Paediatric care

Clinical and therapeutic guidelines

Practical guide for doctors, nurses and other healthcare professionals managing common paediatric conditions

Internal document

2024 edition

Acknowledgements

The *Paediatric care: clinical and therapeutic guidelines*, 1st edition (2023) have been developed by Médecins Sans Frontières (MSF) under the supervision of the International Paediatric Working Group, and in close collaboration with other relevant working groups. These are the first international paediatric guidelines to be produced by MSF and are partly based on the previous OCP-OCG, and OCBA Paediatric Guidelines originally written by Marianne Sutton, which they now replace. We also thank Marie-Claude Bottineau and Myrto Schaefer for their contributions to, and coordination of, the previous guidelines.

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Introduction

Despite a significant reduction in childhood mortality over the last 30 years, under-5 mortality remains unacceptably high. In 2021, 5 million children under the age of 5 died, almost half of whom were neonates, representing a global under-5 mortality rate of 38 deaths per 1000 live births[1]. If current trends continue, 54 countries will fail to meet the Sustainable Development Goal target 3.2, which aims to end preventable newborn and child deaths, and to reduce the under-5 mortality rate to less than 25 deaths per 1000 live births by 2030[2]. Though data on mortality trends among older children are more limited, each year approximately 800 000 children 5-14 years old die worldwide[1]. The significance of this for MSF's work is evident - more than 80% of under-5 deaths occur in the Sahel and southern Asia[1], while over 55% of deaths in the 5–14-year age group occur in sub-Saharan Africa alone[3].

The leading causes of death among young children worldwide remain unchanged – pneumonia, diarrhoea and malaria together accounted for over 1.6 million deaths of children under 5 in 2019[4], despite the availability of simple and effective treatments for these diseases. In the older paediatric age groups, global data on cause of death is not reported, but individual country data implicates the same 3 top killers as for the under-5 age group, with the addition of injuries, as the leading causes of death in the 5-14-year age group[3]. An unacceptably large proportion of childhood deaths could be prevented by access to timely and appropriate medical care, vaccination and adequate nutrition.

These guidelines have been developed to ensure that children seen in MSF facilities receive prompt, high-quality care to reduce child mortality. They provide clear, evidence-based clinical guidance for common paediatric conditions and promote consistency of practice across MSF facilities. Best practice guidance has been adapted and tailored to ensure alignment with the medications and equipment that are available in MSF projects.

These guidelines will be updated regularly online as new evidence and guidance becomes available. As such, new printed editions will be released when necessary. Comments and feedback should be addressed to the Paediatric Working Group at DL-MSF-PediatricWorkingGroupInternational@geneva.msf.org.

References

1. The Global Health Observatory. Child mortality and causes of death. The Global Health Observatory. Accessed November 30, 2023. https://www.who.int/data/gho/data/themes/topics/topic-details/GHO/child-mortality-and-causes-of-death
2. Sustainable Development Goal 3 | Department of Economic and Social Affairs. United Nations. Accessed November 30, 2023. https://sdgs.un.org/goals/goal3
3. Masquelier B, Hug L, Sharrow D, et al. Global, regional, and national mortality trends in older children and young adolescents (5–14 years) from 1990 to 2016: an analysis of empirical data. *Lancet Glob Health*. 2018;6(10):e1087-e1099. https://doi.org/10.1016/S2214-109X(18)30353-X
4. Diarrhoea. UNICEF DATA. Accessed November 30, 2023. https://data.unicef.org/topic/child-health/diarrhoeal-disease/

About these guidelines

This is the first international edition of the MSF Paediatric care guidelines. It is the result of the collective work of numerous internal paediatric guidelines and protocols produced over the years by dedicated paediatricians and paediatric nurses working in MSF Medical departments, Operational cells and projects. These guidelines have been developed by the International Guidelines Publication (IGP) team, in close collaboration with the International Paediatric Working Group (IPWG) and other relevant working groups.

Objective

The objective of these guidelines is to improve the clinical care of a sick or injured child. Although predominantly focused on hospital care, they are designed for use in any inpatient or outpatient healthcare facility with a major paediatric care component. The primary target audience of these guidelines is general clinicians/physicians and clinical officers with little or no experience in paediatric care, but they can be used as a support for all healthcare workers involved in the delivery of medical care for children.

Age range

The Convention on the Rights of the Child defines a child as any human being below the age of 18 years, however acknowledging that the specific needs of adolescents over 15 years are complex and require specific expertise, the age range covered in these guidelines is 1 month to 15 years inclusive.

Definitions

The following WHO definitions for adults, adolescents, children and infants are used in these guidelines[a]:

- A neonate is an infant younger than 4 weeks of age.
- An infant is a child younger than 1 year of age.
- A child is a person 1 to 9 years of age.
- An adolescent is a person 10 to 19 years of age.
- An adult is a person older than 19 years of age.

Antibiotic recommendations

Antimicrobial resistance caused by inappropriate use of antibiotics is a global health problem and antibiotic stewardship is essential in all contexts. Antibiotic choices are therefore aligned with the WHO AWaRe (Access, Watch, Reserve) antibiotic handbook[1] wherever possible.

Children with severe acute malnutrition

General medical complications and their management in children with severe acute malnutrition (SAM) are integrated throughout these guidelines. Where treatment for children with SAM differs from that of children without SAM, it is explicitly outlined in the relevant chapter. For medical complications that are specific to children with SAM and are not relevant to children without SAM e.g. refeeding syndrome, there is a dedicated chapter.

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a Note that countries may have other definitions under their respective national laws.

HIV and tuberculosis in children

Paediatric HIV and tuberculosis are included only briefly in these guidelines as comprehensive guidance is available in disease-specific MSF guidelines.

Illustrations

All illustrations in these guidelines have been redrawn for consistency or are original drawings. The majority have been redrawn with permission by Anthony Calvert, from source material primarily from WHO Hospital Care for Children, MSF publications and from images provided by David Watson. Figure 8.1 - Dorsal slit procedure and Figure 9.1 - Two bag method for delivery of IV fluids in DKA are original drawings by Sarah Imani.

References

1. *The WHO AWaRe (Access, Watch, Reserve) Antibiotic Book*. World Health Organization; 2022. Accessed November 30, 2023. https://www.who.int/publications-detail-redirect/9789240062382

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Abbreviations and acronyms

ADH	Antidiuretic hormone
AIDS	Acquired immune-deficiency syndrome
AKI	Acute kidney injury
ALS	Advanced life support
AP	Anterior-Posterior
ATN	Acute tubular necrosis
AXR	Abdominal x-ray
BC	Blood culture
BGL	Blood glucose level
BLS	Basic life support
BMI	Body mass index
BMR	Basal metabolic rate
BP	Blood pressure
BSA	Body surface area
BUN	Blood urea nitrogen
CCAM	Congenital cystic adenomatoid malformation
CSF	Cerebrospinal fluid
CHD	Congenital heart disease
CMV	Cytomegalovirus
CPR	Cardiopulmonary resuscitation
CRP	C-reactive protein
CRT	Capillary refill time
CSF	Cerebrospinal fluid
CT	Computed tomography
CXR	Chest x-ray
DD	Developmental delay
DKA	Diabetic ketoacidosis
DR-TB	Drug-resistant tuberculosis
DS-TB	Drug-sensitive tuberculosis
ECG	Electrocardiogram
EFAST	Extended focused assessment with sonography in trauma
ENT	Ear, Nose and Throat
EPI	Expanded Programme on Immunisation
ESR	Erythrocyte sedimentation rate
FBC	Full blood count
FR	Frequent relapses
FSGS	Focal segmental glomerulosclerosis

G5%	Glucose (dextrose) 5%
GCS	Glasgow Coma Scale
GFR/eGFR	Glomerular filtration rate/estimated GFR
Hb	Haemoglobin
HIV	Human immunodeficiency virus
HR	Heart rate
HUS	Haemolytic uraemic syndrome
ICU	Intensive care unit
IPD	Inpatient department
ITFC	Inpatient therapeutic feeding centre
IUGR	Intrauterine growth retardation
LOC	Level of consciousness
LUS	Lung ultrasound
MCD	Minimal change disease
MUAC	Mid-upper arm circumference
MVA	Motor vehicle accident
NaCl	Sodium chloride
NBM	Nil by mouth
NGT	Nasogastric tube
NSAID	Non-steroidal anti-inflammatory
OGT	Orogastric tube
OPD	Outpatient department
ORS	Oral rehydration salts
PCR	Polymerase chain reaction
PIGN	Post-infectious glomerulonephritis
POCUS	Point-of-care ultrasound
PRBC	Packed red blood cells
ReSoMal	Rehydration solution for malnutrition
RL	Ringer lactate
RR	Respiratory rate
SDNS	Steroid-dependent nephrotic syndrome
SPA	Suprapubic aspirate
SpO2	Oxygen saturation
SRNS	Steroid-resistant nephrotic syndrome
SSNS	Steroid-sensitive nephrotic syndrome
T1DM	Type 1 diabetes mellitus
TB	Tuberculosis
US	Ultrasound
UTI	Urinary tract infection
WBC	White blood cells

Chapter 1:
Paediatric history and clinical examination

1.1 Introduction

This chapter outlines how to take a comprehensive paediatric history and perform a full clinical examination in a child. It is not always necessary to take a complete history, the scope and detail are determined by the nature of the presenting complaint and/or the child's age. For example, birth and developmental history may provide important information to support the correct diagnosis and management of a young child, while social and past medical history may be more relevant in older children. For adolescents, consider that they may prefer to provide their history or be examined without the presence of their parents/carers.

1.2 Taking a paediatric history

Patient profile

- Age (in months for children < 2 years)
- Gender
- Relationship to accompanying adult

Presenting complaint

- Main problem or symptoms
- If child was referred from another facility, note main reason for referral

History of presenting complaint

- When and how symptoms started. If several symptoms, order of onset
- Previous episodes
- Siblings or other household members with similar illness
- In infants and younger children, ask about:
  - Feeding (any changes to pattern, volume)
  - Bowel movements, wet nappies
  - Sleeping pattern, alertness, activity
  - Weight gain or loss

Past medical history

- Previous illnesses, major injuries, hospital admissions
- Vaccination status (ask for vaccination card if available); note missing vaccinations for age

Medication history

- Current or recent medications
- Traditional treatments used (medicines or procedures, e.g. uvula excision, scarification, circumcision)
- Known allergies

Birth history

- Maternal age
- Obstetric history:
  - Total number of pregnancies and their outcomes
  - Complications during pregnancy
  - HIV status: if maternal HIV status is positive, note whether adequate prophylaxis for prevention of mother-to-child transmission (PMTCT) received; if early infant diagnosis (EID) done, including available results
  - Tuberculosis: if maternal tuberculosis or any household TB contacts, note whether isoniazid prophylaxis was taken and completed
  - Malaria
  - Nutritional status
  - Supplements: folic acid, vitamin D, multivitamins

- Delivery:
  - Assisted: by a skilled (or traditional) birth attendant, midwife and/or obstetrician
  - Location: at a health facility or at home
- Any problems during delivery:
  - Foetal distress
  - Use of instruments (e.g. forceps, vacuum)
  - Breech, footling breech
  - Caesarean section
- Gestational age, birth weight, and Apgar score (if available)
- Any problems with breathing or injuries at birth:
  - Admission to neonatal care unit
  - Jaundice
  - Infection
  - Feeding problems

Developmental history

- Age when key milestones achieved and current developmental stage (see Appendix 1)
- School-age child: any specific problems (academically, physically, socially with peers)
- Behavioural concerns for age: aggression, isolation, self-harm, addictions

Family history

- Any illnesses, diseases or conditions in the family, especially amongst children
- Directly ask about: tuberculosis, sickle cell disease, severe anaemia, thalassaemia, epilepsy, diabetes, hypertension, asthma

Social history

- Ask about the child's living situation and conditions
- Family structure: primary carer, number of siblings
- School attendance (includes religious school)
- Concerns with safety or food security
- Context: refugee or internally displaced persons (IDP) camp or settlement; area affected by conflict, epidemic, isolation; part of neglected or targeted population (based on religion, location, tribe, ethnic group, political affiliation).

1.3 Clinical examination

Tips

- Observe the child and their interaction with parents/carers.
- Get down to the child's level as much as possible; avoid towering over them.
- Try to gain the child's trust.
- Avoid fully undressing the child – undress partially to expose the area to be examined.
- If the child is calm and not distressed, take the opportunity to examine the cardiac, respiratory and neurological systems first.
- Leave examinations that can upset the child (e.g. ear, nose, throat and mouth) and examination of any painful areas until last.
- Examine young children (6 months to 3 years) as much as possible on the parent's/carer's lap.
- Use toys to distract the child during the examination.
- Communicate directly with the child: children 5 to 12 years will usually be co-operative if they are informed about what is going to be examined and how.
- Respect privacy: adolescents may prefer not to be examined in front of their parents/carers; ask them their preference.
- Respect local cultural norms regarding gender of patient and clinician performing examination.
- Be honest: if something is going to hurt, tell the child in a calm fashion.

General appearance

- Note obvious features: well/unwell, active/lethargic, uncomfortable, irritable, distressed, in pain, malnourished.
- Observe for obvious difficulty breathing, e.g. sitting upright and holding self-up with extended arms.
- Note any jaundice, anaemia, cyanosis, clubbing, oedema, lymphadenopathy.
- Specifically look for rashes, petechiae, skin turgor (pinch test for dehydration).

Vital sign measurements

- Measure weight and height and plot on centile chart (see Appendix 2).
- Measure head circumference if < 3 years and plot on centile chart (see Appendix 2).
- Measure and document heart rate, respiratory rate, oxygen saturation (SpO_2) and axillary temperature, comparing to normal for age (see below and Appendix 3):

Age	Respiratory rate normal range (breaths/min)	Heart rate normal range (beats/min)
< 2 months	30-60	100-160
2 to 11 months	30-50	90-160
1 to 5 years	25-40	80-140
6 to 12 years	20-30	70-120
> 12 years	14-20	60-100

– Evaluate nutritional status (select relevant parameter):

Parameter	Indication
Weight-for-height or -length (W/H or L)	Wasting, overweight
Height-for-age (H/A)	Stunting
Weight-for-age (W/A)	Underweight
Body Mass Index (BMI)	Under- or overweight
Mid-upper arm circumference (MUAC)	Wasting

Head and neck

– Children < 24 months: check anterior fontanelle with child in upright position. Persistent bulging or tense fontanelle can indicate raised intracranial pressure. Sunken fontanelle may indicate dehydration or malnutrition.
– Hair: check for signs of kwashiorkor (loss of colour, fragile, dry and brittle).
– Neck: palpate thyroid, check for any cysts or lymphadenopathy.
– Eyes/conjunctivae: note any abnormalities or signs of infection, PERLA (pupils equal and reactive to light and accommodation).
– Ears: check tympanic membranes with otoscope.
– Nose: check nostrils (any foreign bodies, visible polyps, septal deviation).
– Throat: check tonsils (size, colour, presence of exudate) and back of throat (clear airway).
– Mouth: check for cleft palate, palpate for retro-auricular and submandibular lymphadenopathies, and check teeth (number and general hygiene).

Cardiovascular

– Measure: Heart rate (HR), blood pressure (BP), capillary refill time (CRT).
– Pulses: brachial in infants, femoral or radial in older children.
– Palpate: location of apex beat, character of apex beat (heaving/thrusting, hyperdynamic, tapping).
– Auscultate: heart sounds, rhythm, any murmurs.

Respiratory

– Measure: Respiratory rate (RR), oxygen saturation (SpO_2), presence of cyanosis.
– Breathing effort: tracheal tug, use of accessory muscles, chest indrawing, nasal flaring.
– Percussion: dullness may indicate consolidation (pneumonia, empyema, pleural effusion); hyper-resonance may indicate pneumothorax.
– Auscultation: equal/unequal breath sounds; presence of rales, crepitations, stridor (indicates upper airway obstruction), wheeze or rhonchi; transmitted upper airway noises or voice sounds.

Abdomen

– Check for distension, visible masses, peristalsis, hernias.
– Palpate abdomen: superficial palpation then deep palpation, noting tenderness (avoid any known tender area until the end of the exam), rebound tenderness or guarding. If pain is significant, lightly percuss the abdomen rather than palpating – percussion tenderness indicates peritonitis.
– Feel for liver and spleen: note any hepatomegaly or splenomegaly and any tenderness.

