- **Hypotonia:**
  - **Definition**: decreased resistance of movement when muscles of the child are PSSIVELY stretched. Notice that "weakness" is the decreased force generated by ACTIVE contraction of the muscle.
  - **Classification:**
    - ✓ Central hypotonia: upper motor neurons are affected.
    - ✓ Peripheral hypotonia: lower motor neurons are affected.
  - **Etiology:**
    - ✓ Central hypotonia:
      - ❖ *Congenital*: Cerebral malformation, Down syndrome or Prader-Willi syndrome.
      - ❖ *Acquired*: Hypoxic-ischemic encephalopathy, trauma, infection (e.g. sepsis or meningitis), intracranial hemorrhage or electrolytes abnormalities.
    - ✓ Peripheral hypotonia:
      - ❖ *Spinal cord*: spinal muscular atrophy.
      - ❖ *Peripheral nerve*: familial dysautonomia.
      - ❖ *Neuromuscular junction*: neonatal myasthenia or botulism.
      - ❖ *Muscle*: congenital muscular dystrophy or congenital myotonic dystrophy.
  - **Clinical features:**
    - ✓ Weak cry, decreased spontaneous movements and frog-leg posture.
    - ✓ Central hypotonia: Seizures in neonatal period, increased deep tendon reflexes and ankle clonus.
    - ✓ Peripheral hypotonia: History of decreased fetal movements + breech presentation, decreased muscle bulk and deep tendon reflexes.
  - **Investigation:**
    - ✓ Central hypotonia: head CT (looking for lesions), serum electrolytes and FISH/karyotyping (detecting genetic disorders).
    - ✓ Peripheral hypotonia: EMG, muscle biopsy, DNA test for spinal muscular atrophy and serum CK.
  - **Types of peripheral hypotonia:**

Spinal muscular atrophy	• **Definition**: degeneration of anterior horn cells. AR disorder in which mutation is affecting chromosome 5 (SMN1 gene). • 2nd most common neuromuscular disorders after Duchenne. • **Classification**: infantile (< 6 months); intermediate (6-12 months); juvenile (> 3 years). • **Clinical features**: tongue fasciculations, Bell-shaped chest and frog-leg posture. • **Diagnosis**: DNA testing. • **Management**: supportive. • **Prognosis**: infantile (survival beyond 1st year unusual); intermediate (survival to adolescence); juvenile (survival to adulthood).

Infantile botulism	• **Definition**: bulbar weakness and paralysis due to ingestion of Clostridium botilinum spores (botulinum toxin). • Commonly from contaminated **HONEY** thus inhibiting pre-synaptic release of Ach in neuromuscular junction. • **Clinical features (12-48 hours after ingestion of toxin):** constipation (1st most common symptoms); loss of previously obtained motor milestones; ophthalmoplegia and hyporeflexia. Notice that paralysis is symmetrical and descending. • **Diagnosis**: detect bacteria/toxin in stool; EMG. • **Management**: supportive. • **Prognosis**: Excellent (with complete recovery).
Congenital myotonic dystrophy	• **Definition**: AD disorder characterized by inability to relax contracted muscles. • **Etiology**: chromosome 19 is affected; there is trinucleotide repeat commonly transmitted to affected infants through affected MOTHERS. • **Clinical features**: neonatal feeding and respiratory problems; myotonia is not present until the AGE OF 5 YEARS; myotonic fascies; ptosis; stiff-straight smile and inability to release the grip after hand shaking. • **Diagnosis**: DNA testing. • **Management**: supportive. • **Prognosis**: all survivals have mental retardation.

- **Hydrocephalus:**
  - **Definition**: increased CSF under pressure within ventricles of the brain which is caused by:
    - ✓ Increased production of CSF.
    - ✓ Blockage of CSF flow.
    - ✓ Decreased absorption of CSF.
  - **Types:**

Non-communicating	Enlarged ventricles due to blockage of CSF flow (e.g. aqueductal stenosis).
Communicating	Enlarged ventricles due to increased production of CSF (e.g. tumors) or decreased absorption of CSF (e.g. bacterial meningitis).
Ex vacuo	**NOT TRUE HYDROCEPHALUS**; ventricles are enlarged due to brain atrophy

  - **Congenital causes:**
    - ✓ Chiari type-II malformation: downward displacement of cerebellum and medulla through foramen magnum causing obstruction of CSF flow.
    - ✓ Dandy-Walker malformation: combination of absent cerebellar vermis and enlarged 4th ventricle causing obstruction of CSF flow.
    - ✓ Congenital aquiductal stenosis: X-linked trait.
  - **Clinical features:**
    - ✓ Increased head circumference.
    - ✓ Infants: bulging fontanelles, wide sutures and sunset sign (downward deviation of both eyes).

