Chapter 11:

Neurology

Acute weakness

Definitions

- Acute onset weakness is typically caused by upper motor neuron lesions (UMNL) and lower motor neuron lesions (LMNL)
- Weakness in a child can be associated with either hypertonia or hypotonia
- Upper motor neuron weakness:
    - Results from lesions in the cerebral cortex and corticospinal tracts down to, but not including, the anterior horn cell in the ventral spinal cord.
    - Produces spastic paralysis- i.e. weak limbs with increased tone (hypertonia) and brisk reflexes. However, in the early stages, the affected limbs may be flaccid.
- Lower motor neuron weakness:
    - Results from lesions located in the anterior horn cell, nerve roots, peripheral nerve, neuromuscular junction, or muscle
    - Produces flaccid paralysis- i.e. floppy, weak limbs, with reduced tone (hypotonia) and reduced reflexes or even areflexia

Useful Definitions And Descriptions For Weakness
Paraparesis: Partial paralysis or weakness of the lower limbs
Paraplegia: Complete paralysis of lower limbs
Diplegia: weakness affecting all four limbs, but predominantly the lower
Quadriplegia: Significant paralysis of all four limbs
Hemiplegia: Paralysis affecting only one side of body (asymmetrical)- involving the upper and lower limbs
Truncal paresis: Paralysis affecting the muscles of the trunk

Causes Of Acute Limb Weakness Due To LMNLs

Lower motor neurone	Disease conditions
Anterior Horn Cell	• Spinal muscular atrophy (SMA) • Polio
Nerve Root	• Guillain Barre Syndrome • Paralytic rabies
Peripheral Nerve	• Infections: Diptheria, HIV • Drugs: Isoniazid, Vincristine • Toxins: mercury, helium, glue • Metabolic disorders: diabetes, uraemic neuropathy, vitamin B1 & B12 deficiency
Neuromuscular Junction	• Organophosphate poisoning • Botulism • Myasthenia gravis

MISCELLANEOUS	• Organophosphate poisoning • Vitamin B deficiencies	

Approach to a child with limb weakness

History

- Development of limb weakness
    - Speed of onset: Acute, subacute or chronic
    - Progressive or static
    - Symmetry
    - Associated muscle tenderness
    - Paraesthesia of fingers and toes
    - Bowel and bladder function
    - Swallowing or speech difficulties
    - Respiratory difficulties
- Current associated symptoms
    - Fever
    - Confusion or deterioration of consciousness, seizures
    - Meningism (headache, photophobia, neck stiffness)
    - Symptoms of raised intracranial pressure (headache, vomiting, visual disturbance and in end stage bradycardia, high blood pressure and papillary oedema)
    - Back pain or deformity
    - Seizures
    - Recent history of chicken pox
- Preceding health
    - Recent 'viral' illness or history of meningitic symptoms
    - Past medical history (or episodes suggestive of) meningitis/cerebral malaria/sickle cell disease
    - Indicators of HIV infection or HIV treatment
    - Progressive weight loss, night sweats and TB exposure
    - Birth history, developmental milestones (developmental delay or regression), learning difficulties
    - Immunisation history

Examination

- Anthropometry
- Temperature, BP, heart rate to determine autonomic dysfunction
- General examination: Dysmorphology, signs of HIV infection
- Full cardiac exam
- Full neurological assessment including fundoscopy
    - GCS and false lateralising signs due to cerebral edema
    - Cranial nerve exam including pupillary reaction and extraocular movements
    - Peripheral exam should comment on limb appearance, tone, power, reflex, sensation, gait of the patient is able to walk and cerebellar findings
    - Gower's sign, pseudohypertrophy of muscles (? Duchenne muscular dystrophy)
- General exam

- Cardiac examination including feeling all the pulses
- Respiratory examination especially for hypoventilation/associated pneumonia
- Spinal gibbus or kyphoscoliosis
- Muscle atrophy or tenderness
- Spinal tufts or pits, and head circumference
- Dactylitis, skull bossing (? sickle cell disease)
- Check for the presence of all pulses
- Evidence of valvular cardiac disease

Promotion/prevention

- Immunisation e.g. Polio, Haemophilus influenzae, BCG
- Promote good road safety practices e.g. use of helmets on motorcycles, use of car seat/seat belts in motor vehicles
- Use of Isoniazid preventative therapy in all children less than 6 years old who have a positive T.B contact

Investigations

- Infective causes:
  Perfom septic screen if the child is febrile: FBC, LP if meningitic, reduced consciousness, or GBS.
  Note: There is need to exclude features of raised intracranial pressure before an LP is done to avoid cranial herniation
- Suspected TB: Mantoux test, Gene Xpert on induced sputum or gastric aspirate, CXR
- HIV testing
- Urine and stool for ova/cysts/parasite examination
- FBC: Fe deficiency; clotting profile including platelet count
- Sickle cell electrophoresis test
- Imaging:
  - Uss head (infants)
  - Cardiac echo
  - Spinal Xray
  - CT/ MRI brain - discuss with seniors
- Muscle biopsy: may be useful if a myopathy suspected- discuss with specialist

Send stool specimen (and notification) to Ministry of Health in ALL cases of acute flaccid paralysis (please know your AFP focal person)

Management

Primary level

- All children presenting with a new-onset neurological signs at a primary healthcare facility must be referred to a secondary healthcare facility for initial work-up and acute care
- If the child is at risk of respiratory compromise (such as in GBS, polio) consider referral directly to tertiary care level for airway management/respiratory support

Secondary level

- Specific treatments depend on cause identified or suspected.
- Meningitis: Broad-spectrum antibiotics, preferably after lumbar puncture (LP) (note: There are very few absolute contraindications for LP). Contraindicated in a child with signs of raised incranial pressure and suspected compressive myelopathy
- Cerebral or spinal abscess: Ceftriaxone and seek surgical opinion.
- TB spine and tuberculoma: TB treatment and orthopaedic opinion.
- Schistosomiasis: Praziquantel, 40 mg/kg STAT (consider this whenever no other cause for paralysis found and in ALL cases of paraparesis). If very probable consider treating for three days with 60 mg/kg OD
- Consider steroids for ALL spinal cord lesions, unless evidence of bacterial infection

Tertiary level

- Suspected GBS or polio with airway compromise will need airway assessment for possible intubation and respiratory support.
- Tumours: treat with surgery/ chemotherapy if appropriate. Palliative care.
- Organophosphate poisoning as per protocol.
- Thrombotic disease: prophylactic aspirin.

Follow up

- Patient guided – Depending on cause identified, response to treatment, family wishes and social circumstances. Ideally the child will be stable/improving on discharge. Therefore, the family should have knowledge of the condition and its prognosis. The medical team and family can discuss how best they can assist the child
- Early rehabilitation with physiotherapy – the intensity and duration of the rehabilitation will be guided by the severity of the neurological deficit
- In children with progressive or terminal conditions, or those who are likely to have ongoing physical/ medical/psychosocial needs, plans for follow up and community support should be made. Refer to the palliative care team

Stroke

Definition

A neurological deficit attributed to an acute focal injury of a CNS vascular territory with neuro–radiological evidence of an ischemic or a haemorrhagic lesion

Risk factors/causes

Ischaemic	Haemorrhagic
Vascular **Noninflammatory** • Arterial dissection • Hypertension • Moyamoya • Congenital heart disease **Inflammatory** • Takayasu arteritis • Giant cell arteritis • Kawasaki disease • Infectious/postinfectious vasculitis e.g. HIV, Varicella, Syphilis, TB, Fungal	**Vascular** • Hypertension • Vascular malformations • Arteriovenous malformations, cavernous malformations • Aneurysms
Haematologic • Sickle cell disease • Iron deficiency anaemia **Inherited prothrombotic states** • Protein C • Protein S • Factor V leiden • Polycythemia vera **Acquired prothrombotic states** • Estrogen contraceptives • Protein losing enteropathy • Nephrotic syndrome • Leukaemia and other malignancies • Pregnancy	**Haematologic** • Thrombocytopenia • Platelet dysfunction (ITP) • Haemophilia • Sickle cell disease
Cardiac • Congenital heart disease, arrhythmia, cardiomyopathy, endocarditis, rheumatic heart disease, myocarditis, cardiac surgery	**Other** • Brain tumours

Prevention/promotion

- Preventative measures depend on the etiology of stroke
- As sickle cell anaemia is a common cause of stroke in our setting, chronic blood transfusion and the use of hydroxyurea play a role in preventing both primary and secondary strokes in these patients (See the sickle cell section)
- Antenatal screening and treatment of syphilis and treatment of congenital syphilis will prevent manifestations of tertiary syphilis
- Children with stroke frequently present late to health facilities in our setting due to delayed self/ primary/secondary health facility referral to tertiary level care

Signs and symptoms

- Focal Manifestations
    - Hemiparesis and hemifacial weakness
    - Speech or language disturbance
    - Visual disturbance
    - Ataxia
    - Developing handedness before the age of 1 year
- Non localizing manifestations (usually pointing to haemorrhagic stroke)
    - Headache, neck pains
    - Altered mental status
    - Vomiting
    - Seizures

The signs and symptoms of stroke are frequently overlooked. The American Heart Association encourages the use of the acronym FAST standing for:

- F facial droop
- A arm weakness
- S speech difficulty
- T time to seek help.

This acronym can be used to help raise awareness amongst parents and health care workers at all levels of health care in so doing improving the early identification of strokes amongst children.

