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Management of the sick child

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Introduction

Of the 9 million deaths/yr that occur in children <5yrs, 3.6 million occur in the 1st month of life and 70% of the others are caused by acute respiratory infections, diarrhoea, measles, and malaria, +/− malnutrition. Most very sick children present with clinical features of more than one diagnosis; ∴ a single diagnosis at admission is often impossible. In many

low-resource settings, there may be no paediatrician and sick children are managed by non-specialists.

Deaths in hospitals often occur within the first 24h, so sick children need to be identified on arrival, and appropriate treatment instituted. The Emergency Triage Assessment and Treatment (ETAT) strategy, advocated by WHO, is a rapid screening process to identify children who require immediate treatment to avert death and long-term morbidity. Treatment of sick children must never be on a 'first come, first served' basis. WHO has published guidelines for the management of common childhood illnesses (second edition 2013), available online (see Box 1.1).

Box 1.1 WHO online paediatric publications

- *Pocket book of hospital care for children: guidelines for the management of common illnesses with limited resources*. Available at: http://www.who.int/maternal_child_adolescent/documents/child_hospital_care/en/index.html
- *Emergency triage, assessment and treatment: manual for participants*. Available at: http://www.who.int/maternal_child_adolescent/documents/9241546875/en/
  - Developed by the World Health Organization (WHO), for rapid screening of sick children to identify those with emergency, priority, or non-urgent signs (triage), and to instigate immediate treatment for children with emergency signs.
  - Children should be prioritized on presence of emergency signs, rather than on a 'first come first served' basis.
  - All health workers should triage and follow ABCD approach (airway, breathing, circulation/coma/convulsions, and dehydration).
  - Disease-specific treatment should be started after managing ABCD.
- *Integrated management of childhood illness (IMCI)*. Available at: http://www.who.int/maternal_child_adolescent/documents/imci/en/
  - IMCI uses a syndromic approach, combining management of individual diseases with nutrition, immunization, and maternal health. It aims to improve the skills of healthcare workers (HCWs).
  - 'Danger signs' are first identified. Children are then assigned defined clinical syndromes on the basis of simple questions and a basic clinical examination; more than one syndrome may be assigned.

- The severity of each syndrome is defined and management directed: either urgent referral to a secondary care facility, treatment, and advice, or advice to the parent/caregiver for home management.
- IMCI is targeted at HCWs in health centres and outpatient departments of small hospitals. This can be extended to include community health workers, shopkeepers, and pharmacists, who are often the first port of call for medical advice.
- IMCI has improved healthcare seeking behaviour, rational prescribing, immunization coverage, and availability of basic equipment, and has also reduced costs.
- Bigger reductions in mortality should result from combining IMCI with key programmes, such as the WHO pneumonia and diarrhoea case management strategies.

Emergency triage assessment

Immediately on presentation to a health facility (i.e. *before* joining a queue), children should be rapidly triaged to identify those with:

- *Emergency signs:* require immediate treatment to prevent death (see Box 1.2; 🕮 Emergency management of the sick child—ABC, p.[link]).
- *Priority signs:* should be assessed and treated without delay (Box 1.3).
- *Non-urgent cases* that have neither emergency nor priority signs who should follow the regular queue.

Box 1.2 Emergency signs

- Central cyanosis.
- Severe respiratory distress.
- Obstructed breathing.
- Altered level of consciousness.
- Convulsions.
- Signs of shock.
- Signs of severe dehydration in a child with diarrhoea.

Box 1.3 Priority signs

- Any sick child aged <2mths.
- Visible severe wasting; oedema affecting both feet.
- *High fever:* temperature >38.5°C.
- Irritability, restlessness, lethargy.
- Severe palmar pallor.
- Major burns.
- Any respiratory distress.
- Child with urgent referral note from the health facility.
- Trauma or urgent surgical condition.
- Poisoning.
- Severe pain.

Triage should be carried out at the first point of contact; this may be at the outpatient clinic, the emergency room, or even in a hospital paediatric ward. All children must be assessed for these signs *before* any routine procedures like registration and weighing.

Assess airway and breathing

- Look, listen, and feel for chest movement, exhaled air, and breathing sounds by placing your ear close to the child's nostrils.
- Check for respiratory distress and signs of airway obstruction (Box 1.4).
- Check the tongue and buccal mucosa for central cyanosis.
- Do not move neck if cervical injury is possible, e.g. following trauma. Use jaw thrust manoeuvre to open the airway if needed.

Box 1.4 Signs of severe respiratory distress

- Lower chest wall indrawing (Fig. **1.1**).
- Grunting.
- Inability to speak, drink, or feed due to respiratory distress.
- Head nodding/use of accessory muscles of respiration.

Other signs of respiratory distress

- *Fast breathing:* ≥60 breaths/min in infants <2mths; ≥50/min in children 2–11mths; ≥40/min in children 12mths to 5yr.
- Nasal flaring.

Signs of obstructed breathing

- Stridor.
- Weak cough.
- Drooling.
- Inability to speak.
- Splinted chest.

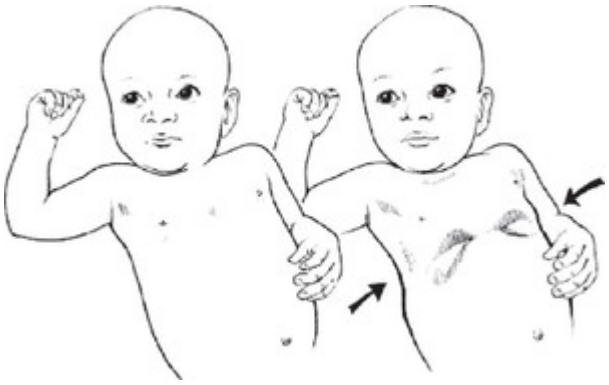

Fig. 1.1
Lower chest wall indrawing: with inspiration the lower chest wall moves in. (Note the distinction between lower chest wall *indrawing* and *intercostal recession*, in which the soft tissue between the ribs is sucked inwards on inspiration. Although intercostal recession may occur in respiratory distress, alone, it is not a sign of severe respiratory distress.) Reproduced from World Health Organization, *Pocket Book of Hospital Care for Children*, 2005: 74, with permission of WHO.

Assess circulation for signs of shock

- Check if child's hands are cold.
- *Assess capillary refill time (CRT):* apply pressure to whiten nail of thumb or big toe for 5s. Release pressure and note how long it takes nail bed to refill and turn pink; CRT ≥3s usually a sign of shock or dehydration.
- *Check pulse:* if radial pulse not palpable, feel for brachial or femoral pulse in infant, or carotid pulse in older children. In hypovolaemic

shock, central pulses may be weak and rapid, or absent. In septic (distributive) shock you may find warm peripheries, CRT <1s and bounding pulse.

• *Blood pressure:* if able to measure blood pressure (BP) you may see a wide pulse pressure, but measurement of BP is difficult in children (important to have correct cuff size), and low BP is a late clinical sign.

• WHO definition of shock is given in Box 1.5.

Box 1.5 WHO defined shock

Cold hands a*nd* CRT >3s, *and* weak, fast pulse.

