CHAPTER 15 – CENTRAL NERVOUS SYSTEM

First Nations and Inuit Health Branch (FNIHB) Pediatric Clinical Practice Guidelines for Nurses in Primary Care.
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For more information on the history and physical examination of the central nervous system in older children and adolescents, see Chapter 8, *“Central Nervous System”* in the adult clinical guidelines.

ASSESSMENT OF THE CENTRAL NERVOUS SYSTEM

HISTORY OF PRESENT ILLNESS AND REVIEW OF SYSTEM

It is important to obtain a complete history and details of all presenting symptoms, including information about onset (sudden or gradual), duration and progression.

- Change in level of consciousness (for example, lethargy, stupor)
- Changes in cry (in infants < 6 months old)
- Changes in feeding patterns
- Changes in speech, language, behaviour or affect[1]
- Irritability, difficulty consoling child
- Presence of headache and its characteristics: site, duration, alleviating factors, association with vomiting or visual disturbance
- Visual disturbance (for example, double vision [diplopia] indicates involvement of cranial nerves)
- Changes in hearing, smell or taste in older child
- Vertigo (indicates inner ear disturbance)
- Muscle weakness or wasting
- Involuntary motor movements (for example, tics, tremor)
- Abnormal muscle tone (hypertonia [increased tone] or hypotonia [decreased tone])
- Abnormal changes in sensation (for example, tingling, numbness)
- Detailed description of any seizures, fainting or other spells: skin colour, respiration, precipitants, duration, associated limb and eye movements, level of consciousness, behaviour before and after the seizure
- Chronology of attainment of normal developmental milestones
- Previous history of neurologic disorder
- Family history of neurologic disorder
- Details of mother's pregnancy, labour, delivery and neonatal period (especially for children < 2 years old)
- Immunization status

PHYSICAL EXAMINATION

A general physical examination, as well as a detailed neurologic examination, is important. Assess the following:

- Level of consciousness (can be quantified by means of the pediatric Glasgow Coma Score; *see Table 1, "Scoring for the Pediatric Glasgow Coma Score"*)
- Mental status
- Speech
- Cranial nerve assessment[1] *(see Table 8, "Cranial nerve assessment in children" in Chapter 1, "Pediatric Health Assessment")*
- Tone, strength and reflexes of limbs
- Reflex testing including biceps, brachioradialis, triceps, patellar, achilles, clonus[1]
- Superficial reflexes: Babinski, abdominal[1]
- Developmental reflexes: rooting, sucking, palmar grasp, moro, tonic neck and stepping[1] *(see the section "Central Nervous System" in Chapter 1, "Pediatric Health Assessment")*
- Eye examination: full-range extraocular movements, PERRLA (pupils equal, round and reactive to light; accommodation normal), funduscopy for clarity and vascularity of optic disk
- Head shape and size (measure circumference), fontanel and suture size
- Facial dysmorphism (may indicate a genetic syndrome)
- Cutaneous birthmarks (may indicate a neurocutaneous disorder)
- Sinus of lower back and hair tuft over sacrum
- Observation of child with respect to achievement of major age-appropriate developmental milestones (for example, crawling, walking, playing with toys)
- Observation of gait while child is walking
- Meningeal signs (for example, neck stiffness, Kernig's sign [pain with passive knee extension and hip flexion], Brudzinski's sign [spontaneous hip flexion with passive neck flexion])
- Respiratory examination: look for underlying pneumonia
- Cardiac examination: listen for murmur
- Abdominal examination: check for enlargement of liver or spleen

Table 1 – Scoring for the Pediatric Glasgow Coma Score*

Feature	Score	Age Group and Response	
Eyes opening		**≥ 2 years**	**< 2 years**
	4	Spontaneously	Spontaneously
	3	To verbal stimuli	To speech
	2	To pain	To pain
	1	No response	No response
Best motor response		**≥ 2 years**	**< 2 years**
	6	Obeys command	Normal spontaneous movement
	5	Localizes pain	Withdraws to touch
	4	Withdraws to pain	Withdraws to pain
	3	Flexion abnormal (decorticate rigidity)	Flexion abnormal (decorticate rigidity)
	2	Extension (decerebrate rigidity)	Extension (decerebrate rigidity)
	1	No response	No response
Best verbal response		**≥ 2 years**	**< 2 years**
	5	Oriented** and converses	Smiles, listens, coos
	4	Disoriented and converses	Cries, irritable, consolable
	3	Inappropriate words, screaming, cries	Inappropriate persistent cry and/or screaming
	2	Incomprehensible sounds	Agitated, moans to pain
	1	No response	No response

*Score is obtained by determining the score for each of the three criteria (eye-opening, best motor response, best verbal response) and summing them. Score > 8: Head injury moderate/minor. Score < 8: Head injury severe.