- Feel for kidneys: palpate the flank area to check for a renal mass; tap gently with the ulnar part of your hand to examine for signs of pyelonephritis.
- Auscultate for bowel sounds: overactive bowel sounds are present with gastroenteritis; bowel sounds are often decreased in appendicitis; absent or tinkling bowel sounds indicate intestinal obstruction.
- Check for ascites (if clinically relevant): ask the child to lie flat on their back and percuss from periphery of abdomen towards the umbilicus. If ascites is present, it will be dull to percussion initially, becoming tympanic towards the umbilicus. Note the level of ascites, that corresponds to the change in percussion note. Another technique for ascites detection is to ask the patient or parent/carer to place a hand in the midline of their abdomen, while the examiner taps one flank side of the abdomen with the palm of their other hand resting on the opposite flank area; a fluid wave will be felt in the palm of their hand if ascites is present.

Musculoskeletal

- Ask child to walk and observe gait and any limp.
- Where relevant, examine: the back for kyphosis, lordosis or scoliosis; extremities for any muscle atrophy; affected joints (range of motion, stability, any swelling or tenderness).

Neurological

- Note level of consciousness (AVPU, see Appendix 3), neck stiffness (nuchal rigidity).
- Tone: check for hypotonia or hypertonia. For infants over 6 months, pull gently by the arms to a sitting position and check for head lag, too weak to sit or any stiffness.
- Reflexes: test patellar reflex by tapping the patellar tendon with a reflex hammer.
- Ask the child to walk, walk heel-to-toe, and stand on one leg. Note any abnormalities.
- If any neurologic or neuromuscular abnormalities are detected or suspected, perform a full neurological examination (Chapter 7, Section 7.1) and developmental assessment (compare to milestones in Appendix 1).

External genitalia

- Check for any hernias, hydroceles (accumulation of fluids inside scrotum) or cryptorchidism (absence of one or both testes from the scrotum).
- In girls, check and note any scarring or signs of female genital mutilation (be discreet and sensitive to the context).
- Rectal examination should only be done when there is a specific indication.

Chapter 2: Emergencies

2.1 Resuscitation

Cardiopulmonary arrest in children usually has a very poor outcome. Paediatric cardiopulmonary arrest occurs most commonly secondary to respiratory or circulatory failure, and less frequently due to a primary cardiac cause such as an arrhythmia[1], unlike in adults. Primary respiratory arrest may occur with drowning or poisoning. To optimize survival, imminent cardiopulmonary arrest can be prevented in a seriously ill or injured child with early and effective resuscitation by providing basic and/or advanced life support.

Basic life support (BLS) can be performed by any healthcare worker in any setting. The objective is to rapidly assess for signs of respiratory or circulatory problems and to take immediate steps to support the airway (A), breathing (B) and circulation (C). Advanced life support (ALS) should be performed in hospitals and emergency departments with adequate staffing and training.

2.1.1 Basic life support

Based on European Resuscitation Council Guidelines 2021[1], see Figure 2.4 page 31 for algorithm.

Before approaching the child, briefly check that the area is safe and shout for help from bystanders.

Is the child responsive?

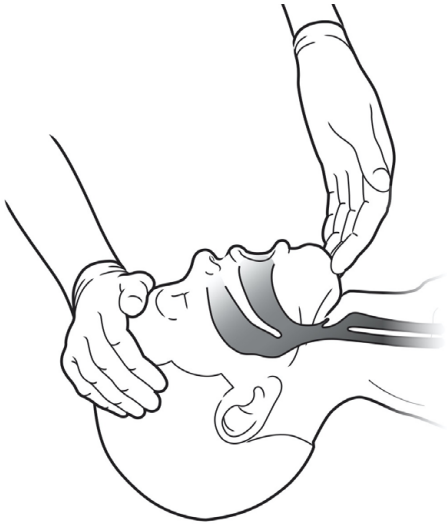
Stimulate the child and ask loudly if they are ok.

– Yes, child responds, cries or moves:
  - Evaluate their condition and request help.
  - Monitor closely.

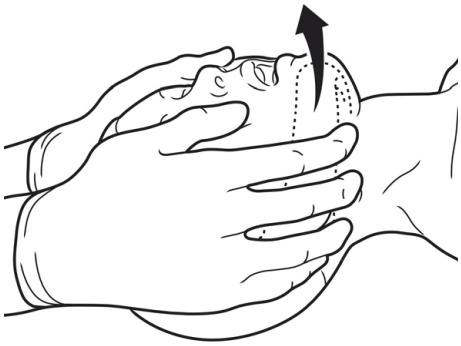
– No, child does not respond:
  - If there is more than one rescuer, call for advanced support as soon as unconsciousness is recognised.
  - Turn the child carefully onto their back (immobilise cervical spine first if likely spinal injury, see Section 2.7.1, though this should not take priority over resuscitation).
  - Open airway: simultaneously tilt the head back gently by placing one hand on the forehead, and lift the chin by placing the fingertips of the other hand under the chin (see Figure 2.1a). Be careful, especially in infants, not to push down on the soft tissues of the neck.
  - If unable to open airway this way, try a two-handed jaw thrust: standing at the child's head, place thumbs gently on the child's cheeks and put first two fingers of each hand behind the angle of the jaw to push mandible forwards (see Figure 2.1b).
  - Maintain the airway in a neutral position for infants (< 1 year), using a small roll under shoulder blades if necessary due to their prominent occiput, and in slight extension ('sniffing position') for children (see Figure 2.1c and Figure 2.1d). Avoid hyperextending the neck as this may obstruct the airway.

Figures 2.1 - Airway manoeuvres for paediatric BLS

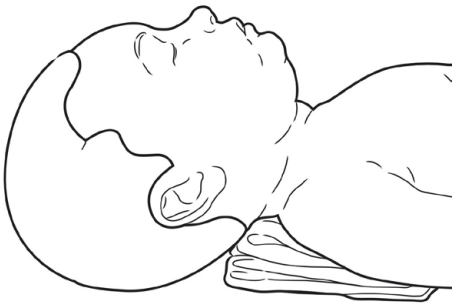
2.1a - Head tilt-chin lift



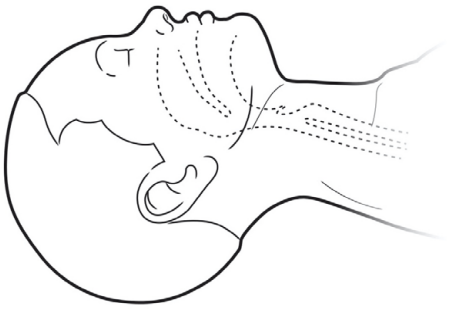
2.1b - Jaw thrust



2.1c - Neutral airway position (< 1 year)



2.1d - Sniffing position (≥ 1 year old)



Is the child breathing?

Keeping the airway open (as above), put your face close to the child's face so that your cheek and ear are directly above the nose and mouth of the child, looking towards their chest. Then look, listen and feel for maximum 10 seconds: look for chest movement; listen for breath sounds; feel for air movement against your cheek.

– Yes, breathing normally:
  - Place into recovery position
  - Call for help
  - Monitor breathing.

– No, not breathing normally:
  - Remove any obvious and/or visible airway obstruction carefully. Take caution not to push objects deeper or damage the airway during attempts for removal.
  - Give 5 rescue breaths (see below for details).

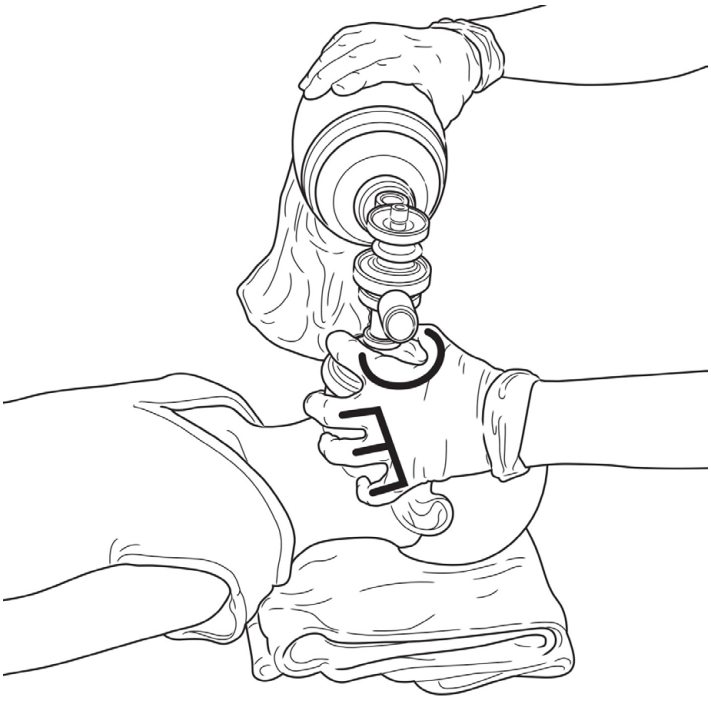
Rescue breaths

Bag-mask ventilation (with self-inflating bag):

– Choose the correct size and shape of face mask to get a good seal around the mouth and nose. The mask should cover the mouth and nose without pressing down on either, and without covering the eyes. If the child is between sizes, the larger size is usually better.

– Choose the correct ventilation bag size according to weight:
  • < 10 kg: neonatal (volume 320 mL)
  • 10 to 30 kg: paediatric (volume 600-700 mL)
  • ≥ 30 kg: adult (volume > 1000 mL)
– Use the E-C clamp technique (Figure 2.2) to lift the jaw against the mask, pressing and sealing the mask on the face:
  • Position the third, fourth and fifth fingers of one hand (forming an “E” shape) along the jaw to lift it upwards.
  • Next, use the thumb and index finger of the same hand (forming a “C” shape) to hold the mask onto the face, ensuring a good seal.
  • Avoid pressure on the soft tissues underneath the chin because this can push the tongue into the posterior pharynx, resulting in airway compression and obstruction.
– With the other hand, squeeze the ventilation bag until the chest rises. Deliver each breath over 1 second, making sure the chest rises with each breath. Avoid excessive ventilation, aiming to deliver one ventilation breath every 2-3 seconds.
– In older children, it may be difficult to achieve a good seal with one hand therefore a two-handed technique can be used when there are two rescuers available. Use the E-C clamp technique with both hands to hold the mask onto the face, while a second rescuer squeezes the ventilation bag.

Figure 2.2 - E-C clamp technique for bag-mask ventilation



Are there signs of life?

Clear signs of life: Any movement, coughing, breathing (gasping or infrequent irregular breaths are not normal breathing).

– Yes, clear signs of life:
  • Continue to give rescue breaths at a rate of approximately one breath every 2-3 seconds until child breathing well.
  • Monitor carefully.

– No, no clear signs of life[a]:
  • Immediately start cardiopulmonary resuscitation (CPR):
    ▷ Give 15 chest compressions (see below for details) followed by 2 rescue breaths.
    ▷ Continue providing CPR with chest compressions and breaths at a ratio of 15:2 until child shows signs of life (waking up, moving, opening eyes, breathing normally).

High Quality CPR

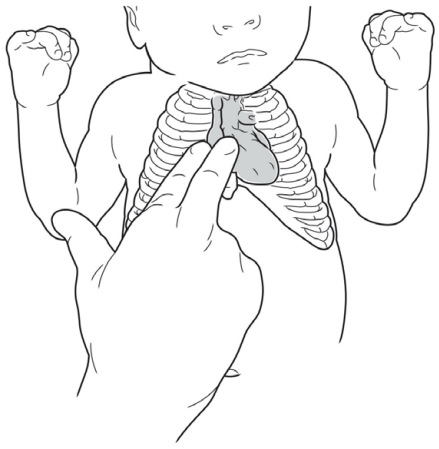
- Rate 100-120 compressions/min for both infants and children.
- Compression depth to at least 1/3 of the anterior-posterior diameter of chest, being sure not to exceed the adult limit of 6 cm in larger children.
- Allow complete chest recoil after each compression and avoid leaning on the chest.
- Minimise interruptions in chest compressions.
- Avoid excessive ventilation.
- Ideally perform chest compressions on a firm surface.

Chest compressions

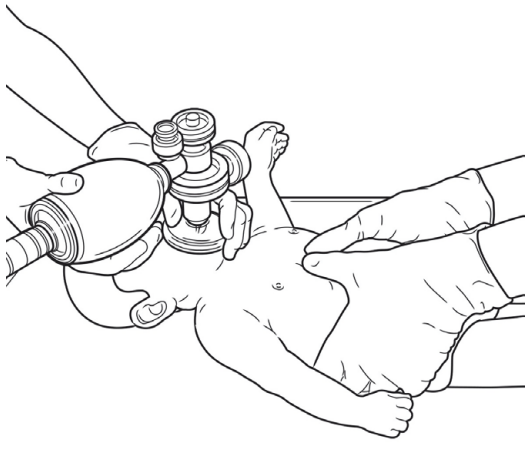
– In all infants and children, chest compressions are done on the lower half of the sternum:
  • **In infants**: chest compressions are given just below the inter-nipple line. If one rescuer, use two fingertips to compress the chest (Figure 2.3a); if two rescuers, use two thumbs by encircling hands around chest to do compressions (Figure 2.3b). Compress to at least 1/3 of anterior-posterior depth of chest.
  • **In children**: trace the lowest ribs to the middle of the chest to locate the xiphisternum. Place the heel of one hand on the sternum one finger breadth above the xiphisternum, ensuring that the fingers are lifted off the chest to avoid restricting chest movement. Position yourself directly above the child's chest and, keeping the arm straight, compress the chest. For larger children, both hands with fingers interlocked can be used.
– Depress sternum by at least 1/3 of anterior-posterior depth of chest (maximum 6 cm[1]) with each compression, then release pressure completely. Continue at a rate of 100-120/minute.
– After 15 compressions, repeat head tilt-chin lift and give 2 breaths. If there are two rescuers, one should remain focused on the airway to maintain the correct position, while the other carries out chest compressions (and squeezes the ventilation bag if a two-handed ventilation technique is used).

Figures 2.3 - Hand positions for chest compressions in infants

2.3a - One rescuer technique

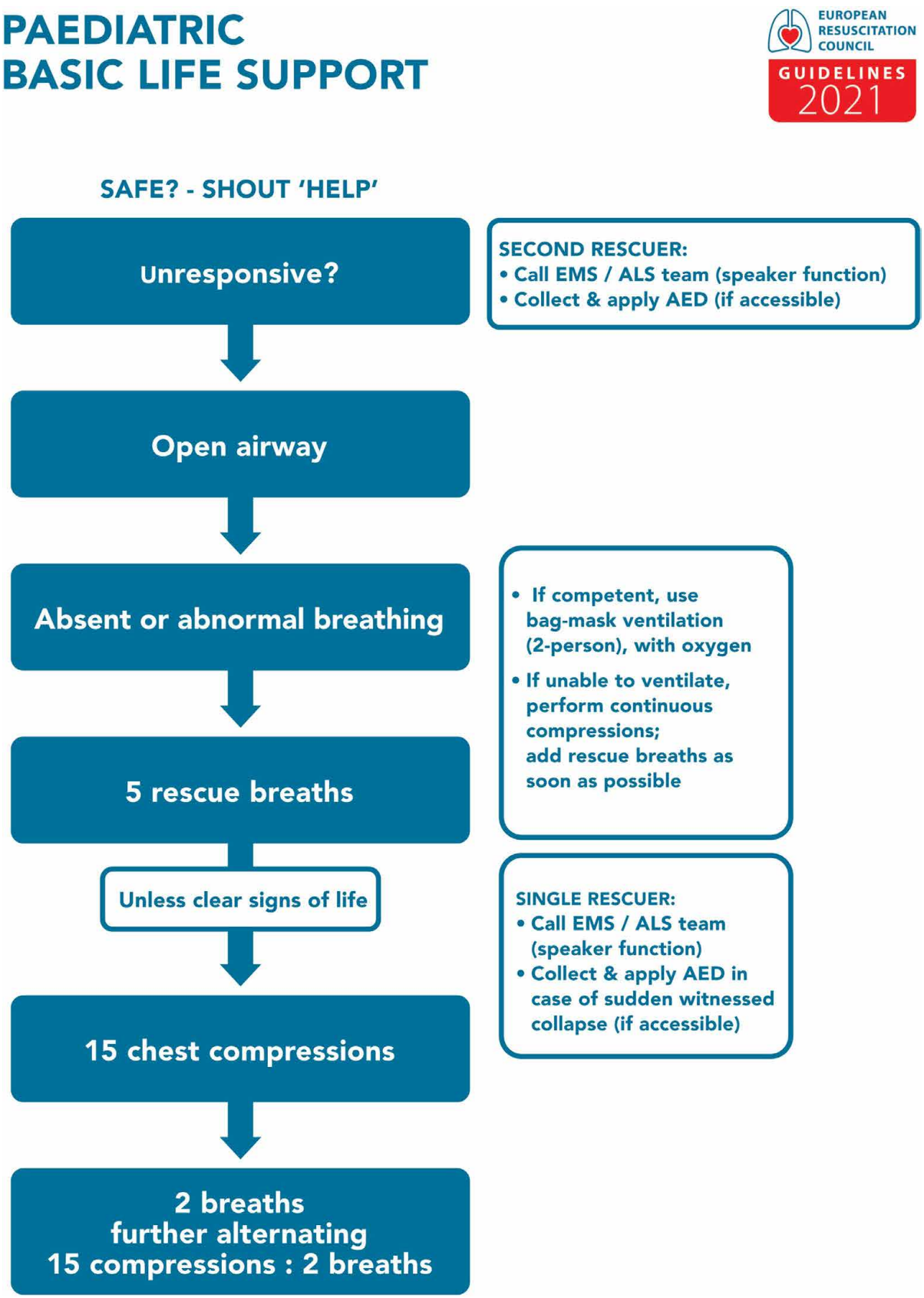


2.3b -Two rescuers technique



a New ERC guidance no longer recommends checking for a pulse before starting chest compressions.