Signs of hypovolaemic shock (e.g. due to dehydration)

- Temperature gradient (peripheries much colder than trunk).
- CRT >3s.
- Fast, weak pulse.

Signs of distributive shock (e.g. due to sepsis)

- Warm hands and feet: no temperature gradient.
- CRT <1s.
- Bounding pulses.
- Large pulse pressure with low diastolic pressure.

Also note

- Anuria.
- Hypotension is a late sign in children.
- Altered level of consciousness.
- Acidotic (Kussmaul) breathing 2° to poor tissue perfusion.

Assess for coma, convulsions, or other abnormal mental status

• Check for continued irritability, restlessness, lethargy, or convulsions.

• Assess level of consciousness using AVPU scale (Box 1.6) or Blantyre Coma Scale.

Box 1.6 AVPU scale

The AVPU scale is a quick and approximate way of rating a person's level of consciousness:

- **A** Alert.
- **V** Responds to verbal commands.
- **P** Responds to painful stimulus. Press down firmly on the middle fingernail with a pen, or rub your knuckles on the sternum.
- **U** Unconscious.

Assess for severe dehydration if child has diarrhoea

- Check with mother if the child's eyes are unusually sunken.
- Assess skin turgor by pinching skin of abdomen halfway between umbilicus and flank. Pinch for 1s and observe how the skin returns. >2s implies marked loss of skin turgor.
- Severe dehydration is defined as ≥2 of the following: lethargy or unconsciousness; sunken eyes; marked loss of skin turgor; inability to drink or drinking poorly.
- Signs of severe dehydration are unreliable in children with severe malnutrition and management should be guided by a history of diarrhoea or change in appearance.
- See Box 1.7 for calculation of maintenance fluids.

Box 1.7 Calculating maintenance fluids in children

- If oral or NG feeds are tolerated, these are usually preferable to giving intravenous (IV) fluids.
- For children, total daily maintenance IV fluid requirement is calculated with the following formula:
  - 100mL/kg for the first 10kg.
  - 50mL/kg for the next 10kg.
  - 25mL/kg for each subsequent kg.
- For example, a 6-kg infant receives 6 × 100mL = 600mL/day, an 18-kg child (10 × 100) + (8 × 50) = 1400mL/day.
- An alternative formula is to use 4mL/kg/h for the first 10kg, 2mL/kg/h for the second 10kg and 1mL/kg/h for each subsequent

kg. For example, a 6-kg infant receives 6 × 4mL/h = 24mL/h, an 18-kg child (4 × 10) + (2 × 8) = 56mL/h.

• For neonates, see feed and fluid requirements (📖 Fluid requirements, p. [link]). Fluid requirements may be higher in febrile children, and in hot environments.

Assess for signs of severe malnutrition

• Examine for severe muscle wasting, especially around ribs, shoulders, arms, buttocks, and thighs.

• Assess mid-upper arm circumference (MUAC): if <11.5cm (age 6mths–6yr) or bilateral pedal oedema +/− other signs of kwashiorkor. Treat as severe malnutrition.

Assess for severe anaemia

Compare the colour of the child's palm with yours: if the skin is very pale or so pale that it looks white, the child has severe palmar pallor.

Assess for a major burn

See 📖 Burns, p. [link].

Assess for other priority indicators

• All sick infants <2mths.

• All children referred from another health facility.

Emergency management of the sick child—ABC

If emergency signs are present, call for help and give emergency treatment:

Airway and breathing

• Severe respiratory distress, obstructed breathing, or central cyanosis is an emergency.

• If there is a history or evidence of foreign body aspiration, manage as for a choking child (see 📖 Foreign body aspiration in an unconscious child, p. [link]).

• Open airway using head tilt and chin lift: in infants the 'tilt' should be to the neutral position to avoid obstruction of the airway due to hyperextension. In older children, tilt the head to the 'sniffing' position (see Fig. **1.2**).

- If this fails to open the airway (or if you suspect cervical spine injury), use the jaw thrust manoeuvre to open the airway: place the first two fingers of each hand behind each side of the child's mandible and push the jaw forward.
- Inspect the mouth and remove any visible foreign body.
- Clear secretions from oropharynx (use suction if available).
- If inadequate or no spontaneous respiratory effort, use bag, valve, and mask (BVM) ventilation: 40–60 breaths/min in newborns and a slower rate in older children.
- Where expertise/facilities exist, endotracheal intubation should be performed. However, attempted intubation by the inexperienced must not compromise adequate BVM ventilation.

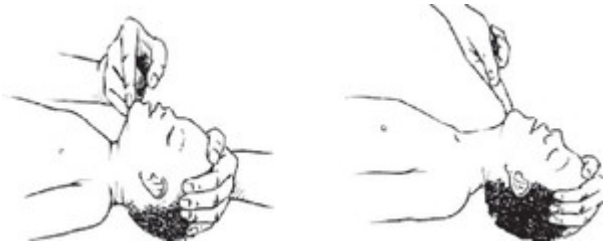

Fig. 1.2
(A) Neutral position in infants (B) 'Sniffing' position in older child.
Reproduced from World Health Organization, *Pocket Book of Hospital Care for Children* 2005: 8, with permission of WHO.

Foreign body aspiration in a choking, conscious child

- If the child has an effective cough, encourage coughing and continually reassess for clinical deterioration or relief of the obstruction.
- If NO effective cough, or there is severe respiratory distress, obstructed breathing, or central cyanosis, manage as for choking child.
- Position infant head down and give up to 5 sharp back blows between the shoulder blades using the heel of the hand as shown in Fig. **1.3**.
- If obstruction persists:
  - If <1yr, give five chest thrusts using two fingers (Fig. **1.3**), similar to chest compressions, but sharper and at a slower rate.
  - If >1yr, if obstruction persists, perform the Heimlich manoeuvre (Fig. **1.3**): stand behind the child and form a fist below the sternum with one hand. Place other hand over fist and pull both hands backwards and upwards. Repeat manoeuvre 5 times.

• If obstruction persists, check infant's mouth for any obstruction that can be removed and repeat this sequence, starting with back blows.

Fig. 1.3
Back blows and chest thrusts to relieve airway obstruction in a choking infant. Heimlich manoeuvre in an older choking child.
Reproduced from World Health Organization, *Pocket Book of Hospital Care for Children* 2005: 6–7, with permission of WHO.

Foreign body aspiration in an unconscious child

If infant/child with a foreign body aspiration is or becomes unconscious, call for help, place on a flat surface, and proceed with airway, breathing, circulation/coma/convulsions (ABC). Open the airway and remove any visible object and attempt 5 rescue breaths. If no response, proceed with chest compressions as detailed on 📖 Foreign body aspiration in a choking, conscious child, p. [link]. When you re-assess A, check for any removable foreign body. If obstruction has been relieved, continue giving rescue breaths until the child is breathing spontaneously.

Circulation and shock

• Remember ABC and give oxygen; **shock is an emergency** (Box 1.8).

• Assess for WHO defined shock (cold hands a*nd* CRT >3s, *and* weak, fast pulse). ❗ This is a contentious area: see Box 1.5 for children who do not fulfil WHO definition of shock.

• Insert IV line (blood for Hb/haematocrit, glucose and cross-match).

• If unable to establish peripheral IV access quickly, insert external jugular or intraosseous line (Fig. **1.4**), whichever is quicker.