** Young children will demonstrate orientation by identifying their parents correctly or giving their own name.

Source: Adapted from Children's Hospital of Eastern Ontario. *Emergency care orientation manual*. (2008). Hockenberry MJ, Wilson D. *Wong's nursing care of infants and children*. 8th ed. Mosby Elsevier; 2007. p.1619.

COMMON PROBLEMS OF THE CENTRAL NERVOUS SYSTEM

HYPOTONIA ("FLOPPY INFANT")

Lower-than-normal muscular resistance to passive movement of a joint. Muscle strength is a key component of this resistance. An impairment commonly associated with many different pediatric disorders including diseases of the motor unit, genetic and metabolic disorders and central nervous system dysfunction.[2]

Benzodiazepines may cause hypotonia[3] if they are taken by the mother in late pregnancy. Since the fetus and neonate metabolize benzodiazepines very slowly, significant concentrations may persist in the infant for up to two weeks after birth. Withdrawal symptoms include hyperexcitability, high-pitched crying and feeding difficulties.[3]

If used in therapeutic doses, benzodiazepines have little risk of causing major congenital malformations. However, chronic maternal use may impair fetal intrauterine growth and delay brain development. There is increasing concern that such children in later life may be prone to attention deficit disorder, hyperactivity, learning difficulties and a spectrum of autistic disorders.

CAUSES

– Underlying pathology can be divided into four broad categories, central nervous system, peripheral nerves (motor and sensory), neuromuscular junction and muscle[4]
– Hypotonia of central nervous system origin accounts for about 66% to 88% of cases[4]

- Static encephalopathy related to perinatal or prenatal insult (for example, hypoxia, ischemia at birth, intracranial hemorrhage)
- Direct central nervous system (CNS) injury (for example, spinal cord or brain injury)
- Myasthenia gravis
- Congenital myopathy
- Myotonic dystrophy
- Muscular dystrophy
- Systemic illness (for example, congenital heart disease, hypothyroidism, celiac disease, inborn errors of metabolism)
- Congenital disorders of glycosylation including cerebellar abnormalities and peripheral neuropathy[4]

HISTORY

- Onset (acute or gradual)
- Present from birth
- Duration
- Progression
- Past history of any acute illness (for example, TB, meningitis)
- Family history of myopathy or other neurologic disorders
- Family history of muscle diseases, genetic disorders[4]
- Parental consanguinity (can increase the possibility of autosomal recessive disorders)[4]
- Clinical and developmental assessments and developmental milestones[4]
- Prenatal history including fetal movements, maternal illness, maternal exposure to infectious agents, maternal drug alcohol use[4]
- History of complications during labour and delivery
- Social history: infant-parent interaction, siblings' history

Associated Symptoms

- Respiratory and feeding difficulties
- Fasciculations
- Ptosis
- Seizures
- History of any delays in reaching milestones
- Inappropriate weight gain for age

Obstetrical History

- Physiologic insults during pregnancy or birth
- Maternal health problems (for example, hypertension, diabetes mellitus)
- Maternal infections
- Maternal use of neurotoxic drugs

PHYSICAL FINDINGS

- Vital signs
- General physical examination to rule out any underlying cause
- Dysmorphic features (for example, webbed neck, low-set ears, wide-set eyes)
- Complete CNS examination *(see "Physical Examination," above and the "Newborn" and "Infant", "CNS Exam" in Chapter 1, "Pediatric Health Assessment")*
- Assessment of developmental milestones for age
- Assessment of primitive reflexes of the newborn *(see "Physical Examination of the Newborn", Table 7, "Newborn and Infant Reflexes" in Chapter 1, "Pediatric Health Assessment")*
- Muscle tone decreased (hypotonia)

DIFFERENTIAL DIAGNOSIS

See *"Causes"*.

COMPLICATIONS

- Long-term disability and developmental delays

DIAGNOSTIC TESTS

- None

MANAGEMENT

Management depends on the cause of the hypotonia.

Goals of Treatment

- Identify underlying cause early
- Minimize long-term disability

Appropriate Consultation

Consult a physician immediately to discuss the case.

Referral

A hypotonic child should be evacuated for evaluation and investigation. The urgency of evacuation depends on the child's clinical condition and possible causes of the hypotonia.

EMERGENCY PROBLEMS OF THE CENTRAL NERVOUS SYSTEM

SEIZURE DISORDERS

Seizures are behavioural changes resulting from abnormal paroxysmal neuronal discharge and are a symptom of an underlying brain problem.[5] The symptoms depend on the part of brain that is involved and may include any of the following:

- Altered level of consciousness
- Tonic-clonic movements of some or all body parts
- Eye movements
- Visual, auditory or olfactory disturbance

Most seizures in children involve loss of consciousness and tonic-clonic movements, but auditory, visual or olfactory disturbance, behavioural change or absences in attention may also occur.

Seizures must be differentiated from other "spells" (for example, fainting, breath-holding, arrhythmia, vertigo, tic).