Figure 2.4 - Paediatric basic life support algorithm, European Resuscitation Council (ERC)[b]



b Reprinted from *European Resuscitation Council Guidelines 2021: Paediatric Life Support*, with permission from European Resuscitation Council. Copyright European Resuscitation Council – www.erc.edu – 2023_NGL_008.

2.1.2 Advanced life support

This section applies to settings where paediatric emergency care and resources are available.
- In any seriously ill or injured child, approach emergency management based on the principles of **ABCDE**, where **A** is airway, **B** is breathing, **C** is circulation, **D** is disability, and **E** is exposure.
- The aim is to support vital functions (respiratory, circulatory, neurological) and stabilise the patient. Without treatment, decompensation of respiratory or circulatory failure will lead to cardiopulmonary arrest.
- In emergency care settings, a team leader[c] should be pre-identified to coordinate the management, ensure treatment sequence and rapidly identify changes in the child's condition (improvement or deterioration).

If the child is unresponsive, follow the BLS algorithm (Section 2.1.1) to determine the need for CPR before doing an advanced ABCDE assessment. Otherwise assess and manage ABCDE in any seriously unwell or injured child as follows:

Assess A (airway) and B (breathing)

- Check airway patency.
- Check respiratory rate (RR) and oxygen saturation (SpO_2).
- Assess for signs of respiratory distress or failure:
  - Increased respiratory effort: nasal flaring, retractions (subcostal, substernal, intercostal), head bobbing, grunting (infants).
  - Abnormal RR: too fast or too slow (see Chapter 1, Section 1.3 and Appendix 3).
  - Inefficient breathing: shallow breathing, irregular breathing, decreased chest expansion.
  - Decreased air entry on auscultation.
  - Hypoxia: visible cyanosis or $SpO_2 < 94\%$.

Manage A (airway) and B (breathing)

- Open and clear the airway (see BLS guidance (Section 2.1.1) for more details). Remove any obvious airway obstruction carefully.
- Insert an airway adjunct to maintain a patent airway if necessary. Use an oropharyngeal airway in an unconscious child with no gag reflex (see Appendix 4 for insertion method).
- Administer high-flow oxygen (> 6 L/min) via mask (use non-rebreathing mask if available), aiming for $SpO_2 > 94\%$.
- Assist ventilation and oxygenation with bag-mask ventilation if needed.
- Identify and treat any critical conditions immediately.

Assess C (circulation)

- Check heart rate (HR); capillary refill time (CRT); blood pressure (BP, only if capacity to be done quickly and accurately); character of pulse.
- Look for signs of circulatory impairment:
  - Weak radial pulse, or severe tachycardia[d]
  - Lower limb temperature gradient[e]
  - CRT of 3 or more seconds.

⚠ All 3 signs of circulatory impairment present: the child is in shock.
Slow HR and low BP: the child is decompensating; start BLS.

c If HR capacity is limited, the team leader should be involved in the resuscitation, but preferably only in minor tasks so as to keep an overview of the resuscitation.

d Severe tachycardia is HR > 180 bpm in children < 12 months, > 160 bpm in children 1 to 5 years, > 140 bpm in children > 5 years.

e The temperature gradient is assessed by running the back of hand from the toe to the knee; a positive temperature gradient is defined as a notable temperature change from cold (dorsum of foot) to warm (knee).

– Assess for active bleeding, pallor and dehydration.
– Assess for signs of inadequate perfusion to other organs:
  • Altered level of consciousness
  • Signs of respiratory distress (common in children with severe anaemia)
  • Decreased urine output (based on history from parents/carers including fewer wet nappies).

Manage C (circulation)

– Obtain vascular access (IV/IO). If unable to get IV access after 3 attempts or maximum 90 seconds, insert IO needle (see MSF Manual of Nursing Care Procedures, Procedure: Peripheral intravenous catheter for details on gaining IV access and MSF Manual of Nursing Care Procedures, Procedure: Intraosseous needle, and Appendix 5 for IO access).
– Stop any active bleeding (see Section 2.5).
– Perform rapid tests for haemoglobin (Hb), blood glucose level (BGL), and malaria (in endemic malaria contexts).
– Check electrolytes, if available.
– Promptly administer fluids and/or blood to improve circulatory volume and perfusion, depending on underlying cause:
  • Circulatory failure or shock: see Section 2.2.
  • Anaphylaxis: see Section 2.4.
  • Severe bleeding: see Section 2.5.
  • Trauma: see Section 2.7.
– Reassess ABC every 15 minutes and monitor and record vital signs frequently (or continuously if possible) using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts) while identifying underlying diagnosis.

Assess and manage D (disability)

– Perform a brief examination of neurological function:
  • Examine the pupils: size, symmetry, reaction to light.
  • Assess level of consciousness using AVPU:
    ▷ **A**lert
    ▷ **V**oice: responds to vocal stimuli
    ▷ **P**ain: responds to painful stimuli[f]
    ▷ **U**nresponsive
– Treat hypoglycaemia (BGL < 3.3 mmol/L or < 60 mg/dL) with 2 mL/kg of **glucose** (**dextrose**) **10%** IV/IO over 2-3 minutes, or 10 mL/kg via nasogastric tube (NGT). See Chapter 9, Section 9.3 for further detail.
– If seizures, see Chapter 7, Section 7.2.3 for management.
– If reduced level of consciousness, nurse in lateral position if airway not protected and continue oxygen via mask. Once ABC are stable, try to identify the underlying cause and manage accordingly. See Chapter 7, Section 7.5 for further detail on altered level of consciousness.
– Check for possible drug-induced cause and give antidote where appropriate, e.g. naloxone for opioid toxicity (see Section 2.9).

Assess and manage E (exposure)

– Expose the child fully to complete the initial examination. Note to respect dignity and limit heat loss.
– Rapidly assess for malnutrition using mid upper arm circumference (MUAC) and oedema criteria.

f A painful stimulus can be given by applying supra-orbital pressure at the supraorbital notch or by applying pressure to the nailbed.

– Check temperature and look for any skin eruptions, rash, purpura, or trauma.
– Complete a focused medical history using SAMPLE:
  • **S**igns and symptoms
  • **A**llergies
  • **M**edication
  • **P**ast medical history
  • **L**ast meal
  • **E**vents leading to presentation.

Cardiopulmonary arrest

If child deteriorates and becomes unresponsive, is not breathing (gasping or intermittent breaths), and no pulse is felt within 10 seconds (or pulse < 60 beats/min with signs of poor perfusion), start CPR (see Section 2.1.1 for more details):
– Give 5 initial rescue breaths and begin CPR with a ratio of 15 chest compressions: 2 breaths.
– Continue CPR in the absence of signs of life (moving, coughing, breathing) and concomitantly obtain IV/IO access. Attach cardiac monitor, if available.
– Administer **epinephrine** IV/IO: 10 micrograms/kg[g] every 3 to 5 minutes (see MSF Paediatric Injectables Handbook and MSF Vasopressor Therapy – Adrenaline protocol for more detailed administration guidance) without interruption to chest compressions until infant/child meets criteria to stop resuscitation (see below).
– If cardiac monitoring in place, stop chest compressions briefly to check for electrical activity every 2 minutes. If there is electrical activity, check briefly for a pulse, minimising any interruption to chest compressions.
– Treat reversible causes: hypovolaemia, hypoxia, hypoglycaemia, hypothermia, hypo- or hyperkalaemia, tension pneumothorax.

If there are obvious signs of life or if pulse returns, stop CPR and:
– Follow ABCDE approach to assess and manage the child further.
– Assist ventilation and oxygenation, as necessary.
– Treat precipitating or underlying cause.
– Avoid hypothermia (wrap in blankets, cover head of infants).

When to stop CPR if no response:
– After 10 minutes if still no signs of life, confirmed by the absence of a pulse.
– After 30 minutes if pulse is present but no breathing and no reversible cause has been identified.

Communication

Communication with family during resuscitation is extremely important and where possible it is useful to have someone dedicated to keeping the family up to date and explaining what is happening throughout the resuscitation. This will both reassure the family and allow them to understand what the medical team is doing.

Effective team work also involves good communication, ensuring clarity of roles and responsibilities and maintaining a calm, low-stress atmosphere. Closed loop communication[h] is useful in emergencies to avoid misunderstandings. After the resuscitation, it is important to carefully record the events and any medications that were administered (if not recorded in real time).

g Solution of 100 micrograms/mL (1:10 000) i.e. dilute 1 mL of adrenaline 1:1000 with 9 mL sodium chloride 0.9%.

h Closed loop communication is when the person receiving the message repeats it back to the person who gave the message to ensure that it has been correctly understood. It reduces error from ambiguous messages.

2.2 Circulatory impairment and shock

Impaired circulation can occur in any severely ill or injured child. Early recognition of circulatory impairment, identification of the underlying cause and prompt treatment can prevent progression to shock and be life-saving. Shock is a clinical condition in which there is inadequate oxygen delivered to the vital organs and tissue, and, if prolonged, results in irreversible multi-organ failure and death. Mortality in children with shock is extremely high.

In clinical practice, differentiation between circulatory impairment and shock can be difficult. In addition, the proportion of children with true shock among all those with evidence of circulatory impairment, is very small[2]. Evidence has shown that children with circulatory impairment who do not meet the definition of shock benefit from the same treatment as those in shock[2]. Therefore, for the purposes of this chapter, treatment of children is the same for both circulatory impairment and shock. This chapter does not apply to children in diabetic ketoacidosis (DKA) (see Chapter 9, Section 9.2), children with circulatory impairment due to massive haemorrhage (see Section 2.5) or trauma (see Section 2.7) as they have a specific pathophysiology and different management requirements.

2.2.1 Classification of circulatory impairment and shock

Shock in children can be classified according to the pathophysiology associated with the underlying cause (see Table 2.1).

Table 2.1 - Classification and causes of shock in children[3]

Classification	Pathophysiology		Causes
Hypovolaemic	Intravascular volume loss	Fluid loss, inadequate fluid intake	Gastroenteritis, dehydration, diabetic ketoacidosis
		Blood loss/haemorrhage	Trauma, splenic rupture, viral haemorrhagic fevers
		Capillary leak	Burns, bowel obstruction
Distributive	Intravascular volume shift	Increased capillary permeability, decreased vasomotor tone	Sepsis, anaphylaxis
		Loss of sympathetic tone leads to vasodilation	Spinal cord injury
Cardiogenic	Reduced cardiac output	Intrinsic pump failure	Congenital heart disease, cardiomyopathy, myocarditis, valvular disease, arrhythmias
Obstructive	Obstructed cardiac output	Extracardiac obstruction of blood flow	Tension pneumothorax, cardiac tamponade, pulmonary embolism, coarctation of aorta

The most common causes of circulatory impairment/shock in children which will be covered in this section are severe dehydration (most often due to diarrhoea), sepsis, and severe anaemia, and management is tailored to the underlying cause. Severely unwell children may have multiple potential causes, and management must take into account the different possible underlying conditions. Careful monitoring during and after stabilisation (or acute management) is vital to ensure optimal survival and a positive outcome for the child.

Refer to relevant sections for further management of DKA (Chapter 9, Section 9.2) severe haemorrhage (Section 2.5), trauma (Section 2.7), anaphylaxis (Section 2.4) and underlying cardiac conditions (Chapter 6, Section 6.2).

2.2.2 Clinical features

Children are critically unwell with any one of the following signs of impaired circulation:
- Weak radial pulse, or severe tachycardia[a]
- Lower limb temperature gradient[b]
- CRT of 3 or more seconds.

If all 3 signs of circulatory impairment are present, the child is in shock.
Blood pressure may remain normal even if a child is in shock.

The diagnosis of circulatory impairment is not always easy and requires good clinical judgement. Children must be **critically unwell** to make a diagnosis of circulatory impairment based on a single sign. Each of the individual signs above can also be found in non-critically unwell children, e.g. a child may have cold feet, but if the child is otherwise well, they do not have circulatory impairment.

The following signs indicate decompensated shock and imminent cardiopulmonary arrest:
- Inadequate respiratory effort
- Hypotension/ weak central pulses
- Bradycardia

These children need immediate resuscitation (see Section 2.1.1 and Section 2.1.2).

2.2.3 Immediate management

This section addresses immediate management of circulatory impairment/shock to stabilise the child, during which the underlying causes should be identified and addressed where possible. The goal is to restore adequate perfusion and oxygenation without causing harm.

Specific management is determined by identification of the most obvious reason for circulatory impairment:
- Sepsis or severe febrile illness
- Severe anaemia (unless due to massive haemorrhage, in which case see Section 2.5)
- Severe dehydration (unless due to DKA, in which case see Chapter 9, Section 9.2)

The use of IV fluid boluses is no longer recommended in the management of circulatory impairment/shock due to sepsis/severe febrile illness in the absence of available advanced supportive care (mechanical ventilation, vasopressor support)[4,5].

a > 180 bpm in children < 12 months, > 160 bpm in children 1 to 5 years, > 140 bpm in children > 5 years.

b The temperature gradient is assessed by running the back of hand from the toe to the knee; a positive temperature gradient is defined as a notable temperature change from cold (dorsum of foot) to warm (knee).

Emergency management

– Move the child to a critical care area (emergency or intensive care) and assess rapidly while stabilising or resuscitating:
  • Take rapid history (SAMPLE) and try to determine underlying cause.
  • Obtain age and weight of the child. Measure mid-upper arm circumference (MUAC) and check for oedema as a rapid assessment for malnutrition.
– Assess and manage **A**irway and **B**reathing (see Section 2.1.1 and Section 2.1.2):
  • Open airway and administer oxygen > 6 L/min via mask (use non-rebreathing mask if available).
  • Attach pulse oximetry and monitor; aim for SpO_2 between 94-98%.
  • Assist ventilation and oxygenation with bag-mask ventilation if needed.
– Assess and manage **C**irculation (see Section 2.1.2):
  • Obtain IV/IO access.
  • Perform rapid tests for Hb, BGL, malaria (where endemic) and send blood for culture, if available, and blood group (see MSF Blood transfusion guideline).
  • Administer **parenteral fluids and/or blood**[c] IV/IO corresponding to specific cause of circulatory impairment (see below: Specific management).
– Administer antimalarial treatment if malaria test positive.
– Treat hypoglycaemia (BGL < 3.3 mmol/L or < 60 mg/dL) with 2 mL/kg of **glucose** (**dextrose**) **10%** IV/IO over 2-3 minutes, or 10 mL/kg via NGT. See Chapter 9, Section 9.3 for further detail on ongoing management of hypoglycaemia.
– Administer **ceftriaxone** IV: 80 mg/kg (max. 4 g if < 50 kg; max. 2 g if ≥ 50 kg) single dose ***as soon as possible***, within 1 hour of diagnosed circulatory impairment. Revise need for further antibiotic treatment once underlying cause identified.

