# CHAPTER 20 – GENERAL EMERGENCIES AND MAJOR TRAUMA

First Nations and Inuit Health Branch (FNIHB) Pediatric Clinical Practice Guidelines for Nurses in Primary Care. The content of this chapter has been reviewed May 2009.

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Trauma is a significant cause of morbidity and mortality in all childhood age groups, except the first year of life. To reduce morbidity and mortality rates, early resuscitation and rapid transport to hospital are key in the critical early hours after trauma has occurred (the “golden period”).

For any emergency, always remember your ABCs (airway, breathing, circulation).

**NUANCES OF PEDIATRIC TRAUMA**

- Multisystem injury is the rule rather than the exception
- The priorities of pediatric trauma management are the same for children as for adults; however, children’s unique anatomic characteristics deserve special consideration
- Because of smaller body mass, energy from linear forces (for example, fenders, bumpers, falls) results in greater force applied per unit body area
- Children have less fat, less elastic connective tissue and close proximity of organs, which leads to more multisystem organ injuries
- The skeleton is incompletely calcified and more pliable
- Internal organs may be damaged without evidence of overlying bone fractures
- If bones are broken, assume that a massive amount of energy was applied
- The child’s ability to interact and cooperate with parents or caregivers is limited, which makes history-taking and physical examinations difficult
- Children have a large body surface area in relation to their weight, relatively thin skin and a lack of insulating fat. These characteristics lead to increased loss of water and heat. Appropriate measures (for example, thermal blankets, warmed intravenous [IV] fluids) must be taken to ensure that injured children do not become hypothermic
- “Normal” systolic blood pressure can be estimated by adding 80 to two times the child’s age in years. Normal diastolic blood pressure is roughly two-thirds of the systolic pressure
- Because of children’s excellent capacity for physiologic adaptation, shock may go unrecognized in its early stages

**AIRWAY INJURY**

The smaller the child, the greater the disproportion between the size of the cranium and the size of the midface. This produces a greater propensity for the posterior pharyngeal area to buckle as the relatively large occiput forces passive flexion of the cervical spine.

**CHEST TRAUMA**

The child’s chest wall is very compliant, which allows energy to be transferred to the intrathoracic soft tissues, frequently without any evidence of external chest wall injury. Consequently, pulmonary contusions and intrapulmonary hemorrhage are common.

The mobility of the thoracic structures makes the child more sensitive to tension pneumothorax and flail segments.

**HEAD TRAUMA**

Children are particularly susceptible to the secondary effects of brain injury produced by hypoxia, hypotension, seizures and hyperthermia. Shock resuscitation and avoidance of hypoxia are critically important to a favourable outcome.

Young children with open fontanels and mobile cranial suture lines are more tolerant of expansion of intracranial mass lesions, and decompensation may not occur until the mass lesion has become large. A bulging fontanel or a widened suture is an ominous sign.

**SPINAL CORD INJURY**

Children may sustain spinal cord injury without radiographic abnormality (known by the acronym SCIWORA). This situation occurs because the pediatric spine is so much more elastic and mobile than the adult spine. The interspinous ligaments and joint capsules are more flexible, the facet joints are flatter, and the relatively large size of the head allows for more angular momentum to be generated during flexion and extension, which in turn results in greater energy transfer. Spinal precautions must be maintained if a spinal cord injury is suspected.
**GENERAL APPROACH TO THE CHILD WITH TRAUMA**

ABCs (airway, breathing and circulation) are the first priority. Primary survey and resuscitation are followed by secondary survey, definitive care and finally transport.

The primary survey and resuscitation are done simultaneously. During this period, a patent airway is established while control of the cervical spine is maintained. Maintenance of airway patency is obviously the most critical factor, and cervical spine injury should be assumed in every seriously injured child, until proven otherwise.

The next priorities are as follows:

- Adequate ventilation
- Treatment of shock
- Identification of life-threatening injuries

The child with multisystem trauma may have both cardiorespiratory failure and shock. A rapid evaluation of the cardiopulmonary system must be performed, along with a rapid thorax-abdominal examination to detect life-threatening chest or abdominal injuries that might interfere with successful resuscitation.

For instance, ventilation and oxygen therapies may be ineffective until tension pneumothorax is treated.

Common errors in resuscitation include failure to:

- Open and maintain the airway
- Provide appropriate and adequate fluid resuscitation to children with head injuries
- Recognize and treat internal hemorrhage

**PRIMARY SURVEY**

The primary survey is performed to identify and simultaneously manage life-threatening conditions. It consists of ABC plus D and E:

- A for **airway** maintenance with cervical spine control
- B for **breathing** and ventilation
- C for **circulation** with hemorrhage control
- D for **disability** (neurologic evaluation)
- E for **exposure** and **environmental** control

**AIRWAY**

- Assess for signs of airway obstruction such as foreign bodies or facial, mandibular, tracheal or laryngeal fracture. Signs that suggest upper airway obstruction are increased respiratory effort with chest retractions (intercostals indrawing), abnormal breath sounds and decreased air movement
- Open and maintain airway
- The cervical spine must be protected (use chin lift or jaw thrust). Do not hyperextend, hyperflex or rotate the cervical spine. Cervical immobilization should be achieved
- Suction nose and mouth as needed
- Administer O2 to all patients initially; bag and mask ventilation if necessary

**BREATHING AND VENTILATION**

- Assess breathing by evaluating respiratory rate, effort, air movement, airway and breath sounds and pulse oximetry, as well as utilizing inspection, palpation, percussion and auscultation
- Assess for tension pneumothorax, flail chest, pulmonary contusions, open pneumothorax, fractured ribs and any other condition that might compromise breathing

Key point: a respiratory rate that is consistently > 60 breaths per minute in a child of any age is abnormal. Consider this rate to be a warning sign.

**CIRCULATION WITH HEMORRHAGE CONTROL**

Evaluate heart rate, pulses, capillary refill time, skin colour and temperature, and blood pressure.

Hypotension after trauma should be considered hypovolemic in origin until proven otherwise.

- It is generally assumed that any child who is hypotensive secondary to hypovolemia has lost at least 25% of their blood volume
- Reduction in level of consciousness may be caused by cerebral hypoperfusion
- Ashen gray or white skin colour is a sign of hypovolemia
- Rapid, thready pulses and delay of capillary refill are early signs of hypovolemia
- Rapid external blood loss should be managed initially by direct manual pressure on the wound
DISABILITY (NEUROLOGIC EVALUATION)

Use the AVPU method, as well as pupillary size and reactivity, to assess level of consciousness. The pediatric Glasgow coma score is always obtained during the secondary survey (see Table 1, “Scoring for the Pediatric Glasgow Coma Score”).

- A for alert
- V for responds to verbal stimuli
- P for responds only to painful stimuli
- U for unresponsive

Key point: As a child’s level of consciousness decreases, the child will progress from irritability to agitation to anxiety to decreased responsiveness. These are important clues to the child’s clinical condition.