Investigations

Imaging:

- Urgent neuroimaging is vital to confirm the diagnosis of stroke and delineate the type of stroke to guide appropriate targeted investigations
- If ischaemic, this facilitates the institution of hyper acute reperfusion therapies e.g. within 4.5 hours from when the patient was last well for intravenous thrombolysis and mechanical thrombectomy within 24 hours from when they were last seen well
- Obtain a brain MRI and MRI Angiography as initial studies as these are more sensitive for the diagnosis of acute ischaemic stroke particularly on diffuse weighted imaging
- If this is not available or cannot be obtained urgently, a CT scan of the brain with angiography can be done
- It should be noted that children with haemorrhagic stroke are at risk of subsequent ischaemic strokes due to compression of blood vessels as a result of mass effect from intracranial haemorrhage and vasospasm

- It is possible to clinically localize strokes in children upon presentation even before confirmation with brain imaging.
- The table below can assist with stroke localization

Anterior cerebral artery (ACA)	Contralateral leg> arm and face weakness
Right Middle Cerebral Artery (MCA)	Left face & arm> leg weakness, left field cut, neglect
Left Middle Cerebral Artery (MCA)	Right face & arm > leg weakness, right field cut, aphasia
Posterior Cerebral Artery (PCA)	Contralateral homonymous haemianopsia w/central sparing
Internal Capsule (Deep MCA Branch)	Contralateral face=leg=arm weakness
Thalamus (MCA and PCA penetrators)	Can be very variable. Haemibody sensory loss, aphasia, field cuts all possible
Brainstem	Multiple cranial nerve anomalies
Lateral Medullary Posterior Inferior Cerebellar Artery (PICA)	Ipsilateral horner's, ipsilateral ataxia, ipsilateral face pain/ temperature loss, contralateral body pain/temperature loss, dysarthria/dysphasia
Dystonia	Basal ganglia

Laboratory Investigations:

- FBC
- Urea, electrolytes and creatinine
- Serum Glucose
- Clotting profile (PT, PTT, INR platelets)
- HB electrophoresis /sickle cell rapid test
- VDRL
- LP if infection suspected e.g. herpes, varicella encephalitis, TB. LP should only be done after brain imaging deems it safe
- EEG if abnormal movements are suspected to be seizures and as an aid for making a diagnosis e.g. in herpes encephalitis
- ECG, cardiac echo
- Consider a hypercoagulable state (prothrombotic work-up: Protein C, S, antithrombin III)
- CRP, ESR and an ANA if suspicious of an inflammatory condition or unexplained etiology e.g. SLE, polyartertis nodosa, adenosine deaminase 2 deficiency and primary angitis of the CNS

Differential diagnosis

- Cerebral venous sinus thrombosis
- Todd's paralysis
- Migraine
- Bell's palsy
- Alternating hemiplegia of childhood
- Brain tumours
- CNS Infection: meningitis, encephalitis, abscess
- Posterior reversible encephalopathy syndrome (PRES)
- Acute disseminated encephalomyelitis (ADEM)
- Acute cerebellar ataxia

Management

Primary level

- Manage ABCDE and neuroprotective care then urgent referral
- Keep the patient as cool as possible, high temperatures exacerbate ischemia
- Maintain normal glycaemia

Secondary/tertiary level

- Manage the patient in a high care setting e.g. HDU
- Patient should be placed on a monitor
- Ascertain patient's ABC are stable
- Maintain normothermia treat any fever greater than 38oC
- Maintain a euglycaemic state, avoid hyperglycaemia
- Avoid hypotension
- Monitor fluid input and output
- Treat seizures appropriately (see seizure management)
- Consider administration of hypertonic saline or mannitol
- Refer to neurosurgeon for CSF diversion: EVD or VP shunt if hydrocephalus

Ischaemic stroke

- Discuss with your overseeing consultant if low dose aspirin 3-5mg/kg to a maximum of 300mg should be started depending on the absence of haemorrhagic transformation

Haemorrhagic stroke

- If the cause of the stroke is hypertension and the blood pressure is elevated anti-hypertensives should be used cautiously with frequent BP monitoring.
- Do neurological observations and watch out for early signs of raised intracranial pressure e.g. vomiting, worsening headache if awake, papilloedema
  Note: The development of cushings triad might be a late sign
- Discuss with neurosurgeons

Medical management of raised ICP

General neuroprotective measures include:

- Rapid treatment of hypoxia, hypercarbia, and hypotension

- Elevation of the head of the bed to at least 30o
- Maintenance of the head and neck in the midline to facilitate venous drainage
- Aggressive treatment of fever with antipyretics
- Maintenance of adequate analgesia

Control of shivering in intubated patients with muscle relaxants (e.g. vecuronium, rocuronium)

Supportive and rehabilitattive management

- Maintaine adequate nutrition (may need feeding aids like NGT)
- Hourly turning to prevent pressure sores
- Frequent changing of soiled/wet beddings/nappies
- Urinary catheterization if necessary
- Initiate physiotherapy once the patient is haemodynamically stable
- Psychosocial support should be offered to parent and child

Long term management

- Follow up all patients in outpatient clinics
- Treat underlying cause to prevent recurrence of stroke
- Continued physiotherapy including mobility aids if necessary
- Some patients may need speech therapy and occupational therapy
- School needs assessment
- Family counselling
- Feeding and nutritional support
- Early rehabilitation through physiotherapy – the intensity of the rehabilitation will be guided by the severity of the neurological deficit

Follow up

- Patient guided – Depending on cause identified, response to treatment, family wishes and social circumstances. Ideally the child will be stable/improving on discharge therefore the family should have knowledge of the condition and its prognosis. The medical team and family can discuss how best they can assist the child
- In children with progressive or in terminal conditions, or those who are likely to have ongoing physical/medical/psychosocial needs, plans for follow up and community support should be made.
- Involve palliative care team

Hydrocephalus

Definition
A disorder characterized by ventricular dilatation and increased intracranial pressure resulting from the excessive accumulation of CSF within the cerebral ventricles and/or the sub arachnoid spaces which leads to raised intracranial pressure

Communicating hydrocephalus occurs as a result of impaired CSF absorption in the sub-arachnoid spaces. It may also result from an increased production of CSF

Non-communicating (obstructive) hydrocephalus occurs as a result of excess accumulation of CSF due to structural obstruction of CSF flow within the ventricular system. The obstruction can occur at the level of the Foramen of Munroe, the aqueduct of Sylvius, the fourth ventricle or its outlets. Dilatation will occur proximal to the level of the obstruction

Note: Many cases of hydrocephalus have a combination of obstructive and absorptive causes

Risk factors/causes

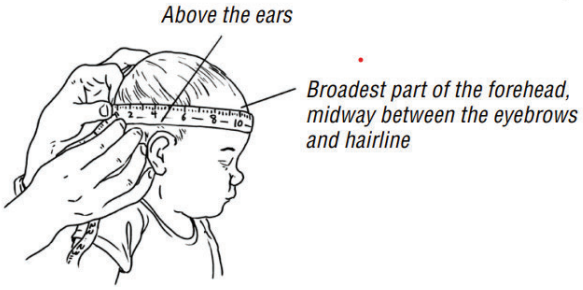
Communicating Hydrocephalus	Non-Communicating Hydrocephalus
Congenital Causes • Infections (TORCH) • Intraventricular haemorrhage • Post infectious aqueduct stenosis • Choroid plexus papilloma	**Congenital Causes** • Neuro tube defects (Myelomeningocele associated with Chiari 2 malformation, Encephalocele) • Aqueduct stenosis • X linked hydrocephalus • Dandy-Walker malformation • Vascular malformations • Infections (TORCH) • Intraventricular haemorrhage • Post infectious aqueduct stenosis • Choroid plexus papilloma
Acquired Causes • Post-haemorrhagic hydrocephalus • CNS infections • Dural venous sinus thrombosis	**Acquired Causes** • Post-haemorrhagic hydrocephalus • CNS tumours (meduloblastoma, astrocytoma, ependymoma) • CNS infections (bacterial and TB meningitis)

Prevention/promotion
- Immunisation
- Early diagnosis and adequate treatment of meningitis to prevent the complication of hydrocephalus
- Follow up patients with meningitis after discharge and monitor head circumference
- Maternal prenatal USS can assist in diagnosing fetal hydrocephalus due to structural malformations
- Under five clinic nurses should be encouraged to measure infant head circumferences each time they come for their weight checks. Early detection and timely referral can change the outcome and the quality of lives of these children

- Every preterm baby born less than 36 weeks should have cranial USS before discharge to look for features of intraventricular haemorrhage
- Infants treated with bacterial meningitis should be flagged in the road to health books to have serial head circumference checks at their local clinic
- Early presentation to the hospital is critical in ensuring good long-term outcomes
- Promote head circumference monitoring for all infants
- Folic acid before conception
- Avoid smoking, drinking alcohol and substance abuse during pregnancy

Signs and Symptoms

- Rapidly increasing head circumference (see image below on how to measure)
    - Measure and document at least weekly
    - Compare to WHO head circumference charts for age and sex
- Bulging fontanellelele
- Widening suture lines (if not closed yet)
- Distended scalp veins
- Sun setting eye sign
- Signs of raised intracranial pressure (early morning headache, vomiting, blurred vision, high BP, low PR, reduced conscious level, bradypnoea)
- Developmental delay or regression and/or ataxia
- Abnormal hypothalamic function in childhood
- Seizures



Head circumference measurement
Measure the head circumference with a non-stretchable tape. Take three measurements until you get a consistent value. Use the same chart for the same child over time.