Types of symptoms:

- Motor symptoms: movements often begin in a single muscle group and spread to entire side of body[6]
- Sensory symptoms: changes may involve paresthesia or visual disturbances such as visualization of flashing lights[6]
- Autonomic symptoms: may include tachycardia, loss of bowel/bladder control[6]
- Psychic symptoms: may report hallucinatory experiences or dreamlike state[6]

TYPES

Generalized Seizure

Absence seizures:

- Impairment of consciousness
- Very brief frequent periods of non-distractible staring (average 10 seconds)[6]
- Occurs primarily in children (age of first seizure varies from 3–20 years)[6]
- Increased or decreased muscle tone may occur as well as automatisms or mild clonic movements[6]
- Recovery is rapid[6]

Primarily generalized tonic-clonic (grand-mal):

- Loss of consciousness (without warning preceded by myoclonic jerks)[6]
- Clinical features are similar to those of secondarily generalized partial seizures[6]
- Affects both hemispheres
- Characterized by change in level of consciousness
- Bilateral motor involvement
- Examples: absence seizure or grand mal seizure with tonic-clonic movements of all four limbs

Simple Partial Seizure

- No signs and symptoms may be motor, sensory, autonomic or psychic[6]
- Affects only part of brain (focal, motor or sensory)
- Formerly called focal seizures

Complex Partial Seizure

Partial seizure with affective or behavioural changes and loss of consciousness.

- Impairment of consciousness occurs[7]
- Seizure may occur without warning or with motor, autonomic or psychic symptoms[7]
- Seizure is often followed by period of confusion[7]

Febrile Seizure

Febrile seizures are related to a quick rise in body temperature associated with a febrile illness. It usually occurs within the first 24 hours of the febrile illness. Febrile seizures are the most common type of seizures during childhood, typically occurring in the 6 months to 5 years age group.[8]

- Associated with temperature > 38°C
- Occurs in children < 6 years old (prevalence is 2% to 4% among children between 6 months and 3 years old). Median age of occurrence is 18–22 months[8]
- No signs or history of underlying seizure disorder
- Often familial
- High rate of seizures associated with roseola, shigellosis and salmonellosis[9]
- Uncomplicated and benign if seizure is of short duration (< 5 minutes)
- Involves tonic-clonic movements
- Bilateral

Other complex seizures (not covered by categories listed above) may require more complete tertiary assessment.

HISTORY

- Previous episodes (that is, known seizures)
- Review of systems should focus on discovering the source of the fever[10]
- Assess developmental milestones[10]

History of Present Seizures

- Onset (sudden or gradual)
- Date and time of onset
- Whether consciousness has been regained since onset of seizure activity
- Was there complete loss of consciousness and/or incontinence
- Duration of seizure
- Sequence of seizures
- Type of seizure (generalized or partial)
- Association with fever
- Association with head injury
- Ingestion of poisonous substance or other poisoning (for example, lead encephalopathy)
- Was/were seizure(s) witnessed
- Any similarities between seizures (if occurred in the past)
- Frequency of seizures
- Any associated aura, antegrade amnesia, or post-ictal period[6]
- Any rash

Other Factors

- Compliance with anticonvulsant therapy in child known to have epilepsy
- Other chronic disease
- Medication use
- Allergies to medications
- Symptoms of intercurrent illness (for example, fever, malaise, cough)
- Past medical history of head trauma, birth complications, febrile convulsions, middle ear or sinus infections, alcohol or drug use prenatally or symptoms of cancer[6]
- Toxic exposure (environmental allergens)[6]

PHYSICAL FINDINGS

Acute Seizure

- Temperature normal unless underlying infection is present
- Heart rate elevated and may be irregular
- Respiration irregular (absent during seizure, present between seizures)
- Blood pressure elevated or low
- Oxygen saturation may be decreased
- Loss of consciousness
- Skin pale or cyanotic
- Evidence of loss of bowel and bladder control
- Repeated episodes of tonic-clonic movements
- Foaming at mouth may be present
- Blood around or in mouth if child has bitten tongue
- Abnormalities suggesting underlying cause (for example, stiff neck and bulging fontanel would suggest meningitis)
- Focal neurologic findings (for example, hemiparesis or abnormal deep tendon reflexes would be of specific concern)

Always consider meningitis in a child with an apparent simple febrile convulsion. Meningitis can usually be diagnosed on clinical grounds alone, but if in doubt, contact a physician.

For any child who is having a generalized grand mal seizure on arrival and for whom the exact time of onset of the convulsion is unknown, manage as you would for status epilepticus (a condition lasting longer than 30 minutes and characterized by continuous seizure activity or intermittent convulsive activity with failure to regain consciousness between convulsions). See *"Management of Acute Seizure (Status Epilepticus)"*.

