Chapter 1:

Trauma and Emergency

Trauma

Aetiology

- Road traffic accidents: pedestrian vs. vehicle, cyclist vs. vehicle, passenger in vehicle (restrained or unrestrained)
- Falls: out of trees, off walls, into septic tanks
- Crush injuries: buildings collapsing
- Burns: fire, scalds, immersion, electrical, lightening
- Drowning: rivers, water, septic tanks
- Animal bites: dog, snake, hyena, crocodile
- Inflicted injuries: beatings, stabbing, gunshot

Important points in history

- age, name
- Location where accident occurred, if others involved, number of casualties, any deaths at the scene
- Date and time of injury
- Mechanism of injury: e.g. road traffic accidents: speed of vehicle, contact point, distance thrown, dragged by vehicle, ridden over by vehicle; or fall: height of fall, how landed, what landed on
- If drowning: length of immersion time
- If animal bite: what animal, vaccine history (TTV, Rabies)
- Events after injury:
    - Clinical: loss of consciousness and duration, seizure, vomiting, confusion, abnormal behaviour, bleeding, respiratory arrest
    - Treatment prior to presentation (including local medicines/herbs)
- Last meal
- Past medical history, social history, family history
- Regular medications, immunisations
- Allergies
- Suspicion of non-accidental injury

Important differences between children and adults

During rescuscitation, it is important to note anatomical/physiological differences between a child and an adult. A child has:

- A relatively large head compared to the body therefore has more shearing type injuries with head trauma
- Weaker neck muscles so cervical spine injuries occur at higher spinal levels
- Cartilaginous ribs result in more compliant chest wall; pulmonary contusion and haemopneumothorax may occur without rib fractures
- Low respiratory reserves and higher metabolic rate result in greater risk of hypoxic injury compounding trauma
- Intra-abdominal organs are less protected therefore more likely to have solid organ injury
- Small blood volume – haemorrhage may be life threatening
- Bladder abdominal rather than pelvic – increased risk of bladder injury

- Possibility of non-accidental injury.

Relatively large skin surface to body mass and loses heat rapidly

Primary survey and emergency management (cAcBCDE)

The primary survey is a systematic approach to evaluating and managing trauma cases, and to identify and treat the most life-threatening injuries first. The initial evaluation of injured children has two main goals:

1. Identify and immediately treat potentially life-threatening injuries
2. Determine the trauma resuscitation

It is important to use a standardised approach (cAcBCDE) when assessing trauma cases, to avoid omission of potentially life-saving interventions. It is key to treat life threatening problems as identified. Deal with each problem as found in a step-by-step process. Cut off all clothes to facilitate full assessment

cAcBCDE:

c: catastrophic external haemorrhage - stop bleeding by firm compression on the site
Ac: Airway and c-spine stabilisation
B: Breathing - if necessary with ventilatory support
C: Circulation with haemorrhage control
D: Disability with prevention of secondary insult
E: Exposure with temperature control

c - Catastrophic haemorrhage

If evident, apply direct pressure immediately. Use of a tourniquet is not recommended

Ac - Airway + cervical spine stabilisation

Two categories of children need to be identified:

a. Those with a patent airway requiring no support
b. Those who will need an intervention to establish a patent airway
    - Suctioning of secretions/blood/vomit
    - Airway manoeuvres - in trauma cases this is done using the jaw thrust. A chin lift and head tilt is never advised in trauma patients with a suspected injury of the cervical spine

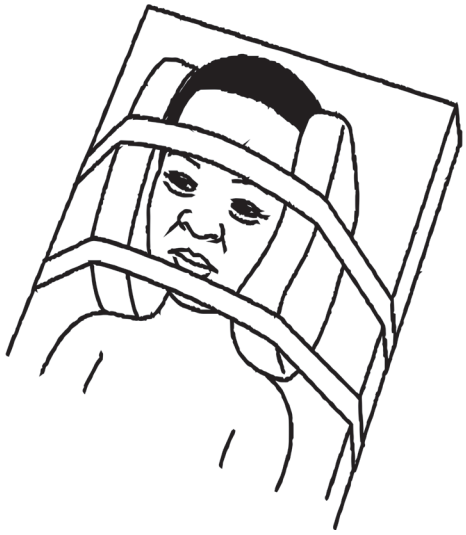
<u>Use of adjuvants</u>

A Guedel airway is the main adjuvant used. This is measured from the middle of the incisors to the angle of the jaw. Under 1-year of age this is inserted directly (the right way up). Over 1-year of age it is inserted upside down and then turned round

<u>Cervical spine protection</u>

- Assume a cervical spine injury in any significant trauma
- Manual inline stabilisation: should be commenced immediately when there is a high suspicion of cervical spine injury
- In-line immobilisation: triple immobilisation comprises fluid bags or sandbags either side of the head with tape/twisted chitenje then fixed to the hard surface of the bed or trolley (see diagram below)
  Note: Rigid collars are not used
- If uncooperative/combative c-spine immobilisation can be harmful

- If significant concern about c-spine injury maintain in-line immobilisation during any movement of the patient. When assessing the back a log-roll should be used. If the patient vomits then they should be turned to the side using a log-roll



WHO (who.mg-solutions.it.com/TraumainChildren.aspx)