How to measure head circumference

Investigations

- Cranial USS
- MRI or CT scan of the brain
- CSF samples: for cell counts and differential, microscopy culture and sensitivity and Gene X-pert for T.B
- Consider ventricular tap if signs of infection/raised Intracranial Pressure (ICP) and prior to surgery

How to perform a ventricular tap

Equipment

- Shave pack and Skin cleaning solution
- Sterile gloves
- Sterile drapes/dressing pack
- Lumbar puncture needle (size 22G or 23G)
- Specimen bottles
- Plaster

Procedure

1. Shave the scalp overlying the lateral angle of the anterior fontanellelele taking care not to injure the skin

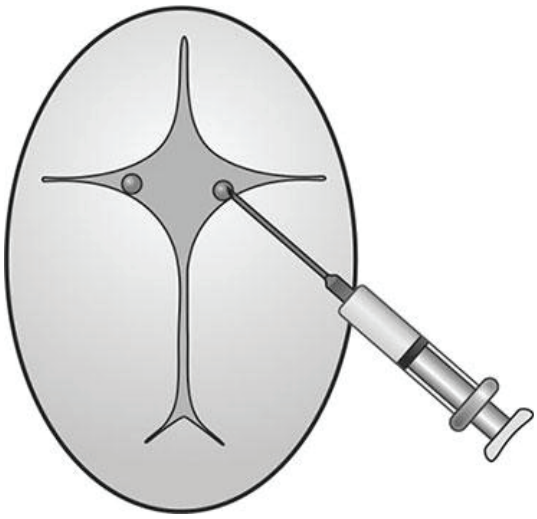
2. Clean a wide area of the head with appropriate solution

3. Position the infant supine with the top of the infant's head facing toward the operator

4. With left hand index and thumb, move skin over point of entry such that when tap done and the needle is removed, the skin moves back to original position and the track of the needle is broken

5. Insert the spinal needle into the lateral angle of the fontanellelele and advance it toward the inner angle of the ipsilateral eye. The needle should be inserted smoothly without change of direction to minimise trauma to the brain

Position for ventricular tap



Kocher's point, is a traditional point for ventricular tap. Kocher's point is defined as a point 2-3 cm from the midline and 10-12 cm from the glabella or 1 cm anterior to the coronal suture

6. Once the ventricle has been penetrated, the stylet is removed, and the CSF should drip out rather than be aspirated

7. Once the required amount of CSF is obtained the needle should be removed and pressure applied to the area to prevent leakage of CSF

8. Clean the area with 1% chlorhexidine solution and let dry

Contraindications for ventricular tap
- Infection over the site of entry
- Bleeding disorder due to coagulopathy

Differential Diagnosis
- Tumours e.g. craniopharyngioma, pituitary tumors, primary CNS Lymphoma
- NF1
- Sturge Weber
- Subdural empyema
- Idiopathic Intracranial hypertension
- Other causes of macrocephaly e.g. familial macrocephaly, Sotos syndrome

Management

Primary level
- Manage ABCCCD and refer

Secondary/tertiary level
- Treat infection if any (ventriculitis may require longer term parenteral treatment than meningitis)
- Therapeutic ventricular tap if signs of acute raised ICP
- Medical reduction of CSF while awaiting surgery in communicating hydrocephalus- acetazolamide or furosemide
- Surgical/neurosurgical referral for ventriculo-peritoneal (VP) shunt or Endoscopic Third Ventriculostomy (ETV)

Complications of VP shunts
- Shunts can become infected or blocked and need to be treated urgently.
- Suspect infection or blockage in a child with VP shunt if any of the following:
    - Vomiting
    - Headache
    - Reduced level of consciousness
    - New onset or worsening seizures
    - Increasing head circumference
    - Ataxia
    - Cranial nerve palsy
    - Visual disturbance
    - Fever
    - Developmental regression
    - Ascites and peritonitis
    - Pain and/or inflammation along the shunt track

Investigations of possibly infected or blocked shunts

- FBC
- Blood culture if febrile
- Xray shunt series
- USS brain/CT scan/MRI if possible
- Avoid LP as this can result in coning if shunt is blocked. If possible, perform a ventricular tap

Management of blocked Shunts

Primary level

- Manage ABCCCD and refer

Secondary level

- Assess patient and initiate treatment
  - Manage ABCD
  - Start IV antibiotics as for meningitis (ceftriaxone 100mg/kg IV daily)
- Urgent referral to tertiary level

Tertiary level

- Manage the patient, including complications and comorbidities
  - Manage ABCCCD
  - Start iv antibiotics as for meningitis (Ceftriaxone 100mg/kg I.V daily)
- Refer to neurosurgeons for possible urgent shunt removal if blocked or infected and subsequent revision/replacement at a later date
- Coordinate efforts of the multidisciplinary team
  - Physiotherapy
  - Occupational therapy
  - Nutritional support
  - Hearing and Visual assessment
  - Hydrocephalus parental support groups

Follow-up

- Follow-up in a surgical or neurosurgical clinic every 3 months or more frequently if complications arise
- Follow-up can be done in tertiary facilities or secondary facilities where a multidisciplinary team is available

Cerebral Palsy (CP)

Definition

It is a group of permanent disorders of the development of movement and posture, causing activity limitations that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain

Risk factors/causes

Prenatal factors:

- Maternal alcohol consumption, smoking, obesity
- Intrauterine infections; cytomegalovirus, syphilis, varicella virus, and toxoplasmosis
- Gestational hypertensive disorders
- Intrauterine growth restriction, antepartum haemorrhage, severe placental pathology, multiple pregnancy
- Genetic disorders
- Congenital abnormalities, particularly structural central nervous system abnormalities

Perinatal factors:

- Perinatal hypoxia-ischemia
- Prematurity – due to periventricular leukomalacia (PVL), intraventricular haemorrhage (IVH), and/or bronchopulmonary dysplasia (BPD)
- Kernicterus – typically resulting in choreoathetosis CP
- Perinatal stroke

Postnatal factors in the older child (up to age 5 years):

- Infections e.g. sepsis/meningitis, cerebral malaria
- Stroke in congenital heart disease, prothrombotic disorder, sickle cell disease, vasculopathy, or metabolic disorder
- Traumatic brain injury
- Severe hypoxic events e.g. near-drowning and uncontrolled seizures
- Metabolic disorders-hypoglycaemia, hypo and hyper natraemia, hypocalcemia
- Intracranial bleeding e.g. trauma, coagulopathies, shaken baby syndromes

Prevention/promotion

- Prevention is dependent on the causative insult
- Focused antenatal and intrapartum care could reduce the risk for cerebral palsy
- Parents and primary health care workers should be educated on early signs suggestive of CP
- All children attending routine Under 5 clinic visits should be screened for these signs
- Monitor at risk children for early detection and intervention

Children presenting with these features should be referred early for evaluation:
- Abnormal eye/body movements
- Poor head control by 3 months
- Not sitting by 8 months
- Not walking by 18 months
- If a child is having developmental regression/ losing milestones, consider other causes.
- Refer to a tertiary facility for comprehensive assessment.

Signs and symptoms

- Specific CP syndromes recognized after five years of age, although suggestive signs and symptoms may be present in infancy
    - Poor feeding, drooling, choking on feeds
    - Failure to thrive
    - Irritability, poor sleep, vomiting
    - Leg scissoring
    - Difficult to handle and cuddle due to opisthotonic posturing
    - Poor visual attention
    - Hearing impairment
    - Delay disappearance of primitive reflexes
    - Seizures and abnormal movements
    - Motor tone in the extremities may be normal, decreased, or increased
    - Persistent or asymmetric fisting, abnormal oromotor patterns include tongue retraction and thrust, tonic bite, oral hypersensitivity, and grimacing.
    - Poor head control with excessive head lag. Not achieving motor milestones (e.g. six motor milestones - roll prone to supine, roll supine to prone, sit with support, sit without support, crawl, and cruise)
    - Constipation
    - Emotional and behavioural problems
- Perform full head to toe examination. Look out for features of dysmorphism, neurocutaneous lesions, malnutrition, neglect and pressure sores

Classification of CP according to the Surveillance of Cerebral Palsy in Europe (SCPE)

1. **Spastic syndromes**: Symmetric or asymmetric, involve one or more extremities, spastic hypertonia, and if very severe form may have rigidity in flexion or extension:

    - **Spastic Diplegia** Lower limbs affected more than upper limbs. If mild, good hand function is preserved. In severely affected patients, upper limb function compromised, sensory loss, associated involuntary movements, and intellectual disability

    - **Spastic Hemiplegia** arm and leg on one side affected. The upper limb typically more affected than lower limb. Usually vascular origin

    - **Spastic Quadriplegia** bilateral arms and legs equally affected with severe intellectual impairment and other comorbidities (severe intellectual disability, speech and language impairment and visual impairment, epilepsy, feeding difficulties)