Alteration in the level of consciousness should prompt an immediate re-evaluation of oxygenation, ventilation and circulation. If these are adequate, assume that the trauma is the cause of the decrease in level of consciousness. Alcohol or drugs may also reduce the level of consciousness, but they are diagnoses of exclusion in a person with trauma.

Monitor blood glucose level. Low blood glucose level may cause altered level of consciousness and other signs.

EXPOSURE AND ENVIRONMENTAL CONTROL

Completely undress the child, but protect from hypothermia. Warm blankets, warmed IV fluids and a warm environment must be provided.

RESUSCITATION

AIRWAY

A person with compromised airways and anyone with ventilatory problems needs an oral airway. The airway must be protected and maintained at all times, and ventilation with bag or mask should be performed as required.

OXYGEN

Oxygen should be given to all children with trauma, and should be freely used (10–12 L/min by non-rebreather mask).

INTRAVenOUS THERAPY

Initiate venous access using two large-bore IV lines (14–20 gauge, depending on the age).

If the child is in severe shock or in has multisystem trauma where intravenous access cannot be achieved within three attempts or 60–90 seconds, whichever comes first, an intraosseous needle can be inserted instead (see “Intraosseous Access” in the chapter “Pediatric Procedures”). Intraosseous infusion provides rapid access to assist circulation. Do not try to establish intraosseous access in a fractured bone.

SHOCK

See also “Shock” under “Major Emergency Situations.”

Shock should be assumed to be hypovolemic in origin, since neurogenic shock and cardiogenic shock are rare in children with trauma. Shock should be treated aggressively with fluids.

Fluid resuscitation is generally achieved with normal saline or ringer’s lactate. A fluid bolus of 20 mL/kg is given over a short period of time (for example, 20 minutes). If normovolemia is not restored, repeat boluses may be given up to a total fluid amount of 40–80 mL/kg during the first hour. Bolus infusions are continued until stabilization is achieved.

ECG MONITORING

If available, use ECG monitoring.

- Dysrhythmias, tachycardia, atrial fibrillation, premature ventricular contractions and ST segment changes may all indicate cardiac contusion
- Bradycardia, premature beats or aberrant conduction patterns may indicate hypoxia, hypothermia or hypoperfusion

URINARY CATHETER

Place a urinary catheter, unless urethral transection or injury is suspected.

Genital and rectal examinations are required before insertion of a urinary catheter.

Contraindications to placing a Foley catheter:

- Blood is apparent at the urethral meatus
- Blood is apparent in the scrotum

Verifying adequate urinary output (1–2 mL/kg per hour) is important in the assessment of fluid replacement, but in the initial time period associated with resuscitation, the vital signs are more important.
If fracture of the skull, cribiform plate or midface is confirmed or suspected, a gastric tube should not be inserted. Consult a physician about inserting a gastric tube. It can be used to reduce stomach distension and to reduce the risk of aspiration.

SECONDARY SURVEY

The secondary survey begins once the primary survey (ABCs) is completed, resuscitation has commenced and the child’s ABCs have been reassessed.

The secondary survey serves to identify any potentially life-threatening cardiopulmonary injuries that were not immediately evident in the primary survey. It consists of a head-to-toe evaluation, including all vital signs, accompanied by a complete history and physical examination, a complete neurologic evaluation and the pediatric Glasgow coma score.

1. Record vital signs, including pulse oximetry.
2. Obtain a history of the injury. The history should include the time and mechanisms of the injury (for example, whether it was blunt or penetrating), the child’s status at the scene of the incident, any changes in status over time and any complaints the child may have. If the child is younger or unconscious, ask bystanders or witnesses. If the child is unconscious, look for a medical alert tag.
3. The SAMPLE mnemonic is useful in obtaining the history from a conscious child or parent:
   - S for symptoms
   - A for allergies
   - M for medications
   - P for past medical history
   - L for last meal time
   - E for events and environment related to the injury
4. Perform a detailed head-to-toe physical examination. Use log roll maneuver with spine precautions to assess posterior chest wall, flanks, back and rectum. If you find an impaled object, do not remove it. Instead, stabilize the object in place.

HEAD AND NECK

First, reassess ABCs.

**Inspection and Palpation of Skull and Face**

- Deformities, contusions, abrasions, penetration, burns, lacerations or swelling
- Tenderness, instability or crepitations
- Battle’s sign (bluish discolouration over mastoid process) – may be observed as a late sign
- Eyes: conjunctiva, PERRLA (pupils equal, round, reactive to light, accommodation)
- Racoon-like eyes (which could indicate basal skull fracture) – may be observed as a late sign
- Clear nasal discharge (which indicates cerebrospinal fluid rhinorrhea)
- Ears: clear discharge or blood in canal or hemotympanum (bluish purple colour behind eardrum due to presence of blood; occurs with basal skull fracture)
- Check for voluntary symmetric movement of facial muscles

**Inspection and Palpation of Neck**

- Assume C-spine fracture until proven otherwise
- Distension of neck veins (sign of tension pneumothorax or cardiac tamponade)
- Tracheal deviation, stridor, abnormal cry
- Deformities, contusions, abrasions, penetration, burns, lacerations or swelling, subcutaneous emphysema
- Check carotid pulse again
- Assume injury to the cervical spine if trauma has occurred above clavicle
- Ensure adequate immobilization of the neck
- Apply a cervical collar if not already done

**CHEST**

**Inspection**
- Respiratory effort
- Equality of chest movement
- Deformity
- Bruising over precordium, flail segment
- Lacerations
- Penetrating wounds

**Palpation**
- Equality of chest movement
- Position of trachea
- Crepitus, deformity
- Fractures of the lower ribs (spleenic or kidney injury may also be present)
**Percussion**
- Area of dullness

**Auscultation**
- Air entry
- Quality of breath sounds
- Equality of breath sounds

**CARDIOVASCULAR SYSTEM**
- Auscultate heart for heart sounds: presence, quality

**ABDOMEN**

**Inspection**
- Penetrating wounds, blunt trauma, lacerations
- Bruising (anterior, sides)
- Bleeding
- Distension
- Movement with respiration

**Auscultation**
- Bowel sounds

**Palpation**
- Tenderness
- Abdominal guarding, rigidity
- Rebound tenderness
- Fractures of lower ribs (ruptured spleen, possible penetrating wound, bowel injury and intraperitoneal hemorrhage possible)

**PELVIS AND GENITALIA**

**Inspection**
- Perineal laceration, hematoma or active bleeding
- Blood coming from urethral meatus

**Palpation**
- Tenderness of iliac crest and symphysis pubis (indicating pelvic fracture)
- Distension of bladder

Remember that pelvic and femoral fractures can cause extensive blood loss.