B - Breathing

- In trauma a full assessment of breathing is crucial
- Respiration rate and oxygen saturations should always be assessed
- Inspect for any evidence of chest wall trauma
- Examine for symmetry of chest movements and signs of respiratory distress
- Perform percussion and assess for tracheal deviation
- Auscultate the chest to identify likely pathology
- Exclude tension pneumothorax, open pneumothorax, flail chest, pulmonary contusions and massive haemothorax

Tension pneumothorax

- Clinical diagnosis: Tracheal deviation away from the side of pneumothorax; absence of breath sounds over the involved lung and hyper resonant on percussion; neck vein distension, tachycardia and hypotension with respiratory distress. When the clinical diagnosis is made, the chest should immediately be decompressed by placing a large bore canula into the second intercostal space, mid clavicular line, above the rib
- Ensure IV access
- Chest drain insertion will be needed after decompression. Call for HELP!!! While this is being arranged continue with cAcBCDE assessment and management

Open pneumothorax

- This is also referred to as a sucking chest wound
- This injury can cause mediastinal shift, decreased venous return and cardiopulmonary collapse
- A non-occlusive dressing should be applied over the injury and fixed on three sides. This enables air to escape on expiration but inhibits air entry on inspiration. Gauze does not work as it becomes adherent to the wound

Flail chest

- This occurs when a segment of chest wall has lost continuity with the movement of the thoracic cage occurring when two or more ribs are fractured in two or more positions
- First line management is adequate pain relief, but these patients may also require ventilatory support

Massive haemothorax

- Presentation includes decreased breath sounds and dullness to percussion on the affected side. The trachea may be deviated away from the affected side
- The patient will usually be in shock: Insert 2 large bore cannula, send blood for urgent group and crossmatch and commence fluid resuscitation prior to chest drain insertion
- Treatment is by chest drain insertion
- Consider the possibility of cardiac tamponade. If clinically evident, do an urgent echocardiogram, but if not feasible then perform pericardiocentesis
- Consider other mediastinal injuries, disruption of great vessels, diaphragmatic rupture etc.
- If respiratory effort is inadequate – call for help, consider need for intubation and ventilation, consider starting bag mask ventilation
- If bag valve mask ventilation is indicated use the right size mask and if possible, the right sized self-inflating mask according to weight [neonatal (volume 200-250 mL), paediatric up to 25-30 kg (volume 500-600 mL), adult for large child/adolescent (volume 1500-2000 mL)]
- If bag and mask ventilation are not successful one can consider more invasive procedures e.g. endotracheal intubation or surgical airway
- In this case anticipate a difficult airway as some may have had facial injuries, swollen oral structures, loose teeth
- During these invasive airway manoeuvres, the cervical spine needs to be maintained in-line

Indication for intubation and ventilation

- Persistent airway obstruction
- Predicted airway obstruction (e.g. inhalational burn, severe facial trauma)
- Loss of airway reflexes/loss of consciousness
- Inadequate respiratory effort or increasing fatigue
- Disrupted ventilator mechanism e.g. flail chest
- Persistent hypoxia despite oxygen administration
- Severe traumatic brain injury (GCS <8)

Note: Resources for mechanical ventilation are limited. Decision to intubate and ventilate should be made in consultation with a paediatrician/anaesthetist/paediatric intensivist, so call for help

Note: On the usage of drugs for intubation, ketamine (1mg/kg) and vecuronium (0.1mg/kg) or rocuronium (1mg/kg) are used as induction agents

C- Circulation

- Objective assessment of circulation is made by measuring heart rate, blood pressure and capillary refill time and feeling the peripheries

  Note: Tachycardia alone cannot be used for assessing circulation as this can be a sign of pain or distress. Also, hypotension is a very late sign of severe shock
- All potential sites of bleeding must be examined as part of the circulation assessment including: on the floor (catastrophic bleeding), chest, abdomen, pelvis, long-bones and in a baby with an

open fontanelle the head

- Two main interventions for managing cardiovascular compromise are controlling external haemorrhage and fluid resuscitation
- Fluid resuscitation requires insertion of two large bore cannula. In the event of failure to establish percutaneous IV access call for **help** and consider other options:
  - Intraosseous – avoid injured limb
  - Central vein – external jugular, femoral
  - Cut down: cephalic vein (elbow)/long saphenous vein (ankle)
- Take samples for FBC, crossmatch, blood sugar, MPS & PCV
- Perform a FAST scan

If in shock:

- Ideally give blood.
- If not available administer 10mL/kg of normal saline or ringers lactate over 20 minutes. Do not give fluids as a rapid bolus as this can exacerbate bleeding
- Reassess and if necessary, repeat up to a total of 40mL/kg
- Consider type specific or O-negative blood in extreme emergencies
- Contact surgical/orthopaedic team early
- Blood loss in case of femur fractures can be massive - alignment and traction is needed

Catastrophic external hemorrhage - Simple direct pressure, specialised haemostatic dressing or a tourniquet must be applied instantly

Activation Criteria for a Paediatric Massive Transfusion Protocol (PMTP)