• Fluid resuscitate for WHO defined shock according to guidelines listed below, unless severely malnourished, which is managed differently (see 📖 Management of shock in children with severe malnutrition, p. [link]).

- Stop bleeding; look for severe palmar pallor (severe anaemia, Box 1.9).
- Ensure child is warm.
- Monitor blood glucose levels whilst fluid resuscitating.

Box 1.8 Treatment of shock

A recent large randomized controlled trial (RCT) comparing fluid bolus resuscitation to IV maintenance fluid in children in Africa with clinical features of shock, showed increased mortality in those treated with fluid boluses. The study did not include children with hypotension, severe acute malnutrition or gastroenteritis. The study also showed that WHO defined shock is rare in the population studied and did not demonstrate evidence for harm in children with WHO defined shock.

Children with WHO defined shock should be resuscitated according to WHO guidelines (📖 p. [link]). For children with gastroenteritis, rehydrate according to WHO guidelines (📖 General management of dehydration, p. [link]) and for children with severe acute malnutrition (SAM) treat shock as per WHO guideline (📖 Management of shock in children with severe malnutrition, p. [link]). In children with some features of shock, but not fulfilling the WHO definition, treatment of their underlying condition is the priority. Maintenance fluids should be given, and giving additional fluids cannot be recommended.

Maitland K, Kiguli S, Opoka RO, *et al*. Mortality after fluid bolus in African children with severe infection. *N Engl J Med* 2011; 364(26): 2483–95. Available at: http://www.nejm.org/doi/full/10.1056/NEJMoa1101549

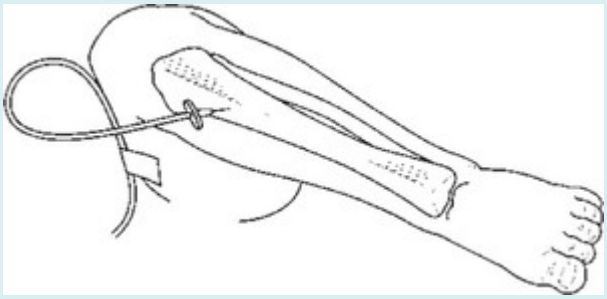

Fig. 1.4
Intraosseous needle insertion.
Reproduced from World Health Organization, *Pocket Book of Hospital Care for Children* 2005: 311, with permission of WHO.

Box 1.9 Children with severe anaemia and shock

Do not delay fluid resuscitation, resuscitate as required per guidelines on 📖 p. [link], while awaiting blood for transfusion.

- Obtain blood for Hb/haematocrit, cross-match (and malaria slide in endemic areas) in all children with severe palmar pallor.
- If Hb <4g/dL, or haematocrit <12%, or Hb result not available quickly and clinical signs of severe anaemia, transfuse 20mL/kg whole blood.
- *In the presence of very severe palmar pallor and shock*, consider urgent transfusion with O -ve blood.

Management of shock in children who fulfil WHO definition of shock and are NOT severely malnourished

Fluid resuscitate rapidly

- Give 20mL/kg bolus (normal saline or Ringer's lactate) as rapidly as possible, then reassess.
- If no improvement, give a second 20mL/kg fluid bolus (blood 20mL/kg over 30min if child is bleeding and it is available) then reassess.
- If still no improvement and signs of dehydration or septic shock, give a third 20mL/kg bolus as rapidly as possible. Otherwise management is guided by the working diagnosis.

If improvement occurs at any stage (pulse slower, CRT faster)

- Assess need for rehydration.
- If no rehydration needed, give maintenance IV fluids.
- If dehydrated or history of profuse diarrhoea, give 70mL/kg Ringer's lactate or normal saline over 5h if <12mths and over 2.5h if 12mths–5yr.
- Continue to assess the child every 1–2h. Some children may deteriorate after initial recovery.
- Give oral rehydration solution (📖 ORS, p. [link]) 5mL/kg/h as soon as child can drink.
- Follow appropriate treatment plan A, B, or C for dehydration (see 📖 Diarrhoeal diseases, p. [link]) based on this assessment.

Management of shock in children with severe malnutrition

WHO recommended treatment for children with severe malnutrition, signs of shock and who are lethargic or have lost consciousness. See 📖 Nutrition, p. [link], for treatment of dehydration in severe acute malnutrition.

- Signs of shock and dehydration are less reliable in children with severe malnutrition.
- Types of fluid, volumes, and rates of administration are different to those used in well-nourished children.
- 💧 Giving too much IV fluid can → overload if cardiac output is impaired. They cannot excrete Na^+ load. This is a contentious area and further studies are awaited.
- Never use diuretics to treat the oedema of kwashiorkor as this will extract fluid from the intravascular space only.

At the start of treatment

- Weigh the child (or estimate weight) to calculate fluid requirements.
- Record pulse rate (PR) and respiratory rate (RR).
- Assess and treat hypoglycaemia (5mL/kg of 10% dextrose). If unable to measure glucose, assume there is hypoglycaemia.
- *For WHO-defined shock:* infuse 15mL/kg IV fluid over 1h. Use (in order of preference) Ringer's lactate with 5% glucose, half-normal saline with 5% glucose, or half-strength Darrow's solution with 5% glucose. Use Ringer's lactate if these are not available.
- Monitor PR and RR every 5–10min.

• If child deteriorates during IV rehydration (RR ↑ by 5/min or PR ↑ by 15/min or ↑ oedema or facial puffiness), stop the infusion.

If there are signs of improvement (PR & RR ↓)

• Repeat 15mL/kg IV bolus over 1h.

• Then switch to oral or NG feeds if not comatose. Give hourly feeds, 10mL/kg/h alternating ReSoMal with F75.

• Assess 2–3-h hydration status and continue the hourly rehydration to a maximum of 10h (be careful not to overload).

• Continue feeding with F75.

If there are still no signs of improvement

• Give maintenance IV fluids while waiting for blood.

• Transfuse 10mL/kg fresh whole blood slowly over 3h; give packed cells if fluid overload/heart failure; consider furosemide during transfusion.

• Start frequent small feeds with F75, or alternative low lactose and low osmolarity preparation (📖 Nutrition, p. [link]).

In all cases, proceed to full assessment and management of severe malnutrition, including broad-spectrum antibiotic therapy (📖 Diarrhoeal diseases, p. [link]).

Box 1.11 Intraosseous needle insertion

Intraosseous infusion is a quick, safe, and reliable method of giving fluid, blood and drugs when it is not possible to establish peripheral venous access. The usual site of insertion is the proximal tibia (Fig. **1.4**):

• Place padding under child's knee so that it is flexed ~30° from the straight position with the heel resting on the bed.

• Identify the insertion site 1–2cm below the tibial tuberosity, midway between the anterior ridge of the tibia and its medial edge.

• Use a dedicated intraosseous or bone marrow aspiration needle (15–18 gauge or, if not available, 21 gauge); if neither available, a large bore hypodermic needle may be used in young children.

• Clean the skin with antiseptic solution.

• Stabilize the leg, grasping thigh and knee above and lateral to the cannulation site with non-dominant hand, taking care to keep hand away from cannulation site to avoid needle-stick injury.