**EXTREMITIES**

**Inspection**
- Bleeding, lacerations, bruising, swelling, deformity
- Leg position: unusual external rotation of a leg may indicate fracture of the femoral neck or the limb
- Movement of limbs

**Palpation**
- Sensation
- Tenderness
- Crepitus
- Muscle tone
- Distal pulses, capillary refill
- Reflexes: presence, quality

Remember that pelvic and femoral fractures can cause extensive blood loss.

**BACK**

Perform log roll maneuver with spine precautions maintained to assess back and rectum.

**Inspection**
- Bleeding
- Lacerations
- Bruising: posterior chest wall, flanks, low back, buttocks
- Swelling

**Palpation**
- Tenderness
- Deformity
- Crepitus

**RECTUM**

Perform log roll maneuver with spine precautions to assess back and rectum.

**Inspection**
- Occult blood

**Palpation**
- Integrity of walls, sphincter muscle tone
CENTRAL NERVOUS SYSTEM

Perform a neurologic assessment to evaluate the child’s present level of function.

- Determine the level of consciousness by calculating the Pediatric Glasgow Coma Score (see Table 1, “Scoring for the Pediatric Glasgow Coma Score”)
- Cranial nerves
  - Pupil abnormalities: position, size, equality, reactivity, funduscoppy
  - Re-examine nose for rhinorrhea
  - Motor function (voluntary movement of fingers and toes)
  - Sensation (child’s ability to feel your fingers when you touch his or her fingers and toes)
  - Assess blood glucose

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Table 1 – Scoring for the Pediatric Glasgow Coma Score*

<table>
<thead>
<tr>
<th>Feature</th>
<th>Score</th>
<th>Age Group and Response</th>
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<tbody>
<tr>
<td>Eyes opening</td>
<td>&gt; 1 year (child)</td>
<td>&lt; 1 year (infant)</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Spontaneously</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>To speech</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>To pain only</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>No response</td>
</tr>
<tr>
<td>Best motor response</td>
<td>&gt; 1 year</td>
<td>&lt; 1 year</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Obeys commands</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Localizes pain stimulus</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Withdraws in response to pain</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Flexion in response to pain</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Extension in response to pain</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>No response</td>
</tr>
<tr>
<td>Best verbal response</td>
<td>&gt; 1 year</td>
<td>&lt; 1 year</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Oriented and appropriate</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Confused</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Inappropriate words</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Incomprehensible sounds</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>No response</td>
</tr>
</tbody>
</table>

*Score is obtained by determining the score for each of the three criteria (eye-opening, best motor response, best verbal response) and summing them. Normal score depends on age: 0–6 months – a score of 9; 6–12 months – a score of 11; 1–2 years – a score of 12; 2–5 years – a score of 13; > 5 years – a score of 14.

**Signs of Skull Fracture**

- Periorbital bruising (indicates basal skull fracture)
- Clear nasal discharge (cerebrospinal fluid)
  (indicates basal skull fracture)
- Bruising behind ears, clear fluid or blood coming from ears, blood behind eardrum (indicates basal skull fracture)
- Skull lacerations with palpable bony irregularity or depression (indicates some form of skull fracture)

Remain calm and think clearly. Try to do things in a logical order, as outlined above.
DEFINITIVE CARE

- Continue resuscitative measures initiated earlier (for example, airway, IV therapy, oxygen)
- Manage identified conditions according to their priority
- Ensure that airway is protected in an unconscious child
- Apply suction as needed
- Administer supplemental oxygen, even if breathing appears adequate
- Treat hypotension aggressively with IV fluid replacement (see “Shock” under “Major Emergency Situations”)
- Insert nasogastric tube and apply suction (if not already done), unless the child has facial fractures or a suspected basal skull fracture; if in doubt, do not insert the tube – consult a physician first
- Insert Foley catheter (if no contraindications and not already done). Contraindications to catheterization: blood at urethral meatus, blood in scrotum, obvious pelvic fracture

BANDAGING AND SPLINTING

- If necessary, finish bandaging and splinting injuries
- Angulated fractures of the upper extremities are best splinted as found
- Fractures of the lower extremities should be gently straightened with traction splints (for example, Thomas splint)
- Check neurovascular status distal to the injury before and after bandaging or splinting
- Elevate the extremity

MONITORING AND FOLLOW-UP

- Monitor and reassess ABCs frequently
- Monitor vital signs as frequently as possible until condition is stable
- Perform a reassessment survey anytime the child’s condition worsens
- Perform a reassessment survey anytime you carry out an intervention
- Monitor hourly urine output (aim for urine output > 1 mL/kg per hour)
- Do not give anything by mouth unless a physician is in agreement

Irritability or restlessness may be caused by hypoxia, bladder or gastric distension, fear, pain or head injury. However, do not assume head injury. Rule out correctable causes first (for example, low blood glucose).

Head injuries are never a cause of hypovolemic shock. Look for a source of hemorrhage elsewhere.

CHECKLIST

- Check airway tubes for patency
- Check oxygen rate
- Check IV lines for patency and rate of infusion
- Check for patency of decompression needle for tension pneumothorax, if inserted
- Check splints and dressings
- Check rate of hyperventilation (by bag or mask) of any child with decreased level of consciousness

CONSULTATION

Consult a physician at transfer facility as soon as able (for example, when child’s condition is stabilized).

REFERRAL

- Medevac as soon as possible
- Make sure that child’s condition is as stable as possible before leaving the health facility or request that the paramedics come to the nursing station to take over client care
- Pressure effects on certain injuries are accentuated in unpressurized aircraft; maximum flying altitudes are applicable

ANAPHYLAXIS

Rare and potentially life-threatening allergic reaction. The symptoms develop over several minutes, may involve multiple body systems (for example, skin, respiratory system, circulatory system) and may progress to unconsciousness.

Anaphylaxis must be distinguished from fainting (vasovagal syncope), which is a more common and benign occurrence. Rapidity of onset is a key difference. When a person faints, the change from a normal to an unconscious state occurs within seconds. Fainting is managed simply by placing the person in a recumbent position with legs raised.

PREVENTION OF VACCINE-RELATED ANAPHYLAXIS

Prevention strategies require taking a history to detect contraindications to a vaccine and previous reactions to the product being administered or to similar products. If a positive history is obtained, a medical consultation is required prior to the subsequent administration of the product. A history of other allergies and hypersensitivities, along with their specific symptoms and medications currently used, should be taken.

CAUSES\(^8,9\)

- Vaccines
- Injectable drugs, oral medication (antibiotics, ASA [acetylsalicylic acid], NSAIDs [nonsteroidal anti-inflammatory drugs])
- Insect sting and animal venom
- Food and food additives
- Latex
- Blood and blood products transfusions
- Exercise

HISTORY

Anaphylaxis usually begins a few minutes after injection, inhalation or ingestion of the offending substance and is usually evident within 15 minutes.