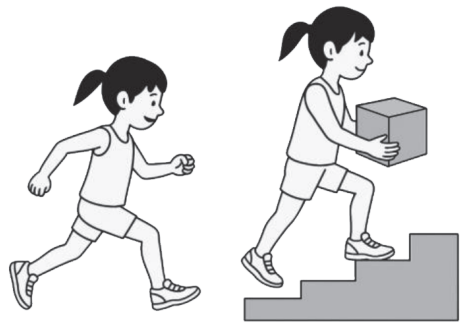
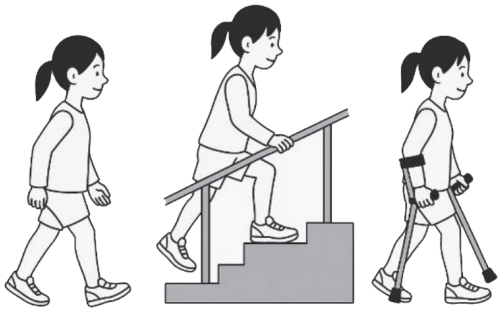
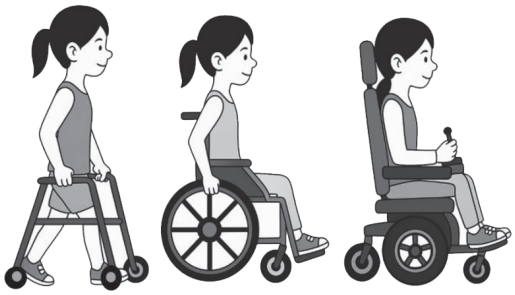
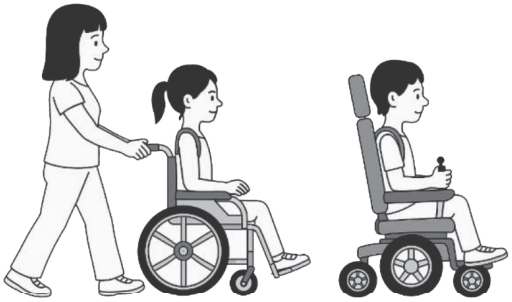
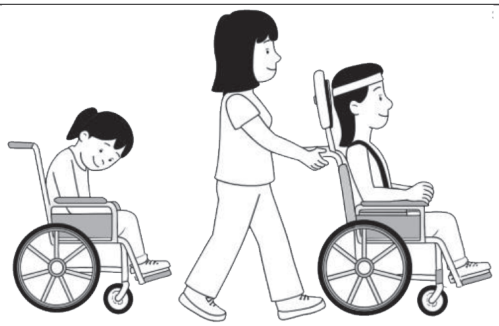
2. **Dyskinetic syndromes**: Involuntary movement:
    - **Choreoathetosis**: Rapid, irregular, unpredictable contractions of individual muscles or small muscle groups that involve the face, bulbar muscles, proximal extremities, and fingers and toes. Athetosis consists of slow, smooth, writhing movements that involve distal muscles. It should also be noted that some children with CP can have choreic and athetoid CP types in isolation

    - **Dystonia:** Pyramidal signs and anarthria. Sudden involuntary increase in tone that affects both flexor and extensor muscles. The limbs become stiff during attempted movement or with emotion
3. **Ataxic CP (rare)**: Motor milestones and language skills are delayed. Ataxia usually improves with time. Speech is slow, jerky and explosive

4. **Mixed CP:** Mixture of all above motor disorders

Gross Motor Function Classification System (GMFCS)

- The gross motor function of children and young people aged above 6 years of age with cerebral palsy can be categorized into 5 different levels using GMFCS tool
- GMFCS looks at movements such as sitting, walking and use of mobility devices. It is helpful because it provides families and clinicians with:
    - A clear description of a child's current motor function
    - An idea of what equipment or mobility aids a child may need in the future, e.g. crutches, walking frames or wheelchairs

	**GMFCS Level I** Youth walk at home, school, outdoors and in the community. Youth are able to climb curbs and stairs without physical assistance or a railing. They perform gross motor skills such as running and jumping but speed, balance and coordination are limited.
	**GMFCS Level II** Youth walk in most settings but environmental factors and personal choice influence mobility choices. At school or work they may require a hand held mobility device for safety and climb stairs holding onto a railing. Outdoors and in the community youth may use wheeled mobility when traveling long distances.
	**GMFCS Level III** Youth are capable of walking using a hand-held mobility device. Youth may climb stairs holding onto a railing with supervision or assistance. At school they may self-propel a manual wheelchair or use powered mobility. Outdoors and in the community youth are transported in a wheelchair or use powered mobility.
	**GMFCS Level IV** Youth use wheeled mobility in most settings. Physical assistance of 1-2 people is required for transfers. Indoors, youth may walk short distances with physical assistance, use wheeled mobility or a body support walker when positioned. They may operate a powered chair, otherwise are transported in a manual wheelchair.
	**GMFCS Level IV** Youth are transported in a manual wheelchair in all settings. Youth are limited in their ability to maintain antigravity head and trunk postures and control leg and arm movements. Self-mobility is severely limited, even with the use of assistive technology.
GMFCS descriptors: Palisano et al. (1997) Dev Med Child Neurol 39:214-23 CanChild:www.canchild.ca	Illustrations copyright in the original source: ©Kerr Graham, Bill Reid and Adrienne Harvey, The Royal Children´s Hospital, Melbourne

Source: Burns F, Stewart R, Reddihough D, Scheinberg A, Ooi K, Graham HK. The cerebral palsy transition clinic: administrative chore, clinical responsibility, or opportunity for audit and clinical research?. *J Child Orthop*. 2014;8(3):203-213. doi:10.1007/s11832-014-0569-0

Differential diagnosis

- HIV encephalopathy
- Leukdystrophy
- Congenital myopathy
- Muscular dystrophy
- spinal muscular atrophy
- Wilson's disease
- Huntington's chorea
- Tethered cord syndrome
- Genetic syndromes (Angelman syndrome)
- Hereditary spastic paraplegia

Associated conditions/comorbidities

- Neurological disorders: Hearing impairment, visual impairment, pain, intellectual disability, speech-language disorders
- Epilepsy: Onset of seizures during the first two years of life, usually partial seizures with secondary generalization. N.B seizure syndromes like infantile spasms may cause or worsen cerebral palsy
- Behaviour disorder, sleep disorder, self-injurious behavior, attention deficit
- Urinary disorders: (enuresis) bladder control problems
- GI problems: Chronic constipation, gastroesophageal reflux and/or vomiting, swallowing disorders
- Growth failure: Primarily due to poor nutrition. Other feeding issues include gastroesophageal reflux disease, pseudobulbar palsy with drooling, constipation
- Pulmonary disease: Recurrent aspiration, scoliosis, ineffective cough and clearance of pulmonary secretions
- Orthopedic disorders: Subluxation, dislocation, and progressive dysplasia of the hip. Foot deformities, scoliosis, osteopenia, pathological fractures
- Skin: Pressure sores

Investigations

- Should be guided by history, clinical examination and the presence of comorbidities.
- History and clinical examination will guide in identifying the timing of CP (prenatal, perinatal or postnatal)
- Consider imaging with brain ultrasound and/or CT scan/ MRI if organic cause suspected e.g. If there is developmental regression
- Investigate for any intercurrent problems e.g UTI, aspiration pneuomonia.
- X- rays for dislocations and fractures

Management

- This requires a multidisciplinary approach. There is need for ongoing follow up care in a general/ neurology clinic to address the evolving needs as the child ages

Primary level

- Education of child and guardians and community
- Immunizations
- Nutrition: Needs ongoing assessment and rehabilitation. Look out for and manage undernutrition
- Screen all children attending routine Under 5 clinic visits for developmental delay. Children presenting with these features should be referred to the District Hospital for early evaluation

Secondary

- Opthalmology: Visual assessment
- Audiology: Hearing assessment and aids
- Physiotherapy: for limbs and chest. Physical mobility aid e.g. wheel chair, feeding/sitting chair
- Speech therapy: sucking and swallowing assessment and therapy
- Antispasmodic Drugs: Diazepam1-2.5mg PO 4 to 6 hourly as initial dose to reduce spasticity. Can increase dose depending on response
- Social and psychological support, palliative care
- Adolescent sexual and reproductive health: Discuss birth control
- Explore education and occupational therapy based on the child's level of function
- Follow up children in general clinic and coordinate care with the different subspecialties as indicated above
- Seizure management should be initiated in all children with epilepsy
- Refer Children with poorly controlled epilepsy and those needing specialist care that is not available in the district hospital to the central hospital

Tertiary level

- Opthalmology: Visual assessment
- Audiology: Hearing assessment and aids
- Physiotherapy: for limbs and chest. Physical mobility aid e.g. wheel chair, feeding/sitting chair
- Speech therapy: sucking and swallowing assessment and therapy
- Audiology: Hearing assessment and aids
- Drugs against spasticity and dystonia:
    - Baclofen: 1-2 mg/kg 8hrly. Side effects: confusion, sedation, hypotonia, ataxia, paresthesias, and nausea. Seizures if drug discontinued abruptly
    - Diazepam 1 - 2.5mg po 4 to 6 hourly as initial dose. Can increase dose depending on response
- Antiepileptics – see seizures protocol
- Orthopedics: Contracture release, fracture care, acute hip disorders
- Social and psychological support, palliative care
- Adolescent sexual and reproductive health: Discuss birth control
- Explore education and occupational therapy based on the child's level of function

Follow-up

- Follow-up children in PEN-Plus clinic and coordinate care with the different members of the multidisciplinary team

