CHAPTER 1

EMERGENCIES AND TRAUMA

1.1 PAEDIATRIC EMERGENCIES

Certain emergencies are dealt with in the chapters on respiratory, cardiac and nervous system. This section deals only with the approach to the severely ill child and selected conditions (cardiorespiratory arrest, anaphylaxis, shock, foreign body inhalation and burns). All doctors should ensure that they can provide basic (and preferably advanced) life support to children.

> The most experienced clinician present should take control of the resuscitation.

1.1.1 TRIAGE

Early recognition of life-threatening emergencies and rapid provision of appropriate care can prevent childhood deaths and reduce associated morbidity.

Triage aims to identify those children most in need of resuscitation and emergency care. It involves the rapid examination of all sick children when they first arrive in hospital to prioritise their care. They should be reassessed regularly while awaiting definitive care.

Categories

1. Emergencies: Conditions that cannot wait and require immediate treatment.
2. Priority signs (place ahead of the normal queue).
3. Non-urgent (join the queue).

Emergencies:
Conditions that cannot wait and require immediate treatment.
If any emergency sign is present: give emergency treatment, call for help, and perform relevant emergency laboratory investigations.

(A&B) Airway and Breathing

» Not breathing

or

» Airway obstructed

or

» Central cyanosis

or

» Severe respiratory distress

(C) Circulation

» Cold hands

and

» Capillary refill ≥ 3 seconds

and

» Weak and fast pulse

(C) Coma/Convulsing

» Coma

or

» Convulsing (at the time of evaluation)

(D) Severe dehydration

Fluid loss plus any two of the following:

» Lethargy
» Sunken eyes
» Very slow skin pinch (the fold is visible for more than 2 seconds)

Priority signs (place ahead of the normal queue):

These children need prompt assessment and treatment:

» young infant (< 3 months),
» temperature very high (> 38 ºC) or very low (< 36.4 ºC),
» trauma or other urgent surgical condition,
» severe pallor,
» history of poisoning,
» severe pain,
» respiratory distress,
» restless, continuously irritable, or lethargic,
» urgent referral from another health professional,
» malnutrition: visible severe wasting,
» oedema of both feet,
» burns (major).

Non-urgent (queue):

Proceed with assessment and further treatment according to the child's priority.

A number of different triage processes exist and the above is based on the South African Emergency Triage Assessment and Treatment (ETAT).

In addition, the use of clinical markers such as respiratory rate, blood pressure and pulse rate add precision to triage.

Other important conditions may be added to the ETAT guidelines based on local circumstances, such as identifying infectious diseases that need immediate isolation, dehydration (not severe), facial or inhalational burns, evidence of meningococcal septicaemia, and inconsolable crying.

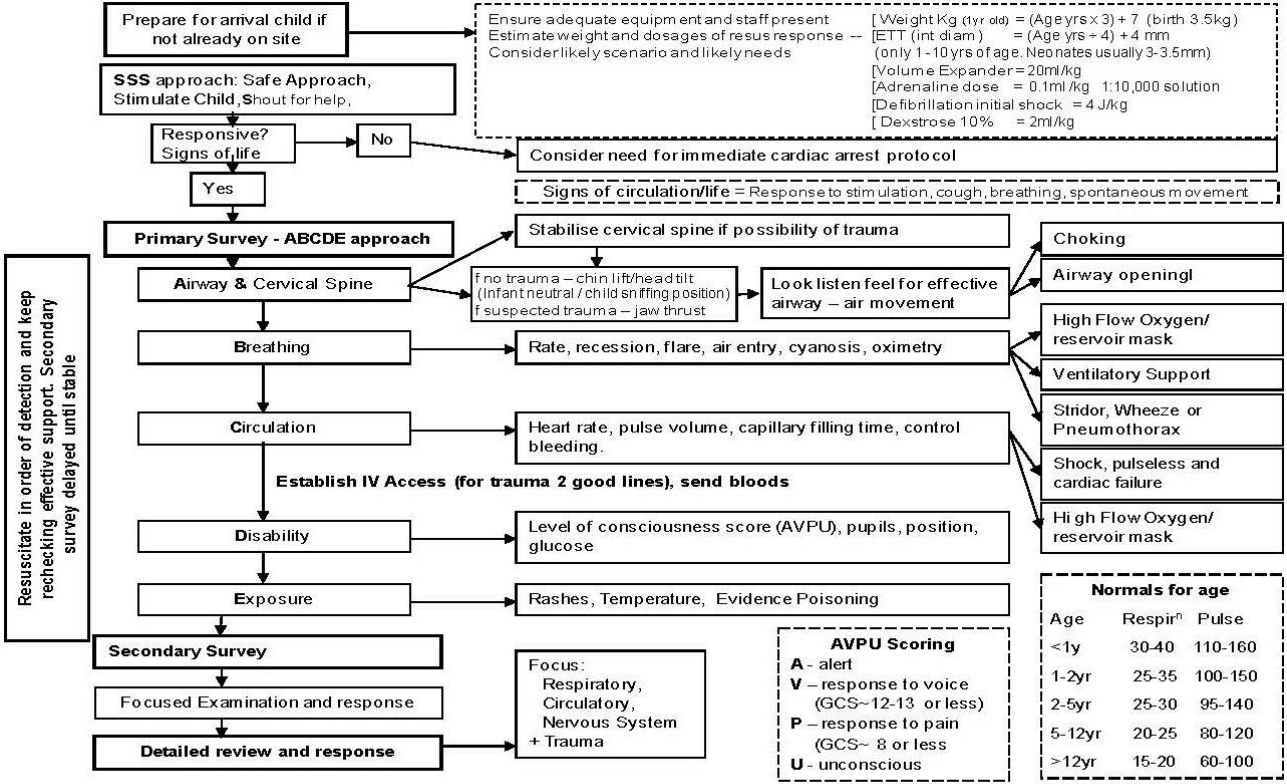
The ETAT triage presented above should be a minimum standard of triage in community health centres, district or regional hospitals in South Africa.

1.1.2 RESUSCITATION OF THE CHILD

A structured approach to the seriously ill or injured child can rapidly optimise their outcome.

Estimation of weight in children is inaccurate and they should be weighed as soon as stabilised. The PAWPER tape allows for consideration of body habitus when estimating weight and can be used as an alternative to the formulae provided (in the diagram below).

The following is a diagrammatic overview derived from an approach to advanced paediatric life support.



A brief summary of the approach and primary survey adapted from paediatric life support documentation – for comprehensive competence an advanced paediatric life support course should be attended.

To optimise oxygen delivery:

- Oxygen, high flow, 15 L/minute via facemask with reservoir bag **or** 6–10 L/minute.
  - If oxygen saturation < 92% or P_aO_2 < 80 mmHg despite maximal oxygen supply, consider providing additional respiratory support.