Signs and symptoms may include the following:

- Sneezing, rhinorrhea
- Coughing
- Itching
- “Pins-and-needles” sensation of the skin
- Flushing of the skin
- Facial edema (perioral, oral or periorbital urticaria)
- Anxiety
- Nausea, vomiting
- Early respiratory difficulties (for example, wheezing, dyspnea, tightness of the chest)
- Choking sensation with feeling of air not entering
- Palpitations, tachycardia
- Hypotension, which may progress to shock and collapse

Cardiovascular collapse can occur without respiratory symptoms.

Severe Reaction

- Severe respiratory distress (lower respiratory obstruction characterized by high-pitched wheezing, upper airway obstruction characterized by stridor)
- Difficulty speaking, hoarseness
- Difficulty swallowing
- Agitation
- Shock
- Loss of consciousness

PHYSICAL FINDINGS

- Tachycardia
- Tachypnea, laboured respiration
- Blood pressure low-normal (child hypotensive if in shock)
- Pulse oximetry may show hypoxia
- Child in moderate to severe distress
- Use of accessory muscles of respiration and tracheal tugging
- Stridor
- Chest: air entry reduced, mild to severe wheezing
- Child flushed and diaphoretic
- Generalized urticaria (hives)
- Facial edema
- Diminished level of consciousness
- Skin feels cool and clammy
DIFFERENTIAL DIAGNOSIS
- Asthma
- Panic attacks
- Foreign-body aspiration
- Vasovagal reaction
- Angioedema

COMPLICATIONS
- Airway obstruction due to edema of upper airway
- Hypoxia
- Shock
- Convulsions
- Aspiration
- Death

DIAGNOSTIC TESTS
- None

MANAGEMENT

Goals of Treatment
- Maintain airway
- Improve oxygenation
- Alleviate symptoms
- Prevent complications
- Prevent recurrence

Early recognition and treatment of anaphylaxis are vital.

Appropriate Consultation

Severe Anaphylaxis
Consult a physician as soon as child’s condition stabilizes; discuss use of IV corticosteroids.

Nonpharmacologic Interventions
- Place the child in a recumbent position (elevating the feet if possible)
- If post-injection, place a tourniquet (when possible) above the site of injection; release for 1 minute every 3 minutes
- Establish an oral airway if necessary

Adjuvant Therapy

Severe Anaphylaxis
- Give oxygen by mask, 6–12 L/min by non-rebreather mask; keep oxygen saturations > 97% to 98%
- Start intravenous (IV) therapy with normal saline to keep vein open, unless severe anaphylaxis and signs of shock are evident (see “Shock” for details of fluid resuscitation in shock)

Pharmacologic Interventions

Promptly administer:

0.01 mL/kg (maximum 0.5 mL) of aqueous epinephrine (1:1000), intramuscular (IM) or subcutaneous (SC) in the limb opposite to the one where the original injection was given (see Table 2, “Epinephrine Dose on the Basis of Age”).

In severe cases, an IM injection should be given because this route leads more quickly to generalized distribution of the drug. A single SC injection is usually sufficient for mild or early anaphylaxis.

Epinephrine can be repeated twice at 5-minute intervals for a total of three doses, if necessary. A different limb is preferred for each dose to maximize drug absorption.

If the vaccine causing anaphylaxis was given subcutaneously, an additional dose of 0.005 mL/kg (maximum dose 0.3 mL) of aqueous epinephrine (1:1000) can be injected into the vaccination site to slow absorption of the vaccine. However, if the vaccine was given intramuscularly, local injection of epinephrine at the vaccination site is contraindicated because it will dilate the vessels and speed absorption.

Speedy intervention is of paramount importance. Failure to use epinephrine promptly is more dangerous than using it quickly but improperly.

Epinephrine Dose

The epinephrine dose should be carefully determined. Calculations based on body weight are preferred when weight is known. When body weight is not known, the dose of epinephrine (1:1000) can be approximated from the subject’s age (see Table 2, “Epinephrine Dose on the Basis of Age”).
Excessive doses of epinephrine can compound a subject’s distress by causing palpitations, tachycardia, flushing and headache. Although unpleasant, such side effects pose little danger. Cardiac dysrhythmias may occur in older adults but are rare in otherwise healthy children.

**Table 2 – Epinephrine Dose on the Basis of Age**

<table>
<thead>
<tr>
<th>Age</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>2–6 months*</td>
<td>0.07 mL (0.07 mg)</td>
</tr>
<tr>
<td>12 months*</td>
<td>0.1 mL (0.1 mg)</td>
</tr>
<tr>
<td>18 months* to 4 years</td>
<td>0.15 mL (0.15 mg)</td>
</tr>
<tr>
<td>5 years</td>
<td>0.2 mL (0.2 mg)</td>
</tr>
<tr>
<td>6–9 years</td>
<td>0.3 mL (0.3 mg)</td>
</tr>
<tr>
<td>10–13 years</td>
<td>0.4 mL† (0.4 mg)</td>
</tr>
<tr>
<td>³ 14 years</td>
<td>0.5 mL† (0.5 mg)</td>
</tr>
</tbody>
</table>

* Dose for children between the ages shown should be approximated, the volume being intermediate between the values shown or increased to the next larger dose, depending on practicability.

† For a mild reaction a dose of 0.3 mL can be considered.

**Severe Anaphylaxis**

In addition to the epinephrine, give the following:

- diphenhydramine hydrochloride (Benadryl), 1–2 mg/kg IV/PO, maximum 50 mg

The same dose of diphenhydramine can also be given IM if symptoms are less severe, but IM injection is painful.

**Table 3 – Diphenhydramine Hydrochloride Dose on the Basis of Age**

<table>
<thead>
<tr>
<th>Age</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2 years</td>
<td>0.25 mL (12.5 mg)</td>
</tr>
<tr>
<td>2–4 years</td>
<td>0.5 mL (25 mg)</td>
</tr>
<tr>
<td>5–11 years</td>
<td>0.5–1 mL (25–50 mg)</td>
</tr>
<tr>
<td>≥ 12 years</td>
<td>1 mL (50 mg)</td>
</tr>
</tbody>
</table>

The following medications may be considered after a physician is consulted:

- methylprednisolone 1–2 mg/kg IV OR prednisone 0.5–1 mg/kg PO for less severe reactions

and

- ranitidine 1 mg/kg IV over 5 min (maximum 50 mg) or 2 mg/kg PO

For bronchospasm refractory to epinephrine administration:

- salbutamol (Ventolin) by mask/nebulizer, 0.15 mg/kg (maximum 5 mg/dose) q20min for 3 doses

**Monitoring and Follow-Up**

**Severe Anaphylaxis**

Monitor ABCs (airway, breathing and circulation), vital signs and cardiorespiratory status frequently.

Because anaphylaxis is rare, epinephrine vials and other emergency supplies should be checked regularly and replaced if outdated.

**Referral**

Medevac as soon as possible. In all but the mildest cases, children with anaphylaxis should be hospitalized overnight or monitored for at least 12 hours.