- ✓ Older children: S&S of increased intracranial pressure (e.g. headache, nausea/vomiting and papilledema).

- **Diagnosis**: head CT-scan.
- **Management**: VENTRICULO-PERITONEAL SHUNT. Complications are: shunt infection or obstruction.

- **Spina bifida:**
  - **Definitions:**

Spina bifida	Failure of bone fusion in posterior midline of vertebral column
Meningocele	Herniation of **meninges only**; NOT associated with neural deficits
Meningomyelocele	Herniation of **meninges and spinal cord**; MORE COMMON THAN MENINGOCELE

  - **Epidemiology**: HIGHEST incidence in Ireland; LOWEST in Japan.
  - **Etiology**: it is associated with folic acid deficiency and exposure to teratogens (e.g. valproic acid and phenytoin).
  - **Clinical features:**
    - ✓ Spinal bifida occulta: hairy patch covering the area in lumbar region; no neurologic deficits.
    - ✓ Meningocele: transilluminated mass filled with CSF; usually no neurologic deficits.
    - ✓ Meningomyelocele:
      - ❖ *Neurologic defects*: complete paraplegia (above L3); bladder/bowel incontinence (S3 and below).
      - ❖ *Associated complication*: hydrocephalus and lower extremity fractures due to loss of sensation.
  - **Diagnosis:**
    - ✓ Pre-natal diagnosis (common): ↑ maternal serum alpha fetoprotein; ultrasound.
    - ✓ Spina bifida occulta: presence of skin abnormality and confirmed by spinal radiographs.
    - ✓ Meningocele & meningomyelocele: physical examination.
  - **Management:**
    - ✓ Spina bifida occulta: no intervention needed.
    - ✓ Meningocele and myningomyelocele: surgical repair which must be done within 24 hours (in meningomyelocele) to prevent further trauma to exposed neural tissue.
  - **Prognosis:**
    - ✓ Spina bifida occulta and meningocele: EXCELLENT.
    - ✓ Meningomyelocele: wheelchair dependency; bladder/bowel incontinence and mental retardation.

- **Seizure:**
  - **Definitions:**
    - ✓ Seizure: it is excessive electrical discharge from a group of cerebral neurons.
    - ✓ Epilepsy: occurrence of ≥ 2 spontaneous seizures with no precipitating factors.
    - ✓ Status epilepticus: seizure lasting ≥ 30 minutes during which patient does not regain consciousness.
  - **Etiology (UNKNOWN in 60-70% of cases):** hypoxic-ischemic encephalopathy; trauma (e.g. subdural hematoma); tumor (e.g. astrocytoma); infection (e.g. meningitis/encephalitis); hemorrhage (e.g. intracranial hemorrhage); electrolyte disturbances (e.g. hypoglycemia, hypocalcemia, hypomagensemia or hypo/hyper-natremia).