1.1.3 ANAPHYLAXIS/ANAPHYLACTIC REACTIONS

T78.2

DESCRIPTION

An acute, potentially life-threatening hypersensitivity reaction starting within seconds to minutes after administration of, or exposure to, a substance to which the individual is sensitised. Clinical manifestations include at least one of the following: upper airway obstruction, bronchospasm, hypotension, or shock.

The reaction can be short-lived, protracted or biphasic, i.e. acute with recurrence several hours later. Immediate reactions are usually the most severe.

DIAGNOSTIC CRITERIA

Clinical

» **Acute onset** of signs and symptoms.
» Dizziness, paraesthesia, syncope, sweating, flushing, dysrhythmias.
» Swelling of eyes, lips and tongue (angioedema).
» Upper airway obstruction with stridor.
» Hypotension and shock.
» Bronchospasm, wheezing, dyspnoea, chest tightness.
» Gastrointestinal symptoms such as nausea, vomiting, diarrhoea.

A life-threatening anaphylactic reaction requires **immediate** treatment. Facilities to initiate treatment must be available at all health centres.

GENERAL AND SUPPORTIVE MEASURES

» Place hypotensive or shocked patient in the horizontal position. Do not place in a sitting position.
» Assess and secure airway. If necessary, bag via mask or intubate.

MEDICINE TREATMENT

- Adrenaline (epinephrine) 1:1000 (undiluted), IM, 0.01 mL/kg. (i.e. 10 mcg/kg).
  - Can be repeated every 5 minutes, if necessary.
  - Maximum per dose: 0.5 mL.

Do not administer IV unless there is failure to respond to several doses of IM.

If no response, use IV:

- Adrenaline (epinephrine) 1:1000 (undiluted), IV infusion at 0.02 mcg/kg/minute (mix 0.06 mg/kg adrenaline in 50 mL 5% dextrose, 1 mL/hour = 0.02 mcg/kg/minute).

To maintain arterial oxygen saturation ≥ 95%:

- Oxygen, at least 1–2 L/minute by nasal prong.

In severe anaphylaxis, nasal oxygen is unlikely to be adequate:

- Oxygen, 15 L/minute by face mask with a reservoir bag.

Crystalloid solutions, e.g.:

- Sodium chloride 0.9% OR Ringers Lactate, IV, 20 mL/kg rapidly.
  - Repeat if necessary until circulation, tissue perfusion and blood pressure improves (up to 60 mL/kg).

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- Hydrocortisone, IV, 5 mg/kg, 4–6 hourly for 12–24 hours.
  - **Note**: Steroids are adjunctive therapy, are not part of first line treatment, and should never be the sole treatment of anaphylaxis.

- Promethazine, IV/IM, 0.25–0.5 mg/kg/dose. Contra-indicated in children < 2 years old.

Continue with:

- Chlorphenamine, oral, 0.1 mg/kg/dose 6 hourly for 24–48 hours, if necessary.

If associated bronchospasm:

- Salbutamol, nebulised, 1 mL salbutamol respirator solution in 3 mL sodium chloride 0.9%.
  - Nebulise at 20-minute intervals.

If associated stridor:

- Adrenaline (epinephrine), 1:1000, nebulise with oxygen, every 15–30 minutes until expiratory obstruction is abolished.
  - 1 mL adrenaline (epinephrine) 1:1000 diluted in 1 mL sodium chloride 0.9%.

Observe for 24 hours, in particular for recurrent symptoms as part of a 'biphasic' reaction.

PREVENTATIVE MEASURES AND HOME BASED TREATMENT

» Obtain a history of allergies/anaphylaxis on all patients before administering medication/immunisation.
» Identify offending agent and avoid further exposure.

» Ensure patient wears allergy identification disc/bracelet.
» Train patients to self-administer adrenaline (epinephrine) pre-filled auto injecting device. Specialist initiated for patients who have anaphylactic reactions.
» Educate patient and parent/caregiver on allergy and anaphylaxis.

REFERRAL

Caution

- **Do not refer the patient during the acute phase.**
- **Transfer can only be done once the patient is stable.**
- **Patients supplied with self-administered adrenaline (epinephrine) must be informed of the shelf life of adrenaline (epinephrine) and when they must come in to get a replacement.**

» Bee sting anaphylaxis for desensitisation.

1.1.4 CARDIORESPIRATORY ARREST

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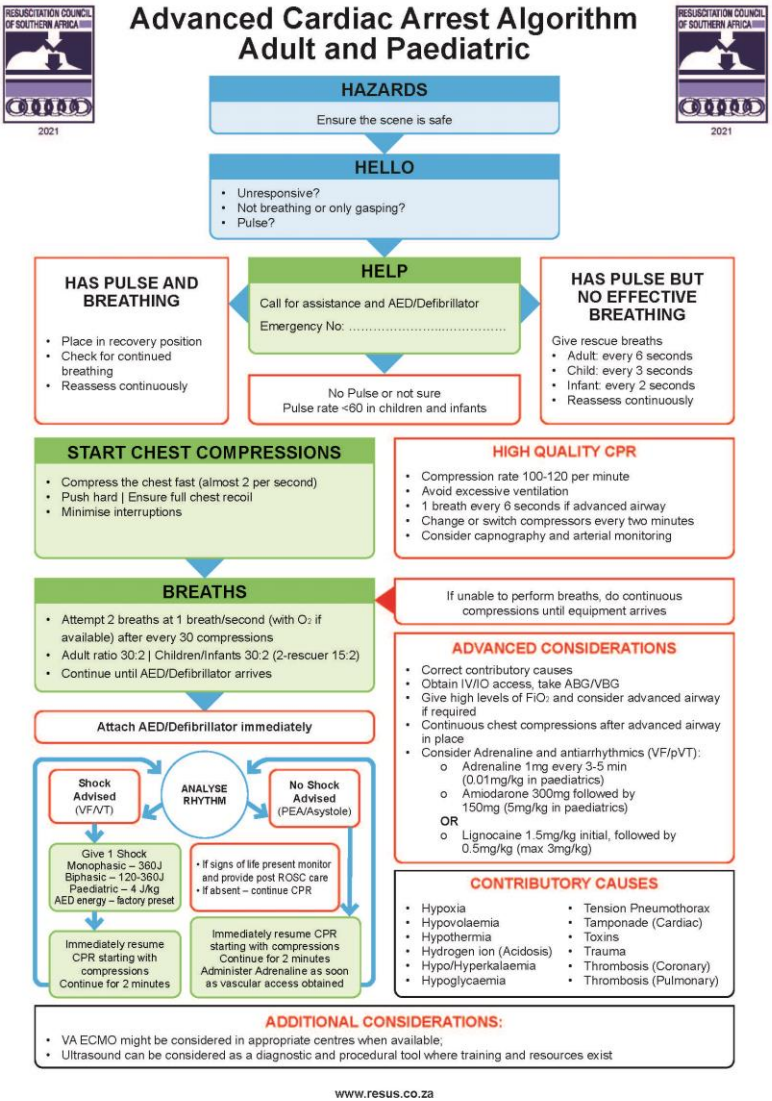

DESCRIPTION

Cardiorespiratory arrest in children usually follows a period of circulatory or respiratory insufficiency and less commonly is precipitated by a sudden cardiac event. It is, therefore, important to pre-empt cardiorespiratory arrest in children by recognising and urgently treating respiratory or circulatory compromise.