- Critical bleeding with coagulopathy
- Anticipated, or estimated blood loss > 1⁄2 blood volume
- Critical bleeding continuing after transfusion of 1⁄2 blood volume
- Any child requiring more than 20mL/kg of packed red blood cells (PRBC) in 2 hours and/or anticipated ongoing blood loss
- Any child requiring more than 40mL/kg of PRBC in a 24-hour period with ongoing blood loss
- Consider Tranexamic acid (15mg/kg)

D - Disability

- Use AVPU or GCS to assess consciousness
- Establishment of baseline GCS may have prognostic value among children with evolving intracranial injury. The motor score has been shown to be the best predictor of outcome after injury
- Check pupils for size, equality and reactivity
- Check child can move all 4 limbs
- Please note that the accurate assessment of disability will help establish the need for airway support
- All children with neurologic injury must be referred to the neurosurgical team for assessment and for surgical interventions if needed

AVPU SCHEME	
A	Alert
V	Responds to voice
P	Pesponds to pain
U	Unresponsive

Glasgow Coma Scale (GCS)

>5 years	<5 years
Motor	
Obeys commands (6)	Normal spontaneous movements (6)
Localises pain (5)	Withdraws to touch (5)
Withdraws to pain (4)	Withdraws to pain (4)
Flexion to pain (decorticate) (3)	Abnormal flexion (decorticate) (3)
Extension to pain (decerebrate) (2)	Abnormal extension (decerebrate) (2)
No response (1)	No response (1)
Verbal	
Orientated (in person or place or address) (5)	Alert, babbles, words or sentences to usual ability (normal) (5)
Confused (4)	Less than usual ability, irritable cry (4)
Inappropriate words (3)	Cries to pain (3)
Incomprehensible sounds (2)	Moans to pain (2)
No response to pain (1)	No response to pain (1)
Eyes	
Spontaneous (4)	Spontaneous (4)
To voice (3)	To voice (3)
To pain (2)	To pain (2)
None (1)	None (1)

- Basic management of traumatic brain injury to prevent secondary brain injury:
  - Adequate oxygenation. Saturations should be kept above 94%. Consider need for intubation if ICU is available
  - Control of CO2 tension – intubation & ventilation might be needed. Do not hyperventilate. Keep CO2 between 40-45 mmHg
  - Maintenance of adequate cerebral perfusion pressure (CPP) by maintaining good blood pressure: aim for target mean arterial pressure (MAP) above 99th percentile for age to maintain a good CPP
  - Maintain normovolaemia. Fluid resuscitate as required to correct shock. May need inotropes. Use normal saline & glucose for maintenance fluids at 2/3 maintenance
  - Head up position (around 30 degrees), midline position
  - Control of potentially raised ICP: consider mannitol: 250-500mg/kg (1.25-2.5mL/kg of 20% Mannitol) IV over 30-60 minutes or hypertonic saline if available
  - Maintain normoglycaemia
  - Treat convulsions
  - Maintain normal temperature
  - Avoid aspiration: insert OGT and keep on free drainage
  - Avoid electrolyte imbalance (especially hyponatremia)
- All patients with a GCS of 5-8 should be discussed with the neurosurgical and ICU teams, for possible referral and safe transfer to a tertiary level facility

E - Exposure

Fully expose the child to assess for other injuries. This should include examination of the back, using a log roll if a cervical spine injury is suspected. It is important to keep the child covered to minimise heat loss.

The secondary survey

- This occurs once the child has been successfully resuscitated. It includes a medical and events history, a more complete physical examination and additional interventions
- The acronym AMPLE is useful for remembering these key elements:
  A – Allergies
  M – Medications
  P – Past medical history
  L – Last meal
  E – Environment and events detailed history leading up to injury

- The physical examination comprises a full head to toe examination to identify any other injuries
  - Reassess ABCD
  - Start at the head: check for signs of a head injury and examine the face including ears, eyes, nose, mastoid, maxilla, mandible and oral cavity
  - Re-examine the chest, abdomen and pelvis
  - Examine the genitalia
  - Perform a neurological examination including level of consciousness, pupils, fundoscopy, tone, power, reflexes, sensation
  - Examine all limbs, including hands, feet, fingers and toes for evidence of fractures, wounds, vascular injury, compartment syndrome
  - Examine the back. In case of a potential spinal injury, the child should be log-rolled (see below)
  - Check the back of the head, the cervical, thoracic, lumbar spine and sacral region