DIFFERENTIAL DIAGNOSIS

- Meningitis
- No access to prescription medication
- Interruption of prescription medication
- Epilepsy
- Drugs/alcohol[6] (noncompliance with prescription, withdrawal syndrome, overdose, multiple drug abuse)
- Hypoxia
- Brain tumour
- Infection (for example, meningitis)
- Metabolic disturbances (for example, hypoglycemia, uremia, liver failure, electrolyte disturbance)
- Hypoglycemia, hyponatremia and hypocalcemia are very important causes of afebrile seizures[11]
- Head injury
- Breath-holding spells

COMPLICATIONS

- Hypoxia during seizures
- Status epilepticus
- Arrhythmia
- Injury during seizure
- Aspiration
- Brain damage
- Death

DIAGNOSTIC TESTS

Acute Seizure

- Random glucose test
- Pulse oximetry
- CBC, chemistry profile
- Consider toxicology screening[12]

MANAGEMENT OF ACUTE SEIZURE (STATUS EPILEPTICUS)

Goals of Treatment

- Protect airway
- Stabilize cardiorespiratory function
- Provide supportive care during seizures

ABCs (airway, breathing and circulation) are the first priority:

- Maintain airway
- Suction secretions as necessary
- Insert oropharyngeal airway
- Assist ventilation as needed by means of Ambu-bag with oxygen

Appropriate Consultation

Consult a physician as soon as possible after emergency care.

Adjuvant Therapy

- Give oxygen 6–10 L/min by mask or more as necessary to maintain oxygen saturation
- Keep oxygen saturation > 97%
- Start IV therapy with normal saline, adjusting rate according to state of hydration

Nonpharmacologic Interventions

- Maintain child in side-lying position
- Keep child warm
- Give nothing by mouth until child has fully recovered

Pharmacologic Interventions

lorazepam (Ativan), 0.05–0.10 mg/kg IV (maximum 4 mg per dose); may repeat once in 10 minutes if necessary (administer slowly over 5 minutes at a maximum rate of 2 mg/min)

or

diazepam (Valium), 0.3 mg/kg IV (maximum 5 mg per dose for child ≤ 5 years old, 10 mg per dose for child > 5 years old); repeat dose in 10 minutes, if necessary, to a maximum of 3 doses (administer slowly over 5 minutes at a maximum rate of 2 mg/min)

If unable to achieve IV access, diazepam and lorazepam can be given effectively by the rectal route.

Use IV solution without dilution and administer by inserting the smallest possible syringe or a small catheter affixed to the end of a syringe (if the dose is less than 5 mg, a tuberculin syringe is ideal):

lorazepam (Ativan), 0.05–0.10 mg/kg IV (maximum 4 mg per dose); may repeat once in 10 minutes if necessary (administer slowly over 5 minutes, at a maximum rate of 2 mg/min)

or

diazepam (Valium), 0.5 mg/kg per dose PR (maximum dose of 10 mg); may repeat in 10 minutes if necessary, for a total of 3 doses (at a maximum rate of 2 mg/min)

The medication should be placed a distance of 2.5 cm into the rectum, adjacent to the rectal mucosa. The buttocks should be elevated and held together for up to 5 minutes for complete absorption. Two doses may be given, 5–10 minutes apart.

Risks of drug therapy:

- Hypotension
- Respiratory depression

Monitoring and Follow-Up

- Identify focal neurologic deficits
- Observe for return to normal level of consciousness
- Monitor vital signs, ABCs, pulse oximetry (if available)
- Monitor closely for continued seizure activity

Referral

- Medevac for diagnostic work-up is indicated if this is a previously undiagnosed seizure or you suspect meningitis or another underlying metabolic cause
- Afebrile seizures or seizures associated with severe infection must be referred and investigated

– Benign febrile seizures can usually be handled in the community
– Investigation is required only if the seizures are of long duration (≥ 15 minutes), they are complicated (for example, focal, residual paralysis) or child is ≤ 3 months old

It is important that seizures be controlled before transport. If at all possible, obtain the assistance of an experienced critical care pediatric professional in stabilizing and transferring the child to hospital.

MANAGEMENT OF CHRONIC SEIZURE DISORDER

Management depends on underlying cause and severity of symptoms.

Goals of Treatment

– Control seizures
– Prevent recurrence
– Allow child to return to a normal lifestyle
– Achieve good adherence to treatment regimen over a long period
– Discontinue medications eventually, with continued control of seizures

Nonpharmacologic Interventions

Provide reassurance.

Client Education

– Explain prognosis
– Emphasize importance of adhering to medication regimen
– Counsel about first aid during seizures
– Advise supervision during swimming
– Advise that the child be treated as a normal child would be
– Advise about possible teratogenic effects of medications (for example, phenytoin) for sexually active females

Pharmacologic Interventions

Anticonvulsants are tailored to the specific type of seizure. Monotherapy is ideal, but some patients may need two or more medications. Poor compliance is the major cause of seizure recurrence.