**OVERDOSES, POISONING AND TOXIDROMES**

Ingestion of a potentially toxic substance, including a drug, a household or industrial chemical, plant material or waste products.

**CAUSES**

- Drug(s)
- Household or industrial chemical
- Plant material
- Waste products

In Canada, poisoning forms 6% of all unintentional injuries in children < 15 years of age. One of the unique features of poisoning during childhood is its two very different scenarios. The first involves the young child between 1 and 5 years of age who accidentally ingests a small amount of a substance that may or may not have pharmaceutical properties. The second involves the teenager who intentionally ingests a large amount of one or more substances, usually pharmaceutical.

The management of intentional overdose by teenagers is the same as for adults (see “Overdoses, Poisonings and Toxidromes” in the adult chapter “General Emergencies and Major Trauma”).
HISTORY

ABCs are the first priority. Ensure that the child’s condition is stable. If not, take steps to stabilize the child before obtaining the history, performing the physical examination and instituting management.

Typically the young child is brought to the healthcare provider very soon after the discovery of the accidental ingestion. In most situations, there has not been enough time for symptoms to have occurred.

Determine:

- Circumstances of ingestion
- What and how much was taken
- The time of ingestion
- When the symptoms began, if any
- Whether symptom intensity has decreased, increased or remained the same

Retrieve the container (send someone to the child’s home if necessary) and any spilled pills. If the informant can reliably state how much of the substance had already been used, this information can be used in the calculation:

\[
\text{Initial volume or number of pills minus amount remaining} = \text{maximum ingestion}
\]

Always assume maximum ingestion. For example, if two children have shared a bottle of pills, assume that either child could have ingested the whole amount.

Make inquiries about the circumstances of the ingestion:

- How did the child get at the container?
- Was the container left within easy reach?
- Was the child-resistant closure left disengaged?

This information is useful for preventive counselling at the end of the encounter.

Although most childhood poisonings are accidental, always be on guard for purposeful administration by a parent or caregiver. This should be considered especially in children < 1 year old and in any child with repeated ingestion of a potentially toxic substance, particularly if the various incidents involve the same compound.

A careful history is the most important part of the assessment, as there may be no clinical signs at the time of presentation.

PHYSICAL EXAMINATION

- ABCs are the priority
- Vital signs: temperature, heart rate, respiratory rate, depth of respiration, blood pressure
- Level of consciousness
- Closely examine cardiovascular, respiratory and central nervous systems

Signs vary with the type of poison. The main systems involved in poisoning are the cardiovascular, respiratory and central nervous systems, but in certain situations there is a need to focus on other systems (for example, the mouth and the esophagus after ingestion of caustic alkali).

DIAGNOSTIC TESTS

- Blood glucose
- Others depend on substance ingested (for example, serum acetaminophen level)

MANAGEMENT: GENERAL APPROACH

If poisoning is suspected consult your regional Poison Control Centre for management recommendations.

Goals of Treatment

- Maintain airway, breathing, circulation
- Alleviate symptoms
- Prevent complications
- Prevent recurrence

Appropriate Consultation

The primary consultant for poisonings is your regional Poison Control Centre. This service is immediately available at all times. Be prepared to provide the following information:

- Product ingested
- Approximate dose
- Time of ingestion
- Age and weight of child
- Vital signs
- Level of consciousness
- Any pertinent symptoms or signs

Your regional Poison Control Centre will advise whether the exposure is potentially toxic, will provide treatment advice and will suggest whether evacuation to a medical facility is required.

Also consult a physician to review unfamiliar management and recommendations for evacuation.
**Nonpharmacologic Interventions**

**Prevention**

Information obtained during the initial history is often very helpful for post-encounter preventive counselling. Poison prevention as well as accident prevention counselling should be a regular part of your follow-up and a regular part of well-baby visits beginning after the child reaches 6 months of age.

**Adjuvant Therapy**

Stabilize ABCs as required.

For all children with decreased level of consciousness without apparent cause:

- Give oxygen, 6–12 L/min or more by non-rebreather mask
- Start IV therapy with normal saline (if there is evidence of compromise in circulation or significant dehydration); run at a rate sufficient to maintain vital signs and hydration (see “Shock” for details of fluid resuscitation in shock)

Nasogastric tube may be necessary, after consultation with a physician, for a child who will not drink. It also may be necessary for a child who is unconscious.

Insert Foley catheter (in child with altered level of consciousness).

**Pharmacologic Interventions**

Your regional Poison Control Centre will direct pharmacologic interventions.

**GI Tract Decontamination**

Gastric decontamination such as gastric lavage and activated charcoal are no longer routinely recommended and should only be given on the recommendation of a Poison Control Centre.

Activated charcoal is most effective if given within one hour following toxic ingestion.

- Dose for children: charcoal in water 1 g/kg PO (maximum 50–60 g) or (if child will not drink) by nasogastric tube (use a 12–14 French tube; smaller ones tend to become clogged) Subsequent doses should be given only as advised by Poison Control Centre
- Shake the bottle thoroughly before opening because the charcoal tends to settle
- Before infusing the charcoal into a nasogastric tube, verify that the tube is in the stomach (by spontaneous return of gastric contents and testing for a pH < 4. If possible, confirm placement by x-ray)
- Syrup of ipecac is no longer recommended because of lack of evidence in improving patient outcomes

**Monitoring and Follow-Up**

- Monitor ABCs, vital signs, level of consciousness, cardiorespiratory function, and intake and output frequently if the child’s condition is unstable and transfer to hospital is planned
- If child is discharged home, next-day follow-up is recommended

**Referral**

The child should be medevaced if there is a possibility that he or she ingested a toxic amount of the compound or there are clinical symptoms of toxic effects.

Remember to obtain a blood sample before evacuation and to note the time that this sample was obtained.

In your letter of referral, include all of the information requested above, as well as any treatment interventions already undertaken, the interim clinical course, and the time at which the blood was drawn.

**SPECIFIC POISONINGS**

Table 4 presents the antidotes for specific poisonings likely to occur in the North. Your regional Poison Control Centre will direct pharmacologic interventions. Other options may be suggested.

<table>
<thead>
<tr>
<th>Toxins and indications</th>
<th>Antidote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetaminophen</td>
<td>N-acetylcysteine (Mucomyst)</td>
</tr>
<tr>
<td>Ethylene glycol, methanol</td>
<td>Ethanol</td>
</tr>
<tr>
<td>Iron (challenge test or treatment)</td>
<td>Deferoxamine mesylate (Desferal)</td>
</tr>
<tr>
<td>Isoniazid (INH)</td>
<td>Pyridoxine (vitamin B&lt;sub&gt;6&lt;/sub&gt;)</td>
</tr>
<tr>
<td>Narcotics</td>
<td>Naloxone (Narcan)</td>
</tr>
<tr>
<td>Organophosphates or carbamate insecticides; cholinergic crisis</td>
<td>Atropine should be used first, pralidoxime</td>
</tr>
<tr>
<td>Some oral toxins</td>
<td>Activated charcoal</td>
</tr>
</tbody>
</table>
**Acetaminophen**

This is the most common drug overdose at all ages. Ingestions of greater than 150 mg/kg should be a cause for concern, but remember that this figure also incorporates a safety factor, such that significant toxic effects actually manifest at a somewhat higher dose. The organ at risk is the liver, with toxic effects occurring a few days after the ingestion.