Cardiorespiratory arrest is diagnosed clinically in the unresponsive child who has no respiratory effort and/or in whom there is no palpable pulse and no signs of life, i.e. cough or spontaneous movement.

GENERAL AND SUPPORTIVE MEASURES

Always call for help immediately.

Ensure an open airway (position head in a neutral position for toddlers or sniffing position for older children with head-tilt, chin-lift manoeuvre or jaw-thrust in trauma cases).

If there is still no respiration, then commence with artificial breathing using a self-inflating bag, with a reservoir and an appropriate mask. Connect the bag to a high flow oxygen source (15 L/minute). Squeeze the bag with enough air to cause the chest to rise, do not overinflate the child's lungs with too much tidal volume.

If there is inadequate chest movement with bag-valve-mask ventilation, re-assess airway patency and adjust, re-positioning the airway with a naso or oropharyngeal tube/airway. If necessary, place an appropriately sized endotracheal tube. In the event of an unexpected arrest or an arrest where there are no witnesses, consider foreign body obstruction. See section 1.1.7: Inhalation, foreign body.

Checklist:

1. Reassess head position to keep airway open.
2. Reassess for an adequate seal when performing bag-mask ventilation.
3. Ensure an adequate size bag is used according to the size of the patient.
4. Ensure no leaks in bag.
5. Exclude a pneumothorax.

Once effective breathing has been established, provide chest compressions at a rate of 100–120/minute for all children excluding neonates. Provide artificial breaths at a ratio of 30 compressions to 2 breaths (30:2) if alone and 15 compressions to 2 breaths (15:2) if two rescuers are present.
Attach a cardiac monitor to the child and secure vascular access. If unable to insert an IV line, obtain intra-osseous access. See section 1.1.10: Intra-osseous infusion in emergencies.

MEDICINE TREATMENT

Asystole or pulseless electrical activity (i.e. no palpable pulse even if normal electrical pattern (PEA)):

- Adrenaline (epinephrine) 1:10 000 (diluted), IV/intra-osseous, 0.1 mL/kg. (Follow each dose with a small bolus of sodium chloride 0.9%)

- 0.1 mL of 1:10 000 solution = 10 mcg.
- Dilute a 1 mL ampoule of adrenaline (epinephrine) 1:1000 in 9 mL of sodium chloride 0.9% or sterile water to make a 1:10 000 solution.

ETT adrenaline is no longer recommended as absorption is unpredictable. It is faster to get an IO line than intubating the child – rather go for IO adrenaline.

Repeat the dose of adrenaline (epinephrine) every 4 minutes if asystole/PEA persists while CPR continues.
When an ECG sinus rhythm trace is present, continue CPR until an effective pulse and circulation is present.

If the arrest was preceded by circulatory shock:

- Sodium chloride 0.9% OR Ringers Lactate, IV, 20 mL/kg as a bolus.

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During the resuscitation consider if any of the following correctable conditions are present (and if present correct them):

» Hypoxia
» Hypovolaemia
» Hyperkalaemia, hypokalaemia, hypocalcaemia.
» Hypothermia
» Tension pneumothorax.
» Tamponade (cardiac).
» Toxins (e.g. tricyclic antidepressants).
» Thrombo-embolic event.

Note:
There is no evidence to support the **routine** use of any of the following in cardiac arrest:

» sodium bicarbonate,
» calcium,
» high dose IV adrenaline (epinephrine) (100 mcg/kg/dose).

Ventricular fibrillation or pulseless ventricular tachycardia
Consider the following and if present, correct:

» Hypoxia
» Hypovolaemia
» Hyperkalaemia, hypokalaemia, hypocalcaemia.
» Hypothermia
» Tension pneumothorax.
» Tamponade (cardiac).
» Toxins (e.g. tricyclic antidepressants).
» Thrombo-embolic event.

Proceed to immediate defibrillation, but during this process cardiorespiratory resuscitation (compressions and ventilation) must continue, except during the actual administration of each shock. Continue until adequate circulation can be demonstrated.
For pulseless ventricular tachycardia and ventricular fibrillation, the defibrillator should be set to asynchronous mode and 4 J/kg shocks administered.

Do not increase voltage; give 4 J/kg repeatedly, if needed.

After each shock continue CPR immediately for 2 minutes and only re-assess the ECG rhythm thereafter.

If ventricular tachycardia/fibrillation has reverted to sinus rhythm, stop shock cycle, but continue CPR until good stable circulation and adequate spontaneous breathing is evident.

If fibrillation/ventricular tachycardia is still present, give further shocks for 3 x 2-minute cycles of shocks every 4 minutes.

Thereafter, if necessary, the 2-minute shock cycles should continue but, in addition, give the following after the 3rd shock:

- Adrenaline (epinephrine) 1:10 000 (diluted), IV, 0.1 mL/kg and then repeat after every 2nd shock, i.e. every 4 minutes. (Follow each dose with a small bolus of sodium chloride 0.9%.)
  - 0.1 mL of 1:10 000 solution = 10 mcg.
  - Dilute a 1 mL ampoule of adrenaline (epinephrine) 1:1000 in 9 mL of sodium chloride 0.9% or sterile water to make a 1:10 000 solution.

Allow one minute of cardiopulmonary resuscitation between the administration of any medicine and a repeat cycle of shocks.

REFERRAL

» To an intensive care unit after recovery from an arrest.

1.1.5 POST RESUSCITATION CARE

Once children have been successfully resuscitated and emergency treatment provided, they remain at high risk for death or disability.

In order to optimise outcomes, the following principles of care apply:

1. Admit or refer to a ward with appropriate monitoring facilities, e.g. a high care or intensive care unit as soon as possible.
2. Identify and manage underlying pathology.
3. Maintain normoxia (avoid both hyperoxia and hypoxia).
4. Avoid hypo- and hypercapnia.