Some commonly used anticonvulsants:

– Carbamazepine (Tegretol)
– Lamotrigine (Lamictal)
– Phenytoin (Dilantin)
– Primidone (Mysoline)
– Valproic acid (Depakene)
– Vigabatrin (Sabril)

Monitoring and Follow-Up

– Follow up every 6 months if seizures are well controlled, more frequently if child is having breakthrough seizures
– Assess adherence to medication regimen
– Adverse drug effects[13]
– Care during a seizure[13]
– Monitor serum drug levels every 6 months if stable, more frequently if necessary
– The importance of carrying medical identification (for example a medical alert bracelet)[13]
– For adolescents, counsel patients regarding the risks associated with driving and epilepsy and the applicable provincial driving laws[14]
– Advise the patient to contact their province's motor vehicle department for information on a driver's license[13]

Referral

– Refer electively for review by a physician at least annually if seizures are well controlled
– Refer urgently if child is having breakthrough seizures
– Consider neurologic follow-up if symptoms are not controlled on current medications

HEAD TRAUMA

Trauma to the head, simple linear skull fractures and concussions are the most common examples of minor head injuries.[15] Head trauma is common among children and results in a significant number of visits to emergency clinics.

Children are more predisposed than adults to head injury because their head to body ratio is greater, their brains are less myelinated and thus more prone to injury, and their cranial bones are thinner. Although the incidence of mass lesions is lower among children than among adults, children are more likely to suffer from a unique form of brain injury called malignant brain edema. In addition, children may lose relatively large amounts of blood from scalp lacerations and subgaleal hematomas and may present in hemorrhagic shock.

HISTORY

Head trauma may be due to child abuse or serious neglect by a parent or caregiver. In all cases, a thorough history should be obtained of past injuries and of the circumstances surrounding the present injury. It may be impractical to review old records for all children with head injuries, but in suspicious cases these records must be reviewed and appropriate follow-up arranged.

Ascertain the following:

- Mechanism of injury
- Time of injury
- Loss of consciousness
- Amnesia
- Irritability
- Visual disturbance
- Disorientation
- Abnormal gait
- Lethargy, pallor or agitation may indicate severe injury
- Vomiting
- Symptoms of increased intracranial pressure (vomiting, headache, irritability)
- Explore possibility of alcohol or illicit drug use[16]
- Ask about neck pain or pain in other areas of the body, or other bodily injuries[16]
- Ask about self-treatment[16]
- Ask about previous head injuries, particularly in athletes to determine "second impact syndrome" (*this occurs when an athlete, who has already sustained a head injury, sustains a second head injury before symptoms have cleared from the first injury – may lead to massive acute-brain swelling and ultimately death*)[16]

Many children will vomit after even a minor head injury. However, protracted vomiting and retching, associated with other symptoms or signs, indicates a more severe head injury.

The child's complete medical history must be obtained. Evidence of conditions such as a predisposition to seizures or bleeding problems is important and will affect the clinical management.

PHYSICAL FINDINGS

Severity of intracranial injury can be assessed from a variety of characteristics *(see Table 2, "Classification of Severity of Intracranial Injury").*

Table 2 – Classification of Severity of Intracranial Injury

Mild	Moderate	Severe
Asymptomatic	Progressive lethargy	Focal neurologic signs present
Mild headache	Progressive headache	
No evidence of skull fracture, facial injury or other trauma	Signs of basal skull fracture; possible penetrating injury or depressed skull fracture; serious facial injury, multiple trauma	Penetrating skull injury; palpable depressed skull fracture or compound skull fracture; serious facial injury or multiple trauma
Three or fewer episodes of vomiting	Vomiting protracted (more than three episodes) or associated with other symptoms	
Glasgow coma score 15	Glasgow coma score 11–14	Glasgow coma score ≤ 10; a decrease of 2 or more points in serial Glasgow coma scores, not clearly caused by seizures, drugs, decreased cerebral perfusion or metabolic factors
Loss of consciousness for < 5 minutes	Loss of consciousness for ≥ 5 minutes	Unconscious
	Post-traumatic amnesia or seizure	

Adapted with permission from Canadian Paediatric Society, Emergency Paediatrics Section. Management of children with head trauma. (Ref. No. EP90-01; approved by CPS Board of Directors 1990.) *CMAJ* 1990;142(9):949-52.

VITAL SIGNS

- Temperature usually normal
- Tachypnea: rapid heart rate may signify blood loss, in which case evidence of other injuries should be sought
- Bradycardia with hypertension (Cushing response): usually a late response in children with increased intracranial pressure and therefore not very reliable
- Hypertension: late sign of increased intracranial pressure
- Hypotension signifies shock: look for other injuries, since shock is not a usual sign of brain injury, unless there is significant intracranial bleeding

Signs of Skull Fracture

- Approximately 75% of skull fractures in children are linear[17]
- Hematotympanum
- Periorbital or post-auricular ecchymosis
- Cerebrospinal fluid otorrhea or rhinorrhea
- Depressed fracture or penetrating injury
- Skull fractures with underlying lacerations may predispose the patient to meningitis[18]

Palpate scalp hematomas and contusions for underlying depressions, which signify depressed skull fracture. Before suturing, explore all full-thickness skull lacerations to ensure that the underlying bone is intact.