⚠ Parenteral fluids must be administered with caution in children with severe febrile illness, pneumonia, malaria, meningitis, severe acute malnutrition, severe anaemia, underlying cardiac conditions, renal failure or diabetic ketoacidosis. Adjust rate and volume of fluid administration in these groups of children according to respective guidance and ensure that a paediatric infusion set is always used, if available.

Specific management

Sepsis or severe febrile illness

– Administer maintenance fluids with **glucose** (**dextrose**) **5%/Ringer lactate** (G5%/RL) IV/IO (or **glucose** (**dextrose**) **5%/sodium chloride 0.9%** (G5%/NaCl 0.9%) if RL is unavailable). See Chapter 15, Section 15.2.
– Monitor and record vital signs, neurological status and urine output at least every 15-30 minutes, using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts). Monitor carefully for any signs of fluid overload.
– If deterioration or no improvement at all after 2 hours of IV fluids and IV antibiotics (as above), check Hb[d] and administer a blood transfusion (see below and Chapter 10, Section 10.1.2). Continue IV maintenance fluids while waiting for blood and stop during transfusion. Restart IV maintenance fluids after completion of blood transfusion.
– See Chapter 3, Section 3.2 for ongoing management after stabilisation including antibiotic advice.

c Always ensure bedside verification of ABO compatibility immediately before transfusion using an ABO testing card.

d Blood transfusion for unresponsive sepsis is not strictly dependent on Hb, however if Hb is above 10 g/dL transfusion may not be beneficial and decision to transfuse should be based on the balance of potential risks and benefits.

Severe anaemia (Hb < 6 g/dL)

– Administer **blood transfusion**[e] (see Chapter 10, Section 10.1.2), calculating volume according to presence or absence of fever[6] as follows:
  • No fever (≤ 37.5 °C) from the time of ordering blood to the time of transfusion[f]: administer 30 mL/kg **whole blood** over 4 hours or 15 mL/kg **packed red blood cells** (**PRBC**) over 3 hours.
  • Fever (> 37.5 °C) at any point from the time of ordering blood to the time of transfusion[f]: administer 20 mL/kg **whole blood** over 4 hours or 10 mL/kg **PRBC** over 3 hours.
– While waiting for blood, start fluid rehydration:
  • Start maintenance fluids with **G5%/RL** IV/IO (or **G5%/NaCl 0.9%** if RL is unavailable). See Chapter 15, Section 15.2.
  • Stop fluids during transfusion.
– Monitor and record vital signs, neurological status and urine output at least every 15-30 minutes using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts). Monitor carefully for any signs of fluid overload.

Severe dehydration

– Administer fluids according to WHO treatment plan C (for non-malnourished children) or 'Plan C SAM' (for malnourished children). See Chapter 5, Section 5.3 for details.
– Monitor and record vital signs, neurological status and urine output at least every 15-30 minutes using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts). Monitor carefully for any signs of fluid overload.
– If deterioration or no improvement at all after 2 hours of IV fluids, check Hb[g] and administer a blood transfusion (see above and Chapter 10, Section 10.1.2).
– Continue IV rehydration fluids as per plan at the same time as blood transfusion using a separate IV line.

See Figure 2.5, page 41 for full shock algorithm.

2.2.4 Monitoring and further management

– Continue monitoring every 30 minutes (vital signs, neurological status, urine output, BGL) and continue further management of underlying cause in an intensive care facility, if available. Record all vital signs using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
– Signs indicating improvement in circulation and perfusion:
  • Improved peripheral and central pulses
  • Urine output > 1 ml/kg/hour[h]
  • Improved level of consciousness

e Always ensure bedside verification of ABO compatibility immediately before transfusion using an ABO testing card.

f Ensure temperature is checked and recorded at the time of ordering blood and immediately prior to transfusion as a minimum.

g Blood transfusion for severe dehydration that is unresponsive to initial fluid resuscitation is not strictly dependent on Hb, however if Hb is above 10 g/dL transfusion may not be beneficial and decision to transfuse should be based on the balance of potential risks and benefits.

h Accurate urine output can only be measured if a urinary catheter is in situ or by weighing nappies.

– Monitor continuously for signs of fluid overload, which are:
  • Increased RR by ≥ 10 breaths/min from initial RR, or
  • Increased HR by ≥ 20 beats/min from initial HR
– Plus any one of the following:
  • New or worsening hypoxia (decrease in SpO_2 by > 5%)
  • New onset of rales and/or pulmonary oedema (fine crackles in lung fields)
  • New galloping heart rhythm
  • Increased liver size (liver size must have been marked with pen on arrival)
  • New peripheral oedema and/or puffy eyelids.

Management if signs of fluid overload present:
– Stop fluids (or slow down transfusion).
– Administer **furosemide** IV: 0.5 mg/kg (repeat once if necessary).
– Place child into semi-sitting position and ensure high-flow oxygen via non-rebreathing mask, if available.
– Monitor and record vital signs every 15 minutes using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts) until child has been stable for at least one hour.

Management if improvement in circulation and perfusion:
– Severe dehydration: complete further treatment with WHO treatment plan C or 'Plan C SAM'.
– Sepsis or febrile illness:
  • Continue IV **maintenance fluids** until stable.
  • Remove any potential entry point of infection, e.g. indwelling catheter.
  • Adjust antibiotic regimen according to suspected source of infection. If meningitis suspected, increase to **ceftriaxone** IV: 100 mg/kg (max. 4 g) once daily.
– Severe anaemia: refer to Chapter 10, Section 10.1.

Fluid refractory shock

Management if no improvement in circulation and perfusion despite adequate management as described above:
– Clinical signs of shock persist despite maximum fluid management and/or blood transfusion. Further fluids can be harmful and should be avoided. Consider and investigate for another diagnosis or underlying cause.
– For acute kidney injury (AKI): persistently low urine output (< 0.5 mL/kg/hour for more than 6 hours) despite adequate fluid management. Stop any nephrotoxic drugs and adjust fluid management (see Chapter 8, Section 8.4).
– Consider **thiamine** if altered mental status and/or prolonged seizures, or if severe malnutrition or persistent hypoglycaemia in septic, hypovolaemic or cardiogenic shock. Not useful in anaphylactic or haemorrhagic shock.

thiamine IV/PO

– **Loading dose** < 15 years: 100 mg slow IV infusion over 30 minutes once daily for 48 hours.
  If IV not possible: give PO/via NGT at the same dose.
– **Maintenance dose** to be started after 48 hours of IV treatment:
  • ≤ 12 years: 25 mg PO once daily for 1 month
  • > 12 years: 25 mg PO twice daily for 1 month

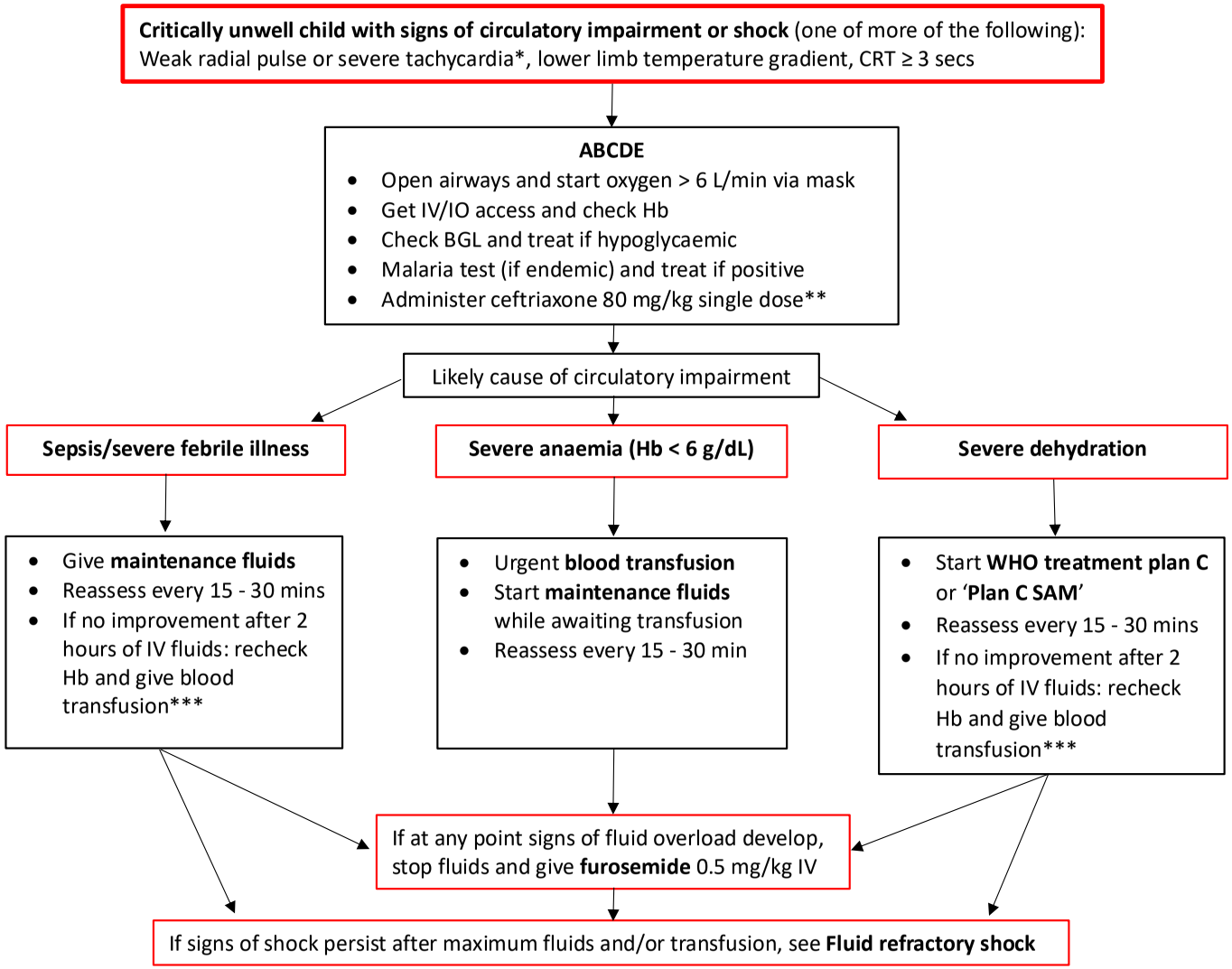
2.2.5 Further critical care management when intensive care is available

Recommended where sufficient numbers of trained personnel, protocols, syringe pumps, continuous monitoring and laboratory services are available:

- Non-invasive ventilation (NIV) to support breathing (see Chapter 4, Section 4.1.3).
- Inotropes: low-dose **epinephrine** IV infusion: starting at 0.05 micrograms/kg/min with gradual titration (see MSF Vasopressor Therapy – Adrenaline protocol).
- If severe hypotension[i] (systolic blood pressure of < 50 mm Hg in < 12 months of age, < 60 mm Hg in 1 to 5 years of age, and < 70 mm Hg in children > 5 years of age), consider giving a fluid bolus of **Ringer lactate** (RL) IV, 20 mL/kg over 15 minutes.
- Electrolyte correction (if possible to measure accurately). Treat hypocalcaemia, if present with **10% calcium gluconate** IV: 0.5 mL/kg (max. 10 mL). See Chapter 15, Section 15.3.4 for more details.
- **Hydrocortisone**: consider if signs of adrenal dysfunction (e.g. persistent hypoglycaemia despite treatment). Initial dose 2 mg/kg IV, followed by: 1 mg/kg IV every 6 hours for the first 24 hours; then 0.5 mg/kg IV every 6 hours for the next 24-48 hours.

i Requires accurate blood pressure measurement. Weak pulse is not a reliable proxy for low blood pressure.

Figure 2.5 - Treatment algorithm for circulatory impairment/shock



* > 180 bpm in < 12 months, > 160 bpm 1 to 5 years, > 140 bpm in > 5 years
** Revise necessity of further antibiotic treatment once underlying infection identified.
*** If Hb is above 10 g/dL transfusion may not be beneficial and decision to transfuse should be based on the balance of potential risks and benefits.

2.3 Choking

Sudden onset of respiratory distress associated with coughing, gagging or stridor.

Immediate assessment and management

Call for help.

Is the child coughing effectively?

Effective cough	Ineffective cough
Crying or verbal response to questions Loud cough Able to take a breath before coughing Fully responsive	Unable to vocalise Quiet or silent cough Unable to breathe Cyanosis Decreasing level of consciousness

Effective cough:
- No external manoeuvres are necessary. Encourage the child to continue coughing. Effective cough means that air is passing in/out of the upper airways and is the most effective way to dislodge the foreign body. Do not interfere but monitor continuously.
- If the child is stable and there is a concern of a foreign body lodged in the oesophagus or airway, obtain an x-ray.

Seen on x-ray	Not seen on x-ray
Metal (except aluminium)	Aluminium
Most animal bones	Most wood
Glass	Most plastic
Stones	Most fish bones

Ineffective cough or becoming ineffective:
- Call for help and assess if child is conscious.

Is the child conscious?

Not conscious:
- Lay child on a flat surface
- Open airway and look for any obvious foreign body. If visible, try to carefully remove with a finger sweep (do not go blindly or repeat many times as this could push the foreign body further into the airway).
- Start BLS with 5 rescue breaths (see Section 2.1.1).
- If no response, start CPR (see Section 2.1.1).

Conscious: use external manoeuvres to dislodge foreign body as follows[1]:

Step 1: Give 5 back blows.

– Infant (< 1 year):
  • Lie infant along the forearm with head facing downwards, supporting the infant's head with your thumb on the angle of the lower jaw and two fingers on the other side of the jaw (see Figure 2.6). Lay the arm supporting the infant on your thigh for stability.
  • Using the palm of your hand, deliver sharp back blows between the infant's shoulder blades.

– Child (≥ 1 year):
  • Depending on the size of the child, either place child with head leaning forwards over one knee or with support over an arm (see Figure 2.7). Using the palm of your hand, deliver sharp back blows between the child's shoulder blades.

Try to dislodge the foreign body with each blow. Repeat up to a total of 5 times if no obvious foreign body has come out, then re-assess.

Figure 2.6 - Back blows in an infant

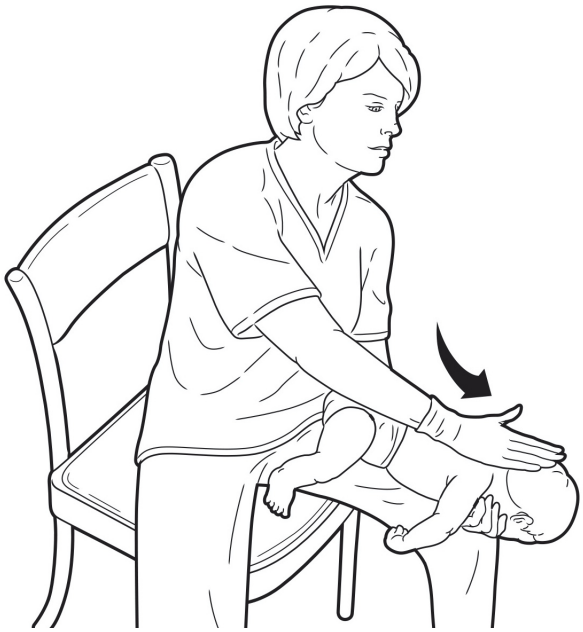


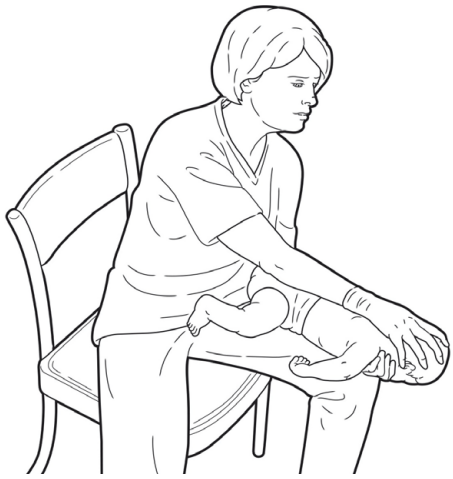
Figure 2.7 - Back blows in a child

Re-assess:

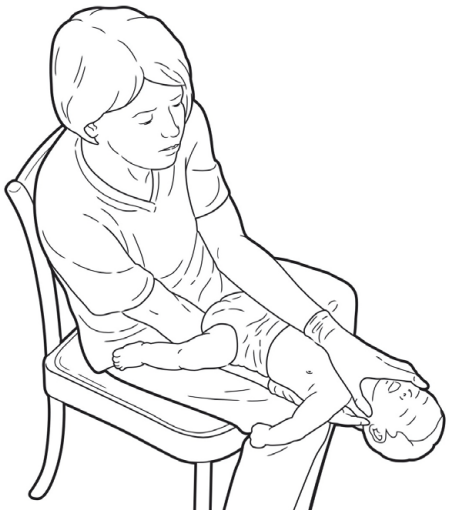
– Turn the child around to face you or turn the infant to face upwards (Figure 2.8a to Figure 2.8b) while continuing to support the body, neck and head, and look for any obvious foreign body (if visible try to remove carefully, as above).
– Check if airway still obstructed and assess if conscious or not.
  • If not conscious, start BLS (see Section 2.1.1).
  • If still conscious but airway obstructed, move to Step 2 to give 5 chest thrusts (infant) or abdominal thrusts (child).