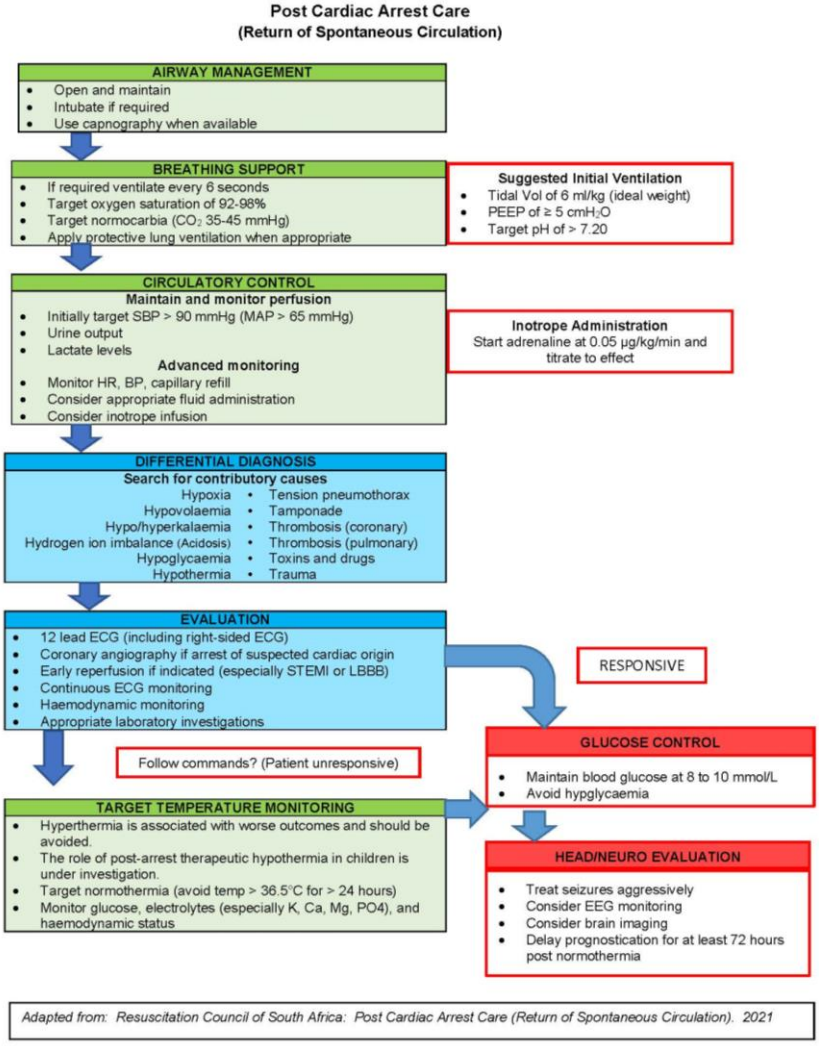
5. Maintain systolic BP ≥ 5th percentile for age (refer to Chapter 4: Cardiovascular System, section 4.11: Hypertension); this may require intravascular fluids and/or inotropes.
6. Avoid hyperthermia and treat fever aggressively.
7. Provide adequate nutrition.
8. Monitor and correct glucose and electrolyte abnormalities.
9. Provide appropriate analgesia.
10. Consider rehabilitation requirements.

1.1.5.1 TERMINATION OF RESUSCITATION

» The decision to stop CPR attempts depends on the specifics of the individual patient and should be based on clinical judgement.
» Consider stopping resuscitation attempts and pronouncing death if there is incurable underlying disease, or if asystole > 20 minutes.

Consider carrying on for longer especially with:
» hypothermia and drowning,
» poisoning or medicine overdose,
» neurotoxic envenomation (e.g. black and green mamba or Cape cobra snakebite) – see section 18.2.3: Snakebite.

This decision should take into consideration the potential risk that CPR poses to the rescuer, e.g. infectious diseases.



1.1.6 CONVULSIONS, NOT FEBRILE CONVULSIONS

See section 13.1: Seizures.

1.1.7 INHALATION, FOREIGN BODY

T17.9

DESCRIPTION

Accidental inhalation of a solid object that may obstruct the airway at any level.

DIAGNOSTIC CRITERIA

Ask specifically about a possible choking episode if there is any suspicion of a foreign body aspiration.

» Initial symptom is frequently sudden onset of choking followed by persistent unilateral wheeze (may be bilateral), chronic cough, or stridor.
» Segmental or lobar pneumonia failing to respond to standard therapy.
» Mediastinal shift.
» Chest X-ray on full expiration and full inspiration may show hyperinflation and/or collapse or sometimes, a radio-opaque foreign body.

GENERAL AND SUPPORTIVE MEASURES

ACUTE EPISODE

» If coughing effectively and breathing adequately, provide oxygen and refer urgently for airway visualisation. Carry out transfer with a person who is able to manage the foreign body process accompanying the child.
» If the child is still breathing but unable to cough or breathe adequately, attempt to dislodge the foreign body by cycles of 5 back slaps followed by 5 chest compressions (infants), or 5 Heimlich manoeuvres (child) repeatedly.
» If the child is unresponsive, carry out standard cardiorespiratory resuscitation, i.e. cardiac compressions and ventilation (provide artificial breaths at a ratio of 30 compressions to 2 breaths (30:2) if alone and 15 compressions to 2 breaths (15:2) if two rescuers are present).

Caution

Blind finger sweeps are dangerous and contra-indicated.
Foreign bodies may be removed under direct vision.
All cases should have airway visualisation or be referred for airway visualisation.

REFERRAL

» All cases for the removal of retained foreign bodies.
» Unresolved respiratory complications.

1.1.8 SHOCK

R57.9

DESCRIPTION

An acute syndrome that reflects the inability of the pulmonary and circulatory system to provide adequate perfusion, oxygen and nutrients to meet physiological and metabolic demands.

Compensation is achieved by increased pulse rate, and peripheral vascular constriction. The blood pressure may be relatively well maintained but the patient still requires urgent resuscitation. Hypotension is a late and ominous sign.

Shock can be further characterised:

» **Hypovolaemic shock:** e.g. dehydration, haemorrhage or fluid shifts.
» **Distributive shock:** e.g. septicaemia and anaphylaxis.
» **Cardiogenic shock:** e.g. cardiac dysfunction.
» **Dissociative shock:** e.g. profound anaemia and carbon monoxide poisoning.
» **Obstructive shock:** e.g. pneumothorax and cardiac tamponade.
» **Septic shock:** many mechanisms are operative in septic shock.
» **Neurogenic shock:** e.g. spinal cord trauma.

Complications of shock include multi-organ dysfunction and/or failure. A patient may have more than one type of shock present, e.g. a trauma patient with spinal cord injury, pneumothorax and haemorrhagic shock.

DIAGNOSTIC CRITERIA

Evidence of compensated shock includes:

» cold peripheries,
» weak pulse pressure especially peripheral pulse weaker than central pulses,
» prolonged capillary filling, i.e. ≥ 3 seconds,
» agitation/confusion/decreased level of consciousness,
» skin pallor,
» increased heart rate,
» signs and symptoms of underlying conditions.