NEUROLOGIC EXAMINATION

- Observe gait[19]
- Examine nasopharynx and ears for evidence of fresh blood[19]
- Pediatric Glasgow coma scale: *see Table 1, "Scoring for the Pediatric Glasgow Coma Score"*
- Bulging fontanel, widely separated scalp sutures
- Papilledema (increased intracranial pressure)
- Pupillary light reflexes (PERRLA [pupils equal, round, reactive to light; accommodation normal])
- Cranial nerve examination
- Movement of extremities, deep tendon reflexes, sensory and motor functioning and coordination[20]
- Abnormal posture (decorticate or decerebrate)
- Muscle flaccidity, spasticity
- Plantar responses

Injuries to other areas such as the thorax or abdomen should be sought and treated promptly, since they may contribute to morbidity and death.

Clues to increased intracranial pressure:

- Decrease in Glasgow coma score of 2 points or more
- Abnormality or changes in pupillary size and reaction to light
- Respiratory abnormalities
- Development of paresis in absence of shock
- Hypoxia
- Seizures
- Elevation of blood pressure, elevated systolic pressure[16]
- Decrease in heart rate
- Decrease in respiratory rate
- Papilledema[16]
- Wide pulse pressure[16]

Maintain a high index of suspicion for child abuse.

MANAGEMENT OF MILD INJURY

Children with mild intracranial injury may be discharged home. An instruction sheet should be given to the parents or caregiver concerning observation and precautions *(see Table 3, "Instructions to Parents or Caregivers for Observation at Home of Children with Head Trauma" and Table 4, "Instructions to Parents or Caregivers for Observation at Home of Infants and Young Children with Head Trauma").*

Table 3 – Instructions to Parents or Caregivers for Observation at Home of Children and Adolescents with Head Trauma

Bring child back to clinic immediately if any of the following signs and symptoms appear within the first 72 hours after discharge:
Any unusual behaviour
Disorientation as to name and place
Problems with balance
Worsening headache
Seizures
Difficulty seeing, hearing, speaking or walking
Unusual drowsiness or hard to wake up
Vomiting more than two or three times
Pupils are unequal and/or do not react to light
Blood or clear fluid running from ears or nose

Table 4 – Instructions to Parents or Caregivers for Observation at Home of Infants and Young Children with Head Trauma

Bring child back to clinic immediately if any of the following signs and symptoms appear within the first 72 hours after discharge:
Poor feeding
Vomiting more than two or three times
Unusual drowsiness or hard to wake up
Bulging fontanel
Any unusual behaviour

Source: Adapted from Children's Hospital of Eastern Ontario. *Emergency care orientation manual*. (2004). Minor Head Injury Discharge Instructions handout.

MANAGEMENT OF MODERATE TO SEVERE INJURY

Management Priorities

ABCs must be assessed before any detailed history-taking or neurologic examination. Instability of the cardiorespiratory system may be due to severe intracranial injury, intracranial hypertension or injury to other areas, such as the thorax or the abdomen. Prompt ventilatory support and treatment of shock *(see the section "Shock" in Chapter 20, "General Emergencies and Major Trauma")* are mandatory since these factors, if left uncorrected, will result in secondary intracranial trauma.

Stabilizing Head and Cervical Spine

Manual in-line stabilization must be maintained until injury to the cervical spine has been excluded or the neck is properly immobilized on a flat, hard surface with weights on either side of the neck.

Suture scalp lacerations, as major blood loss can occur from such lesions.

Appropriate Consultation

For any loss of consciousness, investigation and treatment are to be discussed with a physician.

Adjuvant Therapy

– Start IV therapy with normal saline to keep vein open (unless the child is in shock from other injuries)
– Give oxygen at 6–10 L/min or more, as necessary

Nonpharmacologic Interventions

– Elevate head of bed by 30° to 45°
– Place head and neck in midline position
– Minimize stimuli (for example, suctioning and movement)
– Restrict fluids to 60% of normal intake (except in cases of shock)
– To control increased intracranial pressure: above measures plus establish controlled hyperventilation if intubation is available

Pharmacologic Interventions

Diuretics if intracranial pressure is increased (and there is documented deterioration) despite measures outlined above:

mannitol, 0.5–1 g/kg IV

Monitoring and Follow-Up

Monitor ABCs, vital signs, pulse oximetry (if available), level of consciousness (with serial pediatric Glasgow coma scores), intake and output.

Referral

Medevac.

HEADACHE

ACUTE HEADACHE

Pain in the head involving blood vessels, meninges and bony and soft-tissue components of the head. Also defined as diffuse pain in various parts of the head with the pain not confined to the area of distribution of a nerve.[21]

CHRONIC OR RECURRENT HEADACHE

Pain in the head occurring on a chronic basis with three broad categories of causes: vascular (migraines), muscle contraction (tension headaches) and organic cause. Onset may occur at any age.