Toxic effects can be prevented if the antidote N-acetylcysteine is started within 10 hours after the overdose. Although the antidote becomes less effective beyond 10 hours, it is still worthwhile to initiate therapy between 10 and 24 hours after ingestion. In medical facilities, administration of this antidote is determined by acetaminophen blood level, which is unavailable in the nursing station.

**History and Physical Examination**

Although the child may be completely asymptomatic, there is frequently nausea, vomiting and abdominal cramping in those at risk for hepatic toxicity.

- Obtain history of total maximum ingestion
- Verify ingestion quantity by obtaining the container if possible

**Diagnostic Tests**

Remember to obtain a blood sample before evacuation and to note the time at which it was obtained. An acetaminophen blood level drawn 4 hours after ingestion is most helpful in predicting hepatotoxicity. In addition, test electrolytes, glucose, urea, creatinine, liver enzymes and international normalized ratio (INR) or prothrombin time (PT).

**Management**

Consult your regional Poison Control Centre (see “Management: General Approach”, under “Overdoses, Poisoning and Toxidromes”).

**Specific Interventions**

Children who have ingested more than 150 mg/kg should receive activated charcoal, and N-acetylcysteine (for example, Mucomyst). It may be given according to the oral protocol. The 72-hour oral protocol is:

- loading dose of N-acetylcysteine: 140 mg/Kg PO
- N-acetylcysteines: 70 mg/kg PO q4h for 17 doses over 72 hours

Once N-acetylcysteine has been started, the child should be evacuated to a medical facility. N-acetylcysteine (Mucomyst) may also be administered intravenously. Consult your regional Poison Control Centre.

**Iron**

Iron poisoning can be quite serious, even fatal. It usually results from ingestion of a prenatal supplement or other adult dosage form. The toxic effects depend on the amount of elemental iron ingested (ferrous sulfate is 20% elemental iron, ferrous fumarate is 33% elemental iron, and ferrous gluconate is 12% elemental iron). Therefore, for example, a 300 mg tablet of ferrous sulfate contains 60 mg of elemental iron.

**History**

Verify maximum amount ingested:

- Non-toxic dose: < 20 mg/kg
- Potentially toxic dose: 20–60 mg/kg
- Highly toxic dose: > 60 mg/kg
- Lethal dose: 200–300 mg/kg

With greater amounts ingested, degree of toxic effects also increases. At 20 mg/kg of elemental iron, expect GI symptoms, such as vomiting and diarrhea, with the possibility of blood in the emesis or stool. At 60 mg/kg of elemental iron, there is significant risk of GI hemorrhage, shock and acidosis.

Coma occurs late in the overdose and is a consequence of shock and acidosis.

**Physical Examination**

- ABCs
- Vital signs
- Level of consciousness
- Hydration
- Circulation

**Diagnostic Tests**

- Blood iron level

**Management**

Consult your regional Poison Control Centre.

See “Management: General Approach”, under “Overdoses, Poisoning and Toxidromes”.

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Pediatric Clinical Practice Guidelines for Nurses in Primary Care 2010
**Nonpharmacologic and Pharmacologic Interventions**

Protect the airway.

Activated charcoal is ineffective as it binds iron poorly. It is not useful in the management of iron ingestions. Whole bowel irrigation may be recommended by a Poison Control Centre.

Deferoxamine is the specific antidote for iron poisoning. It should be administered only after consultation with a Poison Control Centre and a physician.

Remember to draw a blood sample for determination of iron level and send it with the child on transfer. It is especially important to obtain this sample before initiating deferoxamine therapy, because the antidote interferes with the laboratory measurement of iron level.

**Referral**

Medevac any child:

- who has symptoms of iron toxicity
- who has been treated with deferoxamine
- who has ingested more than 20 mg/kg of elemental iron

**Opioids**

**Physical Findings**

Remember that all features of the classic opiate toxicity triad (decreased level of consciousness, depressed respiration and pinpoint pupils) need not be present for diagnosis. Other findings might include:

- Cyclical coma
- Hypotension
- Brady- or tachycardia
- Arrhythmias
- Circulatory collapse and cardiac arrest
- Delayed gastric emptying

**Management**

Consult your regional Poison Control Centre.

See “Management: General Approach”, under “Overdoses, Poisoning and Toxidromes”.

**Nonpharmacologic Interventions**

- Stabilize ABCs as required
- Provide oxygen therapy
- Provide continuous ECG monitoring if possible

- Establish IV access with normal saline to keep vein open. Treat shock if present (see Shock for details of fluid resuscitation in shock)

**Pharmacologic Interventions**

If opiate poisoning is suspected:

- Children from birth to 5 years of age or < 20 kg: naloxone 0.1 mg/kg by IV push, maximum 2 mg/dose
- Children > 5 years of age or > 20 kg: naloxone 2 mg/dose. Doses may be repeated every 3 minutes as needed to maintain opioid reversal (maximum 10 mg total)

Patients should be observed continuously for recurrence of respiratory depression for at least 2–3 hours after the last dose of naloxone.

**Online Resource for Overdose, Poisoning and Toxidromes**

This site is not for emergency assistance information:

- Canadian Association of Poison Control Centres, www.capcc.ca

**SEPSIS AND FEVER OF UNKNOWN ORIGIN**

Sepsis is bacteremia with evidence of systemically invasive infection. A fever of unknown origin is a fever lasting more than 14 days with no readily identifiable source of infection, despite a careful history, physical examination and routine tests.

Fever in infants and toddlers is defined as rectal temperature greater than 38°C (see “Temperature Measurement in Children”). Neonates may present with a normal temperature or hypothermia rather than fever as a manifestation of sepsis when other signs and symptoms are present.

Febrile infants and children < 3 years old commonly present for emergency care. The differential diagnosis is broad, from a simple ear infection to more complex problems that might involve multiple systems, as with sepsis.

The child’s age, the clinical presentation, the likelihood of a particular diagnosis and risk factors for sepsis are important considerations when evaluating a child with fever.

**CAUSES**

- Infectious agents
Risk Factors Influencing Susceptibility to Sepsis

Age is a significant factor influencing susceptibility: the younger the child, the greater the risk. Newborns are at greatest risk for bacterial sepsis, and this condition becomes uncommon by 2–3 years of age. Older children with a serious bacterial infection are more consistently identified by clinical examination (rather than by fever). A factor contributing to increased risk is that the neonate’s immune system is not fully developed.