In uncompensated shock, falling BP and failure to act urgently will result in irreversible shock and death.

Facilities to start treatment of shock must be available at all health centres.

GENERAL AND SUPPORTIVE MEASURES

» Follow the ABCDE algorithm. See section 1.1.1: Triage.
» Identify and treat the underlying cause.
» Ensure good intravenous or intra-osseous access. In trauma, two large bore lines for access are important. See section 1.1.10: Intra-osseous infusion in emergencies.

» Perform relevant investigations.
» Monitor:
  > Vital signs and maintain within normal limits.
  > Metabolic parameters and correct as needed.
  > Urinary output – aim for at least 1 mL/kg/hour.

MEDICINE TREATMENT

To optimise oxygen delivery to the tissue, administer:

- Oxygen, high flow, 15 L/minute via facemask with reservoir bag or 6–10 L/minute.

If oxygen saturation < 92% or P_aO_2 < 80 mmHg, consider the need to intubate and continue respiratory support.

1. Hypovolaemic shock

Response to each step of management must be reviewed every 15 minutes.
If after administration of a total of 40 mL/kg of sodium chloride 0.9% fluid, shock has not resolved, consider other causes and the need for inotropes.

For fluid deficit (vs. blood loss):
IV fluids to correct the intravascular fluid deficit and improve circulation:

- Sodium chloride 0.9% OR Ringers Lactate, IV, 20 mL/kg rapidly.
  - Review after each bolus to see if shock has resolved.

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In children with **severe malnutrition**:

- Sodium chloride 0.9%, IV, 10 mL/kg administered over 20 minutes.
  - Review after each bolus to see if shock has resolved.

With each re-assessment, if:
» Shock has resolved (capillary filling time < 3 seconds, good pulse, normal blood pressure, urine output, skin perfusion and level of consciousness improved), do not repeat the fluid bolus.
» Shock is better but still present, repeat bolus (up to 40 mL/kg). After this further care should be in an ICU setting. Consider initiation of inotropes/vasopressors.
» Monitor for persistence of shock, i.e.:
  > Non-responding or decreasing BP.
  > Non-responding or increasing pulse rate/decreasing volume.
  > Non-responding or increasing capillary filling time.
» Monitor for fluid or circulatory overload, i.e.:
  > Increasing respiratory rate.
  > Increasing basal crepitations.
  > Increasing pulse rate.
  > Increasing liver size/tenderness.
  > Increasing JVP.
  > Increasing oxygen requirement.

After circulatory stabilisation, continue with appropriate maintenance fluid.

For blood loss:
- Packed red cells **or** whole blood, 10–20 mL/kg, repeat if required.
  - Stop once haemodynamic stability reached.

While awaiting blood products to arrive, proceed with volume resuscitation.
See section 1.1.9: Massive blood loss.

2. Cardiogenic shock

Ideally, children receiving treatment for cardiogenic shock should be in a high care or ICU.

Inotropic support:
When perfusion is poor and blood pressure response is unsatisfactory, despite adequate fluid replacement.

- Dobutamine, IV, 5–15 mcg/kg/minute.
  - Initiate slowly and with caution as dobutamine can potentially drop BP due to unopposed β-2 adrenergic vasodilation properties.

Chronotropic/inotropic plus vascular tone support:
If tissue perfusion and blood pressure do not improve satisfactorily on adequate fluid volume replacement and inotropic support, consider:
- Adrenaline (epinephrine), IV infusion, 0.05–1 mcg/kg/minute.

If poor ventricular contractility and increased afterload are considered as the primary problem, do not give adrenaline (epinephrine) but consider adding an afterload reducing agent to the dobutamine infusion but only with specialist advice.

3. Septic shock

Treatment for septic shock should be initiated urgently and then patients should preferably be transferred to an ICU.

Response to each step of management must be reviewed every 15 minutes.

IV fluids:
- Sodium chloride 0.9% **OR** Ringers Lactate, IV, 10 mL/kg rapidly.
  - Review after each bolus to see if shock has resolved.

LoE I[1]

In children with **severe malnutrition**:
- Sodium chloride 0.9%, IV, 10 mL/kg administered over 20 minutes.
  - Review after each bolus to see if shock has resolved.

With each reassessment, if:
» Shock has not resolved after 40 mL/kg of sodium chloride 0.9% fluid, consider inotropes.

» Shock has resolved (capillary filling time < 3 seconds, good pulse, normal blood pressure), do not repeat bolus. Proceed to other care.
» Shock is better but still present, repeat bolus (up to 40 mL/kg). After this, further care should be in an ICU setting.
» Monitor for persistence of shock, i.e.:
  > Non-responding or decreasing BP.
  > Non-responding or increasing pulse rate/decreasing volume.
  > Non-responding or increasing capillary filling time.
» Monitor for fluid or circulatory overload, i.e.:
  > Increasing respiratory rate.
  > Increasing basal crepitations.
  > Increasing pulse rate.
  > Increasing liver size/tenderness.
  > Increasing JVP.

Chronotropic/Inotropic plus vascular tone support:
If tissue perfusion and blood pressure do not improve satisfactorily on adequate fluid volume replacement: titrate inotropes against the response and add an additional agent if poor response.

- Adrenaline (epinephrine), IV infusion, 0.05–1 mcg/kg/minute.

If inadequate response:
ADD
- Dobutamine, IV, 5–15 mcg/kg/minute.

Septicaemic shock unresponsive to inotropes:
- Hydrocortisone, IV, 1–2 mg/kg/dose, 6 hourly until shock has resolved.

Antibiotic therapy
» Start empiric antibiotics early.
» Aim to get source control: all pus should be drained; all necrotic tissue should be removed/debrided.

Before initiating antibiotic therapy, take blood and urine specimens, if appropriate, for culture and sensitivity testing.

Consider whether community or hospital acquired and treat based on anticipated susceptibility. Ensure immediate administration.

Reconsider antibiotic and/or antifungal therapy when culture and sensitivity results become available.

Caution **Patients must be resuscitated and stabilised before referral.**

1.1.9 MASSIVE HAEMORRHAGE WITH MASSIVE TRANSFUSION OF BLOOD

DEFINITION

Massive blood loss in children is recognised when a child requires a blood transfusion to replace 50% of total blood volume in 3–4 hours (40 mL/kg) or > 100% of total blood volume in 24 hours or receives replacement of 10% of total blood volume/minute. The rapid recognition is important to maintain tissue oxygenation by restoration of blood volume and haemoglobin.

Common causes:
» Trauma (especially blunt injuries).
» Ruptured aortic aneurysm.
» Liver surgery.
» Gastrointestinal bleeding.
» Invasive tumour.

Presentation: Hypotension, prolonged capillary fill time, tachycardia, urinary output decreases, oxygen saturation reduced, hypothermia.