Figures 2.8 - Switching from back blows to chest thrusts in the choking infant

2.8a - Face down position



2.8b - Face up position



Step 2: Give 5 chest thrusts (infant) or abdominal thrusts (child).

– Infant (< 1 year):
  - Identify landmark for chest compressions (lower half of sternum, around one finger breadth above xiphisternum) and use 2 fingers to deliver chest thrusts (similar to chest compressions but sharper and at a slower rate). See Figure 2.9.

– Child (≥ 1 year):
  - Stand or kneel behind the child and hold the child by encircling the child with your arms under their arms (see Figure 2.10).
  - Make a fist with one hand and place it between the umbilicus and xiphisternum. Using your other hand on top of your closed hand, pull sharply inwards and upwards.

Try to dislodge the foreign body with each thrust. Repeat up to a total of 5 times if no obvious foreign body has come out, then re-assess.

Figure 2.9 - Two-finger chest thrusts (infant)

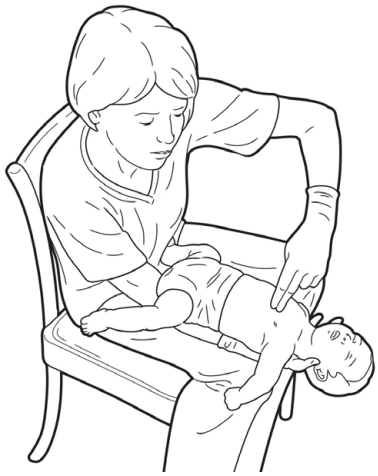


Figure 2.10 - Abdominal thrusts (child)

Re-assess:
- Check if airway still obstructed and assess if conscious or not.
- Repeat Steps 1 and 2 continuously, assessing the child's responsiveness, consciousness and breathing.
- If at any point the foreign body seems visible, remove it carefully.
- If the foreign body seems to have dislodged or child seems to restart breathing effectively, lay the child into recovery position and observe for any respiratory distress.
- If child deteriorates or becomes unconscious, start BLS (see Section 2.1.1).

Only discharge when stable and fully alert, and if clinical examination is normal. If the child lost consciousness at any point during the episode, observe for at least 8 hours and assess prior to discharge.

2.4 Anaphylaxis

Anaphylaxis is a potentially life-threatening, rapid onset, generalised hypersensitivity reaction. Hallmark features include life-threatening airway, breathing or circulatory problems and usually, but not always, associated skin and mucosal changes[7]. The reaction is triggered by an allergen (usually foods, insect bites or stings, or medicines) to which a person is already sensitive. Severity can vary; a child may rapidly develop circulatory collapse or symptoms may resolve spontaneously[8]. The goal is to promptly recognise and diagnose anaphylaxis (not always easy in children) and treat immediately with IM epinephrine.

Although global epidemiological data is limited, published data shows an increasing trend of anaphylaxis, including in children and adolescents[9,10]. The most common trigger reported in children continues to be food products[7].

2.4.1 Clinical features and diagnostic criteria

Diagnosis is based on history (including exposure to, or ingestion of, potential allergen) and clinical features (see Table 2.2).

Table 2.2 - Clinical criteria for diagnosis of anaphylaxis[11]

Anaphylaxis is highly likely when either of the following 2 criteria are met within hours:
1. Acute onset of an illness (minutes to several hours) with involvement of the skin, mucosal tissue, or both (e.g. generalized urticaria, itching, flushing, swollen lips-tongue-uvula) AND ≥ 1 of the following: A. Respiratory symptoms (e.g. dyspnoea, wheeze or bronchospasm, stridor, hypoxia) B. Low BP or associated symptoms of end-organ dysfunction (e.g. hypotonia, syncope, incontinence) C. Severe gastrointestinal symptoms (severe abdominal pain, repetitive vomiting)
OR
2. Acute onset of hypotension or bronchospasm or laryngeal involvement (stridor, vocal changes, odynophagia) after exposure to known or highly probable allergen for that patient.

2.4.2 Management

- Identify quickly and remove external trigger (e.g. remove bee stinger; stop drug infusion if potential likely cause).
- Assess and manage ABCDE including specifically:
  - Prepare IM epinephrine as part of A.
  - Assess for airway swelling: angioedema of lips, tongue, throat (laryngeal oedema). Can child speak or do they feel they cannot swallow?
  - If not breathing or cardiopulmonary arrest, start CPR (Section 2.1.1).

– Administer **epinephrine** IM: 0.01 mg/kg (1 mg/mL (1:1000) undiluted solution in 1 mL syringe) single dose into the mid-anterolateral thigh (maximum dose of 0.3 mg for children < 12 years[12,13]):

Age	Dose to be administered IM
Infant < 6 months	100 to 150 micrograms (0.1 to 0.15 mL)
Child 6 month to < 6 years	150 micrograms (0.15 mL)
Child 6 to < 12 years	300 micrograms (0.3 mL)
Child ≥ 12 years*	500 micrograms (0.5 mL)

* If small or prepubertal, administer 300 micrograms (0.3 mL).

– Repeat IM epinephrine after 5 minutes if response is poor or no clinical improvement[14].
– Keep child supine or at 45 degrees if difficulty breathing.
– Administer oxygen > 6 L/min via mask (use non-rebreathing mask if available).
– Get IV access and administer 10 mL/kg **Ringer lactate** (**RL**) as a rapid bolus (alternatively **sodium chloride 0.9%**). Reassess after 15 minutes or earlier if needed and if signs of poor perfusion, repeat the same fluid bolus once.
– Monitor and record vital signs, particularly RR and CRT, every 5 to 10 minutes.
– If, after 2 doses of IM epinephrine and fluids, the child shows little or no improvement, consider, where feasible[a], starting an IV **epinephrine** continuous infusion (refer to MSF Vasopressor Therapy – Adrenaline protocol). Continue to administer IM epinephrine every 5 minutes until infusion is started[13].
– Ensure continuous vital sign monitoring, or if not available, monitor and record every 5 to 10 minutes. Once stabilised, monitor every 30 minutes, including level of consciousness and urinary output. Gradually reduce the infusion once clinical condition improves.

Additional treatment

Any additional treatment should only be given after the initial emergency treatment of anaphylaxis and should not delay continuation of adrenaline administration in refractory anaphylaxis[13].

– Administer corticosteroid if refractory anaphylaxis or ongoing asthma/shock to prevent or shorten protracted reactions, using **hydrocortisone** IM or IV:

Age	Dose to be administered 3 times daily, adjusted according to response[15]
1 to 5 months	25 mg
6 months to 5 years	50 mg
6 to 11 years	100 mg
12 years and above	200 mg

– Administer IV antihistamine if cutaneous manifestations of anaphylaxis are present.

a Electric syringe pump available and personnel trained in its use.

– Administer nebulised **epinephrine** if stridor or upper airways obstruction present:
  - **epinephrine** nebulised solution: 0.5 mg/kg (max. 5 mg) in 5 mL normal saline over 15 minutes.
  - Repeat another dose as soon as nebuliser finishes (to provide continuous nebulisation) until symptoms improve.
– Administer bronchodilator if wheezing present (see also Chapter 4, Section 4.10), using **salbutamol** nebuliser solution (5 mg = 5 mL):

Age	Dose to be administered over 20 minutes
≤ 5 years	2.5 mg (1.25 mL)
> 5 years	5 mg (2.5 mL)

Follow-up

After an anaphylactic event, provide an explanation to the child and their parents/carers on the condition, its presentation, recognition, and immediate treatment. If a trigger has been identified, give advice on allergen avoidance.

2.5 Haemorrhagic shock

Shock in conjunction with clinical signs of haemorrhage (external and/or internal blood loss). Causes include trauma, gastrointestinal bleeding, splenic rupture (due to severe sickle cell disease, malaria or trauma) or diffuse bleeding due to haemorrhagic fever or dengue shock. If there is ongoing significant bleeding, treat as haemorrhagic shock even if Hb ≥ 8 g/dL. Haemoglobin may initially be normal in haemorrhagic shock as it takes time for the body to equilibrate and for the haemoglobin level to reflect actual blood lost. Repeat Hb after 30 and then 60 minutes if it is initially normal.

2.5.1 Investigations

- Hb, FBC, platelets, blood group and Rhesus
- BGL
- Urine dipstick (macroscopic haematuria suggests renal damage)
- Blood lactate, if available
- Electrolytes, urea nitrogen, creatinine, if available
- Prothrombin time (PT), Partial thromboplastin time (PTT), if available

2.5.2 Management

- Stop any obvious life-threatening external bleeding via compression or tourniquet. In the case of severe trauma, refer to Section 2.7 for trauma management after stabilisation of haemorrhagic shock.
- Ask or estimate weight of child.
- Assess and manage **A**irway and **B**reathing.
- Open airway (support airwas if necessary).
- Administer oxygen > 6 L/min via mask (use non-rebreathing mask if available) aiming for SpO_2 > 94%.
- Assist ventilation and oxygenation with bag-mask ventilation if needed.
- Check **C**irculation and get IV or IO access. Get blood for cross-matching, bedside ABO compatibility, and order blood for transfusion.
- Transfuse 20 mL/kg **whole blood** as fast as possible[a]; group O negative or cross-matched blood, whichever is available faster. Repeat as necessary guided by clinical evolution, Hb, platelets.
- Administer 20 mL/kg of IV **Ringer lactate** (or **sodium chloride 0.9%**) as a rapid bolus if blood is not immediately available. Repeat bolus if necessary until blood is available for transfusion, but be cautious as fluids may dilute coagulation factors and worsen bleeding.
- Reassess clinical condition and monitor and record vital signs every 15 minutes during transfusion.
- Administer **tranexamic acid** IV: 15 mg/kg (max. 1 g).
- Warm child proactively to ensure temperature > 36.5 °C. Stop any air-conditioning and warm all fluids and blood products.
- Insert a nasogastric tube (conical tip) open to air.
- Manage underlying cause of haemorrhage.

a Always ensure bedside verification of ABO compatibility immediately before transfusion using an ABO testing card

2.6 Drowning

Defined as "the process of experiencing respiratory impairment from submersion/immersion in liquid"[a],[16]. Worldwide, drowning claims approximately 372,000 lives per year[b] and 91%[17] of these deaths occur in low- and middle-income countries[18]. Globally it is one of the top 5 causes of death under 14 years of age[c], with the highest drowning rates in children aged 1 to 4 years[16].

Outcome is often fatal but two rapid interventions at the scene of the incident can determine survival; how quickly the child is pulled out of the water, and how swiftly proper resuscitation is performed[3]. Aggressive rescue measures are warranted, especially if submersion was in cold water (< 10˚C) as it induces rapid hypothermia with potentially good neurological outcomes. The diving reflex may also improve survival in infants and small children[d].

In drowning, prolonged resuscitation or respiratory support may be necessary but can have a positive outcome. Predictors of good outcome include cold water submersion (usually 10°C) and being conscious or arousable on admission. Poor outcome predictors include CPR > 30 minutes, delay in CPR and prolonged submersion.

This chapter will cover immediate management at the scene of the incident and emergency management in a health facility. Preventive strategies are key to reducing death from drowning (see *WHO Preventing drowning: an implementation guide 2017*[19]) but are not within the scope of these guidelines.

2.6.1 Pathophysiology

Even a small amount of water aspirated into the airways causes significant alveolar damage and surfactant dysfunction, leading to a clinical picture of non-cardiogenic pulmonary oedema if the child is rescued alive. Clinically, aspiration (and sometimes laryngospasm) leads to hypoxaemia, which rapidly leads to loss of consciousness, anoxic brain injury and respiratory arrest. Without immediate rescue and resuscitation, cardiac arrest may result within seconds or minutes. Hypothermia or ice-water drowning are the exception, where this process can last an hour[20].

2.6.2 Management

Objective is to:
1. Reverse hypoxia and maintain adequate oxygenation.
2. Prevent aspiration.
3. Reverse hypothermia and stabilise body temperature.

a Definition adopted at the first World Congress on Drowning (2002).

b This figure is considered to be an underestimation of actual figures of fatal drowning cases globally as the ICD classification does not include fatal drowning due to floods, tsunamis or boat accidents.

c In the WHO Western Pacific Region, drowning is the first cause of death in children 5 to 14 years. Drowning death rates are the highest in Africa.

d Peripheral and splanchnic vasoconstriction preserves neurological circulation.

Note: the Heimlich manoeuvre or other postural drainage techniques to 'drain' water from the lungs lack evidence to demonstrate value and are not recommended. Rescue breaths should not be delayed in order to carry out such manoeuvres.

Immediate management after rescue

- Rapidly assess ABCDE and start BLS if unconscious (see Section 2.1.1).
- If cardiopulmonary arrest, start CPR.
- If pulse present but breathing is inadequate or reduced level of consciousness, start respiratory support[21]:
  - Open airways
  - Administer 100% oxygen (or highest concentration available) via face mask (use non-rebreathing mask if available).
- Immobilise cervical spine if likely spinal injury but should not take priority over resuscitation (see Section 2.7.1).
- Remove wet clothes[e] and dry the child.
- Wrap with blankets or survival blanket and minimise exposure.
- Presume hypoglycaemia and, if conscious and alert enough to drink safely, give a sugar-containing drink by mouth, such as a milk feed to infants or oral glucose (15 to 30 g) or 125 to 250 mL of a sugary drink (e.g. juice) to older children, if available.
- Transfer immediately to nearest hospital or healthcare facility.

Management in hospital setting

If no immediate management done prior to arrival, start ABCDE and resuscitation (Section 2.1).

Respiratory failure/hypoxia

- Administer 100% oxygen (or highest concentration available) aiming to maintain SpO_2 > 94%.
- Consider bag-mask ventilation if oxygenation inadequate or signs of respiratory failure.
- If alert but remains hypoxic or in respiratory failure, transfer to an intensive care unit for respiratory support (if available).
- If breathing spontaneously:
  - Admit for observation for at least 8 hours.
  - Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
  - Assess respiratory effort, including pulmonary auscultation regularly.
  - Administer oxygen aiming to maintain SpO_2 > 94% and observe carefully.
- If child develops respiratory distress, widespread crackles on auscultation or hypoxia, transfer to intensive care unit for further management and respiratory support.
- If signs of shock develop, treat for shock (see Section 2.2). Be cautious to avoid excess fluid administration as there may be cerebral oedema due to anoxia. Avoid hypotonic solutions.
- Routine antibiotic treatment is not necessary. Only if signs of respiratory infection or sepsis appear (fever, cough, dyspnoea), start appropriate antibiotic treatment (see Chapter 4, Section 4.5 for pneumonia and Chapter 3, Section 3.2 for sepsis treatment).