In the absence of dehydration or high environmental temperature, sepsis is a common cause of fever in the first week of life.

Other factors influencing susceptibility to sepsis:

- Exposure to communicable pathogens
- Immunocompromised states (for example, hyposplenism, sickle cell disease)
- Malignant lesions

HISTORY

In general, the younger the age the greater the possibility a more serious cause is present. Young infants (< 3 months old) with serious bacterial illness present with fever and subtle signs, for example, irritability or lethargy. Older children often present with more specific clinical signs.

- Fever documented at home by caregiver (see Table 5, “Recommended Temperature Measurement Methods in Children”)
- Change in mental status (for example, lethargy, somnolence or decreased level of activity) may indicate a serious bacterial illness
- Recent immunizations
- History of prematurity or lack of immunizations (places the child at higher risk)
- Recent exposure to sick contacts
- Recent antibiotic therapy
- Recurrent illnesses
- Immunocompromised children are not only at higher risk for serious bacterial illness, but they are also susceptible to different pathogens
- Response to antipyretics does not differentiate between bacterial and viral pathogens, nor does it aid in identifying children at risk for serious bacterial illnesses
- Impact of environment (overbundling can increase the temperature from 0.4°C to 0.8°C)

Temperature Measurement in Children

Proper temperature measurement is essential for clinical decision-making in the pediatric population. Children should be unbundled for at least 15 minutes prior to taking their temperature. One needs to be aware of the normal temperature ranges for each measurement method and use recommended temperature measurement methods in children (see Table 5 and Table 6).

<p>| Table 5 – Normal Temperature Ranges |</p>
<table>
<thead>
<tr>
<th>Measurement Method</th>
<th>Normal Temperature Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectal</td>
<td>36.6 to 38°C</td>
</tr>
<tr>
<td>Tympanic</td>
<td>35.8 to 38°C</td>
</tr>
<tr>
<td>Oral</td>
<td>35.5 to 37.5°C</td>
</tr>
<tr>
<td>Axillary</td>
<td>34.7 to 37.3°C</td>
</tr>
</tbody>
</table>

<p>| Table 6 – Recommended Temperature Measurement Methods in Children |</p>
<table>
<thead>
<tr>
<th>Age</th>
<th>Definitive Method</th>
<th>Method to Screen Low-risk Children</th>
</tr>
</thead>
<tbody>
<tr>
<td>Younger than 2 years</td>
<td>Rectal</td>
<td>Axillary</td>
</tr>
<tr>
<td>2–5 years</td>
<td>Rectal</td>
<td>Axillary</td>
</tr>
<tr>
<td>Older than 5 years</td>
<td>Oral</td>
<td>Axillary</td>
</tr>
</tbody>
</table>

General Physical Findings

- Vital signs may reveal hyperthermia, normothermia, hypothermia, tachycardia, tachypnea or hypotension
- Hypothermia in the neonate or immunocompromised child may be the only diagnostic clue to a serious bacterial infection
- Children with sepsis typically appear acutely ill and may exhibit altered mental status (for example, lethargy), hypotension, decreased peripheral perfusion, hypoventilation, hyperventilation or cyanosis
- Presence of rash or petechiae
When evaluating infants, the following observational variables can be used as a clinical guide:

- Quality of cry
- Reaction to parental or caregiver stimuli
- Level of arousal
- Colour
- Hydration status

In the older infant and child, look for focal findings:

- Meningitis in this age group often presents with nuchal rigidity, a positive Kernig’s sign (pain with passive knee extension and hip flexion) and a positive Brudzinski’s sign (spontaneous hip flexion with passive neck flexion)
- The integumentary examination is often overlooked and can sometimes provide diagnostic clues (for example, presence of petechiae and fever represents a broad differential diagnosis that includes meningococcal sepsis and viral exanthems)

DIFFERENTIAL DIAGNOSIS

- Bacterial, viral or fungal infections
- Allergic reaction
- Immunocompromised status
- Hypothermia, hyperthermia

COMPLICATIONS

- Septic shock

DIAGNOSTIC TESTS

- Pulse oximetry
- Blood culture (if available) remains the gold standard for identifying children with sepsis: often more than one sample is taken; collect blood samples for culture as per your zone’s policies
- Blood glucose
- WBC count
- Urinalysis and urine culture should be performed; for infants, the most expedient and reliable method of obtaining urine for urinalysis and culture is by catheter
- Chest x-ray is useful only if there is clinical evidence of a possible respiratory infection (for example, tachypnea, cough, retractions, use of accessory muscles, crackles or wheezing); such imaging should be done only in older infants and children who are relatively less sick and only if the result would affect the decision to transfer to hospital
- Rapid strep test (if available)

MANAGEMENT

Goals of Treatment

The main focus of prehospital care of the febrile child, particularly one who appears acutely ill, should be rapid transport to a hospital emergency department.

Appropriate Consultation

Once the child’s condition has been stabilized, consult a physician according to the following guidelines:

- All infants < 3 months old with fever (≥ 38°C rectally); even if the child does not appear acutely ill and there is no obvious source of infection
- All infants < 3 months old who are irritable with a rectal temperature of 37.5°C
- All children > 3 months of age with a fever of ≥ 38.5°C rectally
- All children who appear acutely ill or who are at increased risk for occult bacteremia or sepsis
- All children with a fever and a rash
- All children with a fever longer than 72 hours
- Any child you are concerned about
- To discuss treatment options

Nonpharmacologic Interventions

- ABCs are the first priority
- Airway management and venous access are indicated if the child has signs of sepsis

Adjuvant Therapy

- Start IV therapy with normal saline and run at a rate sufficient to maintain hydration, unless there are signs of septic shock (see Shock)
- Oxygen may be necessary if there are signs of sepsis (6–10 L/min or more; keep oxygen saturation > 97% to 98%)
- Foley catheter (may be necessary if in septic shock)
**Pharmacologic Interventions**

Discuss treatment options with a physician.

Antibiotics are the standard of care in the management of children with suspected bacteremia or sepsis. The selection of the drug is based on the child’s age and the presence of risk factors for unusual pathogens. Antibiotics should be administered promptly after blood culture(s) have been obtained.

The neonate with bacteremia or sepsis should be treated empirically with broad-spectrum antimicrobial agents on the advice of a physician.

**Monitoring and Follow-Up**

Monitor ABCs, vital signs, pulse oximetry, level of consciousness and urinary output frequently if the child’s condition is unstable.