DIAGNOSTIC CRITERIA

Investigations
» ABG, Thromboelastogam (TEG), haemoglobin, PT/PTT, platelets, INR, clotting factors, DIC screening.
» Haemoglobin must be done initially and repeated every 60 minutes.

MEDICINE TREATMENT

Massive transfusion protocol (MTP) activation must be prompt as every minute from activation to product arrival increases odds of mortality by 5%.

Facilities without access to a blood bank:
- Lyophilised plasma, IV.
  - 1 unit for each unit of emergency blood transfused.

Arrange urgent transfer to a centre with blood bank and specialist services.
Facilities with access to a blood bank:
» Ensure that the blood bank receives an appropriate specimen as soon as the possible need for transfusion is identified.
» Notify the blood bank as soon as possible of the need for a massive transfusion and request a massive transfusion pack.

A massive transfusion pack will typically consist of:
- Red blood cells (RBCs).

AND
- Lyophilised plasma, IV.
  - 1 unit for each unit of emergency blood transfused.

OR

- FFP – thawed when requested.

AND

- Platelets
  - Aim to transfuse the above products in a 1:1:1 ratio, or as guided by laboratory parameters.
  - Send specimens for FBC and INR and continue to monitor.

Watch for complications:

» Electrolyte abnormalities:
  > Hyperkalaemia
  > Hypocalcaemia
» Transfusion:
  > Induced coagulopathy.
» Immunologic reactions:
  > ABO incompatibility.
  > Transfusion-related acute lung injury.
  > Transfusion-associated circulatory overload.
  > Alloimmunization

REFERRAL

» All
» MTP deactivation must be stopped timeously to decrease wastage and adverse effects.

1.1.10 INTRA-OSSEOUS INFUSION IN EMERGENCIES

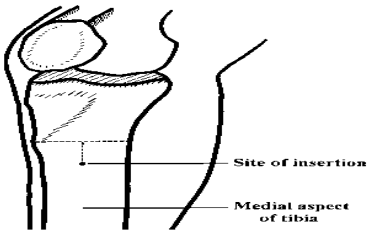
During resuscitation and when managing a critically ill child, if intravenous access is not established within 5 minutes, obtain intra-osseous (IO) access.

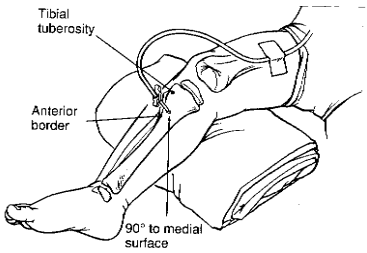
1. Use an intra-osseous needle or if not available, a FG18 x 1.5 cm (or less ideally FG20 x 1.5 cm) or lumbar puncture needle.
2. Grasp the thigh and knee above and lateral to the insertion site with the palm of the left hand (if right-handed). Wrap the fingers around the knee to stabilise the proximal tibia. Do not allow any portion of your hand to rest behind the insertion site.
3. Find the site of insertion, i.e. feel the tibial tuberosity. The site of insertion is about 2 cm below this tuberosity on the broad flat medial surface of the tibia.
4. Careful surgical preparation of the injection site as for lumbar punctures.
5. Insert the needle through the skin over the flat surface of the tibia.
6. Holding the needle low down near the skin, advance the needle through the bony cortex of the tibia, directing the needle perpendicular, i.e. 90° to the long axis, using a gentle but firm twisting or drilling motion.
7. Stop advancing the needle when a sudden decrease in resistance to forward motion of the needle is felt.
8. Remove the stylet from the needle.

9. Slowly inject a small amount of sodium chloride 0.9% through the needle. Check for any signs of increased resistance to injection, increased circumference of the soft tissues of the calf, or increased firmness of the tissue.
10. If the test injection is successful, disconnect the syringe and join an infusion set to the needle. Secure the needle and tubing with tape and support it with a bulky dressing.
11. If the test injection is unsuccessful, i.e. infiltration of the sodium chloride 0.9% into the leg tissue is observed, remove the needle and try again on the other leg.
12. The flow rate should rapidly increase after flushing through. If flow is poor, consider the use of a 3-way tap and syringe.
13. Secure the IO needle to the skin by using forceps/spatula/cord-clamp, clamping the IO needle perpendicular to the leg and place two-plaster straps over the forceps/cord-clamp/spatula. Do not cover the leg with a circumferential dressing, as you need to watch the calf for signs of compartment syndrome.

Signs of successful insertion:

» Sudden decrease in resistance to insertion as the needle passes through the bony cortex.
» The needle remains upright without support.
» Fluid flows freely through the needle without evidence of subcutaneous infiltration.





Automated hand-held intra-osseous access devices are increasingly available and their use allows for the rapid attainment of vascular access in almost all children – when available, their use is strongly encouraged and should be consistent with the manufacturer's instructions. The same landmarks are used as for manual insertion and the procedure is less painful. For older children (> 40 kg) the proximal humerus can be used as an access site.

Aspiration and rapid infusion may be painful; lignocaine 0.5 mg/kg can be slowly infused as analgesia.

1.1.11 EXPOSURE TO POISONOUS SUBSTANCES

See Chapter 18: Poisoning, section 18.1: Poisoning.

1.1.12 INSECT BITES AND STINGS

See Chapter 18: Poisoning, section 18.2: Envenomation.

1.2 TRAUMA

1.2.1 BURNS

T30.0

DESCRIPTION

Burns lead to skin and soft tissue injury and may be caused by:

» heat, e.g. open flame, hot liquids, hot steam,
» chemical compounds,
» physical agents, e.g. electrical/lightning, and
» radiation.

GENERAL AND SUPPORTIVE MEASURES

Emergency treatment

» Remove smouldering or hot clothing.
» Remove constrictive clothing/rings.
» To limit the extent of the burn, soak the affected area generously in cold water for not more than 20 minutes.
» In all burns, > 10% or where carbon monoxide poisoning is possible (enclosed fire, decreased level of consciousness, disorientation) administer high flow oxygen by face mask with reservoir bag (15 L/minute).
» Examine carefully to determine the extent and depth of the burn wounds.
» Respiratory obstruction due to thermal injury or soot inhalation, production of black coloured sputum, shortness of breath, hoarse voice and stridor are serious signals and may rapidly proceed to respiratory compromise. Consider early endotracheal airway placement.

Further assessment and care

Assessment:

The extent and depth may vary from superficial (epidermis) to full-thickness burns of the skin and underlying tissues.

Since burns are usually sterile, empiric antibiotics are not initially indicated.

Depth of burn wound	Surface/Colour	Pain sensation/Healing
Superficial or epidermal	Dry, minor blisters, erythema.	» Painful » Heals within 7 days.