- Using aseptic technique, insert needle with point angled slightly away from the joint space and bevel pointing towards foot.
- Advance needle using a gentle, but firm twisting or drilling motion, until there is a sudden ↓ in resistance as it enters marrow cavity; needle should sit firmly in the bone.
- Remove the stylet, attach a syringe, aspirate marrow contents (looks like blood), and flush with normal saline to confirm needle is in marrow cavity. Blood from marrow aspirate may be sent for full blood count (FBC), biochemistry, malaria slide, and cross-match.
- Apply dressing and secure needle in place. It is now ready to use.
- Stop the intraosseous infusion as soon as venous access is available.

Contraindications

Infection at the insertion site; fracture of the bone.

Alternative sites of insertion

Distal femur, 2cm above the lateral condyle (~ 1–2cm proximal to the superior border of the patella), slightly lateral to anterior ridge.

Coma and convulsions

The presence of coma or convulsions is an emergency.

Manage airway, breathing and circulation

See 📖 Emergency management of the sick child—ABC, p. [link], assess and treat hypoglycaemia.

If convulsing

- Give diazepam 0.5mg/kg rectally or midazolam (buccal) 0.3mg/kg (1–6mth), 2.5mg (6mth–1yr), 5mg (1–5yr).
- If still convulsing after 10 min, give 2nd dose of diazepam or midazolam, or if IV access: diazepam 0.25mg/kg IV.
- If still convulsing after a further 10min, give paraldehyde 0.3–0.4mL/kg rectally, or phenobarbital 15mg/kg IV (as slow infusion over 20min) or IM (*Note:* peak concentration reached 1–4h after intramuscular (IM) administration). In infants <2wks old, give phenobarbital 20mg/kg as slow IV infusion.
- To prevent aspiration, avoid oral medications until the convulsions have terminated and the child is alert.

Note: seizures, especially in children with malaria, may be very subtle, comprising one or more of irregular respiration, nystagmus, or twitching of extremities or lips.

If unconscious

- Position in the left lateral 'recovery' position. If head or neck trauma is suspected, stabilize the neck first and keep the child lying on the back.
- Tepid sponge and administer antipyretics if high fever.
- Assess and treat the treatable: hypoglycaemia, poisoning, diabetes mellitus, septicaemia/meningitis, herpes simplex encephalitis.

Hypoglycaemia

Assess and treat hypoglycaemia

- If lethargic or unconscious, measure blood glucose.
- If unable to measure glucose quickly, or if blood glucose <2.5mmol/L in a well-nourished child (<3mmol/L in severe malnutrition), give 5mL/kg 10% glucose rapidly IV.
- If alert, treat hypoglycaemia with 10mL/kg milk or 10% glucose by mouth or NG tube (NGT).
- Recheck blood glucose level after 2 hours.

Nutritional status

Assess and treat severe malnutrition 📖 Nutrition, p. [link].

Further assessment and diagnosis

After triage assessment complete clinical assessment. Common acute problems in children are:

- Lethargy, ↓ level of consciousness, or convulsions.
- Cough, wheeze, or difficulty breathing.
- Diarrhoea.
- Fever.

Common problems that present less acutely include:

- Chronic cough ≥30 days.
- Fever lasting >7 days.

Major differential diagnoses for each clinical presentation

Causes of lethargy, impaired consciousness, or convulsions

- Meningitis 📖 Neurology, p. [link].
- Cerebral malaria 📖 Malaria, p. [link].
- Febrile convulsions (see Box 1.12).
- Hypoglycaemia (see 📖 Hypoglycaemia, p. [link]).
- Head injury 📖 Neurology, p. [link].
- Poisoning/overdose 📖 Poisoning and envenoming, p. [link].
- Sepsis (unlikely to cause convulsions unless meningitis).
- Shock (unlikely to cause convulsions).
- Acute glomerulonephritis with encephalopathy 📖 Renal medicine, p. [link].
- Diabetic ketoacidosis 📖 Endocrinology and biochemistry, p. [link].

Box 1.12 Febrile convulsions

- Occur in children aged 6mths–6yr.
- Generalized tonic or tonic-clonic seizure lasting up to 5min during a febrile illness.
- Full neurological recovery.
- Generally benign.
- May have a family history.
- In a minority of children may recur in the same or subsequent illness.

More serious cause (e.g. meningitis, cerebral malaria, encephalitis, brain abscess) suggested by:

- Prolonged seizures (>30min).
- Multiple or focal seizures.
- Impaired consciousness or neurological abnormalities.
- Age <6mths or >6yrs.

If in doubt, perform full septic screen including lumbar puncture (LP).

Causes of difficulty breathing +/− cough

- Pneumonia 📖 Chest medicine, p. [link].

- Severe anaemia.
- Malaria 🕮 Malaria, p. [link].
- Cardiac failure 🕮 Cardiovascular medicine, p. [link].
- Congenital heart disease.
- Inhaled foreign body (see 🕮 Emergency management of the sick child—ABC, p. [link]).
- Tuberculosis 🕮 Tuberculosis, p. [link].
- Pertussis 🕮 Chest medicine, p. [link].
- Prematurity 🕮 Surfactant deficiency.

Causes of wheeze

- Asthma 🕮 Chest medicine, p. [link].
- Bronchiolitis 🕮 Chest medicine, p. [link].
- Viral upper respiratory tract infection (URTI).
- Pneumonia 🕮 Chest medicine, p. [link].
- Inhaled foreign body (🕮 Emergency management of the sick child—ABC, p. [link]).

Causes of diarrhoea See 🕮 Diarrhoeal diseases, p. [link].

- *Infections:* viral, bacterial, and parasitic.
- Severe malnutrition.
- Malabsorption.
- Antibiotic related diarrhoea.
- Intussusception (Box 1.13).

Box 1.13 Intussusception

- Invagination of part of intestine into lumen of adjoining bowel.
- Important cause of intestinal obstruction in children aged 2mths–5yr (peak incidence 4–10mths).
- Classically presents with recurrent, colicky, abdominal pain, vomiting, and bloody ‘redcurrant jelly’ stool; may palpate a sausage-shaped abdominal mass.
- Abdominal X-ray (AXR) may show soft tissue mass displacing loops of bowel; barium enema, a filling defect; and ultrasound (US) scan, a ‘target lesion’.
- Urgent intervention can prevent bowel ischaemia and perforation: reduce with air/contrast enema; if this fails, operate.

- Treat shock, sepsis, or electrolyte derangement.

Causes of fever without localizing signs

In most children with fever, cause is clinically apparent. Examine upper airways (viral URTI, otitis media, tonsillitis) and joints (septic arthritis), as well as the major systems (pneumonia, meningitis). Examine skin for infection or a rash (e.g. measles). In absence of localizing signs, consider:

- Malaria 📖 Malaria, p. [link].
- Sepsis bacteraemia/septicaemia (see Box 1.14).
- Urinary tract infection (UTI).
- Typhoid.