- **Classification:**
  - ✓ Febrile seizure:
    - ❖ *Definition*: it is a benign type of seizure which is associated with fever and there is no CNS cause. It occurs in children between 6 months – 6 years of age.
    - ❖ *Classification:*
      - ➢ Simple: generalized seizure lasting < 15 minutes.
      - ➢ Complex: focal seizure lasting > 15 minutes and recurs within 24 hours.
    - ❖ *Diagnosis*: HISTORY WITH NORMAL NEUROLOGIC EXAM AND NO CNS INFECTION ARE ENOUGH FOR DIAGNOSIS. There is no need for EEG or head CT/MRI.
    - ❖ *Management:*
      - ➢ First time or occasional febrile seizure: NO NEED FOR ANTICONVULSANTS, but treat subsequent febrile illness aggressively with anti-pyretics to prevent the occurrence of another febrile seizure.
      - ➢ Frequent, recurrent febrile seizure: abortive treatment with rectal diazepam and daily anticonvulsant prophylaxis.
    - ❖ *Prognosis*: 30% of patients with ONE febrile seizure will have recurrence. Risk of epilepsy is low (2%).
  - ✓ Afebrile seizure:
    - ❖ *Partial (affecting ONE hemisphere):*
      - ➢ Simple: consciousness NOT impaired.
      - ➢ Complex: consciousness IMPAIRED.
    - ❖ *Generalized (affecting BOTH hemispheres):*
      - ➢ Tonic-clonic (most common): body becomes stiff followed by jerky movements, upward rolling of the eyes, incontinence, tongue biting, decreased consciousness and postictal state.
      - ➢ Absence (5-9 years): autosomal dominant (AD) characterized by staring with minor motor manifestations (e.g. eye blinking or mouthing movements) lasting < 15 seconds with no postictal state. EEG is characterized by 3-Hz spike and wave discharge. Prognosis is VERY GOOD.
- **Diagnosis**: History, physical examination, serum electrolytes, head CT-MRI and EEG (NOTICE THAT A NORMAL EEG DOES NOT EXCLUDE THE DIAGNOSIS OF SEIZURE/EPILEPSY).
- **Management:**
  - ✓ Treatment of status epilepticus: starts with a benzodiazepine (e.g. lorazepam/diazepam) → no response → loading dose of Phenobarbital or phenytoin → no response → anesthesia (with propofol).
  - ✓ Treatment of epilepsy:
    - ❖ *Pharmacotherapy:*
      - ➢ Partial epilepsy: carbamazepine.
      - ➢ Generalized epilepsy: valproic acid.
      - ➢ Absence epilepsy: ethosuximide.
    - ❖ *Surgery*: in which there will be removal of epileptic tissue; best results for those with TEMPORAL LOBE LESIONS.
- **Prognosis**: EPILEPSY IS NOT A LIFE-LONG DISORDER. 70% of epileptic children can stop medications after 2 years seizure-free period with normalization of their EEG.

- **Infantile spasm (West syndrome):**
  - ✓ Etiology: it occurs in infants between 3-8 months of age mostly due to TUBEROUS SCLEROSIS. Other causes include: hypoxic ischemic injury, intraventricular hemorrhage or infection (e.g. meningitis/encephalitis).
  - ✓ Clinical features: brief myoclonic jerks lasting 1-2 seconds each, occurring in clusters of 5-10 seizures spread over 3-5 minutes.
  - ✓ Diagnosis: EEG shows HYPSARRHYTHMIA PATTERN.
  - ✓ Management:
    - ❖ ACTH IM injection for 4-6 weeks.
    - ❖ Notice that VIGABATRIN is the most effective drig for patients with infantile spasms caused by tuberous sclerosis.
    - ❖ Valproic acid is the 2nd line drug of choice.
  - ✓ Prognosis: POOR (children often develop moderate-severe mental retardation).
- **Benign rolandic epilepsy:**
  - ✓ Definition: it is an autosomal dominant (AD) nocturnal partial seizure with secondary generalization.
  - ✓ Epidemiology: it is considered as the most common partial seizure in childhood occurring between 3-13 years of age and found more among boys.
  - ✓ Clinical features: oral-buccal manifestations (e.g. pooling of saliva) in early morning hours which then generalize to tonic-clonic seizures.
  - ✓ Diagnosis: EEG shows spike and sharp waves disturbance in mid-temporal and central regions.
  - ✓ Management: valproic acid.
  - ✓ Prognosis: EXCELLENT.