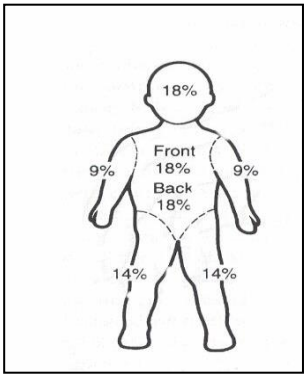
Depth of burn wound	Surface/Colour	Pain sensation/Healing
Superficial partial thickness or superficial dermal	Blisters, moist.	» Painful » Heals within 10–14 days.
Deep partial thickness or deep dermal	Moist white or yellow slough, red mottled.	» Less painful. » Heals within a month or more. » Generally needs surgical debridement and skin graft.
Full thickness (complete loss of dermis)	Dry, charred whitish, brown or black.	» Painless, firm to touch. » Healing by contraction of the margins (generally needs surgical debridement and skin graft).

Burns are classified as minor or major burns.

Major burns:
» Partial thickness burns (superficial or deep) of > 10% body surface area.
» Full thickness burn of > 3% body surface area.
» Any burn involving the head and face, hands, feet and perineum.
» Inhalation injuries.
» Circumferential burns.
» Electrical burn injuries.
» Burns in neonates.
» Burns in patients with serious pre-existing or concomitant injuries.

Minor burns:
» Partial thickness burns of < 10% body surface area in a child > 1 year of age.

Estimation of total body surface area (TBSA) involved in burn injury:



Published with kind permission from SAMJ. South African Burn Society burn stabilisation protocol. JS Karpelowsky, L Wallis, A Maderee and H Rode. 2007. SAMJ Vol 9, No. 8. Page 574–7.

The figure above is used to calculate body surface area percentage, and indicates percentages for the whole leg/arm/head, (and neck in adults) not the front or back.

» In children, the palm of the hand is 1%.
» The following adjustments are made in children up to the age of 8 years old after which adult percentages are used for the head, neck and each lower limb.
» **Less than 1 year**:
  > Head and neck are 18% of TBSA.
  > Each leg is 14% of TBSA.
» **After 1 year**:
  For each year of life:
  > Head and neck decrease by 1% of TBSA until 9% (adult value).
  > Leg gains 1/2% of TBSA until 18% (adult value).

Age (Years)	Head + neck Front + back	Torso Front	Torso Back	Lower limb Front + back	Upper limb Front + back
< 1 year	18%	18%	18%	14%	9%
1 to < 2 years	17%	18%	18%	14.5%	9%
2 to < 3 years	16%	18%	18%	15%	9%
3 to < 4 years	15%	18%	18%	15.5%	9%
4 to < 5 years	14%	18%	18%	16%	9%
5 to < 6 years	13%	18%	18%	16.5%	9%
6 to < 7 years	12%	18%	18%	17%	9%
7 to < 8 years	11%	18%	18%	17.5%	9%
8 to < 9 years	10%	18%	18%	18%	9%
≥ 9 years *(plus 1% perineum)*	9%	18%	18%	18%	9%

Care:

Inhalation injury

In addition to other treatment, the degree of inhalation injury may warrant:
» monitoring of blood gases,
» warm humidified oxygen and/or intubation,
» positive pressure ventilation.

Ensure adequate airway in the presence of inhalational burns.
Children with burns may present with delayed onset of airway obstruction. Consider early intubation.

Suspect carbon monoxide poisoning in all fire victims.
» Obtain carboxyhaemoglobin level.
» Treat by administering 100% oxygen (15 L/min by facemask with reservoir bag).

Prevent heat loss

Nurse all major burns in a warm room (26 °C).

Nasogastric drainage
Use a nasogastric tube on free drainage in all burns > 10% (especially during transfer).
Within the 1st 24 hours, commence nasogastric feeds in children with > 15% TBSA where ileus is not suspected.

Nutritional support
Consult a dietician as children with burns require a higher than usual intake of nutrients (due to a hypermetabolic state).
Start enteral feeds within 6 hours in all children unless there are contraindications.

Estimate daily energy and protein needs using the formulae:

Energy (kJ):	250 kJ/kg body mass + (150 kJ x % burned TBSA)
Protein (g):	3 g/kg body mass + (1 g x % burned TBSA)
Maximum % burn area used for calculation should not exceed 50%.	

Give iron and vitamins routinely until burn wounds are healed and/or skin grafting has successfully been completed.

Note:
Do not supplement with iron during sepsis or infection.
In addition, provide:
» psychological support,
» physiotherapy,
» occupational therapy,
» waterbeds and cradles,
» distraction therapy: music, video games, etc. for dressing changes.

MEDICINE TREATMENT
Fluid replacement

Burns < 10% of total body surface area:
- Oral fluids.

Burns > 10% of total body surface area:
- IV fluid for resuscitation.

If in shock, first treat shock. See section 1.1.8: Shock.

As in all fluid administration in sick children, volumes are estimates, response must be constantly re-evaluated, and rates adjusted appropriately.

CALCULATION OF INITIAL FLUID REPLACEMENT (AFTER SHOCK HAS BEEN TREATED)
First 24 hours:
Replacement fluids for burns
- Sodium chloride 0.9%, IV OR Ringers lactate.
  - Calculate total fluid requirement in 24 hours:

[Total % burn ____x weight (kg) ___x 4 mL] as sodium chloride 0.9%.
Give half of this volume in the 1st 8 hours from the time of the burn.
Administer remaining fluid volume in the next 16 hours.

LoE I[1]

Note:
If urine output not adequate (adequate urine output = 1–2 mL/kg/hour), increase fluids for the next hour by 50% (continue at higher rate until urine output is adequate then resume normal calculated rate).

PLUS
Maintenance fluids in children
In children, give oral or intravenous maintenance fluid in addition to the above calculated volume.

Child maintenance fluid requirement volumes	
≤ 1 year	120 mL/kg/24 hours
All children > 1 year – the sum of the following:	
» For each kg of body weight up to 10 kg	100 mL/kg/24 hours
» For each additional kg of body weight more than 10 kg	50 mL/kg/24 hours
» For each additional kg of body weight more than 20 kg	20 mL/kg/24 hours

Example: 24 kg child with 10% burns	
1st 24 hours:	
» Replacement for expected losses: 4 mL/kg x 24 kg x 10%	 **= 960 mL**
» Maintenance: First 10 kg = 10 kg x 100 mL/kg/24 hours Second 10 kg = 10 kg x 50 mL/kg/24 hours Remaining 4 kg = 4 kg x 20 mL/kg/24 hours Total maintenance:	 = 1000 mL + = 500 mL + = 80 mL **= 1580 mL**
Thus	
1st 8 hours: = ½ resuscitation fluids + ⅓ maintenance fluids	480 mL sodium chloride 0.9% + 527 mL sodium chloride 0.9%/dextrose 5%
Next 16 hours: = ½ resuscitation fluids + ⅔ maintenance fluids	480 mL sodium chloride 0.9% + 1053 mL sodium chloride 0.9%/dextrose 5%

The above are guidelines. Regular review is needed to maintain urine output 1–2 mL/kg/hour.

