees just before he went into the fit.

a) How can you describe this seizure?

- Febrile GTC Status Epilepticus

b) How can you describe this seizure?

1. ABCs First, finger stick glucose
2. IV line and give BDZ (best is Midazolam, otherwise diazepam). If failed PR Diazepam.
3. If seizures does not stop proceed to second and third lines PRN.
4. Reduce temperature and Obtain bloods (electrolytes, CBC, CRP).
5. Examination for source of infection (HEENT, Chest etc.).

The seizure abates after two doses of IV midazolam and a loading dose of IV phenytoin. Ahmed appears drowsy afterwards and remains lethargic for the next 12 hours. no source of infection is found on examination. There are no signs of meningeal irritation.

c) Does Ahmad need a Lumbar Puncture? Why?

Yes.

1. Any child less than 12-18 months should have LP as part of evaluation of febrile seizures.
2. Not a simple febrile seizures (duration over 30 minutes - Feb Status)
3. Prolonged lethargy after febrile seizures warrants LP even in older children. It is an independent predictor of CNS infection in febrile seizures.
4. Should be stressed that signs of meningeal irritation are commonly absent in children under 18 months.

Their absence SHOULD NOT be used to exclude meningitis.

d) What will you ask for in the Lumbar Puncture?

1. Gram stain
2. CSF cell type and count
3. CSF proteins, glucose (paired with serum glucose)
4. Hold tube for Microbiological culture studies Plus or minus viral PCR studies

e) When is the best time to start Antibiotics/ Antivirals?

- Immediately as soon as CNS infection is suspected, empirical coverage with antibiotics with or without acyclovir should be started.
- ***THIS DECISION SHOULD NOT BE DELAYEDPENDING LP OR ITS RESULTS.***

You immediately receive the results of the LP and they are as follows: Gram staining: positive for gram positive diplococci. Cells: 550 cells/HPF, 90% polymorphs, Glucose 7 mg/dl (serum glucose 145 mg/dl), proteins 750 mg/dl (normal 15-45 mg/dl).

f) What is the next step?

- This is most likely a case of pneumococcal meningitis.
- Keep Ahmad on Vancomycin, dexamethasone, and a third generation cephalosporin. Send hold tube for bacterial culture and change antibiotics accordingly.

The culture comes back confirming the diagnosis of pneumococcal meningitis, sensitive to vancomycin. You keep Ahmed on treatment for 14 days as per standard protocol. He makes a slow and steady recovery. on the 14th day, the boy is discharged. After 5 days at home, Ahmad starts to be lethargic again, very irritable and cries inconsolably, which according to his mother

is ‘very not like himself’. She also notices that his anterior head opening has started to swell. she notices his head keeps getting larger. On D20 post discharge she rushes him back again to ER with vomiting. She tells you that he had a brief fit in the morning.

g) What do you suspect?

- Post meningitic complications such as post meningitis hydrocephalus or subdural empyema.

h) What should you do to confirm your suspicions?

- Urgent neuroimaging
- MRI is done and shows hydrocephalic changes.

i) What should you do?

- Refer to neurosurgery for urgent CSF diversion procedure.

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Pediatrics