- **Unsteady gait:**
  - **Definition**: ataxia is the inability to coordinate muscle activity during voluntary movements due to: cerebellar or proprioceptive dysfunction.
  - **What are your differential diagnoses for ataxia?**
    - ✓ Cerebellar ataxia: which is characterized by unsteady, wide-base gait with irregular steps and deviation to one side or the other.
    - ✓ Vertigo.
    - ✓ Vision problems.
    - ✓ Head trauma, drug overdose or infection.
    - ✓ During seizure and postictal state.
    - ✓ Weakness (e.g. Guillain-Barre syndrome).
  - **Acute cerebellar ataxia of childhood:**
    - ✓ It is the most common cause of ataxia in children between 18 months – 7 years that is caused by:
      - ❖ *Immune complex* deposition in the cerebellum.
      - ❖ *Preceding infections*: EBV, influenza, varicella or mycoplasma.
    - ✓ Clinical features:
      - ❖ *Truncal ataxia with deterioration of gait.*
      - ❖ *Slurred speech and nystagmus are often present.*
      - ❖ FEVER IS ABSENT.
    - ✓ Diagnosis: History & physical examination + head CT-scan (which will be NORMAL!).
    - ✓ Management: SUPPORITVE (symptoms will resolve within 2-3 months).
  - **Guillain-Barre syndrome:**
    - ✓ Definition: it is a demyelinating polyneuritis characterized by: ASCENDING weakness, AREFLEXIA, but INTACT sensation.
    - ✓ It is commonly associated with Campylobacter jejuni infection. There will be cell-mediated immune response to the infectious agent that cross-react with Schwann cell membrane of peripheral nerves.

- ✓ Clinical features:
  - ❖ Ascending, symmetric paralysis and areflexia which might progress to respiratory arrest (if involving the diaphragm).
  - ❖ NO SENSORY LOSS.
  - ❖ Cranial nerve involvement: facial weakness in 50% of patients.
- ✓ Diagnosis:
  - ❖ *Lumbar puncture*: there is increased CSF protein.
  - ❖ *EMG*: shows decreased nerve conduction velocity of conduction block.
- ✓ Management: IVIG (preferred treatment in children) or plasmapheresis for 4 days. There is complete recovery from the disease in children.

- **Duchenne and Becker muscular dystrophies (DMD, BMD):**
  - **Definition**: they are progressive, X-linked myopathies characterized by myofiber degeneration. NOTICE THAT DMD IS MORE SEVERE THAN BMD. The onset of symptoms is between 2-5 years of age.
  - **Pathophysiology**: the absence of dystrophin gene leads to rupture of plasma membrane and subsequent degeneration of muscle fibers. Under light microscopy, there will be infiltration by lymphocytes and replacement of damaged muscle fibers with fibroblasts and lipid deposits.
  - **Clinical features:**
    - ✓ Children with DMD lose the ability to walk by 10 years of age while children with BMD lose the ability to walk by ≥ 20 years of age.
    - ✓ Slow, progressive muscle weakness affecting LEGS FIRST (+ Gower's sign).
    - ✓ Pseudohypertrophy of calves (due to deposition of lipids; MORE IN DMD).
    - ✓ Cardiac involvement in 50% of patients.
    - ✓ DMD → mild cognitive impairment; NO cognitive impairment in BMD.
  - **Diagnosis:**
    - ✓ CLINICAL PICTURE IS SUGGESTIVE (a young boy with enlarged calves and muscle weakness).
    - ✓ EMG.
    - ✓ Muscle biopsy.
    - ✓ DNA testing (showing the gene deletion).
    - ✓ CK levels are VERY HIGH.
  - **Management and prognosis**: THERE IS NO CURE.
    - ✓ Patients with DMD will die in their late teens due to respiratory failure.
    - ✓ Patients with BMD have a life expectancy until 50's.
- **Myesthenia gravis:**
  - **Definition**: it is an autoimmune disorder in which there are antibodies directed against acetyl choline receptor at the neuromuscular junction and is found more among girls.
  - **Classification:**
    - ✓ Neonatal: in which there is transient weakness due to transplacental transfer of antibodies from a mother with myasthenia gravis.
    - ✓ Juvenile: there is formation of AChR antibodies.
  - **Clinical features**: BILATERAL PTOSIS IS THE MOST COMMON PRESENTING SIGN; Progressive muscle weakness especially late in the day with repetitive muscle activity; Diplopia (due to decreased movement of extraocular muscles).
  - **Diagnosis**:
    - ✓ Detection of AChR antibodies.
    - ✓ EMG: shows decreased muscle contraction with repetitive nerve stimulation.
    - ✓ Tensilon test: in which edrophonium chloride (cholinesterase inhibitor) is injected and producing transient improvement in ptosis.
  - **Management**: cholinesterase inhibitor is the mainstay of therapy (pyridostigmine) → if fails → corticosteroids/plasmapheresis/IVIG. Notice that thymectomy is often performed.