Epilepsy

Definition

A seizure is a transient occurrence of signs and/or symptoms due to abnormal
Excessive neuronal activity in the brain. The onset of seizures can be focal, generalised, or unknown. Some focal seizures can evolve to bilateral tonic-clonic

Clinical definition of epilepsy, intended as a disease of the brain defined by any of the following conditions:

- At least two unprovoked (or reflex) seizures occurring > 24 h apart
- One unprovoked (or reflex) seizure and a probability of further seizures similar to the general recurrence risk (at least 60%) after two unprovoked seizures, occurring over the next 10 years
- Diagnosis of epilepsy syndrome

Risk factors/causes

- Idiopathic
- Infection: Meningitis, abscess, encephalitis, neurocysticercosis, sepsis
- Metabolic and endocrine disorders: Hyponatremia, hypocalcemia, hyperthyroidism
- Trauma: intracranial bleeding
- Perinatal complications: Prematurity complications, perinatal asphyxia
- Drugs and alcohol (and it's withdrawal)
- Tumours
- Syndromes and congenital disorders
- Vascular disease/stroke: Sickle cell, vasculitis, ischemia, brain malformations
- Neurocutaneous syndromes: Neurofibromatosis, Sturge Webber, tuberous sclerosis
- Neurodegenerative or neurometabolic disease
- Epilepsy syndromes: Lennox Gestaut, Sturge weber, benign familial, myoclonic epilepsy of the infant, infantile spasms
- Vitamin deficiency: Vitamin B6 deficiency

Note: In neonates and infancy most seizures are symptomatic of an identifiable etiology - HIE, metabolic disturbances e.g. hypoglycaemia, hypocalcaemia, vitamin B6 deficiency, phenylketonuria, central nervous system or systemic infection

- Note: In HIV/AIDS consider CNS toxoplasmosis, cryptococcal meningitis, herpes encephalitis, bacterial meningitis, CNS lymphoma, neurosyphilis

Prevention/promotion

- Health education is needed to demystify epilepsy
- Early diagnosis and optimal treatment can lead to improved long-term neuro developmental outcomes
- Tools like epilepsy diaries should be rolled out to accurately monitor seizure frequency at home
- Establish clinics within district and central hospitals to follow up all patients regularly
- Encourage the use of video on smart phones to document seizure episodes
- Advise the patient to avoid sleep deprivation
- Inform the school that the child has epilepsy
- Educate the family on first aid for seizure episodes (see table below)

First Aid Measures during a Seizure (Advise for Parents/Teachers)

- Do not panic, remain calm. Note time of onset of the seizure
- Remove any harmful objects around them
- Loosen the child's clothing especially around the neck
- Place the child in a left lateral position with the head lower than the body
- Wipe any vomitus or secretions from the mouth
- **Do not insert any object into the mouth even if the teeth are clenched**
- Do not give any fluids or drugs orally
- Stay near the child until the seizure is over and comfort the child as he/she is recovering
- If the seizure lasts longer than 5 minutes seek medical attention

Signs and symptoms

Focal seizures

- Originate from one hemisphere of the brain. They may be discretely localized or more widely distributed
- A focal seizure may or may not be associated with impaired awareness
  - Impaired awareness is defined as the inability to respond normally to external stimuli due to altered awareness and/or responsiveness
  - When the patient is aware throughout the seizure, the seizure is described as a focal seizure without impairment of awareness (previously referred to as simple partial seizure)
  - Focal seizures without impairment of awareness may also manifest psychic symptoms including dysphasia, feelings of familiarity ("déjà vu"), distortions of time, affective changes (particularly fear), illusions and formed hallucinations. Such seizures are often referred to as auras
  - Focal seizures with impaired awareness correspond to what were previously called complex partial seizures
  - During focal seizures with impairment of awareness, the patient may have a variety of repetitive semi purposeful movements that are referred to as motor automatisms. These can include chewing, swallowing, sucking, bicycling and kicking movements, flailing of the arms, and even running, jumping and spinning
- Focal seizures are further subdivided primarily based upon the clinical signs and symptoms and the EEG localization e.g.
  - Motor seizures may manifest as focal motor activity, sometimes with an anatomic spread or march of activity (Jacksonian), versive movement (turning of the eyes, head and/or trunk), vocalization, or arrest of speech
  - Sensory seizures: paresthesias, feelings of distortion of an extremity, vertigo, gustatory sensation, olfactory symptoms, auditory symptoms and visual phenomena such as flashing lights
  - Autonomic seizures: may include an epigastric "rising" sensation (a common aura with medial temporal lobe epilepsy), sweating, piloerection, and pupillary changes

Previously used terminology of "secondarily generalized seizure," could be confusing and is no longer recognized in the ILAE classification

The preferred way to describe a seizure, that was known by EEG or by clinical symptoms to begin focally and later generalize to "focal seizure evolving to a bilateral tonic-clonic seizure"

Generalized seizures

- Originate within and rapidly engage both cerebral hemispheres
- Awareness may be impaired, and this impairment may be the initial manifestation.
- Motor manifestations (if present) are bilateral
- The ictal EEG patterns are bilateral from onset
- Generalized seizures can be further divided into motor and non-motor types
- Motor types include:
  - Tonic–clonic seizures:
  - Myoclonic seizures: brief shock like contractions that can be generalised or confined to face, trunk or extremities.
  - Atonic: also known as drop attacks are characterised by loss of consciousness with loss of muscle tone.
  - Epileptic spasms
- Non-motor types are absence seizures:
  - Absence seizures manifest as episodes of sudden, profound impairment of consciousness without loss of body tone. Patients may have low amplitude myoclonic movements as well as mild tonic involvement of the limbs and trunk and simple motor automatisms, similar to those seen in focal seizures with impairment of awareness
  - Typical: Arrest of on-going activity and a blank stare of less than 20 seconds. Muscle tone is preserved, and the patient does not fall, usually with no recollection of the episode although some children will remember the episode
  - A typical: longer absence seizure of more than 20 seconds. There is a much more pronounced change in tone and variability in consciousness level
  - Myoclonic absence: Absence seizures that are accompanied rhythmic myoclonic jerks of shoulders and arms with a tonic abduction that results in progressive lifting of arms during the seizure.
  - Absence with eyelid myoclonus: A triad of eyelid myoclonus that may be accompanied by absence seizures and eye deviation. EEG seizures and photosensitivity lasting less than 10 seconds

Unknown onset

- With some types of epilepsy, the onset cannot be clearly determined as generalized or focal. Epileptic spasms are key example. Epileptic spasms, which include infantile spasms, are seizures that involve spasms of the muscles of the neck, trunk, and extremities

Generalized onset seizures	
Motor	**Non-motor (absence)**
• Tonic-clonic • Clonic • Tonic • Myoclonic • Myoclonic-atonic • Atonic • Epileptic spasms	• Typical • Atypical • Myoclonic • Eyelid myoclonia
Focal onset seizures	
Motor onset	**Non-motor onset**
• Aware • Impaired awareness • Unknown awareness	• Aware • Impaired awareness • Unknown awareness
• Automatisms • Atonic* • Clonic • Epileptic spasms* • Hyperkinetic • Myoclonic • Tonic	• Autonomic • Behaviour arrest • Cognitive • Emotional • Sensory
• Focal to bilateral tonic-clonic	• Focal to bilateral tonic-clonic
Unknown onset seizures	
Motor	**Nonmotor**
• Tonic-clonic • Epileptic spasms	• Behaviour arrest
Unclassified seizures	

ILAE: International League Against Epilepsy
Degree of awareness usually is not specified
Due to inadequate information or inability to place in other categories

Febrile seizures

- Occur in association with a febrile illness (temperature of 38.3 °C) that is not caused by CNS infection or acute electrolyte imbalance in children that are aged between one month and less than 6 years that is otherwise normal
- They can be simple and complex
- Simple febrile seizures: generalized tonic- clonic in nature, lasting less than 15 minutes and do not recur within 24 hours
- Complex febrile seizures: may be focal or lasts more than 10-15 minutes or re-occur within the 24 hours
- There is always an identifiable cause to the fabrile illness. An infective screen is mandatory. Acute

seizure should be managed with acute anti-epileptic agents. However, EEG and long-term anti-epileptic medications are not indicated.