Box 1.14 Bacteraemia and septicaemia

- Common among children in the tropics.
- Under-diagnosed where there are no facilities for blood culture.
- Often there is a focus of infection (e.g. pneumonia, meningitis, soft tissue infection), but may occur without a focus, or a focus may develop later.
- Typhoid and non-typhoid *Salmonella* infections are a cause of sepsis without localizing signs; a similar syndrome may occur with many other organisms, especially in children with severe malnutrition or HIV.
- All children with sepsis should be admitted and started on empiric antibiotics, e.g. ampicillin (or benzylpenicillin) and gentamicin (ideally after blood cultures), during investigations. Note that malaria may be accompanied by bacterial sepsis.

Non-typhi Salmonella (NTS) infection

- NTS infections are a common cause of childhood bacteraemia. Risk factors include malnutrition, malaria, HIV, and sickle cell disease.
- Children may present with acute infection, or sub-acute or prolonged fever without localizing signs, but focal signs and/or diarrhoea occur; splenomegaly is common.
- Some first line antibiotics (e.g. penicillin) do not cover NTS. Treatment is with chloramphenicol, co-trimoxazole, or ampicillin, but multi-drug resistance is an increasing problem. Alternatives are ciprofloxacin (resistance emerging) or ceftriaxone.

Causes of chronic cough

- Tuberculosis 📖 Tuberculosis, p. [link].
- Asthma 📖 Chest medicine, p. [link].
- Persistent infection e.g. Pertussis 📖 Chest medicine, p. [link].
- Inhaled foreign body 📖 Chest medicine, p. [link].
- Bronchiectasis 📖 Chest medicine, p. [link].
- Lung abscess 📖 Chest medicine, p. [link].
- Recurrent pneumonia or HIV-associated lung disease 📖 HIV/AIDS, p. [link].
- Recurrent aspiration.

Differential diagnosis of fever lasting >7 days

Diagnosis is often difficult. Many children will have already been empirically treated and diagnostic facilities may be limited. A detailed clinical assessment is essential. Causes will vary in different regions. A carefully considered trial of treatment for the most likely cause may be necessary if a secure diagnosis cannot be made.

Consider

- Partly treated, drug-resistant malaria.
- Occult abscess (e.g. subphrenic, psoas, retroperitoneal, lung).
- Typhoid and non-typhi *Salmonella* infection (see Box 1.14).
- Infective endocarditis 📖 Cardiovascular medicine, p. [link].
- Rheumatic fever 📖 Cardiovascular medicine, p. [link].
- Tuberculosis 📖 Tuberculosis, p. [link].
- Brucellosis (in endemic areas) 📖 Multi-system diseases and infections, p. [link].
- Visceral leishmaniasis (in endemic areas) 📖 Multi-system diseases and infections, p. [link].

The sick young infant

Infants <2mths are vulnerable, and their illnesses may rapidly → death. All sick young infants should, therefore, be given priority, even in the absence of emergency signs.

Assessment of the sick young infant

Symptoms and signs of illness in young infants are often subtle and non-specific and more than one illness may co-exist.

Check for the danger signs (see Box 1.15), these indicate possible septicaemia, pneumonia, or meningitis requiring immediate treatment.

Box 1.15 Danger signs in young infants

- ↓ Activity or lethargy.
- Poor feeding.
- Vomiting.
- Convulsions, usually subtle or focal.
- Bloody diarrhoea.
- Fever (axillary temp >37.5°C, or rectal >38°C), less common in this age group, but may indicate serious bacterial infection.
- Hypothermia (axillary <35.5°C or rectal <36°C).
- Pallor, jaundice, or cyanosis.
- Tachypnoea (RR ≥60 breaths/min) or ↓ RR (<20/min) or apnoea (no breathing for >15s).
- Severe chest wall indrawing (minimal intercostal indrawing may be normal in young infants in absence of other respiratory signs).
- Nasal flaring and grunting.
- Irregular respiration.
- Bulging/tense fontanelle when not crying.

- *Check for focal signs of infection:* including joint/limb swelling, ↓ limb movement, or tenderness (osteomyelitis or septic arthritis); peri-umbilical hyperaemia +/− purulent discharge; purulent ear discharge; skin infection. Suspect meningitis if child has convulsions or is irritable with high pitched cry, ↓ feeding, lethargy/unconscious, or bulging/tense anterior fontanelle. *Note:* neck stiffness is a rare sign of meningitis in young infants.
- *Check for feeding problems and weight:* check if sucking well and weight adequate for age. Refusal of feeds or inability to suck may be due to sepsis, cardiac or respiratory problems, or oral thrush. In an infant who feeds well, but has low weight for age, look for underlying problems, e.g. metabolic disorders or congenital heart disease.

• *Check for signs of dehydration* (📖 p. [link]). ↓ Intake, ↑ fluid loss from diarrhoea, vomiting or tachypnoea may → dehydration. Diarrhoea is uncommon in breastfed infants of this age except as a sign of sepsis.

• *Check immunization status:* ensure that child is up to date with immunization according to the national schedule.

• Check for congenital malformations.

Emergency treatment of the sick young infant

Establish regular respiration and heart rate. Resuscitation is usually successful if promptly performed:

Airway

Ensure patent airway by careful suctioning and correct positioning of the neck: place a towel under the shoulders to allow the neck to drop to a neutral position or just minimal extension with chin lift; do not hyperextend the neck (Fig. **1.5**).

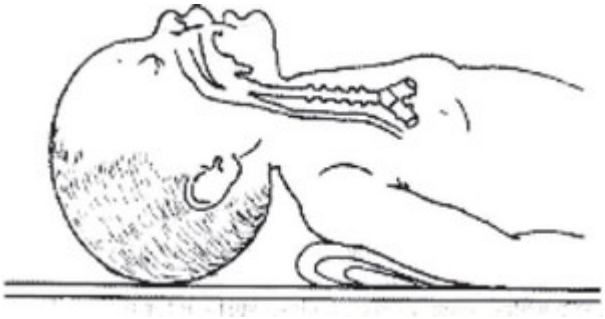

Fig. 1.5
Correct position of the neck for ventilation.
Reproduced from World Health Organization, *Pocket Book of Hospital Care for Children* 2005: 44, with permission of WHO.

Breathing

Look, listen, and feel for 10s. If breathing is irregular, shallow, or absent, commence BVM ventilation with O_2, ensuring mask covers nose and mouth. Check pulse every 2min. Use room air if O_2 is not available. If the child is breathing, but cyanosed or RR >60/min, give O_2.

Circulation

Check for brachial pulse for no longer than 10s. If PR <60/min, absent, or not sure, commence chest compressions. After 2min give adrenaline if no cardiac output (see Box 1.10). Combine chest compressions with ventilation in cycles of 15 compressions to 2 breaths (30:2 if there is no assistance). Use two finger tips over lower third of sternum or both

thumbs with hand encircling chest and compress 1/3 of antero-posterior diameter. Aim for 90 compressions and 10 breaths/min. *For neonates*, give 3 compressions for 1 breath every 2s (90 compressions and 30 breaths/min) see algorithm for newborns (Fig **1.7**).

Box 1.10 Cardiac arrest

Unlike in adults, most arrests in young children are 1° respiratory arrests +/− 2° cardiac arrest. As a result, adequate ventilation alone is sufficient to maintain cardiac output in most cases, while the cause of the arrest is identified and treated.

If there is also cardiac arrest requiring chest compressions:

- Give ratio 3:1 compressions to breaths in neonates.
- Give a ratio of 15:2 in infants and children.