Trauma

- Immobilise C-spine (if not already done) if possible injury suspected, mechanism of injury unclear, or consciousness impaired.

e Clothes should be cut off in case of suspected spinal injury to avoid excessive movement of the neck.

Prevent aspiration

– Vomiting is common following drowning and complications due to aspiration occur frequently in children with altered consciousness.
– If reduced consciousness, insert a nasogastric tube (conical tip) to remove swallowed water (or debris).

Hypothermia

– Remove wet clothes and dry the child (if not already done).
– Wrap with blankets or survival blanket and minimise exposure.
– If core temperature < 35.5 °C, start active warming where possible:
  • Use warmed blankets, heating pads, survival blankets, etc. depending on availability.
  • Administer warmed IV fluids or pass IV fluids via a warmer device, if available.

Hypoglycaemia

– Check BGL and treat hypoglycaemia if BGL < 3.3 mmol/L or < 60 mg/dL with 2 mL/kg of **glucose** (**dextrose**) **10%** IV/IO over 2-3 minutes, or 10 mL/kg via NGT.

2.6.3 Investigations

– No routine investigations required if asymptomatic and alert.
– Perform FBC, BGL and electrolytes (if available) if altered mental status persists despite resuscitation (absence of hypoxia) or if initial cause of drowning not known, e.g. traumatic brain injury, hypoglycaemia, another medical condition.

2.6.4 Post resuscitation management

– Monitor and record vital signs, pulse oximetry, respiratory effort and level of consciousness as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
– Monitor BGL and treat hypoglycaemia (BGL < 3.3 mmol/L or < 60 mg/dL) with 2 mL/kg of **glucose** (**dextrose**) **10%** IV/IO over 2-3 minutes, or 10 mL/kg via NGT. See Chapter 9, Section 9.3 for further detail on ongoing management of hypoglycaemia.
– Observe for signs of complications and treat accordingly:
  • Neurological injury: abnormal neurological examination, seizures, prolonged impaired level of consciousness. Provide supportive care and control seizures. Avoid hypo- and hyperglycaemia.
  • Respiratory distress or infection: bronchospasm is common after drowning. Treat with bronchodilators as for asthma (see Chapter 4, Section 4.10). If clinical signs of pneumonia, treat with appropriate antibiotics (see Chapter 4, Section 4.5).
– Steroids should not be prescribed routinely as there is insufficient data to support their use in the management of drowning.
– If child is asymptomatic, admit child for close observation for approximately 8 hours. If no clinical deterioration and the child is well, discharge after 8 hours.
– Instruct parents/carers to return to the emergency department if any respiratory or other problems develop.

2.7 Trauma

Unintentional trauma, particularly road traffic injuries, falls, drowning, poisoning and burns, are amongst the leading causes of global deaths amongst children[22]. Over 95% of injury related paediatric mortality occurs in low- and middle-income countries. Road traffic injury alone is the leading cause of death amongst 15- to 19-year-olds and the second leading cause of death in children 5 to 14 years. Additionally, children are often victims of trauma and violence in conflict-affected settings[23]. For drowning (Section 2.6), burns (see MSF Clinical Guidelines) and poisoning (Section 2.9) refer to respective chapters.

This chapter covers the management of a child with possible multiple severe injuries due to trauma. The aim is to assess and rapidly identify life-threatening injuries such as[24]:
– Airway obstruction
– Breathing difficulties with chest injuries
– Circulation problems due to severe bleeding (internal or external)
– Disabilities: head and spinal injury.

2.7.1 Primary survey

– Assess and immediately treat any life-threatening conditions[25,26].
– Catastrophic bleeding - stop any obvious massive life-threatening external bleeding:
  • Apply direct pressure.
  • Use tourniquet, if necessary, on limbs.
  • Use haemostatic gauze/agents.
  • If penetrating foreign object, do not remove.
– Apply **A**irway, **B**reathing, **C**irculation, **D**isability and **E**xposure approach as described in Section 2.1.2 and add protection of the cervical spine (see below).

Airway and cervical spine

– If talking or crying vigorously, airway is clear.
– Stabilise the cervical spine if likely head or neck injury associated, or if concern with mechanism of injury. Use appropriate size neck collars or tape and sandbags or fluid bags.
– Assess airway:
  • Identify any obstruction: listen for snoring, stridor, gurgling, grunting; look for blood, vomit, teeth, objects/shrapnel, debris in mouth/nasal passage. Remove or suction any obvious matter.
  • Look for direct trauma of airways, neck, or signs of facial fractures.
  • Examine neck for tracheal deviation (tension pneumothorax) and subcutaneous emphysema (crackling sound when pressing on skin).
  • If burns, check for singeing of nasal hair/eyebrows/eyelashes, burns to the face/neck, hoarse voice, and black ash/soot in saliva, expectoration or on suctioning.
– Maintain patent airway by proper head positioning (use a towel or padding to avoid passive flexion of the cervical spine).
– Avoid excess movement of the cervical spine, especially when performing airway manoeuvres: if cervical spine injury is a concern, use jaw-thrust only, avoiding head-tilt or chin-lift.
– Insert oropharyngeal airway adjunct (e.g. Guedel) to keep airway patent.

– Where feasible, consider the need for a definitive airway (ETT, tracheostomy).
– If not breathing, start bag-mask ventilation while continuing assessment.

Breathing

– Look, listen and feel to assess breathing (see Section 2.1.1).
– If breathing, check if efficient and adequate: assess RR, SpO_2, chest movement, intercostal or subcostal recession, tracheal deviation, air entry or additional sounds on auscultation.
– Administer oxygen > 6 L/min via mask (use non-rebreathing mask if available), aiming for SpO_2 > 94%.
– Examine chest for any bruising, injury (closed or open), and for blood (haemothorax) or air (pneumothorax) in the pleura (see also Section 2.7.3):
  • For tension pneumothorax: insert large bore needle in 2nd intercostal space mid-clavicular line, or 5th intercostal space mid-axillary line to immediately release tension.
  • For pneumothorax or haemothorax: insert a chest drain.
– Insert gastric tube to avoid gastric distension (use orogastric route in the case of head trauma).

Circulation

– Assess HR, CRT, BP, signs of impaired circulation and shock. Note that even with significant bleeding, children may initially have normal BP and Hb, with or without tachycardia, but have an altered mental state indicating circulatory impairment.
– Get IV/IO access[a] (use large bore cannulae, ideally 2 sites) and take blood for Group and crossmatch, Hb and BGL.
– If in shock[b], start appropriate treatment:
  • Administer 20 mL/kg IV **Ringer lactate** (or **sodium chloride 0.9%**) as a rapid bolus.
  • If no response or transient response to initial fluid bolus, administer blood transfusion as for haemorrhagic shock: **whole blood** 20 mL/kg as rapidly as possible.
– Control any major bleeding:
  • Apply direct pressure or compression to any external sites of haemorrhage. Consider temporary use of a tourniquet or blood pressure cuff if necessary to reduce bleeding (refer to MSF Tourniquet for Haemorrhage Control protocol).
  • For suspected pelvic fracture, stabilise using a pelvic binder[c] or a folded wrap around the child at the level of the greater trochanters and secured in place.
  • Reduction: immobilise any obvious long-bone fractures using splints[d].
– Administer **tranexamic acid** IV, 15 mg/kg (max. 1 g) if within 3 hours of injury.
– Initiate surgical consultation for definitive bleeding control if required.
– Once circulation is stabilised, perform 'Extended Focused Assessment with Sonography in Trauma' (EFAST) Point-of-Care Ultrasound (POCUS) exam for patients with blunt abdominal or chest trauma, if trained (see below for more detail).

Disability

– Assess level of consciousness using AVPU or Glasgow Coma Scale (GCS, see Appendix 13), and check pupils.
  • If unconscious, insert an NGT (or orogastric tube (OGT) if concern of basal skull fracture) if not already done. Leave on free drainage. Keep nil by mouth (NBM) until alert and stable.

a Note that all fluids or drugs that are administered via IO require application of pressure either manually or via pump.

b Haemorrhagic shock is most common in trauma, but cardiogenic or neurogenic shock may also be associated.

c EMEQPEBI1M PELVIC BINDER, medium (SAM Sling II)

d EMEQSPLM1190 MOULDABLE SPLINT, 11 x 90 cm; EMEQSPLM1590 MOULDABLE SPLINT, 15 x 90 cm; EMEQSPLM1145 MOULDABLE SPLINT, 11 x 45 cm

– Check BGL.
– Check for active movement of extremities.
– Aim to minimise any further injury to the brain by ensuring adequate oxygenation and intravascular fluid volume and pressure.
– Administer analgesia.

Exposure & environment control

– Full exposure is necessary to do a rapid head-to-toe assessment for any other life-threatening injuries or clinical signs. Undress the child by cutting all clothes away.
– Perform a log roll to examine the back, spine and rectal tone (see footnote[e] for an example of link with images of a paediatric log roll).

How to do a log roll

- A log roll is performed to examine the posterior side of a patient while keeping the spine, especially the cervical spine, aligned in case of possible spinal injury.
- Perform with at least 4 people; one for the head, one for chest, one for pelvis and legs, and one to examine the back. In bigger children, an extra assistant may be necessary to hold the legs. Except for the person at the head, all assistants should stand on the same side of the patient.
- Ensure neck has been immobilised using an appropriately sized neck collar.
- Explain to child what is being done. Ask child to cross arms across their chest with their hands on their shoulders.
- **Head**: stand at head end and hold the head and shoulders securely by placing one hand on either side of the child's head, with the index finger resting below the jaw and the remaining fingers supporting the neck and occiput. This person is responsible for keeping the head aligned with the body when the child is turned to his side.
- **Chest**: the tallest person in the team should take this role. Leaning over the child, place one hand on the child's far shoulder and the other on top of the pelvis on the same side.
- **Pelvis**: Place one hand on top of the iliac crest (crossing arms with the person in control of the chest), and other hand on the underside of the far thigh/knee (depending on the size of the child). This person is responsible for ensuring that the lower spine remains aligned during the roll.
- **Legs**: If the child is bigger, this assistant supports the legs by placing one hand under the knee of the far leg and the other hand under the ankle of the same leg.
- The person in charge of the head counts to 3 and on 3, all assistants roll the child towards them simultaneously, keeping in time with the speed of the head being turned. The body and head of the child should remain aligned at all times.
- When the back examination is finished, the person in charge of the head will again count to 3 and on 3, all assistants roll the child back to the supine position, keeping head and body aligned at all times.

– Assess temperature and take measures for aggressive hypothermia prevention[f]: use warming blankets, fluids and blood warmer, warm the room.

Once the primary survey is completed and life-threatening conditions are stabilised, start the secondary survey. Continue to assess and monitor ABCDE and if at any time the child deteriorates, restart the primary survey.

e Example of source for log roll in images: https://www.clinicalguidelines.scot.nhs.uk/nhsggc-paediatric-clinical-guidelines/nhsggc-guidelines/intensive-and-critical-care/moving-and-handling-the-child-with-suspecteddiagnosed-spinal-injury-cervical-spine-log-rolling/

f Children are more susceptible to hypothermia and it is a major factor in trauma mortality.

2.7.2 Secondary survey

– Take a more detailed history on how the injury or trauma occurred and any relevant medical history:
  - Use AMPLE for history:
    - A-Allergies
    - M-Medications
    - P- Past medical history
    - L- Last meal
    - E- Events
  - For handover between healthcare providers, use MIST:
    - M-Mechanism
    - I- Injuries
    - S-Symptoms
    - T-Treatment given
– Gather information on what happened and the mechanism of trauma. Be aware of high-risk mechanisms including:
  - Motor vehicle accident (MVA) at high-speed
  - Pedestrian or bicycle hit by car
  - Fall > 3 metres (or twice body height)
  - MVA with ejection from vehicle or death of other passengers
– Perform a full clinical examination, take vital signs and complete the head-to-toe assessment of any other injuries not picked up during the primary survey. Record all injuries identified.

Additional investigations (if not already done)

– X-rays as indicated based on injury: CXR and pelvic x-ray.
– Point-of-Care Ultrasound (POCUS) EFAST:
  - Indication: blunt abdominal and chest trauma (penetrating trauma only if stable)
  - Assessment: free abdominal fluid (blood), pericardial or pleural effusion, pneumothorax.
  - Contraindication: clear indication for surgery, unstable patient, untrained clinicians.

EFAST Outcome	Considerations
Positive	• Discuss patient stabilisation and possible surgery with team. • Abdominal free fluid - does patient need surgery? • Pericardial effusion - does patient need pericardiocentesis? • Pleural effusion/ pneumothorax - does patient need thoracentesis/ chest tube?
Negative	• May need to repeat in few hours (ideally within 6 hours), depending on patient condition. • A negative EFAST does NOT exclude internal injury. Always correlate clinically.

Particularities of trauma in children (in comparison to adults) to consider

– Same mechanism of injury can have different consequences.
– Flexible thoracic cage compresses easily, so rib fractures and flail chest are rare but there may be extensive intrathoracic damage from a blunt injury[27].

– Flexible spinal skeleton results in possible cervical spine injuries without radiographical signs of fracture.
– Intracranial injuries more common (head size large in proportion to body size in younger age groups).
– More blood loss with fracture of the long bones or pelvis.
– Initial good compensation to injuries then sudden decompensation.
– Medication and fluid calculations require the weight of the child. If recent weight unknown, calculate an estimated weight based on age (see below) or use a colour-coded length-based tape (e.g. Pediatape[g]) that provides key drug and fluid doses by length.

Age-based weight estimation:

1 year and below: weight = (age in months/2) + 4
1 to 5 years: weight = (age in years x 2) + 8
6 to 12 years: weight = (age in years x 3) + 7

Note: neither the age-based or tape-based weight estimations can be used accurately in children with severe acute malnutrition.

2.7.3 Specific injuries

Head injury

For head injury, see Section 2.8.

Chest injury

Tension pneumothorax

– Tracheal deviation: pneumothorax is on the side that the trachea is deviated away from.
– Reduced air entry with hyper-resonant percussion on affected side.
– Emergency management required:
  • Insert large bore needle into 2nd intercostal space mid-clavicular line, or 5th intercostal space mid-axillary line to immediately release tension. Hissing sound of air being released will be heard.
  • Follow with insertion of chest drain.

Open pneumothorax

– Usually due to penetrating chest injury which allows air to be sucked into and blown out of the wound site.
– Cover with a rectangular dressing that is taped on only 3 sides, allowing air to be expelled during expiration but preventing it from being sucked in during inspiration.
– Follow with insertion of chest drain.

Massive haemothorax

– Reduced chest movement, reduced air entry and dull to percussion on affected side. If bleeding significant, child may be in shock.
– Treat haemorrhagic shock (see Section 2.5) and insert chest drain prior to surgery (save blood, if possible, in sterile container/bag for possible autotransfusion).

g Paediatric Triage Smart Tape or alternatives are Broselow tape or PAWPER tape.

Pulmonary contusion

- Significant internal bruising usually due to blunt trauma.
- Hypoxia results from capillary bleeding that fills up alveoli.
- CXR may initially be normal but can later develop into full white-out from widespread interstitial shadowing.
- Observe carefully, treat with oxygen to maintain SpO_2 > 94% and consider respiratory support where available (see Chapter 4, Section 4.1.3).

Flail chest

- Occurs if there are multiple rib fractures and a section of the rib cage is moving in the opposite direction to the rest of the chest.
- Less common in younger children due to their mobile chest walls.
- Manage with analgesia (see Chapter 15, Section 15.4) and respiratory support (see Chapter 4, Section 4.1.3), if necessary and available.

Abdominal injury

- Consider if abdominal pain, bruising, signs of shock or history of a high-risk mechanism of injury (e.g. handlebar injury to the abdomen, high speed motor vehicle accident, fall from great height).
- Visceral injuries might present with a negative EFAST and delayed onset of peritonitis. If in doubt, admit for serial abdominal examinations and obtain surgical consultation early.
- Examine for: abdominal distension or rigidity, tenderness or guarding on palpation, presence of blood in urethral meatus (if present, do not catheterise).
- Investigate with: POCUS (EFAST) where available to assess for bleeding into the abdomen (see above). Upright CXR for presence of free air under diaphragm indicating perforated bowel.
- Treatment: decompress stomach with NGT if not contraindicated. Refer for surgical exploration or intervention where possible.