- Only 1 to 2% of children that present with first onset febrile seizure will develop epilepsy. The definite risk factors for developing epilepsy after a febrile seizure include:
  - A background of neurodevelopmental disability
  - Complex febrile seizure
  - Family history of epilepsy (genetics contribute significantly to febrile seizure epidemiology
  - Low-grade fever at the time of the seizure

Important points in history

- Detailed description of the seizures, including duration and onset, bowel/bladder incontinence, tongue bites, automatisms
- Seizures in epilepsy are usually:
  - Stereotyped: Each one is like the previous one
  - Random: Occur at any time of the day or night
  - Rarely precipitated by specific environmental, psychological, or physiological events
- Prior seizures
- Trauma
- Perinatal and birth history
- Family history of epilepsy
- Drugs: Prescribed, recreational, local herbs.
- Other illness: Diarrhoea (electrolyte imbalance), fever

Electroencephalogram (EEG)

- EEG may help to confirm the diagnosis, however a normal EEG does not exclude the diagnosis
- Criteria for EEG
  - Seizures that are difficult to control despite 2 appropriate AEM given at optimal doses
  - Suspected epilepsy syndrome
  - Suspected Infantile spasm

Criteria for Brain imaging (MRI/CT-scan):

- Abnormal neurological findings (particularly focal signs)
- Developmental regression
- Global development delay of unknown aetiology

Some Epileptic syndromes

Epilepsy syndrome	Age group	Aetiology	Clinical features	EEG	Diagnosis	Management	Prognosis
Benign familial neonatal epilepsy	2-3 days of life up to 1 week of age	Genetic	Hypertonia Apnea Autonomic features like chewing, vocalization.	flattening with apnea and tonic activity. Spikes and waves discharges.	Family history of neonatal seizures Normal neuro exam.	Phenobarbitone	Spontaneous Resolution by 6 months Good prognosis
Benign neonatal epilepsy	Day 4 and 6 of life	No genetic predisposition	Repetitive focal clonic seizures.	Normal	Clinical exam and no family history of neonatal seizures.	None	Good
Ohtahara syndrome	0-3 months	Brain anomalies, metabolic disorders, genetic mutations in the ARX gene.	Brief tonic spasms that occur in clusters (100-300 per day) profound developmental delay.	Burst suppression in both sleep and awake states.	Fitting risk factors, seizure pattern and EEG findings.	Seizures are resistant to treatment. Benzodiazepines, phenobarbitone, levetiracetam.	The prognosis is poor with high mortality rate. Seizures may evolve into West Syndrome
Early myoclonic encephalopathy	0-7 days	Inborn errors of metabolism Family history.	Triad: intractable myoclonic seizures, focal and tonic epileptic spasms. Encephalopathy Developmental regression.	Burst suppression and brain imaging may be normal initially then later cortical atrophy.	Suspect in infants with erratic myoclonia and encephalopathy.	Trial of sodium benzoate for glycine encephalopathy; pyridoxine and pyridoxal deficiency disorders.	50% die in the first year of life.
West Syndrome	3-12 months	Structural brain damage, Post-infectious, Metabolic disorders, Tuberous sclerosis	Triad: epileptic spasms, developmental regression and hypsarrhythmias on EEG of psychomotor development.	High amplitude hypsarrhythmia, asynchronous slow waves with multifocal spikes and polyspikes. MRI Brain needed to determine the cause.	Spasms as well as EEG findings will confirm the diagnosis. The absence of Hypsarrhythmia on EEG does not exclude the diagnosis.	Epileptic spasms are a pediatric neurology emergency. Treat with prednisone(8mg/kg/day), max dose 60mg for 14 days then taper over another 14 days. Add Sodium Valproate or phenobarbitone concurrently.	Many of these children will evolve to have Lennox Gastaut Syndrome.
Dravet Syndrome	Infancy	Onset recurrent complex febrile seizures or early onset afebrile hemi convulsions.	Focal seizures, myoclonic seizures, absence, and atonic seizures and developmental delay ensues.	Generalised spike waves with isolated bursts and poly spikes. Brain imaging is initially normal; however, later scans may show abnormalities due to seizures.	Clinically, the infant has developmental delay, limb spasticity and ataxia. Plus the various seizure types including the myoclonic seizures.	This is a pharmacoresistant epilepsy. Consider sodium valproate or topiramate as first line with clobazam, stiripentol or levetiracetam as adjunct therapy.	The prognosis is poor with mortality rate as high as 18% death is usually from sudden unexpected death in epilepsy (sudep), drowning or the seizures themselves.

Genetic epilepsy with Febrile seizures plus.	Febrile seizures beyond 6 years of age.	Genetic cause, usually have a strong family history.	Febrile seizures beyond the age of 6 years and associated with other afebrile seizure types.	EEG findings are heterogenous and brain imaging is usually not indicated.	Clinical	Complex febrile seizures will require benzodiazepine rescue therapy for the parents to keep at home. For the afebrile seizure types, anti-epileptic agents should be tailored toward the seizure types that manifest.	Seizures will resolve by puberty and development remains normal. In some cases, children have grown to develop Doose or Dravet syndromes.

Management

Primary level

- Treat the acute seizure, using ABCDE and seizure protocol.
- Child suspected to have epilepsy should be referred to their nearest district hospital for assessment and long term treatment initiation.
- Parents should be encouraged to take a video of the seizure episode if they have access to a phone with video.

Secondary Level

- Manage acute seizure using ABCDE and convulsion protocol
- A thorough evaluation of the patient must be undertaken to establish seizure type and the relevant patient characteristics and comorbidities
- Initiate long term anticonvulsant treatment if:
  - More than 2 afebrile seizure
  - 1 afebrile seizure in a child with neurological condition
- Select drug based on seizure type, epilepsy syndrome and patient characteristics (age, school going, behavioural issues)

SELECTING ANTI-SEIZURE MEDICATION ACCORDING TO SEIZURE TYPES

Focal Seizures
First Line: Carbamazepine, Valproate
Second Line: Lamotrigine, Levetiracetam, Phenytoin, Phenobarbitone

Generalised Seizures

Tonic-clonic / clonic only
First Line: Phenobarbitone, Valproate
Second Line: Lamotrigine, Levetiracetam, Carbamazepine, Phenytoin

Absence
First Line: Valproate, Ethosuximide
Second Line: Lamotrigine, Levetiracetam

Atonic, tonic
First Line: Valproate
Second Line: Lamotrigine, Phenytoin

Tertiary level

- Perform relevant investigations to determine the cause of epilepsy.
- Attempt to classify the seizure syndrome if suspected.
- Coordinate referrals to multidisciplinary team if needed.
- All complex patients should be followed up at designated clinics.
- Monitor for drug side effects and drug interactions.
- Monotherapy:
    - If seizure control is not attained on a single drug, add another drug and optimize the dose slowly to therapeutic dose. Once therapeutic dose is attained, gradually wean off the first drug.
    - Alternatively, you can wean off the first drug while adding and optimizing the second drug.
- Rational combination therapy:
    - Combines drugs with different mechanism of action and consider their spectrum of efficacy, drug interactions adverse effects and availability.
    - Usually combines 2 or maximum 3 drugs.
- Avoid starting females of childbearing potential with sodium valproate because of risk of teratogenicity and neurodevelopmental impairment to the unborn child unless other treatments are ineffective or not tolerated.
- Withdrawal of medication:
    - Needs to be carefully planned and should only be attempted after the patient has been seizure free for 2 years,
    - Consider the likely prognosis and individual circumstances before attempting slow withdrawal of medication over 3-6 months (maybe longer if using clonazepam or phenobarbitone).
- Patients with known Epilepsy syndromes or structural defects must always be discussed with a paediatrician/ neurologist before discontinuation of drug.
- If seizures recur, the last dose reduction is reversed, and medical advice sought

<u>The patients with "Intractable Epilepsy/Supra refractory epilepsy</u>

Please re-evaluate for the following possibilities:

- Is it a seizure or a non-epileptic event?
- Wrong classification of epilepsy syndrome, thus wrong choice of antiepileptic drug
- Antiepileptic drug dose not optimised
- Poor compliance to antiepileptic drug
- Antiepileptic drug aggravating seizures
- Lesional epilepsy, hence a potential epilepsy surgery candidate
- Progressive epilepsy or neurodegenerative disorder
- Discuss with a paediatric neurologist for management options.

Oral dosing and adverse effects of antiseizure medication

Carbamazepine*
Start at 2mg/kg 8 hourly,
Increase every 2 to 4 weeks to 5-10mg/kg 8 hourly
Drug class: Iminostilbene
Mechanism of action: Sodium channel modulator
Common side effects: Drowsiness, dizziness, ataxia, diplopia, rashes
Serious side effects: Steven-Johnson syndrome, agranulocytosis
**contraindicated in myoclonic epilepsy*

Levetiracetam/ Keppra
Start at 7mg/kg 12 hourly
Increase every 2 to 4 weeks to a maximum of 30mg/kg 12 hourly
Drug class: Newer drug
Mechanism of action: Modulator of presynaptic machinery (SV2A)
Common side effects: Somnolence, asthenia, dizziness, irritability, behavioural change

Phenobarbitone
Start at 2mg/kg daily
Increase every 4 weeks to 5 to 8mg/kg once daily
Drug class: Barbiturate:
Mechanism of action: GABA enhancer
Common side effects: Behavioural disturbance, cognitive dysfunction, drowsiness, ataxia, rash

Phenytoin
2mg/kg 8 hourly or 12 hourly
Mechanism of action: GABA enhancer
Common side effects: Ataxia, diplopia, dizziness, sedation, gum hypertrophy, hisrutism, megaloblastic anemia

Sodium valproate
Start at 5mg/kg 12 hourly
Increase every 2-4 weeks to 20mg/kg 8-12 hourly

Mechanism of action: GABA enhancer, Sodium channel modulator
Common side effects: Nausea, epigastric pain, tremor, alopecia, weight gain, hair loss, thrombocytopaenia
Serious side effects: Hepatic toxicity, pancreatitis, encephalopathy

Follow-up

- Follow patients in PEN-Plus clinic regularly
- Monitor response to medication and optimise accordingly
- Monitor medication side-effects
- Monitor compliance and adherence to medication

Status Epilepticus

Definition

For clinical practice purposes status epilepticus (SE) is defined as either a single unremitting seizure lasting longer than five minutes or as frequent clinical seizures without an interictal return to the baseline clinical state. The five-minute window corresponds with the time at which urgent treatment should begin. If SE continues beyond 30 minutes, then long-term consequences including neuronal injury, alteration of neuronal networks and neuronal death can occur

Operational dimensions with t1 indicating the time that emergency treatment of SE should be started and t2 indicating the time at which long-term consequences may be expected		
Types of SE	Operational dimension 1 Time (t1). when a seizure is likely to be prolonged leading to continuous seizure activity	Operational dimension 2 Time (t2). when a seizure may cause long term consequences (including neuronal injury, neuronal death, alteration of neuronal networks and functionial deficits)
Tonic-clonic SE	5 min	30 min
Focal SE with impaired consciousness	10 min	> 60 min
Absence status epilepticus	10 - 15 min *	Unknown
* Evidence for the time frame is currently limited and future data may lead to modifications.		