Drugs

If no response after 2min, administer IV or intraosseous adrenaline 0.1mL/kg of 1:10 000 solution (10microgram/kg) and continue chest compressions and ventilation. This may be repeated after 3–5min if there is no response. In newborns the preferred access is through an umbilical vein catheter (UVC).

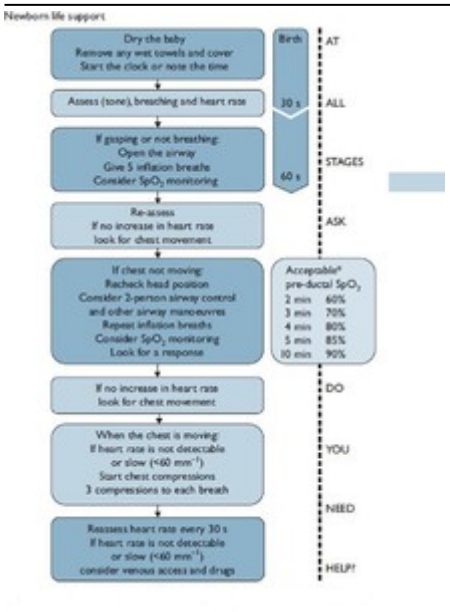

Fig. 1.7
Newborn life support. Note that there are special situations (e.g. meconium at delivery, preterm delivery). See http://www.resus.org.uk/pages/GL2010.pdf for more information.
Reproduced from the Resuscitation Council Guidelines (2010), with permission from the Resuscitation Council UK.

*Dawson JA, Kamlin CO, Vento M, et al. Defining the reference range for oxygen saturation for infants after birth. *Pediatrics 2010* 125:e1340–7.

General measures in the management of sick young infants

Young infants with signs of serious illness (📖 p. [link]) require admission to prevent complications and rapid deterioration. Treatment, including antibiotics (see Box 1.16), will be directed at the specific clinical syndrome. In addition, all young infants require ongoing supportive care, which is crucial to survival even after recovery from the acute illness.

Box 1.16 Antibiotic therapy of infections in young infants

When chosing antibiotics be aware of local data of prevailing organisms and antibiotic sensitivities.

- *Sepsis or pneumonia:* give ampicillin 50mg/kg IV/IM qds* (or benzyl-penicillin 50 000U/kg qds*) plus gentamicin 7.5mg/kg* IV/IM od. Cefotaxime 50mg/kg IV/IM qds* or ceftriaxone 80mg/kg IV/IM od*† are alternatives. If S. *aureus* infection suspected (e.g. nosocomial sepsis, soft tissue infection), give cloxacillin 50mg/kg

IV qds* or cefuroxime 25mg/kg tds, plus gentamicin. Treat until child has remained well for 4 days.

• *Meningitis:* give ampicillin 50mg/kg IV/IM qds*, plus gentamicin 7.5mg/kg*. Treat for a minimum of 14 days, or 21 days if Gram –ve bacterial meningitis proven or suspected. Alternatives are cefotaxime 50mg/kg IV/IM qds* or ceftriaxone 100mg/kg IV/IM od.*†

• *Focal bacterial infections:* co-trimoxazole, amoxicillin, or a cephalosporin.

• Conjunctivitis: teach mother to clean eyes with saline or clean water +/− apply topical antibiotic. Review child after 2 days.

• *Ophthalmia neonatorum*(📖 Conjunctivitis, p. [link]; 📖 Gonorrhoea, p. [link])—a severe, suppurative conjunctivitis, often with associated blepharitis, that occurs in neonates, particularly in the first week of life, and may → permanent blindness if not treated. Caused by *N. gonorrhoea* or *C. trachomatis* perinatally; other organisms include *S. aureus*. Gram stain of the discharge may demonstrate Gram +ve diplococci (*N. gonorrhoea*). If so, give ceftriaxone 50mg/kg IM as a single dose, treat the parents presumptively for *N. gonorrhoea* (📖 Gonorrhoea, p. [link]).

* Doses in first week of life as follows: ampicillin 50mg/kg bd; benzylpenicillin 50 000U/kg bd; gentamicin 5mg/kg od if normal birth weight, 3mg/kg od if low birth weight; cefotaxime 50mg/kg tds in term neonates, bd in premature neonates; cloxacillin 25–50mg/kg bd.

† Avoid ceftriaxone in neonatal jaundice as the drug may displace bilirubin from albumin, increasing the risk of kernicterus.

Feeding

Ensure continued regular feeding. Express breastmilk and give by NGT if infant is unable to suck, or by cup and spoon as soon as infant is able to take oral feeds. Oral intake should be stopped if there is abdominal distention, severe vomiting, frequent convulsions, or respiratory distress. Treat hypoglycaemia with IV 10% dextrose 5mL/kg or 10mL/kg via nasogastric tube and continue regular feeds or IV fluids.

Fluid requirements

Total amount, given as oral or IV in neonates with feeding difficulties: Day 1 (60mL/kg/day), Day 2 (90mL/kg/day), Day 3 (120mL/kg/day), thereafter (150mL/kg/day). May ↑ to 180mL/kg/day). If on phototherapy, increase ×1.2–1.5.

Fluid therapy

Assess hydration status and give oral rehydration solution (ORS) or IV fluids according to WHO guidelines (📖 Diarrhoeal diseases, p. [link]).

Temperature control

Keep infant dry and well dressed/wrapped, including bonnet and booties. Maintain environmental temperature of at least 25°C. Avoid excessive exposure during examination and procedures as this may → chilling. Use incubators when available to allow easy observation with minimal handling of baby in addition to thermal control. Direct skin to skin care (Kangaroo mother care (KMC) see Box 1.17) may be used when the infant is stable. If there is fever, remove clothes and expose, but do not give antipyretics.

Box 1.17 Kangaroo mother care (KMC)

Direct skin-to-skin care of the infant. Baby is placed naked (except for nappy) directly on mother's bare chest, and strapped in place to get warmth, while the mother goes about her regular activity. KMC is an alternative to an incubator and may reduce hospital stay, help early establishment of breastfeeding, and promote mother/child bonding. Close family members, including the father, can also provide KMC.

Oxygen therapy

Indications for O_2 therapy include: central cyanosis, grunting, severe lower chest wall indrawing, difficulty in feeding due to respiratory distress, and head nodding. Stop O_2 if saturations>90% in room air.

Treatment of convulsions

Neonates (<2wks old)

IM phenobarbital 20mg/kg stat; if maintenance is required, give 5mg/kg/day oral/IV.

Infants 2 wks–2mths old

Rectal diazepam 0.5mg/kg, repeat rectal diazepam at 10min if convulsions persist (or IV diazepam 0.25mg/kg). If still convulsing after another 10min give third dose of diazepam or rectal paraldehyde 0.3–0.4mL/kg may be given.

Monitoring

It is essential to observe infant at least every 6h for improvement or deterioration.