Pelvic trauma

- Fracture of the pelvic bone causes massive internal bleeding and there may be injury to the bladder and bowel.
- Examine: palpate for tenderness by gentle bilateral compression of the iliac crests from lateral to medial. Assess for abnormal or asymmetric motion, crepitus, and/or pain. Check urethral meatus for blood and perform rectal exam.
- Investigate: Pelvic x-ray to check for fracture of pelvic ring. POCUS (EFAST) where available to look for free intraabdominal fluid (bleeding).
- Treatment: treat shock (see Section 2.2) and give analgesia (see Chapter 15, Section 15.4). Apply pelvic stabiliser (correct level is at anterior superior iliac spines).
- Refer for surgery if open fracture.

2.8 Head injury

Common presentation to emergency departments, of which majority are minor head injuries but few may have intracranial injury. The patterns of head injury in children differ to those in adults: developmental level of the child, anatomical variations in the brain/head, the possibility of inflicted head injury, and the response of the child's brain to trauma. Delay in diagnosis and intervention can have significant consequences on patient outcomes, but given the difficulties in accessing neuroimaging and risks of exposure to radiation, the approach needs to be systematic and based on risk stratification.

2.8.1 Assessment and initial management

- Perform primary survey and manage ABCDE as necessary (see Section 2.7.1 and Section 2.1.2).
- If unconscious or vomiting recurrently, insert NGT (or OGT if concern of basal skull fracture). Leave on free drainage, keep NBM until alert and stable.
- Once primary survey completed and any life-threatening conditions stabilised, perform secondary survey:
  - Take a thorough history:
    - Details regarding the time and mechanism of injury.
    - Recall of events including any loss of consciousness, seizures, behaviour and activity since injury.
    - Identify any co-morbidities that predispose to intracranial injury.
  - Complete full clinical examination from head-to-toe including complete neurological examination (see Chapter 7, Section 7.2).
  - Palpate for bogginess or swelling of the scalp.
  - Look for signs of basal skull fractures such as Battle's sign or Panda eyes.
  - Examine for haemotympanum or CSF leak from ears or nose.
- Consider **an inflicted head injury** when there are any of the following features:
  - Inadequate history provided for a serious head injury.
  - A serious head injury after a reportedly minor fall/injury.
  - Significant change in history between parents/carers or over time.
  - An unreasonable delay in presentation.
  - Any sub-conjunctival or retinal haemorrhage.
  - Any other unexplained injuries.

Risk stratification

Use risk stratification to guide management (Table 2.3). A high index of suspicion is required for younger children due to the difficulty in clinical assessment. Children aged less than 1 year are at particular risk and need to be assessed very carefully. There is also a greater risk of inflicted injury in this age group. Patients in the high-risk group are more likely to have a significant intra-cranial injury that would require neurosurgical intervention therefore referral is indicated.

Table 2.3 - Risk stratification in children with head injury

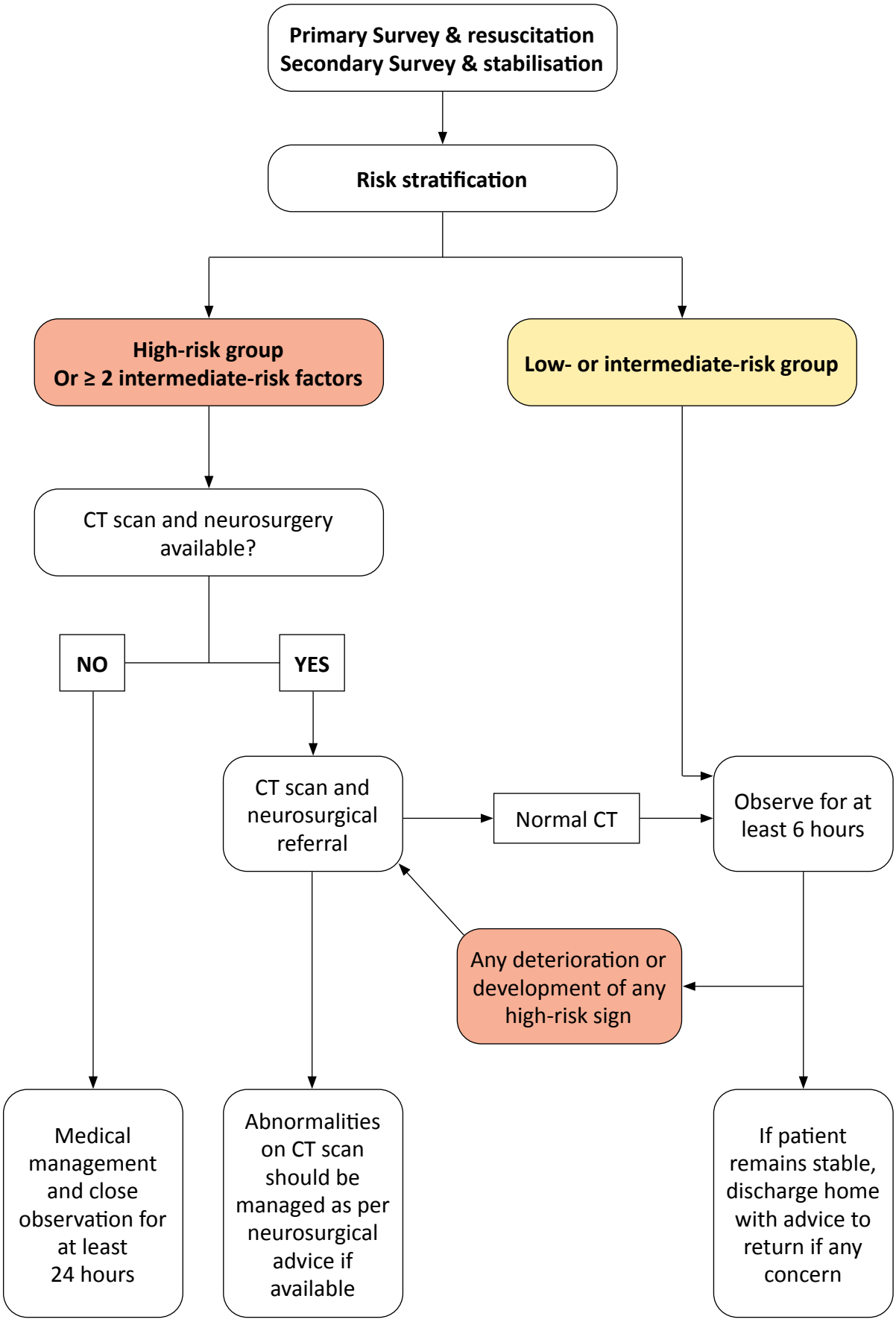
	Low risk	Intermediate risk*	High risk
Mechanism of injury	Low-mod speed MVA[a] Fall 0 to 3 m	High-speed MVA Fall > 3 m	
Injury	Nil injury seen Laceration < 5 cm	Laceration > 5 cm	Tense fontanelle (< 1 year) Open skull fracture Depressed skull fracture Any sign of basal skull fracture: • Haemotympanum • "Panda eyes" • CSF leak from nose/ear • Battle's sign
Level of consciousness (LOC)	Alert/normal (GCS 15 or A on AVPU)		Persistently reduced or fluctuating LOC (GCS < 15 or V,P,U on AVPU)
Neurological deficit	Nil		Any focal neurological sign
Loss of consciousness	Nil or < 5 minutes	> 5 minutes	
Behaviour	Normal or mild agitation	Severe agitation or drowsiness	
Seizures	Nil		Yes (in non-epileptic)
Vomiting	< 2 episodes	> 2 episodes	
Headache	Nil or mild	Persistent	
Co-morbidities	Nil	Bleeding disorders Intra-cranial shunt AV malformations	

* Patients with 2 or more intermediate-risk features are classified in the HIGH-RISK GROUP.

Note: The following features signify poor prognosis and referral is not recommended:
– Unresponsive pupils and GCS < 5 or U on AVPU.
– Reduced LOC with GCS < 9 or P or U on AVPU at 24 hours or more.

a MVA – motor vehicle accident

Figure 2.11 - Overview of management of children with head injury



2.8.2 Management

See also Figure 2.11, page 61 for management algorithm.

Low- and intermediate risk

– Admit for close observation for at least 6 hours.

High-risk or ≥ 2 intermediate risk

– Refer for CT scan and neurosurgical consultation, where available. Stabilise child prior to transfer.
– If CT scan not possible, admit for close observation in a high dependency unit, where available, and provide supportive management for minimum 24 hours.

Observation

– Evaluate and record vital signs and level of consciousness:
  • HR, RR, BP and SpO_2
  • Temperature
  • Level of consciousness (GCS or AVPU)
  • Pupillary response and size
– Pain assessment
  • High risk: every 30 minutes for 2 hours, then every hour if stable
  • Low/intermediate risk: every hour
– Monitor BGL at least every 4 hours.
– Clinical signs of deterioration include:
  • Decrease in level of consciousness.
  • Development of severe or increasing headache, or persistent vomiting.
  • Development of agitation or abnormal behaviour including new confusion or hallucinations.
  • Any seizure activity.
  • Any focal neurological sign.
  • Clinical signs consistent with raised intracranial pressure or herniation:
    ▷ Cushing's triad – hypertension, bradycardia and irregular respirations.
    ▷ Extensor posturing or hemiparesis.
    ▷ Pupillary signs – sluggish reaction, or unilateral/bilateral pupillary dilation.

Where possible, ensure all children admitted with head injury are seen by an experienced senior clinician.

Supportive management

– Nurse at 30 degrees and keep head in midline.
– Temperature: aim for normothermia and avoid hyperthermia at all times.
– Repeated vomiting: administer **ondansetron** IV or PO: 0.15 mg/kg.
– Seizures: follow treatment algorithm for seizures (Chapter 7, Section 7.2). Consider seizure prophylaxis by starting maintenance treatment in high-risk cases.
– Analgesia: if necessary, give paracetamol or ibuprofen. If pain level higher give stronger analgesia, taking into account the level of consciousness of the child. See Chapter 15, Section 15.4 for more detail on pain management.
– If IV fluids are necessary, administer IV maintenance fluids restricted to 70% of usual maintenance volume[b] given the risk of cerebral oedema (see Chapter 15, Section 15.2).

b Increased ADH secretion can cause water retention, leading to fluid overload.

- Monitor BGL and treat hypoglycaemia (BGL < 3.3 mmol/L or < 60 mg/dL) with 2 mL/kg of **glucose** (**dextrose**) **10%** IV/IO over 2-3 minutes, or 10 mL/kg via NGT. See Chapter 9, Section 9.3 for further detail on ongoing management of hypoglycaemia.
- Keep NBM if possible neurosurgical intervention (high risk patients under observation). Do not insert an NGT if concern of basal skull fracture.
- Administer antibiotic treatment (**cefazolin** and **metronidazole**) for penetrating head injury. Start immediately but do not delay referral.
- Monitor blood electrolytes, if available.
- Deep vein thrombosis (DVT) prophylaxis is not recommended in children.

2.8.3 Raised intracranial pressure

If signs of raised intracranial pressure are evident, consider treatment with hyperosmolar fluid (staff should be trained and experienced in its administration). Use prior to referral as a bridge before neurosurgery.

First line: hypertonic saline (preferred due to safety of administration and monitoring)

hypertonic saline (**NaCl 3%**) IV: 5 mL/kg over 5 to 10 minutes

Alternative: mannitol[28,29]

mannitol 20% IV: 5mL/kg over 20 to 30 minutes

If hyperosmolar therapy is commenced, a urinary catheter should be inserted to monitor urine output closely and electrolytes should be monitored, if possible.

2.8.4 Discharge criteria

- Low/intermediate risk or high-risk with normal CT scan:
  - After minimum 6 hours of observation, child remains asymptomatic with normal neurological examination.
  - If any symptoms persist beyond 6 hours, monitor for at least 24 hours until symptoms resolved.
- If severe concussive symptoms, monitor for at least 48 hours.
- High-risk but no CT scan available:
  - After minimum 24 hours of observation, child has been asymptomatic with normal neurological examination for the last 12 hours.
- Ensure parents/carers are informed of the danger signs and significance of changing symptoms, including when to seek urgent review.

2.9 Poisoning

Poisoning or intoxication of a child may occur due to ingestion, inhalation or exposure to a natural or chemical substance. A poisoned child may be asymptomatic or in a life-threatening condition. Initial management is to stabilise the child and to try to identify the toxin involved, provide supportive care, decontaminate to prevent further absorption of the toxin, and where possible, to give an antidote or specific treatment for the identified toxin.

Common substances or situations to consider:
- Drugs: paracetamol, ibuprofen, codeine (in cough syrups), phenobarbital, morphine, diazepam.
- In small children: accidental ingestion of a drug or toxic substance is most common, or inappropriate administration of prescribed or over-the-counter medicines.
- In older children: intentional drug overdose or recreational drugs should be considered.
- In contexts with traditional medical practices: consider toxicity due to administration of traditional medicines (often plant based with plant toxic effects).
- Environmental: pesticides[a], heavy metals (lead), corrosives (bleach), insecticides (organophosphates, cholinergic agents) and carbon monoxide.
- Food-borne (mycotoxins/aflatoxin[b]). Incorrectly prepared foods such as Konzo disease from insufficiently processed bitter cassava.
- Household products, toxic alcohols (methanol, ethylene glycol, ethanol).

Contact a local or national poisons centre where available. Advice is also available from the WHO International Programme on Chemical Safety poisons centres sources[30,31,32].
A global Poisons Centres Directory can be accessed at: https://www.who.int/data/gho/data/themes/topics/indicator-groups/poison-control-and-unintentional-poisoning.

2.9.1 Diagnosis and approach to the suspected poisoned child

The child's condition can range from stable and asymptomatic to life-threatening, depending on the nature of the toxin(s), the severity of the poisoning and the phase of poisoning the child is in. Diagnosis and management should be approached by the clinical condition of the child and based on the signs and symptoms.

Try to identify the toxin

Specific history
- Type of drug/toxin given, administered or taken.
- What time?
- Amount?
- Other substances taken (other drugs, herbs, etc.)
- Underlying health problem or condition.

a Various pesticides used in agriculture and insecticides cause both intentional and unintentional poisoning.

b It is estimated that 25% of the world's crops are affected by mould or fungal growth. Mycotoxin (especially aflatoxin) poisoning (sometimes acute) is a real public health concern.

Clinical examination

– Full clinical examination (see Chapter 1, Section 1.3).
– Look for specific signs and symptoms that may indicate poisoning:

System	Signs or symptoms
General	Temperature instability, hypoglycaemia
Neurological	Altered mental status or level of consciousness Agitation, disorientation, hallucinations Seizures Abnormal muscle tone, presence of clonus, increased reflexes, diminished motor response Abnormal pupillary reactivity and ocular movements
Cardiovascular	Bradycardia, tachycardia, prolonged CRT, hypo- or hypertension, arrhythmias
Gastrointestinal	Hypo- or hyperactive bowel sounds, abdominal pain, diarrhoea, nausea, vomiting, signs of GI bleeding
Respiratory	Tachypnoea, bradypnoea, breath odour, wheezes, stridor, rhonchi, crackles
Liver	Jaundice, hepatomegaly, bleeding
Renal	Oliguria, haematuria, metabolic acidosis
Skin	Dry/moist, flushed/pale, blisters/macules
Mouth	Salivation, laryngeal oedema, oral ulcers, oral and pharyngeal pain, mucous membranes (dry/moist)
Eyes	Dilated pupils (mydriasis), constricted pupils (miosis)

Investigations

– FBC, Hb, BGL
– Electrolytes, serum bicarbonate, urea and creatinine, if available
– Urine dipstick
– ECG, if available
– Chest x-ray, if suspected inhalational exposure
– Toxicology, if available

2.9.2 Initial management and approach

Following initial resuscitation, whether the toxic agent(s) is identified or not, the key to good management of the child is attentive supportive treatment and the prompt reduction of the absorption of the poison.

Initial management and stabilisation

– Assess ABCDE and resuscitate as needed (see Section 2.1).
– Open and secure airway with adjuncts if necessary.
– If feasible, place in recovery position to prevent any aspiration (especially if vomiting).