Convulsive SE

This is defined as episodes of excessive abnormal muscle contractions, usually bilateral, which may be sustained, or interrupted. They may be generalised or focal

Non-convulsive SE

This typically includes patients with 10 continuous minutes or >30 minutes of ictal activity on EEG in any given hour of recording (usually defined in patients on continuous EEG monitoring), with no or subtle evidence of clinical seizures, patients may present with confusion or coma

Refractory SE

This is defined as persistent seizures despite appropriate use of two intravenous medications, one of which is a benzodiazepine. Can be seen in up to 40% of patients with SE

Super-refractory SE

This is defined as SE that continues or recurs 24 hours or more after the onset of anaesthetic therapy, including those cases where status epilepticus recurs on the reduction or withdrawal of anaesthesia

Classification

For classification/categorization of SE the following four axes are used (as far as possible):

1. Semiology – clinical presentation of seizures (generalised or focal)
2. Aetiology
    a. Symptomatic – known cause
    b. Idiopathic or genetic
    c. Unknown
3. Electroencephalographic (EEG) correlates
4. Age
    a. Neonatal
    b. Infancy
    c. Childhood
    d. Adolescent

Causes/risk factors

- Central nervous system infections (cerebral malaria, acute bacterial meningitis, acute viral encephalitis)
- Acute hypoxic-ischemic insult
- Metabolic disease (e.g. hypoglycaemia, inborn error of metabolism)
- Electrolyte imbalance
- Traumatic brain injury
- Drugs, intoxication, poisoning
- Cerebrovascular event
- Epilepsy
- Undetermined

Clinical presentation/recognition of SE

The diagnosis of convulsive SE is clinical and is confirmed by verifying the presence of either an unremitting generalised seizure lasting longer than five minutes or frequent seizures without an interictal return to the baseline level of consciousness

Management

The main goals of treatment are;

- Establish and maintain adequate airway, breathing, and circulation
- Identify and treat hypoglycaemia
- Stop the seizure as quickly as possible and thereby prevent brain injury
- Identify and treat life-threatening causes of SE such as trauma, sepsis, meningitis, encephalitis or structural brain lesion
- SE is a medical emergency, please refer to the medications and algorithm below;

Medications for convulsive status epilepticus

Benzodiazepines

Diazepam 0.2mg/kg IV/IO max 10mg

Rectal Diazepam 0.5 mg/kg max 20mg

Antiseizure medications

Phenobarbital 20mg/kg IV/IO (max 1000mg)

Levetiracetam 60mg/kg IV/IO (max 4500 mg)

Algorithm for management of status epilepticus

Stabilize and support airway, breathing and circulation
Establish IV/IO access
Place continuous monitoring (cardiorespiratory and pulse oximetry)
Test and treat for possible underlying causes;

- Hypoglycaemia
- Metabolic abnormalities, fever/infection
- Severe traumatic brain injury /↑ICP

↓

Seizure at 5 min → Simultaneously with above steps, give first dose of a benzodiazepine (for doses see table above) (IV/IO/Rectal)

↓

10 minutes → Reassess and if seizure continues at 10 minutes give second dose of benzodiazepine (same dose as above)

↓

20 minutes → If seizure continues at 20 minutes give 1st dose of ASM (phenobarbital, levetiracetam) (for doses refer to table below)

↓

30 minutes → If seizure continues at 30 minutes give inform senior/ consultant/PICU and give second dose of phenobarbital. At this point patient needs HDU/PICU care.

Postictal recovery and further evaluation

- Prevent recurrent hypoglycaemia if at risk
- Further history and physical examination plus a detailed neurological evaluation to try and identify the cause
- Laboratory tests where indicated e.g. CSF, blood culture, FBC, U&E's, blood gas, e.t.c.
- Neuroimaging if indicated
- Remember to continue maintenance doses of antiseizure medications
- The need for long term ASM will depend on the underlying cause of SE

Neural Tube Defects

Definition
A group of birth deformities of the central nervous systems resulting from defective neurulation or closure of the neural plate

Risk factors/causes
- Maternal folate deficiency
- Pre- gestational diabetes
- Genetic factors e.g. previous child with NTD
- Maternal obesity
- Maternal hyperthermia in the first trimester
- Amniotic band sequence
- Syndromes: Trisomy 13 or 18 and triploidy

Prevention/promotion
- Women of childbearing age who are planning a family should be screened and treated for anaemia, micronutrient deficiencies and obesity
- Prenatal supplements should be started on schedule and continued as per recommendation for both the general and at-risk population
- For the general population

Supplemental folic acid is a safe and effective treatment for prevention of NTDs
0.4 mg taken once per day, beginning at least one to 3 months prior to attempting conception and continuing throughout pregnancy and for four to six weeks postpartum or until completion of breastfeeding
- For women at risk of having a child with NTD

4 mg dose folic acid supplementation
This dose should be initiated one to three months prior to conception and maintained through the first 12 weeks of gestation, after which the dose is reduced to 0.4 mg and continued until four to six weeks postpartum or until completion of breastfeeding

Signs and symptoms
- These vary and range from being asymptomatic in some closed NTD, lower limb weakness with a neuropathic bladder in the context of a tethered cord, ora fleshy pouch covered in either membrane or exposed notable at birth
- The following associated complications occur with NTD depending on their severity:
  - Neuro developmental disorders e.g. learning difficulties
  - Hydromyelia
  - Tethered cord
  - Seizures
  - Neurogenic bladder
  - Bowel dysfunction
  - Orthopedic problems (e.g. scoliosis, hip dislocation and contractures, rotational abnormalities of the lower extremities)
  - Pressure ulcers
  - Infections (Meningitis, UTI)

Open neural tube defects: These are defects covered only by a membrane and make up 80% of all NTD. These include anencephaly, myelomeningocele, cranioraschisis, lipomyelomeningocele

Closed neural tube defects: These are defects that are covered by skin. These include encephalocele, split cord malformation, spina bifida occulta, dermal sinus or dermal nevus

Anencephaly: Cranial neuropore doesn't close during neural tube closure in the fourth week of embryogenesis. This leads to failure in the development of the brain and bony cranium and this is incompatible with life

Cranioraschisis: Failure of the closure of the skull bones. Also incompatible with life

Myelomeningocele: Failure of primary neurulation (e.g. failure of the spinal neural tube to close normally by 28 days after conception

Encephalocele: A sac containing brain/meninges/cerebrospinal fluid (CSF) forms outside the skull through a bone defect

Split cord malformation: a split along the midline of the cord into 2 symmetric or assymetric segments

Investigations

- Prenatally: Ultrasound scan and measurement of serum alpha feto-protein.
- Most NTD are diagnosed at birth
- NTD is associated with VACTERL anomalies (Vertebral defects, anal atresia, cardiac defects, tracheo-esophageal fistula, renal anomalies and limb abnormalities)
    - Children with an NTD should therefore undergo routine scans to screen for abnormalities in the other organ systems e.g. cardiac echo, ultrasound scan of kidneys, ureters and urinary bladder

Differential diagnosis

- Tethered cord
- Spinal cord hemorrhage
- Spinal cord infarction
- Spinal epidural abscess
- Syringomyelia

Management

- Due to the complications associated with NTD their management requires a multidisciplinary approach

Primary level

- Assess ABCDE, keep the child warm, then refer to secondary level

Secondary level:

- Assess ABCDE, keep warm
- Nurse prone position
- If leaking cover with vaseline gauze not dry gauze
- If leaking, start on ceftriaxone and metronidazole do not give AMINOGLYCOSIDES e.g. no gentamicin
- If multidisciplinary team is available, treatment can be given at secondary level. Refer to tertiary level facility if NTD is severe and needs more extensive multidisciplinary team
- Surgical review is required to assess for closure of MMC
- Make sure the baby is passing urine and not in retention
- Urological review is needed for training in continuous intermittent catheterization (CIC)
- Physiotherapy is required for passive physio required to prevent pressure ulcers
- Bowel management given oral laxatives, suppositories, and enemas, singly or in combination as first line
- Orthopedics are needed to correct associated deformities such as genu varus or valgus
- Psychosocial support
- Refer next day (need not travel at night) to tertiary level for corrective management

Tertiary level

- Patient management requires a multidisciplinary approach often led by the surgical team
- Management principles as in secondary above
- Complications must be screened for and managed
- Care can be stepped down care to a district hospital once treatment is established

Follow up

- Patients should be booked to a neurosurgical clinic for follow up at secondary or tertiary level.
- Follow up can initially every 3 months. Afterwards they need to be seen at least once a year for annual renal USS and urine dipstix due to a high lifetime risk of UTI and renal scarring
- Parents and children receive lifelong support and education from CHILD HELP SBH and a parents' group: CHILD HELP SBH have contact persons at QECH, ZCH, KCH and Mzuzu CH. Parents training weeks happen regularly as well

Headache

Definition
Defined as pain located above the orbitomeatal line. It is one of the most common complaints in children and adolescents and the prevalence increases with age

Primary headaches are most often recurrent, episodic and sporadic

Secondary headaches are headaches that are a symptom of an underlying illness. Once the underlying suspected cause is treated, the secondary headache should resolve.