Outpatient treatment

Infants with non-bloody diarrhoea, and some or no signs of dehydration (📖 Assessment of dehydration in children with diarrhoea, p. [link]), or poor weight gain due to feeding mismanagement, may be treated as outpatients. However, the mother should be informed of danger signs that require urgent review. Local bacterial infections without constitutional symptoms are common and may be treated as an outpatient, with follow-up at short intervals because of the risk of rapid progression to septicaemia. These include omphalitis (*without* hyperaemia of surrounding skin), skin sepsis (if only a few skin pustules), paronychia, and mild conjunctivitis.

Neonatal notes

Newborns and neonates (<28 days) have some special considerations beyond those of the sick young infant (Fig. **1.7**). Resuscitation at birth differs from young infants, in particular with the need for inflation breaths (can be undertaken with air) after delivery. See summary diagram for special features; 📖 Newborn life support, p. **[link]**.

A common complication is perinatal asphyxia (Box 1.19) in resource-poor settings where access to emergency obstetric care may be limited. Fig. **1.6** shows a traditional birth attendant kit for home deliveries. Care after delivery is also important and KMC (see Box 1.17) can help with this. Most at risk are those with low birth weight (LBW) or preterm delivery. Common problems are sepsis (see Box 1.16 for antibiobiotic therapy), jaundice, hypothermia and hypoglycaemia.

Box 1.19 Risk factors for perinatal asphyxia

- *Maternal medical or obstetric factors:* hyper- or hypotension, heart failure, diabetes, severe anaemia, haemoglobinopathies, infections, respiratory illness (e.g. pneumonia, asthma), smoking, alcoholism, pre-eclampsia/eclampsia, primigravidity or grandmultiparity, induction of labour, sedation, analgesia, prolonged rupture of membranes, prolonged labour.
- *Foetal factors:* multiple gestation, prematurity or post-term, IUGR or large for gestational age, intrauterine infections, abnormal presentation, congenital abnormalities.
- *Placental factors: abruptio placenta*, placenta praevia, placental insufficiency, cord compression.

Complications of asphyxia and their management

Asphyxia may → multi-organ dysfunction.

- *Respiratory system:* persistent pulmonary hypertension and respiratory distress syndrome. Ensure good oxygenation.
- *Cardiovascular system:* myocardial damage → poor cardiac output. Monitor capillary refill and BP. Avoid fluid overload and give inotropes if necessary.
- *Gastrointestinal system:* risk of necrotizing enterocolitis. Avoid enteral feeding in first 24–48h (beware hypoglycaemia!). With introduction of feeds, avoid hyperosmolar feeds and stasis.
- *Metabolic:* hypoglycaemia or hyperglycaemia may worsen hypoxic damage to the brain. Hyponatraemia, hyperkalaemia, hypocalcaemia or acidosis may result; monitor blood glucose and electrolytes.
- *Renal function:* ↑ risk of urinary retention and renal failure. Monitor fluid intake, urine output, and urine specific gravity. Catheterize to differentiate between failure to produce or void urine.
- *Haematologic:* bone marrow suppression, neutrophil dysfunction, and coagulopathies. Monitor FBC for evidence of bleeding.
- *Brain:* encephalopathy results from hypoxia, cerebral oedema, ↑ intracranial pressure (ICP). Look for ↓ reflexes, abnormal muscle tone, seizures, varying degrees of altered consciousness, and long-term neurological sequelae.

Other general measures: ensure thermoneutral environment, adequate calories, and hydration, and treat neonatal jaundice.

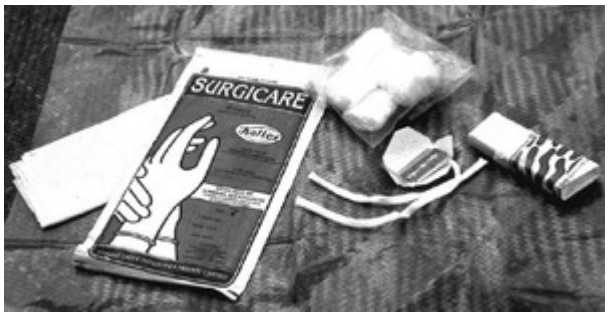

Fig. 1.6
Traditional birth attendant kit for home deliveries. As well as illustrated instructions, the kit contains (all sterile) plastic sheet for delivery, soap, towels, gloves, cotton wool, umbilical cord ties, and razor blade. Reproduced from the Kenya Ministry of Health, with permission.

Low birth weight and prematurity

LBW infants (birth weight <2500g) may result from prematurity or intrauterine growth retardation (IUGR). Infants 1750–2250g, born after 34wks' gestation may be nursed with their mothers, with close supervision, in nursery. Infants >2250g may be sent home if no danger signs.

Essential aspects of LBW care

- *Prevention of infection:* wash hands with soap and water each time infant is to be handled.
- *Temperature control:* (see 📖 Hypothermia, p. [link]): maintain the infant's axillary temperature above 36.5°C.
- *Treatment of infection:* In most cases, premature labour is precipitated by an infection, hence, prematures should be covered with ampicillin and gentamicin empirically.
- *Feeding:* LBW babies are prone to hypoglycaemia and may not suck adequately. They should be breastfed within 1h of birth and may require additional expressed breastmilk by cup and spoon or via NGT. Mothers should be shown proper latching-on techniques. Monitor weight gain. If necrotizing enterocolitis is suspected, all oral intake should be stopped and baby should receive parenteral nutrition, and broad spectrum antibiotics, including anaerobic cover (metronidazole)
- Be alert for danger signs: Refer promptly to neonatal unit if present.

Problems associated with low birth weight

- Poor thermal regulation.
- Feeding problems (inadequate intake, gastro-oesophageal reflux).
- Necrotizing enterocolitis.
- Neonatal jaundice.
- Metabolic problems (hypoglycaemia, acidosis, hypocalcaemia, fluid, and electrolyte imbalance).
- Apnoea.
- Respiratory distress syndrome.
- Patent ductus arteriosus.
- Increased predisposition to infections.

Hypothermia

Hypothermia (body temp <36°C) is a common problem of LBW infants, resulting from low environmental temperature or sepsis. It causes ↑ O_2 consumption, ↑ energy expenditure, and ↓ O_2 delivery to tissues.

- *Complications:* include hypoxia, acidosis, and hypoglycaemia; poor weight gain; ↑ capillary permeability; and respiratory distress due to ↓ surfactant production.
- *Treatment:* re-warm infant using warm clothing, incubator preheated to 35–36°C, heated mattress, or skin-to-skin care. Exclude sepsis.
- *Prevention:* nurse infants in warm environments. Avoid wet clothes and do not place infant on cold surfaces, e.g. X-ray plates and weighing scales.

Apnoea

Apnoeic episodes are common in LBW infants. May be accompanied by bradycardia if prolonged. Gentle physical stimulation often stimulates breathing, but respiratory stimulants (caffeine or theophylline) and occasionally ventilatory support, may be required. Seek underlying causes: infection, hypoxia, metabolic derangement, anaemia, or subtle seizures.

Neonatal jaundice

Jaundice occurs in >50% neonates and is more common in LBW infants. Jaundice may be a sign of serious disease (e.g. infection; see Box 1.18), especially if it occurs on day 1, is associated with fever, is deep (involves palms and soles), or lasts >14 days (>21 days if premature). Jaundice is also commonly physiological, but other causes should be first considered.