**Referral**

- Medevac all febrile infants ≤ 1 month old and all children 1–36 months old who appear acutely ill and in whom sepsis is suspected
- Antibiotics may be administered before transfer, on the advice of a physician
- In some settings, a pediatric transfer team (which often includes a physician) is available for critically ill children

**Children 3–36 Months with a Temperature < 38.5°C**

Some febrile infants and children 3–36 months old may be managed as outpatients. Clinical studies have reported the following criteria identifying the children at lowest risk and hence appropriate for outpatient management:

- Reliable caregivers
- Able to follow up within 24 hours
- Child does not appear acutely ill
- Term gestation
- Child previously healthy
- No current antibiotics
- Normal results on urinalysis
- Normal results on chest x-ray (when indicated and if available)

The febrile child over 3 months of age who has a temperature < 38.5°C and no obvious source of infection and who does not appear acutely ill can be managed with administration of antipyretics and close follow-up.

No diagnostic tests are indicated, and antibiotics are not recommended in these children. Avoidance of antibiotics helps to distinguish viral from bacterial meningitis and also to distinguish sepsis from a viral syndrome in the event of clinical deterioration. However, if there are concerns about reliable follow-up or if the child is at higher risk for serious bacterial illness (for example, presence of immunocompromised state), a more complete diagnostic work-up should be considered.

**Children 3–36 Months with a Temperature ≥ 38.5°C**

The management of febrile children 3–36 months old with a temperature ≥ 38.5°C, but no identifiable source of infection and without appearance of acute illness, is controversial. They may not consistently manifest clinical signs of serious bacterial illness. A physician should be consulted. No matter how extensive the diagnostic evaluation and therapy, these children require close follow-up to prevent infectious complications. Observe closely and re-evaluate within 12–24 hours, at the earliest sign of deterioration or if there are any parental concerns.

**SHOCK**

A condition that occurs when perfusion of tissue with oxygen becomes inadequate. As a result, the cells of the body undergo shock, and grave cellular changes occur. Eventually cell death follows.

Shock is categorized in many ways, for example, according to the state of physiologic progression that has occurred:

- **Compensated shock:** vital organ perfusion is maintained by endogenous compensatory mechanisms
- ** Decompensated shock:** compensatory mechanisms have failed; associated with hypotension and impairment of tissue perfusion
- **Irreversible shock:** multiple end-stage organ failure and death occur, despite occasional return of spontaneous cardiorespiratory function
CAUSES

- **Hypovolemic shock**: inadequate perfusion of vital organs because of reduction in circulating blood volume (hemorrhage, trauma, fluid loss from diarrhea and vomiting, inadequate fluid intake)
- **Cardiogenic shock**: due to the inability of the heart to pump blood to tissues (decreased cardiac output), as in congestive heart failure; rare in children (hypoxia, arrhythmias, congenital heart)
- **Distributive shock**: due to massive vasodilatation from interference with sympathetic nervous system or effects of histamine or toxins, such as in anaphylaxis, septic shock, neurologic injury, spinal cord injury, intoxication with some drugs (for example, tricyclic antidepressants, iron)
- **Obstructive (mechanical) shock**: obstruction of cardiac filling such as that caused by pericardial tamponade or tension pneumothorax, coarctation of the aorta

HISTORY

**Infant**
- May have some signs of irritability initially, then lethargic
- Poor feeding
- Decreased responsiveness to parents or caregivers
- History of trauma
- History of symptoms of an underlying illness, for example, fever, cough, indicating pneumonia
- Decreased urine output

**Older Child**
- Nausea
- Lightheadedness, faintness
- Thirst
- Altered level of consciousness
- Other symptoms depending upon underlying cause
- Trauma

PHYSICAL FINDINGS

ABCs are the priority.

The physical findings are variable, depending on whether the child is in compensated or decompensated shock. It is generally assumed that any child who is hypotensive secondary to hypovolemia has lost at least 25% of total circulating blood volume.

Do not rely on blood pressure readings. In children, blood pressure is preserved by compensatory vasoconstrictive mechanisms until very late in shock. Appearance, breathing and perfusion are more reliable clinical indicators of shock.

Mottled, cool extremities and a prolonged capillary refill (> 2 seconds) is a sign of decreased tissue perfusion and is more beneficial as a sign of shock in children than in adults.

Persistent tachycardia is the most reliable indicator of shock in children.

**Compensated Shock**
- Appearance: alert, anxious
- Work of breathing: tachypnea or hyperpnea
- Circulation: tachycardia, cool or pale skin, decreased peripheral pulses, normal systolic blood pressure

**Decompensated Shock**
- Appearance: altered mental status, reduced level of consciousness
- Work of breathing: tachypnea or bradypnea
- Circulation: tachycardia or bradycardia, mottled or cyanotic skin, peripheral pulses absent

DIFFERENTIAL DIAGNOSIS

- Sepsis
- Trauma
- Anaphylaxis

COMPLICATIONS

- System failure
- Death

DIAGNOSTIC TESTS

- None

MANAGEMENT

ABCs are the priority.

**Goals of Treatment**

- Restore circulating blood volume
- Improve oxygenation of vital tissues
- Prevent ongoing volume losses
Appropriate Consultation
Consult a physician as soon as the client is stabilized.

Nonpharmacologic Interventions
- Assess and stabilize ABCs
- Ensure that airway is patent and ventilation is adequate
- Insert oral airway and ventilate with Ambu bag (using oxygen) as needed
- Control any external bleeding: use direct pressure to control bleeding from external wounds
- Place in Trendelenburg’s position

Adjuvant Therapy
- Give oxygen at 6–15 L/min by non-rebreather mask with reservoir; keep oxygen saturation > 97% or 98%
- Start 2 large-bore IV lines with normal saline (or Ringer’s lactate)
- Give 20 mL/kg IV fluid rapidly as a bolus over 20 minutes
- Reassess for signs of continuing shock
- If shock persists, repeat boluses of 20 mL/kg may be given up to a total fluid amount of 40–80 mL/kg during the first hour. Reassess after each bolus
- Adjust IV rate according to clinical response
- Ongoing IV therapy is based on response to initial fluid resuscitation, continuing losses and underlying cause
- For maintenance fluid requirements, see “Fluid Requirements in Children” in the chapter “Fluid Management”
- If the child is in severe shock where intravenous access cannot be achieved within three attempts or 60–90 seconds, whichever comes first, an intraosseous needle can be inserted instead (see “Intraosseous Access” in the chapter “Pediatric Procedures”)
- After initial resuscitation:
  - Insert indwelling urinary catheter
  - Insert nasogastric tube prn

Monitoring and Follow-Up
- Monitor ABCs, vital signs (including pulse oximetry) and level of consciousness as often as possible until condition is stable
- Reassess frequently for continuing blood loss
- Monitor hourly intake and urine output
- Identify and manage underlying cause of shock (for example, manage sepsis with IV antibiotics)
- Assess stability of pre-existing medical problems (for example, diabetes mellitus)

Referral
- Medevac
GENERAL EMERGENCIES AND MAJOR TRAUMA

20–20

SOURCES

Internet addresses are valid as of June 2010

BOOKS AND MONOGRAPHS


JOURNAL ARTICLES


INTERNET GUIDELINES


Canadian Association of Poison Control Centres. Available at: http://www.capcc.ca


ENDNOTES