CAUSES

Vascular causes (leading to migraine) and muscle contraction (leading to tension headaches) are the most common causes of headache in children. Primary headaches are also caused by traction on pain-sensitive structures, inflammation of vessels and meninges and vascular dilation.[21]

Vascular Lesions

– Arteriovenous malformation
– Berry aneurysm
– Cerebral infarction
– Intracranial hemorrhage

Migraine

Vascular headaches (migraine) are common in children, who often have incomplete manifestations of this condition. This type of headache should be considered in any recurrent problem with headache.

– Classic
– Common
– Cluster

Complicated Migraine

– Basilar artery
– Hemiplegic
– Ophthalmoplegic

Variants of Migraine

– Acute confusional state
– Benign paroxysmal vertigo
– Cyclic vomiting

Muscle Contraction

– Tension

Infection

– Brain abscess
– Dental infection
– Encephalitis
– Meningitis
– Sinusitis (chronic)

Trauma

– Neck injury
– Post-concussion syndrome
– Subdural hematoma

Toxic Effects

– Carbon monoxide
– Heavy metal poisoning (for example, lead)
– Nonmedicinal agents
– Excess intake of vitamins

Psychogenic

– Conversion
– Depression
– Factitious

Other Causes

– Food allergy or sensitivity
– Refractive error
– Ocular muscle imbalance
– Temporomandibular joint (TMJ) dysfunction

Common food triggers: cheese, chocolate, citrus fruits, hot dogs, ham, dairy products, coffee, tea, food dye, additives, artificial sweeteners, wine/beer, nuts, fasting.[22]

Common chemical triggers: tyramine, phenylethylamine, nitrates, nitric oxide, caffeine, caffeine withdrawal, linoleic acid, monosodium glutamate, allergic proteins, sulfites and tartrazine, aspartame, histamine, stress hormone, hypoglycemia.[22]

Headaches Related to Increased Intracranial Pressure

– Brain tumours
– Hydrocephalus
– Hypertension

HISTORY

Gather history from many sources, including the affected child and his or her parents (or caregiver) and teachers. It is best to get a description of both the initial and the most recent headaches. Children > 4 years old may be able to give a good description of their symptoms.

Onset

– When headache began
– Conditions associated with initial headache (for example, trauma, drug ingestion)
– Aura: visual, auditory

Location

– Unilateral or bilateral

Radiation

- Where headache starts
- Where headache hurts the most
- Whether headache spreads to other areas
- Occipital radiation: neck problems, occipital neuralgia, basilar migraine
- Facial radiation: sinus, dental or TMJ

Quality

- Sharp, dull or tight
- Throbbing or pounding (characteristic of vascular headaches)
- Whether character of pain changes over time

Severity

- Severity of the headache on a scale of 1 to 10, with 10 representing the worst pain ever felt
- Whether pain is increasing or decreasing in intensity over time
- Whether headache interferes with child's day-to-day activities

Timing

- Constant or intermittent
- Frequency per day, week and month
- Whether frequency or severity are increasing over time
- Association with particular time of day, week, month or season
- Duration and whether duration is increasing over time

Associated Symptoms (Functional Inquiry)

- Nausea and vomiting with or without abdominal pain (typical of migraine)
- Photophobia, facial pain, fever
- Transient neurologic signs
- Acute confusion, hemiplegia, ophthalmoplegia, syncope, vertigo, paresthesias, phonophobia
- Depression
- Anorexia, declining school performance, insomnia, weight loss
- Other medical problems
- Past medical history
- Family history of headaches

In the absence of other symptoms, recurrent headaches of more than 3 months' duration are rarely due to an organic cause. Headaches of relative recent onset (< 3 weeks) that are increasing in frequency and severity should be investigated promptly**.**

PHYSICAL FINDINGS

Physical findings are usually minimal with headaches.

- Blood pressure usually normal (however, pain may increase blood pressure)
- Temperature may be elevated with infectious process (for example, meningitis)
- Height and weight

HEENT (Head, Eyes, Ears, Nose and Throat)

- Facial grimacing
- Nuchal rigidity
- Funduscopic examination (disks, blood vessels); results are often normal
- Spasm or tenderness of neck muscle, tenderness of TMJ
- Deficits of cranial nerves
- Purulent rhinorrhea
- Halitosis, dental abscesses
- Cephalic bruits: use bell of stethoscope over the frontotemporal areas and orbits

Neurologic Examination

- Level of consciousness
- Mental status: general demeanor, confusion, depression, stress
- Cutaneous lesions (café au lait spots)
- Focal abnormalities (for example, tics, limb paresis)
- Sensory deficits
- Abnormal deep tendon reflexes
- Mental confusion

Clinical Characteristics of Common Headaches

Headaches Related to Increased Intracranial Pressure

- Headaches increase rapidly in frequency and severity
- Headache worst upon awakening in the morning, diminishes during the day
- Headache wakens child from sleep
- Aggravated by coughing or Valsalva's maneuver
- May be relieved by vomiting
- Associated symptoms: focal neurologic findings; altered gait; changes in behaviour, personality, cognition or learning

In most children with a brain tumour, abnormal neurologic signs will be evident within the first 4 months after onset of headache.