Box 1.18 Common causes of neonatal jaundice

Jaundice starting <24h after birth

- Haemolysis (e.g. Rhesus or ABO incompatibility; G6PD or pyruvate kinase deficiency; congenital spherocytosis).
- Infection (TORCH* organisms).

Jaundice starting from day 2 to week 2 after birth

- Physiological jaundice.
- Breastmilk jaundice.
- Severe bruising.
- Infection.

- Haemolysis.

Jaundice persisting for >2wks after birth

- Biliary atresia.
- Neonatal hepatitis.
- Haemolysis.
- Congenital hypothyroidism.
- Infection.
- May also be persistence of breastmilk or physiological jaundice.

*Toxoplasma; syphilis, Varicella zoster virus (VZV), measles; rubella; CMV; Herpes simplex.

Severe jaundice may → *kernicterus* (neurotoxicity). In its mild form, there is lethargy and reduced feeding. Severe kernicterus → irritability, hypertonia +/− opisthotonos, and long-term neurological sequelae.

Investigations for abnormal jaundice

Consider (if available) total serum bilirubin and conjugated/unconjugated bilirubin, FBC, maternal and infant blood group, Coombs test, G6PD screen, thyroid function, syphilis serology, and abdominal US scan.

Management of jaundice

- Ensure adequate hydration.
- Exclude serious causes (see Box 1.15).
- Treat severe jaundice to prevent kernicterus (see Table 1.1).
- *Phototherapy:* reduces jaundice by using ultraviolet light → photodegradation of bilirubin in the skin. Protect infant's eyes. Beware of dehydration, hypothermia, or hyperthermia. Other complications include diarrhoea and rash.
- *Exchange blood transfusion:* may be required for severe jaundice. Twice the infant's blood volume (i.e. 2 × 80mL/kg) is exchanged for fresh donor blood in 10–20mL aliquots via UVC. Low, but definite risk attached to procedure.

Table 1.1 Indications for treatment of neonatal jaundice according to serum bilirubin concentration

Phototherapy					**Exchange Transfusion**			
	Healthy term baby		**Preterm or risk factors**		**Healthy term baby**		**Preterm or risk factors**	
	mg/day	µmol/L	mg/dL	µmol/L	mg/dL	µmol/L	mg/dL	µmol/L
Day 1	Any visible jaundice				15	260	13	220
Day 2	15	260	13	220	25	425	15	260
Day 3	18	310	16	270	30	510	20	340
≥Day 2	20	340	17	290	30	510	20	340

Reproduced from World Health Organization, *Pocket Book of Hospital Care for Children* 2005: 58, with permission of WHO.

Perinatal asphyxia/hypoxic ischaemic encephalopathy

In perinatal asphyxia there is hypoxia, acidosis, and CO_2 accumulation around time of delivery, which may → hypoxic-ischaemic encephalopathy (HIE). It accounts for much neonatal mortality and long-term morbidity, especially in low-resource settings. Largely preventable with improved obstetric care, prompt resuscitation, and supportive care of the neonate.

Assessment

Risk factors for the development of asphyxia are listed in Box 1.19.

Prenatal and intrapartum parameters can indicate asphyxia and the following are indicators of asphyxia at birth:

- Apgar scores ≤5 at 10min (see Table 1.2).
- Resuscitation >10min before spontaneous respiration.
- Cord blood pH <7 or base excess >12mmol/L.

Table 1.2 APGAR score

	Score=0	Score=1	Score=2
Appearance (colour)	Pale/blue	Blue extremities	Completely pink
Pulse rate	Absent	<100/min	>100/min
Respiration	Absent	Slow, irregular	Regular, crying
Reflexes (grimace)	No response to stimulation	Grimace/feeble cry on stimulation	Cry/pull away when stimulated
Activity (muscle tone)	None/flaccid	Some flexion	Well flexed and legs resist extension

Prevention

Monitoring the mother in pregnancy and labour helps to predict infants at risk of asphyxia. However, some babies who present with birth asphyxia have not been exposed to known risk factors. Everyone involved in the delivery of babies should be skilled in newborn resuscitation in order to ↓ morbidity and mortality associated with asphyxia.

Classification of HIE

HIE is used to describe the clinical manifestation of brain injury starting immediately or up to 48h after hypoxic insult (asphyxia) in a term baby. It can be graded into;

- *Mild:* baby is irritable and responds excessively to stimulation, may have feeding difficulties, hyperventilation, or staring eyes.
- *Moderate:* baby shows abnormal tone and movements, cannot feed and may have convulsions.
- *Severe:* baby has no spontaneous movements or response to pain; tone in limbs may fluctuate between hypotonia and hypertonia. Convulsions may be prolonged and often not respond to treatment. Multi-organ failure is present.

Prognosis of HIE

- *Mild HIE:* complete recovery can be expected.
- *Moderate HIE:* if fully recovered by day 7, excellent long-term prognosis, but if abnormalities persist >day 10, full recovery becomes unlikely.
- *Severe HIE:* has a mortality of 30–40%; 80% of survivors have neurodevelopmental disabilities, in particular cerebral palsy.

Treatment

- *In resource-poor settings:* this is primarily treatment of symptoms and supportive care.
- *In resource-rich settings:* therapeutic cooling of term babies in intensive care settings with rigorous protocols has proven effective in reducing morbidity from perinatal asphyxia. Safety and applicability of this has not been established in resource-poor settings and more research is needed before it could be recommended.

Neonatal tetanus

This frequently fatal, preventable condition remains common in some resource-poor countries. *Clostridium tetani* usually infects the infant through the umbilical stump (due to poor hygiene or a tradition of applying dung to the stump) or unsterile circumcision. The pathogenesis of tetanus is described in 🕮 Neurology, p. [link].

Clinical features

Usually presents at 2–14 days, but may occur later.

- Inability to open mouth.

- Refusal of feeds.
- Excessive crying.
- *Muscle rigidity and spasms:* provoked and spontaneous.
- Fever.
- Intact consciousness.

Diagnosis

Mainly clinical.

Treatment

- *Muscle relaxants:* oral diazepam 5mg/kg/day in divided doses via NGT.
- *For difficult to control spasms:*
  - IV diazepam 0.1–0.3mg/kg every 1–4h titrated to spasm frequency.
  - IV midazolam 0.06mg/kg/h is a suitable, but expensive alternative.
  - IV magnesium sulphate may also be useful.
- IM tetanus immune globulin 500U or equine anti-tetanus serum 10 000U single dose.
- Tetanus toxoid (in a different site) if >6wks old.
- *Antibiotics:*
  - Metronidazole (drug of choice) or penicillin or erythromycin.
  - Add broad-spectrum antibiotics (e.g. ceftriaxone if sepsis suspected).
- *Supportive care:*
  - Nutritional support.
  - Nurse in quiet, dark environment to prevent provoked spasms
  - (but ensure adequate clinical supervision).
  - Ensure clear airway and give ventilatory support if needed.

Poor prognostic factors

- Incubation period <7 days.
- Period of onset <24h.
- Associated pneumonia.

Public health note: prevention of neonatal tetanus

- Maternal education.
- Maternal tetanus toxoid immunization.
- Hygienic delivery and cord care practices.
- Immunization of all women in childbearing age with tetanus toxoid.