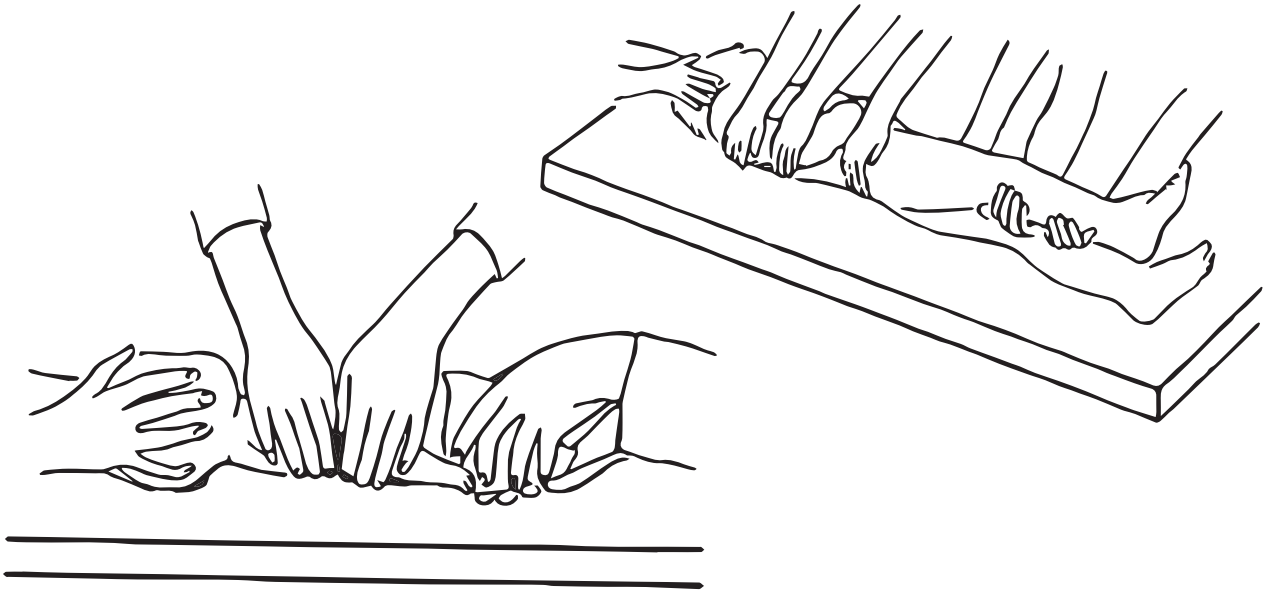
- Examine the bottom and perform a rectal exam
- Also examine the back of the limbs

Examining and clearing a cervical spine

- Remember despite normal x-rays the child can have a Spinal Cord Injury Without Radiological Abnormalities (e.g. haematomas, ligament injuries) – **SCIWORA**
- To clear the c-spine
    - The child should be co-operative and alert
    - Have no midline cervical tenderness on direct palpation
    - Have no focal neurological deficit
    - Have no painful distracting injuries

Log Roll

- Keep the head in a neutral position
- Keep the head and body straight, avoid rotation or flexion/extension
- The person holding the head is in charge: maintain in-line stabilisation of the c-spine (do not cover the ears)
- Assistants hold the arms and legs (see below) to keep the body in line
- On the instructions of the lead person turn the patient onto their side to allow the back to be examined



WHO (mgsolutions-it.com)

Positioning an unconscious child

- If there is no neck trauma consider putting the child in the recovery position
- Turn the child on to their side to reduce the risk of aspiration
- Keep the neck slightly extended and stabilise by placing the cheek on one hand
- Bend one leg to stabilise the body

Diagnostic assessment

- Full Blood Count (FBC)
- Group and crossmatch
- Random blood sugar
- Arterial/venous/capillary blood gas
- Radiographic imaging as indicated per patient. Please note there is no such thing as a trauma series in paediatric trauma. X-ray requests should be based on clinical findings. FAST scans are a useful adjunct in trauma. CT if indicated

Transfer & further management

- Reassess cAcBCDE regularly
- Ensure adequate analgesia
- Consider need for tetanus toxoid and IV antibiotics
- Transfer to HDU, theatre, ICU, radiology department
- Critically ill children need to be accompanied by nurse +/- doctor
- Take resuscitation equipment with you
- Use oxygen cylinder for transfer of sick children
- Handover to receiving team: using SBAR is a useful approach to handing over
- emergency patients
- Regular monitoring, including “neuro-observations” in severely injured child
- Signs of raised ICP due to cerebral oedema or intracranial haematomas (e.g. extradural) can present even hours after initial presentation
- Encourage parents to alert nurses or medical team in case of any concern

Paediatric Shock

Definition
Shock is a life-threatening disorder of the circulatory system that results in inadequate organ perfusion and tissue hypoxia, leading to metabolic disturbances and ultimately irreversible organ damage

Types of shock
- Hypovolaemic shock (dehydration, acute blood loss)
- Distributive shock (anaphylaxis, sepsis)
- Dissociative shock (anaemia)
- Cardiogenic shock (valvular disease, congenital heart disease, cardiac ischaemia,
- arrhythmias, toxins)
- Obstructive shock (tension pneumothorax, cardiac tamponade, pulmonary embolism)

Risk factors/causes
- Diarrhoea/vomiting
- Infections
- Trauma
- Bleeding
- Underlying conditions e.g. congenital/acquired cardiac disease
- Known allergies and recent allergen exposure

Signs and symptoms
- Cold extremities
- Peripheral capillary refill time > 3 seconds
- Weak, fast pulse
- Low systolic blood pressure (late sign)
- Other signs of underlying cause:
    - Signs of severe dehydration (sunken eyes, skin pinch goes back slowly, lethargy)
    - Bleeding
    - Fever
    - Non-blanching rash (petechiae/purpura)
    - Oedema or urticaria
    - Engorged neck veins and hepatomegaly

Prevention/promotion
- Early health seeking behaviour when unwell
- Educating the public on basic life support measures