Classic Migraine

- Headache pulsatile (throbbing), periodic, separated by symptom-free intervals and associated with at least three of the following symptoms: abdominal pain and nausea or vomiting, aura (motor, sensory, visual), family history of migraine
- Unilateral
- Headache relieved by sleep

Tension Headache

- Band-like tightness or pressure in the bifrontal, occipital or posterior cervical regions lasting for days or weeks but not disrupting regular activities (for example, sleep); not associated with a prodrome; seen at any age
- Associated symptoms: tight neck muscles, sore scalp; nausea, vomiting and aura are uncommon

Refractive Error

- Persistent frontal headache, which is worse while reading or doing schoolwork

TMJ Dysfunction

- Temporal headache
- Associated symptoms: local jaw discomfort, malocclusion (crossbite), decreased range of motion of mouth, click with jaw movement, bruxism (grinding of teeth)

Chronic Sinusitis

- Frontal headache
- Tenderness to percussion over the frontal, maxillary or nasal sinuses
- Associated symptoms: prolonged rhinorrhea and congestion, chronic cough and postnasal drip, anorexia, low-grade fever, malaise

It is unusual for children < 10 years old to have recurrent headaches secondary to chronic sinusitis.

DIFFERENTIAL DIAGNOSIS

See *"Causes"*.

COMPLICATIONS

- Recurrent or chronic headaches can be debilitating and may cause absences from school and social withdrawal
- Intracranial lesions, masses or infections are life-threatening

DIAGNOSTIC TESTS

Most headaches can be diagnosed from the history and physical examination. For recurrent or chronic headache, diagnostic information may include daily headache record *(see "Example of a Form to Record Headaches and Seizures")*.

Guidelines show no value in routine lumbar puncture or electroencephalogram.[22]

Neuroimaging recommended if the following changes in headache history are noted:[22]

- Worsening headache
- Changes in types of headaches
- Changes in neurologic function including changes in school performance
- Onset of severe headaches

Example of a Form to Record Headaches and Seizures

NAME
B D
CHART NO.
WARD

MONTHLY RECORD

OF HEADACHES/SEIZURES

DAY OF MONTH	JAN		FEB		MAR		APR		MAY		JUNE		JULY		AUG		SEPT		OCT		NOV		DEC	
	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N
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Total																								
Note: D = day; N = night																								

(Back of form)

DATE AND TIME	**DESCRIPTION:** duration, precipitating factors, record of everything eaten in the 24 hours before headache

MANAGEMENT

Goals of Treatment

Goals of treatment depend on the cause of the headache.

Acute

- Rule out serious organic pathology
- Relieve pain

Recurrent or Chronic

- Relieve pain
- Prevent recurrence
- Avoid disruption of normal life tasks, such as attending school

Appropriate Consultation

Consult a physician immediately in the following circumstances:

- Concern about an underlying organic cause for headaches
- Uncertainty about the diagnosis
- Headaches are chronic and unresponsive to simple analgesia

Nonpharmacologic Interventions

Supportive reassurance and education:

- Advise parents or caregiver that headaches in children are common
- Explain underlying pathophysiology
- Counsel about avoiding factors that trigger headaches
- Identify stressors and advise on how to deal with them
- Counsel about use of medications (dose, frequency, side effects)

Relaxation and imagery therapy:

- Breathing exercises
- Visual imagery exercises
- Hypnotherapy
- Relaxation tapes

Pharmacologic Interventions

For tension headaches and mild migraines, analgesics are useful:

acetaminophen (Tylenol), 10–15 mg/kg per dose (usually analgesic of choice), q4h prn

Children > 6 years old may be given 325 mg, and children > 12 years old may be given 325–650 mg PO q4h prn

or

Nonsteroidal anti-inflammatory drugs (NSAIDs):

ibuprofen (Motrin), 5–10 mg/kg per dose, PO q6-8h prn, to maximum of 40 mg/kg/day

Do not use ASA (acetylsalicylic acid), as it is associated with Reye's syndrome.

For migraines:

- Avoid precipitants (triggers)
- Simple analgesic (acetaminophen, ibuprofen) may be given at first sign of aura or headache
- Avoid narcotics

On the advice of a physician, migraine prophylaxis may be ordered.

For information on treatment and prophylaxis of migraines, see *"Migraine Headaches"* in adult Chapter 8, *"Central Nervous System"*.

Monitoring and Follow-Up

During follow-up visits:

- Review daily headache record if unable to identify cause on first visit, as well as to monitor management
- Reinforce balanced health habits of sleep, exercise and diet

Referral

Medevac any child with acute symptoms in whom organic pathology is evident or cannot be ruled out without investigation. If symptoms are mild, refer the child electively to a physician.

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