Risk factors/causes

Primary Headache:
- Migraine headaches, tension-type headaches, cluster headaches.

Secondary headache:
- Acute febrile illness (influenza, upper respiratory infection)
- Recurrent rhinosinusitis (one of the most common misdiagnoses for headaches, with the majority actually being a primary headache and usually migraine
- Posttraumatic headaches
- Medications (headache is a potential side effect of multiple medications, frequent overuse of analgesic medication)
- Acute and severe systemic hypertension (may cause headache or be a response to increased intracranial pressure)
- Infections: Meningitis, encephalitis, malaria
- Brain tumour
- Idiopathic intracranial hypertension
- Hydrocephalus
- Intracranial haemorrhage (typically sudden severe unilateral headache)
- Visual refractive error

Prevention/promotion
Please note that these suggestions are general recommendations, and it's important to consult with a healthcare professional for personalized advice and guidance if symptoms persist.

- **Ensure proper hydration:** Encourage your child to drink plenty of water throughout the day, as dehydration can contribute to headaches

- **Promote regular sleep patterns**: Establish a consistent sleep schedule for your child, ensuring they get enough sleep each night. Lack of sleep or irregular sleep patterns can trigger headaches

- **Encourage healthy eating habits**: Provide a well-balanced diet for your child, including fruits, vegetables, whole grains and lean proteins. Avoid excessive consumption of sugary foods, processed snacks and caffeine, as these can be headache triggers

- **Limit screen time**: Encourage breaks and outdoor activities to reduce screen time

- **Promote good posture**: Encourage your child to maintain proper posture, especially when sitting. Poor posture can strain the neck and contribute to tension headaches

- **Ensure a well-lit environment**: Provide adequate lighting in your child's study area and other spaces they spend time in. Poor lighting can strain the eyes and trigger headaches

- **Identify and avoid triggers**: Pay attention to any specific triggers that seem to cause headaches in your child, such as certain foods, strong odors, or environmental factors. Help your child avoid or minimize exposure to these triggers

Signs and symptoms

- Dependents on the cause of the headache. Primary headaches will have specific characteristics and/or patterns that can help distinguish them

Migraine:

- Characterized by intermittent attacks of headache which are recurrent, typically moderate to severe in intensity, lasting 2 to 72 hours if not treated
- Pain may be focal, throbbing, worsens with activity or causes avoidance of activity. It can be accompanied by nausea, vomiting, light sensitivity ("photophobia") and sound sensitivity ("phonophobia")
- The duration of headache lengthens with age
- Pain is most often bilateral (bifrontal or bitemporal)
- Migraine remains the most common cause of occipital headaches however, they have an increased risk of a secondary cause and need to be investigated further
- There may be a positive family history of migraine
- Approximately 10 percent of children have associated auras that include visual, sensory, speech/ language, motor, brainstem, or retinal symptoms, paresthesias, dysphasia, hemiplegia, weakness, ataxia, or confusion
- Chronic migraine is defined as headaches on 15 or more days per month, with at least eight having migraine features.

Tension-type headaches:

- Diffuse in location, non-throbbing, mild to moderate severity and do not worsen with activity
- The pain feels like there is a band squeezing their head
- They can last from 30 minutes to 7 days
- May be associated with either photophobia or phonophobia but is not accompanied by nausea, vomiting, or aura
- May have tenderness around the forehead
- It is associated with stress, anxiety or depression

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Cluster headaches:

- Most common trigeminal autonomic cephalalgia characterised by trigeminal location and association with autonomic features
- Typically, unilateral and frontal-periorbital in location
- The pain is severe and lasts less than three hours, but multiple headaches occur in a very short period of time (hence "cluster")
- Usually associated with ipsilateral autonomic findings, including lacrimation, conjunctival injection, nasal congestion and/or rhinorrhea, facial and forehead sweating, eyelid edema and miosis and/or ptosis

- Usually occur between the ages of 10 and 20 years, but may occur in younger children

Symptom	Migraine	Tension type headache	Trigeminal autonomic cephalalgia (e.g. cluster headache)
Location	• Young children; commonly bilateral. • Adolescents and young adults; commonly unilateral, global in 30%	• Bilateral	• Always unilateral, usually begins around the eye or temple
Characteristic	• Gradual in onset, crescendo pattern; pulsating; moderate or severe intensity; aggravated by routine physical activity	• Pressure or tightness that waxes and wanes	• Pain begins quickly, reaches a crescendo within minutes; pain is deep, continuous, excruciating, and explosive in quality
Patient appearance	• Patient prefers to rest in a dark, quiet room	• Patient may remain active or may need to rest	• Patient remains active
Duration	• 2 to 72 hours	• Variable	• 30 minutes to 3 hours
Associated symptoms	• Nausea, vomiting, photophobia, phonophobia; may have aura (usually visual, but can involve other senses or cause speech or motor deficits)	• None	• Ipsilateral lacrimation and redness of the eye; stuffy nose; rhinorrhea; pallor; sweating; Horner syndrome; focal neurologic symptoms rare; sensitivity to alcohol

Clinical feature	Possible significance
General appearance	• Altered mental status (meningitis, encephalitis, intracranial hemorrhage, elevated intracranial pressure, hypertensive encephalopathy)
Vital signs	• Hypertension may cause headache or be a response to increased intracranial pressure • Fever suggests infection
Head circumference	• Macrocephaly may indicate slowly progressive increases in intracranial pressure

Height and weight trajectories	• Abnormal or altered trajectories may indicate intracranial pathology
Auscultation of the neck, eyes, and head for bruit	• Bruit may indicate arteriovenous malformation
Palpation of the head and neck	• Localised scalp tenderness may occur in migraine and tension-type headaches • Scalp swelling may indicate head trauma • Sinus tenderness may indicate sinusitis • Temporomandibular joint (TMJ) and/or masseter tenderness suggests TMJ dysfunction • Nuchal rigidity may indicate meningitis • Posterior neck pain may indicate an anatomic abnormality (e.g. Chiari malformation) • Thyromegaly may indicate thyroid dysfunction
Visual fields	• Visual field abnormalities may indicate increased intracranial pressure and/or a space-occupying lesion
Fundoscopy	• Papilledema may indicate increased intracranial pressure • Funduscopic examination is normal in primary headache
Otoscopy	• May demonstrate otitis media; hemotympanum may indicate trauma
Oropharynx	• Signs of pharyngitis? Dental decay or abscess?
Neurologic examination	• Abnormal examination may indicate intracranial pathology but also may occur with migraine headache
Skin examination	• Trauma, neurocutaneous disorders (e.g. neurofibromatosis, tuberous sclerosis complex)
Spine	• Occult spinal dysraphism may be associated with structural abnormalities (e.g. Chiari malformation)

Investigations

- FBC with differential and ESR
- Serum or urine toxicology screens (if acute or chronic intoxication is suspected)
- Thyroid function tests (if thyroid dysfunction is suspected)
- LP if suspected intracranial infection, subarachnoid haemorrhage, or idiopathic intracranial hypertension.
- Brain MRI: Indicated in children with any of the following features:
    - Abnormal neurologic examination
    - Younger than six years old
    - Who have features worrisome for a pathologic intracranial process

Differential diagnosis

Refer to causes of secondary headaches

Management

Primary/secondary/tertiary level

Treat underlying conditions
Some common management principles when managing recurrent headaches include:

- A diary in which the quality, location, severity, timing, precipitating and relieving factors and associated features of the headache are recorded is useful
- Providing realistic expectations (e.g. the frequency and severity of the headaches may decrease over weeks to months of therapy, but the headaches may continue to occur
- Return to school for children who have been absent; if necessary, they can go to the school nurse or office once daily for 15 minutes when headache pain peaks.
- Avoidance of headache triggers (e.g. dietary triggers, caffeine, lack of sleep, inadequate hydration, overuse of electronic devices)
- Daily exercise for 20 to 30 minutes
- Addressing comorbid sleep problems (e.g. delayed sleep onset, frequent night waking)
- Avoid overuse of headache medication as this can worsen headache
- Educating and enabling patients to manage their disease to enhance personal control
- Reduction of headache-related distress and psychologic symptoms

Migraine Headache

Primary level

- Relieve headache as quickly as possible with return to normal function. Can use NSAIDS

Secondary level:

- Relieve headache as quickly as possible with return to normal function. This mainly includes 2 groups of medications: nonsteroidal anti-inflammatory drugs (NSAIDs) and triptans

Tertiary level

- Consult neurologist for persistent headaches

Tension Type Headache

Primary level

- Simple analgesics (ibuprofen or paracetamol) can be effective for acute treatment

Secondary level:

- Amitriptyline can be effective for prevention of tension type headache.

Tertiary level

- Bio-behavioral therapy and copings skills training may also be beneficial if stress is suspected as an underlying cause. Consult neurologist for persistent headaches

Follow up

- Patients with headache should be scheduled for follow up in general/neurology clinic at secondary or tertiary level

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