Investigations
- Are dependent on cause, but may include, FBC, Blood culture, Blood glucose, Arterial/venous capillary blood gas e.t.c

Differential diagnosis
- Are dependent on history and examination (see risk factors/causes)

Management

Primary/secondary level

Call for help

Keep the child calm

A = Clear airway

B = Start oxygen, check for breathing

C = Circulation

- Check heart rate. If absent/< 60 bpm initiate CPR
- Establish IV access - 2 x large bore IV cannulas according to the child's size
  - If IV access unsuccessful after 2 attempts (maximum 5 minutes) insert intraosseous needle

- **Hypovolaemic shock**
  - **Trauma:** Stop bleeding. Give IV fluids 10mL/kg over 20 minutes and reassess. Repeat up to a maximum of 40mL/kg. Aim to get blood as soon as possible
  - **Dehydration:** Give IV fluids 30 mL/kg over 30 minutes/1 hour depending on age and reassess. Repeat if necessary or continue with 70 mL/kg over 2.5/5 hours depending on age

- **Distributive shock**
  - **Septic shock:** Give IV fluids 10 mL/kg over 1 hour and reassess. Repeat up to a maximum of 40mL/kg. Give antibiotics. May need inotropic support
  - **Anaphylactic shock:** Give IV fluids 10 mL/kg over 20 minutes and reassess. Repeat up to a maximum of 40 mL/kg. Definitive treatment is IM adrenaline (0.01mL/kg 1:1000). Other treatments include steroids, antihistamines, adrenaline nebulisers and salbutamol nebulisers

- **Dissociative shock**
  - **Anaemia:** Do not give fluid resuscitation. Needs blood transfusion If no blood available put on IV maintenance fluids

- **Cardiogenic shock**
  - Avoid IV fluid if possible, but if evidence of preload insufficiency give 10mL/kg over 1 hour

- **For shock with severe acute malnutrition and diabetic ketoacidosis follow local guidelines, but it is important to avoid aggressive fluid resuscitation**

Note: Patients who remain in shock despite adequate treatment of the underlying cause need to be discussed with a consultant

C = Coma
- AVPU/GCS/BCS
- Treat hypoglycaemia

C = Convulsion
- Treat hypoglycaemia
- Treat convulsions

D = Dehydration
- Assess severity and treat with Plan C

E = History and thorough examination
- Obtain relevant blood samples
- Manage other associated conditions

Refer after initial stabilisation if still unwell

Tertiary level

Manage as above

Refractory shock
- Patients who remain in shock despite adequate treatment of the underlying cause need to be discussed with the consultant
- Other alternative treatments include:
  - Vasoactive agents (adrenaline, noradrenaline)
  - Corticosteroids (hydrocortisone) - for suspected critical illness-related adrenal insufficiency
  - Bicarbonate - for correction of metabolic acidosis
  - ICU admission

Follow up
- Depends on cause

Drowning

Definition

Drowning is respiratory impairment after the head is submerged in liquid. Drowning can be fatal, have subsequent morbidity or cause no harm

- Pulmonary oedema encountered after drowning is due to acute respiratory distress and not from fluid overload
- Central nervous system injury is by far the most important cause of death and long-term functional impairment among drowning survivors
- The outcome of drowning victims depends largely on the success of resuscitation measures at the scene of injury

Pathophysiology

After initial panic and fight, comes breath holding and aspiration of large amounts of water. Laryngospasm, hypoxia and convulsions immediately follow resulting in death

Respiratory system

- Aspirated fluid results in reduced O2 uptake, CO2 elimination and surfactant disruption resulting in hypoxia and hypercarbia
- Approximately 15% of drowning victims have severe laryngospasms after submersion and die without aspirating water
- The drowned victims will usually have a combined respiratory acidosis (hypercarbia) and metabolic acidosis (hypoxia-anaerobic aspiration)
- Pneumonia and pulmonary oedema develop as the aspirated fluid washes out surfactant, disrupting the alveolar-capillary membrane leading to increased permeability and aspirated debris/bacteria from contaminated water

Cardiovascular system

- Cardiovascular effects result from hypoxia causing poor myocardial perfusion, contractility and cardiac output
- The hypoxia can also lead to life threatening dysrhythmias e.g. ventricular fibrillation, ventricular tachycardia or asystole

Central nervous system

- Hypoxia, if sufficiently prolonged, causes profound disturbances of the central nervous system. The severity of brain injury depends on the magnitude and duration of hypoxia and cerebral perfusion
- However, if promptly rescued and successfully resuscitated this can be reversed

Management

- All drowning victims should receive aggressive basic and advanced life support as necessary. This applies for both at the scene and in the emergency department
- The right management in the immediate post drowning period is very important
- The fundamentals of basic life support are the same as for any other patient requiring resuscitation
- The following are other things to consider:
  - Remove from water as soon as possible (at the scene)
  - Airway, breathing and circulation as well as cervical spine stabilisation
    - If the child is very cold on arrival, resuscitation efforts should theoretically be continued

until the body temperature is normalised. However, this can be challenging. Body temperature should be raised slowly
    - Prolonged attempts to remove water from the lungs are futile and may delay attempts to establish breathing manoeuvres
    - Beware of patients regurgitating aspirated contents into the airway as they have swallowed a lot of water. Insert an OGT
    - Any debris seen on the mouth/oropharynx must be removed
- The need for admission should be determined by the severity of the drowning episode
- All patients with history of drowning with mild symptoms should be observed in the hospital for 4-6 hours
- If evidence of persistent hypoxia and hypercapnia, consider intubation and ICU referral
- It is advisable to cover the drowned patient on antibiotics if there is a history of having drowned in contaminated water