Avoid circumferential taping when securing infusion lines as oedema under the eschar may decrease the venous return.

If urine output > 1–2 mL/kg/hour or base excess (BE) better than minus 4, stop resuscitation fluids. Too much fluid is almost as harmful as too little fluid.

Second 24 hours:
If urine output is adequate, continue resuscitation:
- Sodium chloride 0.9%, IV, 1.5 mL/kg/% burn/24 hours.

PLUS

Maintenance:
- Sodium chloride 0.9%/dextrose 5% (dextrose saline), as per maintenance requirement above.

Part of this volume may be replaced by enteral feeds.

Thereafter, progressively decrease IV fluids and increase enteral fluids according to response over time. Aim for full enteral feeds as soon as possible.

Anaemia
If haemoglobin < 7 g/dL:
- Packed red cells, 10 mL/kg over 3 hours.

Hypoalbuminaemia
If indicated by symptomatic hypoalbuminaemia:
- Albumin 20%, IV, 2 g/kg/day. (2 g = 100 mL.)

For pain

Pain associated with burn injury is often severe and requires active and continuous management. Procedural pain management measures need to be taken during dressing changes.

See Chapter 20, section 20.1.1: Management of pain.

For pruritus
Antihistamines
- Chlorphenamine, oral, 0.1 mg/kg/dose as a single dose at night.
  - Maximum: 4 mg.

For children 2 years and older, second-generation antihistamines can be considered:
- Cetirizine, oral, as a single dose.
  - Children 2–6 years: 5 mg.
  - Children 6–12 years: 10 mg.

Topical
- Aqueous cream.

If not controlled:
- Ondansetron, oral, 0.1–0.2 mg/kg 12 hourly.

If oral route cannot be used:
- Ondansetron, IV, 0.1 mg/kg immediately.
  - Maximum: 4 mg/day.

Refractory pruritus: Refer for consideration of gabapentinoids.

Change of dressing
Provide analgesic cover at each dressing change (Chapter 20: Pain Control).
In major burns, change dressings under procedural sedation or general anaesthesia.

Gastric erosions
Preventative medication treatment is not given. Effective early resuscitation and early feeding decrease the incidence of gastric erosion.

If gastric erosion is suspected due to haematemesis or brownish gastric aspirates.

Proton pump inhibitor, e.g.
- Omeprazole, oral, 0.4–0.8 mg/kg/dose 12 hourly. Specialist initiated.
  - Maximum dose: 20–40 mg/dose.
  - If 1 month–2 years: 2.5 mg 12 hourly.
  - If > 2–6 years: 5 mg 12 hourly.
  - If > 7–12 years: 10 mg 12 hourly.

If unable to take orally:
- Proton pump inhibitor, e.g.
  - Pantoprazole, IV, 0.5 mg/kg/dose 12 hourly.

OR
- Ranitidine, IV, 1 mg/kg 6 hourly.

Local treatment of burns
Gently clean the wounds with running water, utilising appropriate pain and sedation, see Chapter 20, section 20.1.1: Management of pain.
Remove loose skin and debride dead tissue and dress with topical antiseptic cream and non-adherent dressing.
Thereafter, daily rinse with running water and dress with topical antiseptic cream and non-adherent dressing.

In < 20% body surface area burns:
- Povidone-iodine 0.5%, with occlusive dressings.

In > 20% body surface area burns:
- Silver-sulphadiazine 1%, on non-adhesive dressings.
  - Cover with paraffin gauze and crepe bandages.

- Change dressings daily.

Excise and graft all full thickness or deep dermal burns as soon as the patient is stable.
Consider skin grafting in wounds not healed in three weeks.

Antibiotics
Consider if signs of infection are present as these may be subtle:
» pyrexia/hypothermia,
» shock (compensated or not compensated),
» rising pulse or respiratory rate,
» petechiae,
» leucocytosis/thrombocytopenia,
» looks ill/toxic/altered level of consciousness,
» local inflammatory changes,
» vomiting.

The choice of antibiotics is based on the culture and sensitivity results of wound, urine and blood cultures once available.
Positive wound cultures alone do not indicate systemic infections requiring antibiotic treatment.
» Start empiric antibiotics early.
» Aim to get source control: all pus should be drained; all necrotic tissue should be removed/debrided.

Before initiating antibiotic therapy, take blood and urine specimens, if appropriate, for culture and sensitivity testing.

Consider whether community or hospital acquired and treat based on anticipated susceptibility. Ensure immediate administration.

Reconsider antibiotic and/or antifungal therapy when culture and sensitivity results become available.

Tetanus prevention
Patients with no previous immunisation in the last 5 years:
- Tetanus toxoid, IM, 0.5 mL.
  - Complete course in previously unvaccinated patients.

Where deep necrotic lesions are part of the burn and if the immunisation status is not known:
- Tetanus immunoglobulin, IM, 500 IU.

Prior to transport/referral
» Commence resuscitative measures, if necessary.
» Administer 100% humidified oxygen by facemask for inhalation injuries, if necessary.

» Cover wounds with clean dressings after hot or smouldering clothing have been removed.

REFERRAL
» Major burn injuries.

1.2.2 TRAUMATIC BRAIN INJURY
S06.2

See Chapter 23: ICU, section 23.7: Traumatic Brain Injury (TBI) and neuro-protection in the ICU, for full management details.

DESCRIPTION
Types:
» Concussion (minor), e.g. shaken baby.
» Contusion
» Penetrative
» Anoxic – commonest, e.g. falls, vehicle collusion, violence, sport injuries.

DIAGNOSTIC CRITERIA
Symptoms:
» Headache
» Eating/nursing habits.
» Unusual or easy irritability.
» Persistent crying & inability to console.
» Change in sleeping habits.
» Seizure
» Mood
» Drowsiness
» Loss of interest in toys.

Signs of raised intracranial pressure (> 20 mmHg):
» Cushing response (hypertension and bradycardia).
» Crackpot sign.
» Features on fundoscopy.

Imaging:
» CTS – done within 0–6 hours.
» Transcranial doppler: Cerebral perfusion pressure > 40 mmHg.

GENERAL AND SUPPORTIVE MEASURES
» Rest/Trendelenburg position.
» Tight glucose and calcium control.

REFERRAL
» Refer all patients.

References

[1] Kartha GB, Rameshkumar R, Mahadevan S. Randomized Double-blind Trial or Ringers Lactate versus Normal Saline in Pediatric Acute Severe Diarrheal Dehydration. Journal of Pediatric Gastroenterology and Nutrition. 2017, (6):621-626.