Snake bite

Clinically snake bites can cause:
- Bleeding from decreased blood coagulability
- Oedema
- Tissue damage
- Pain

There are four main types of envenoming:
- **Cytotoxic envenoming:** Very painful and progressive swelling. Blistering and bruising on the bite
- **Haemorrhagic envenoming:** Bleeding from gums, gastrointestinal and genitourinary tracts
- **Neurotoxic envenoming:** Moderate or absent local swelling. Progressive descending paralysis starting with the drooping of eyelids and later paralysis of eye movement. Can progress to difficult swallowing and breathing
- **Myotoxic envenoming:** Negligible local swelling, generalised muscle pain and tenderness. Can also have features of neurotoxic envenoming

Clinical assessment

History

A precise history of the time and circumstances of the bite and the progression of local and systemic symptoms and signs is vital:
- Where is the bite located on the body?
- When did the incident happen?
- Was the snake seen, what did it look like?
- How is the patient feeling now, what symptoms is the patient experiencing?

Examination
- Check for fang marks, note if scarification present or not
- Look for evidence of use of a tourniquet
- Check bitten limb for swelling, pulses, colour and viability
- Mark with a pen, the level of swelling on a limb so that further swelling can be assessed
- Bleeding (puncture wound, venepuncture sites, gums)
- Shock (blood pressure, cold, cyanosed, sweaty skin, reduced coma score)
- Paralysis (blurred vision, drowsiness, heavy eyelids, paradoxical breathing, drooling, poor cough)

Clinical Sign of Envenoming

Local signs and symptoms
Immediate localised pain, oedema and bruising at the site of the bite, persistent bleeding from fang puncture wounds. Enlarged and swollen regional lymph nodes.
Blisters (blood or fluid filled)

Generalised signs and symptoms
Signs of hypotensive shock, neurotoxic symptoms, acute renal failure (secondary to hypotension or rhabdomyolysis)

Note: Mixed types of envenoming may occur i.e. mixed cytotoxic and neurotoxic; mixed haemorrhagic and cytotoxic

Note: Not all bites, even from the deadliest of snakes, always cause envenoming. Up to 50% of bites may be un-envenomed i.e. 'dry bites'
Some of the presenting symptoms and signs can result from fear and treatment (first aid/ traditional)

Investigations
- FBC: Leucocytosis, low haemoglobin, low platelets
- Coagulation studies:
  - 20 minute whole blood clotting test (see how long it takes for blood to clot in a plain tube)
  - prothrombin time, thrombin and activated partial thromboplastin times, D-dimer, INR
- Biochemistry: creatine kinase, LFTS, U&E, blood gas
- Group and crossmatch

First aid management
- Move the patient away from the place where the bite has occurred
- Remove anything tight from the bitten part of the body e.g. rings, bracelets, bands from bitten limbs
- Reassure the victim
- Immobilise the victim, splint the limb to keep it still
- Never use a tight arterial tourniquet
- Avoid traditional first aid methods, herbal medicines. The following are discouraged:
  - Tattooing around the area, suctioning out venom by mouth, ice packs
  - Do not wash, rub or massage or tamper with the bite wound in any way. These interventions may encourage systemic absorption of venom from the site and/or they may introduce infection

Management

Primary level

- Snake bite is a medical emergency, so use the ABCCDE approach
- Place on maintenance fluids
- Check that tetanus toxoid immunisation is up to date, if not give it
- Treat pain
- Refer patient

Secondary/tertiary level

- As above
- Treat pain appropriately – oral paracetamol is our first line, but morphine may be needed
- Elevate the limb if there is extensive swelling and monitor for compartment syndrome
- If local circulation is threatened, inform the surgical team on call as compartment syndrome may need fasciotomy
- The following are signs and symptoms that may indicate a need for anti-snake venom:
  - Neurotoxicity
  - Spontaneous systemic bleeding
  - Incoagulable blood
  - Cardiovascular instability
  - Extensive swelling (involving more than half the bitten limb)
  - Rapidly progressive swelling
  - Bites on fingers and toes
  - If anti venom is needed:
    - Give 40mls in 200mls of normal saline IV over 1hour but have adrenaline standing by: anaphylactic reactions are not uncommon
- If any signs of necrotic tissue, surgical debridement is vital

Toxicology

The incidence of poisoning is highest among children 1 to 3 years of age. Boys slightly outnumber girls as victims of unintentional exposures. A second peak occurs in adolescence due to suicide attempts or accidental overdose during substance abuse. The most common agents involved in preschool poisonings are medications, household products (cleaning agents, soaps, detergents), pesticides

History

- Rememeber there may be no clear history
- Route of exposure: Ingestion, inhalation, dermal, ocular or parenteral
- Time of the exposure/incident: The delay between the time of ingestion and the onset of symptoms is important
- Toxin involved: Important to establish the precise ingredients of what has been ingested
- Parents must be encouraged to bring the product container or label
- Estimated volume/quantity ingested: For estimations of liquid toxins, the average swallow of a young child is approximately 5 to 10 mL while that of the older child and adolescent is 10 to 15 mL
- Initial symptoms post ingestion if any
- Prehospital attempts at decontamination
- Include the patient's past medical history, allergies, current medications, last meal and events surrounding the ingestion

Physical examination

- May be asymptomatic
- Drowsiness/coma
- Convulsions (severe organophosphate poisoning)
- Diarrhoea (if a child is dehydrated, but salivating ++ consider organophosphate poisoning, with pin point pupils)
- Pupillary abnormalities - pin-point pupils (organophosphate poisoning, sometimes mushrooms); dilated pupils (barbiturates)
- Ataxia
- Tachypnoea/tachycardia or flushing/bradycardia (organophosphate poisoning, atropine)
- Wheezing (paraffin inhalation)
- Cardiac arrhythmia or hypotension
- Presence of burns within the mouth (bleach or acid with oesophageal injury)
- Stridor (laryngeal damage)
- Abdominal distension (local medicine intoxication)
- Hypersecretions and noisy wet breathing: organophosphate poisoning
- Acidotic

Investigations

Investigations should be done after stabilising patient:

- Blood glucose: rapid identification and treatment of hypoglycaemia is crucial.
- Urea and Electrolytes
- Arterial/venous/capillary blood gas: identify hypercapnia, acid base disturbances
- Electrocardiogram (ECG)

Management

Primary level

- Primary assessment (ABCCCDE) to recognise and treat life-threatening emergencies
- Many toxins are rapidly absorbed from the gastrointestinal tract, skin and respiratory system. The development of severe toxicity may be avoided if further absorption can be prevented. Dermal and ocular decontamination should consist of flushing the skin and eyes with tepid water and removal of all exposed clothing
- Refer to secondary level

Secondary level

- As above
- The adequacy of the airway and breathing should be addressed immediately
- Supplemental oxygen should be administered for any degree of hypoxaemia
- Stabilisation of vital physiological functions takes priority over the diagnosis of the specific toxin
- Often, supportive measures are adequate, and no specific therapy is required
- Supportive measures include the evaluation and treatment of cardiopulmonary, neurologic and metabolic abnormalities
- Refer to tertiary level

Tertiary level

- As Above
- Endotracheal intubation and mechanical ventilation should be considered in any child with progressive neurologic deterioration
- Definitive management of specific condition once stabilised
  Refer to treatment of specific poisons below

Treatment of Specific Poisons

1. Organophosphates and Carbamates

Found in many insecticides, pesticides and most exposures are accidental. They can occur both via oral ingestion and transdermal route. Most accidental ingestions are seen around the time of maize harvest and treatment for storage

Patients often present with a constellation of signs that create a toxidrome of cholinergic findings. The mnemonic "DUMBELLS" refers to Diarrhoea, Urination, Miosis, Bronchorrhea and Bronchospasm, Emesis, Lacrimation, Lethargy and Salivation

The nicotinic signs include alteration in mental status, seizures, sweating, muscle fasciculations, weakness and paralysis. Other symptoms include bradycardia, hypotension, and hypothermia

Management:

- Get rid of poison and control ongoing absorption hence if the toxin was absorbed through the skin remove all clothing and wash the patient. Oral ingestion is much more common in children
- Atropine is a selective muscarinic receptor blocker and therefore will reverse only muscarinic effects. It will not improve weakness or paralysis
- Doses of 20 micrograms/kg IV or IM every 15 minutes may be required to achieve "atropinisation", (no secretions, clear chest)
- Monitor regularly (secretions, respiratory rate, heart rate, coma score)
- Atropine is stopped when the chest is dry. It is NOT determined by pupil size
- Continuous infusions of atropine may be required (0.02–0.08 mg/kg/hour) if there is no improvement with initial treatment. Atropine infusion may need ICU admission

2. Iron poisoning

Ingestion of 40–60 mg/kg of elemental iron in children places them at risk for significant toxicity. Five classical stages described:

- GIT phase: occurs within 30 minutes to 6 hours post ingestion. Secondary to the corrosive effect of iron. Vomiting, diarrhoea, haemorrhagic necrosis and shock are symptoms described
- Latent or relative stable phase: 6-24 hours after ingestion
- Shock and metabolic acidosis: 6-72 hours after ingestion
- Hepatotoxicity/hepatic necrosis: 12-96 hours after ingestion
- Bowel obstruction: 2-8 weeks after ingestion

Management:

- IV fluid resuscitation
- May need potassium and glucose supplementation
- Chelation therapy with deferoxamine should be initiated if there is evidence of hypovolaemia, shock, lethargy, persistent vomiting, diarrhoea, positive anion gap, metabolic acidosis, large number of pills on abdominal radiograph, or a serum iron level > 500 µg/dL
- Desferrioxamine is most effective when given as an infusion at 15–35 mg/kg/hour, depending on the clinical severity

3. Paracetamol poisoning

- Doses greater than 140–200 mg/kg have been associated with toxicity in children

- There are four clinical stages in paracetamol poisoning:
    - **Stage 1:** first 24 hours post ingestion. Most appear normal. They may exhibit anorexia, pallor, nausea and vomiting. Biochemical evidence is usually absent
    - **Stage 2:** 24-72 hours post ingestion, right upper quadrant pain. Biochemical evidence with aspartate aminotransferase (AST) as the most sensitive marker. High bilirubin and prothrombin time are also noted
    - **Stage 3:** 72-96 hours post ingestion: patient develops hepatic necrosis and encephalopathy. Nausea and vomiting reappear, and patients may develop jaundice, myocardial dysfunction, haemorrhage and renal failure. Laboratory values for AST and alanine transferase (ALT) are above 10,000 IU/L. PT (INR) and bilirubin are raised. Hypoglycaemia and metabolic acidosis may occur and are important prognostic indicators
    - **Stage 4:** 4 days to 2 weeks. If irreversible damage has occurred, complete hepatic failure ensues, and transplantation is required for survival

Management:

- Supportive care (ABCCCDE)
- **Activated Charcoal:** Paracetamol is completely absorbed from the gastrointestinal tract in the first few hours after drug ingestion. Therefore, activated charcoal (1 g/kg body weight) is recommended only in the first 4 hours after acetaminophen overdose
- **N-acetylcysteine***:* Best outcome if given within 8-10 hours of ingestion. But it can be beneficial up to 36 hours after ingestion. Can be given either orally or parenterally

<u>Oral</u>
Use 10% NAC (100 mg/mL) and dilute 2:1 in water or juice to make a 5% solution (50 mg/mL).
Initial dose: 140 mg/kg
Maintenance dosage: 70 mg/kg every 4 hours for 17 doses

<u>Intravenous</u>
Use 20% NAC (200 mg/mL) for each of the doses below and infuse in
150 mg/kg in 200 mL D5W over 60 minutes
50 mg/kg in 500 mL D5W over 4 hours
100 mg/kg in 1000 mL D5W over 16 hours

4. <u>Salicylates poisoning</u>

- Common medications containing salicylates are aspirin and oil of wintergreen. Acute ingestions of 150–300 mg/kg of salicylates are associated with mild symptoms and greater than 500 mg/kg with severe symptoms and death

- Presentation
    - Patients will present initially with nausea, vomiting, mild tachypnoea and tinnitus. They develop hyperpnoea and hyperventilation due to direct stimulation of the respiratory centre. Confusion, agitation, seizures and coma may also develop
    - Respiratory alkalosis predominates early but later there is respiratory acidosis plus specific electrolyte disturbances (hypokalaemia, hyperglycaemia, hypoglycaemia). An anion gap

metabolic acidosis occurs in severe cases

Management:
- ABCCCDE
- Correct fluid and electrolyte abnormalities
- Salicylate excretion:
    - Activated charcoal is beneficial (each gram of charcoal absorbs 550g of salicylate acid)
    - Alkalinisation of urine (P–H> 7.5) by giving sodium bicarbonate (1-2 mmol/kg with maximum dose of 100 mmol) increases salicylate excretion through ion trapping
    - Dialysis in severe cases

5. Caustics
- Caustics consist of acidic and alkali compounds often used as cleaning materials (e.g. bleach), or compounds used to make soap or detergents
    - Acids produce damage by coagulating proteins and causing tissue necrosis
    - Alkalis dissolve proteins and cause liquefaction necrosis
- Patients often present with burns to the eyes, skin, mouth, oropharynx, oesophagus and stomach. Symptoms include pain, vomiting, drooling or difficulty swallowing
- Injuries to the oesophagus may result in perforation and later strictures while damage to the stomach may lead to ulceration and gastric outlet obstruction secondary to scarring of the pylorus
- Respiratory symptoms may predominate if pulmonary aspiration has occurred

Management:
- ABCCCDE
- Decontamination: If the fluid was on the skin, remove all clothing, and wash skin immediately. If in the eyes, wash continuously for 15-30 minutes
- DO NOT induce vomiting, NO gastric lavage, NO activated charcoal
- If any evidence of airway involvement, alert ICU or anaesthesia as they are at risk of obstruction with worsening oedema
- For careful assessment of GI tract, endoscopy may be indicated
- Important to follow these children long term as they can have late complications with strictures weeks after initial injury

6. Hydrocarbons
- Hydrocarbons are organic compounds that consist solely of carbon and hydrogen molecules. Examples are fuels, household cleaners
- They are classified based on viscosity (ability to flow against friction) and volatility (ability to vaporise). This classification can aid in determining expected clinical effects
- Aspirations of low viscosity can cause chemical pneumonitis and surfactant denaturing. Resulting in acute respiratory distress

Management:
- Stabilisation of ABCCCDE
- Supportive treatment
- DO NOT induce vomiting
- NO activated charcoal/gastric lavage

7. Local medicine

- This is usually noted in children that have diarrhoea and vomiting. It is also given to neonates and its use is influenced by cultural practices
- In children with burns the medicine may be given either topical and/or orally
- The most common presentation is severe metabolic acidosis not in keeping with the history. Some may also have acute kidney injury

Management:

- Supportive management is the most effective management as the constituents of traditional medications are usually not known

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