- Administer high-flow oxygen via face mask, aiming to maintain SpO_2 > 94%. Treat with 100% oxygen if suspected carbon monoxide poisoning (e.g. burns, found by heating device); altered mental state, 'reddish' skin and lips.
- Get IV or IO access. If signs of circulatory impairment, treat as shock (see Section 2.2).
- Check BGL and treat hypoglycaemia. See Chapter 9, Section 9.3.
- Manage seizures (see Chapter 7, Section 7.2).
- Consider decontamination if appropriate: for potentially life-threatening ingestions or skin exposure, refer to Section 2.9.4.

Evaluate the phase of the poisoning

Based on history obtained and clinical signs and symptoms, whether toxin known or not, try to assess the phase of acute poisoning the child is in to guide management:

- Pre-clinical phase: after exposure but before the development of signs and symptoms. Treatment is guided by the history and is aimed at reducing or preventing the predicted toxicity.
- Toxic phase: the period from the onset to the peak of clinical symptoms of toxicity. The treatment objectives are to shorten the duration and lessen the severity of toxicity. Treatment is guided largely by clinical examination.
- Resolution phase: the period from peak toxicity to recovery.

2.9.3 Toxic agent not known: the toxidromic approach[33,34]

When the toxic agent(s) is not known or cannot be identified, try to identify whether specific signs and symptoms correspond to a toxidrome (see Table 2.4). A toxidrome is a syndrome caused by excessive levels of toxin in the body, for example, cholinergic or muscarinic toxidrome. Recognising the toxidrome the child is presenting may help identify the possible toxic agent.

Specific treatment, where available, corresponding to the toxidrome should be given as an adjunct to supportive treatment.

Supportive treatment

- Reassess ABCDE and the child's clinical condition regularly and provide supportive treatment accordingly.
- Protect airways, be particularly attentive in children with reduced consciousness or absence of cough reflex.
- Administer oxygen if necessary, aiming to maintain SpO_2 between 94% - 98%.
- Keep in recovery position and aspirate gastric contents if necessary. Keep NBM until alert.
- Close observation with vital sign monitoring. When clinically indicated and available, repeat ECG every 6 to 12 hours.
- Start IV maintenance fluids while NBM to ensure adequate hydration. If there are signs of impaired circulation, treat for shock (Section 2.2).
- Monitor temperature (treat fever with paracetamol if able to confirm paracetamol was not source of poisoning or no signs suggestive of liver failure such as bleeding).
- Assess urine output. If there are signs of urinary retention, insert urethral catheter carefully.
- If aspiration of gastric contents suspected, start IV antibiotic treatment for pneumonia (Chapter 4, Section 4.5.3).

Specific management

– Seizures: treat with benzodiazepines (see Chapter 7, Section 7.2).
– Clinical signs or suspicion of muscarinic toxidrome: administer **atropine**.
– Clinical signs or suspicion of cytotoxic toxidrome: administer **hydroxocobalamine** IV: 70 mg/kg (maximum 5 g) over 15 minutes and **sodium thiosulphate** IV: 400 mg/kg (1.6 mL/kg) maximum 50 mL (25% solution) where available.

Management of gastritis or gastrointestinal haemorrhage

– Keep NBM for 24 hours from the time of suspected ingestion or the time symptoms indicating gastritis or gastrointestinal haemorrhage developed.
– If no signs of further bleeding after 24 hours, introduce oral fluids and monitor over 24 hours. If this is well tolerated, solid food can be reintroduced.
– Administer **omeprazole** IV: 0.5 mg/kg slow IV (over 5 minutes) once daily.
– Once tolerating solid food, change to **omeprazole** PO: 10 mg (weight < 20 kg) or 20 mg (weight ≥ 20 kg) once daily for 10 days.

Management of hepatic toxicity

– Signs of hepatotoxicity include coagulopathy, encephalopathy, hepatomegaly, and jaundice.
– Administer IV acetylcysteine in an intensive care unit where possible.

> **acetylcysteine** IV: 300 mg/kg in glucose (dextrose) 5% IV perfusion total over 20 hours
> • Loading dose: 200 mg/kg over 4 hours
> • Followed by 100 mg/kg over next 16 hours
> Monitor carefully. Anaphylaxis may occur, particularly in children with a history of asthma.

– Monitor for signs of coagulopathy (bruising, bleeding, prolonged bleeding time). Only in the case of active bleeding, administer a single dose of **vitamin K** slow IV: 1 to 2 mg in infants or 5 mg in children ≥ 12 months.
– Avoid antiplatelet and hepatotoxic drugs (NSAIDS, ibuprofen, paracetamol).
– Administer IV omeprazole as a precaution and treatment of gastrointestinal haemorrhage (see above).
– Monitor BGL regularly and treat hypoglycaemia. See Chapter 9, Section 9.3.
– If signs of hepatic encephalopathy develop, lactulose may be given:

> **lactulose** PO: < 1 year: 2.5 mL 2 times daily; ≥ 1 year: 10 to 30 mL 3 times daily

Table 2.4 - Toxidrome by drug groups[35]

Drug group	Common signs	Common causative agents
Anticholinergic (antimuscarinic)	Delirium, tachycardia, dry flushed skin and mucosa, dilated pupils, myoclonus, raised temperature, urinary retention, decreased bowel sounds. Seizures and dysrhythmias in severe cases.	Antihistamines, antipsychotics, antispasmodics, atropine, cyclic anti-depressants, belladonna alkaloids[c], toxic mushrooms

c Belladona plant also known as deadly nightshade, including the Datura species.

Drug group	Common signs		Common causative agents
Cholinergic (muscarinic and nicotinic receptor stimulation)	*Muscarinic toxidrome* DUMBELS: • **D**iaphoresis • **U**rination • **M**iosis • **B**ronchorrhoea, bradycardia, bronchospasm • **E**mesis • **L**acrimation • **S**alivation, Sweating	*Nicotinic toxidrome* MTWtHFSS (days of the week in English): • **M**ydriasis • **T**achycardia • **W**eakness • **H**ypertension • **F**asciculations • **S**eizures • **S**omnolence	Organophosphates, pesticides, nerve agents, tobacco, liquid nicotine, some mushrooms
Cytotoxics	Delayed abdominal pain, nausea, vomiting, altered mental status, seizures, cardiovascular collapse, lactic acidosis, multisystem organ failure.		Cyanogenic glycosides (e.g. poorly processed cassava)
Opioids	Sedated, respiratory depression, bradycardia, hypotension, hypothermia, constricted pupils.		Morphine, codeine, fentanyl, methadone
Sedatives Hypnotics	Reduced mental state, but mostly normal vital signs. Possible reduced RR and hypoglycaemia.		Barbiturates, benzodiazepines, ethanol, amitraz (pesticide).
Sympathetic nervous system stimulants	Tachycardia (or bradycardia), hypertension, dysrhythmias, dilated pupils, delirium, delusions, paranoia, hyperreflexia, seizures, raised temperature, diaphoresis, piloerection.		Amphetamines, cocaine, decongestants, ephedrine, methamphetamines, salbutamol

2.9.4 Decontamination

Skin decontamination in case of skin exposure (e.g. pesticides)

– Remove contaminated clothing and place in sealed plastic bag.
– Flush exposed areas with lukewarm water for minimum 20 minutes.

Eye decontamination

– Flush each eye with lukewarm water or **sodium chloride 0.9%** (≥ 1 L/eye) for 10-15 minutes.
– Refer to ophthalmologist, if available, for examination of the cornea.

Gastrointestinal decontamination in case of toxin ingestion

This has a limited role in most cases of intoxication, particularly when presentation is delayed or timing of ingestion is unclear. Before initiation it is important to consider the risk/benefits of the intervention and discuss with a senior clinician if available. Induced vomiting is contraindicated and gastric lavage is no longer recommended. Other methods should only be considered in a conscious patient that is not at imminent risk of seizures.

Gastric aspiration

This is rarely performed unless child has taken a very toxic substance or is intubated.
– If the child is not intubated, place the child in an upright position.
– Using a larger sized NGT (conical tip) with respect to the size of the child, suction any oral secretions and aspirate gastric contents gently.

– Look for signs of the toxic substance within the gastric aspirates.
Caution: if possible caustic ingestion, aspiration or suctioning is contraindicated.

Absorption with activated charcoal[36]

The most effective way to decontaminate a child with moderate to severe poisoning is activated charcoal, which can bind most therapeutic drugs and reduce further absorption from the gastrointestinal tract. However, metals (including iron substances), corrosives, hydrocarbons (gasoline, kerosene) and alcohols are poorly adsorbed by activated charcoal.

Activated charcoal:
– Can be administered up to 4 hours post ingestion.
– Is contraindicated in a child with reduced level of consciousness (unless intubated).
– Is contraindicated in gastrointestinal haemorrhage or corrosive ingestion.

⚠ Use with caution: aspiration of activated charcoal can cause significant morbidity and even mortality. If giving via NGT, strictly confirm the tube is in the correct position first.

Give **activated charcoal** as soon as possible, within 4 hours of ingestion or if toxic substance is found during stomach aspiration:

activated charcoal PO/NGT, give slowly to reduce risk of vomiting
- < 1 year: 1 g/kg, once
- 1 to 12 years: 1 to 2 g/kg or 25 to 50 g/dose (maximum 50 g), once
- > 12 years: 50 to 100 g/dose, once

Add a minimum of 240 mL of drinking water with 20 to 30 grams of charcoal and mix well until smooth. If necessary, juice or ice-cream can be added to improve taste. 1 tablespoon of charcoal powder = 30 grams.

2.9.5 Toxic agent known: specific treatment

Consult a local or national poisons information centre as soon as possible, where this is available. For some drugs or agents that can lead to poisoning, specific antidotes may be available (refer to Table 2.5, page 70).

Paracetamol overdose

– Administer **activated charcoal** if within 4 hours of ingestion[37]. Activated charcoal may be less effective in younger children if liquid paracetamol was consumed.
– Where possible, measure serum paracetamol levels.
– Administer IV **acetylcysteine** (as above) as an antidote in the following cases:
  - Known toxic ingestion: acute ingestion of ≥ 200 mg/kg or repeated supratherapeutic ingestion of > 100 mg/kg/day, or
  - Signs of hepatic toxicity.

Methanol

Refer to MSF Methanol Poisoning protocol.
– Metabolite (formic acid) is highly toxic and responsible for metabolic acidosis.
– Contamination of traditional beverages (intentional or unintentional).
– History: consumption of household products (e.g. windshield liquid wash) or traditionally made alcoholic contaminated beverages.

– Key signs: tachypnoea (acidosis), blurred vision, abdominal pain, nausea, vomiting; can lead to blindness, coma, death.
– If symptomatic, administer **ethanol** (via NGT) which will compete with methanol.

Morphine or codeine-based drugs

Refer also to MSF Perioperative Management of Surgical/Trauma Pain protocol.
– Excessive sedation is the first sign of morphine overdose, followed by respiratory depression.
– If intoxication occurs during morphine-based treatment, stop morphine treatment and stimulate verbally and via tactile stimulation.
– Start supportive treatment with oxygen and bag-mask ventilation if necessary.
– Naloxone is a morphine antagonist and is indicated in patients who cannot be aroused and/or have significant respiratory depression (respiratory pauses, apnoea) despite stimulation.
– In cardiorespiratory collapse, begin CPR immediately and call for help (see Section 2.1.1).

Organophosphates

Refer to MSF Exposure to Chemical Agents Manual.

Table 2.5 - Specific antidotes for common toxins

Substance/toxin	Specific antidote
Benzodiazepines	**flumazenil** IV: 10 micrograms/kg every 1 minute if required (max. dose 200 micrograms) up to 5 times
Beta-blockers	If bradycardia: **atropine** IV: 40 micrograms/kg (max. 3 mg per dose) If cardiogenic shock, no response to atropine, administer **glucagon** IV: 50-150 micrograms/kg (max. 10 mg per dose) in **glucose** (**dextrose**) **5%**. Then IV infusion of 50 micrograms/kg/hour.
Calcium-channel blockers	**calcium** **insulin/glucose**
Iron (> 40 mg/kg of elemental iron)	Iron chelation if available: **desferrioxamine** IV: 15 mg/kg/hour until serum iron < 60 micromol/L or asymptomatic
Isoniazid	**pyridoxine**
Methanol	**ethanol** or **fomepizole** and bicarbonate (see MSF Methanol Poisoning protocol).
Narcotics Morphine or codeine-based drugs	**naloxone** IV: 5 micrograms/kg (0.25 mL/kg)[d] repeated every 1 to 2 minutes until: RR > 20 in < 1 year; RR > 15 in 1-5 years; RR > 10 in > 5 years; and child is **awake**. If life-threatening effects of opioid overdose (e.g. apnoea), **naloxone** IV: 100 micrograms/kg (max. 2 mg).
Organophosphates (insecticides) or nerve agent Certain mushrooms (cholinergic syndrome)	**atropine** IV: 20 micrograms/kg every 5 to 10 minutes until skin flushed and dry, pupils dilate, bradycardia resolved.
Paracetamol (> 200 mg/kg acute ingestion, or > 100 mg/kg/day for > 72 hrs)	**acetylcysteine** IV: Loading dose: 200 mg/kg over 4 hours, followed by 100 mg/kg over next 16 hours

d Dilution: 1 vial of 0.4 mg naloxone + 19 mL normal saline = 20 micrograms/mL

2.9.6 Prevention

Medicines are the most common product that causes accidental poisoning in children, and particularly so in children under 5 years of age[38]. This can be avoided by ensuring that medicines are not left in a place where children can reach them. Medicines should be stored safely in a place that can be locked or cannot be accessed by children. If available, ask for containers with child-proof caps. Dispose of any medicines that have expired.

Traditional medicine

If there are multiple cases of suspected poisoning from the use of traditional medicines, try to identify the products and/or practices that are potentially harmful.

References Chapter 2

1. Van De Voorde P, Turner NM, Djakow J, et al. European Resuscitation Council Guidelines 2021: Paediatric Life Support. *Resuscitation*. 2021;161:327-387. https://doi.org/10.1016/j.resuscitation.2021.02.015
2. Houston KA, George EC, Maitland K. Implications for paediatric shock management in resource-limited settings: a perspective from the FEAST trial. *Crit Care*. 2018;22(1):119. https://doi.org/10.1186/s13054-018-1966-4
3. Kleinman ME, Chameides L, Schexnayder SM, et al. Part 14: Pediatric Advanced Life Support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2010;122(18_suppl_3). https://doi.org/10.1161/CIRCULATIONAHA.110.971101
4. 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):2483-2495. https://doi.org/10.1056/NEJMoa1101549
5. Weiss SL, Peters MJ, Alhazzani W, et al. Surviving sepsis campaign international guidelines for the management of septic shock and sepsis-associated organ dysfunction in children. *Intensive Care Med*. 2020;46(S1):10-67. https://doi.org/10.1007/s00134-019-05878-6
6. Maitland K, Olupot-Olupot P, Kiguli S, et al. Transfusion Volume for Children with Severe Anemia in Africa. *N Engl J Med*. 2019;381(5):420-431. https://doi.org/10.1056/NEJMoa1900100
7. Muraro A, Roberts G, Worm M, et al. Anaphylaxis: guidelines from the European Academy of Allergy and Clinical Immunology. *Allergy*. 2014;69(8):1026-1045. https://doi.org/10.1111/all.12437
8. Simons FER, Clark S, Camargo CA. Anaphylaxis in the community: Learning from the survivors. *J Allergy Clin Immunol*. 2009;124(2):301-306. https://doi.org/10.1016/j.jaci.2009.03.050
9. Tanno LK, Bierrenbach AL, et al. Critical view of anaphylaxis epidemiology: open questions and new perspectives. *Allergy Asthma Clin Immunol*. 2018;14(1):12. https://doi.org/10.1186/s13223-018-0234-0
10. Simons FER, Ebisawa M, Sanchez-Borges M, et al. 2015 update of the evidence base: World Allergy Organization anaphylaxis guidelines. *World Allergy Organ J*. 2015;8:32. https://doi.org/10.1186/s40413-015-0080-1
11. Cardona V, Ansotegui IJ, Ebisawa M, et al. World Allergy Organization Anaphylaxis Guidance 2020. *World Allergy Organ J*. 2020;13(10):100472. https://doi.org/10.1016/j.waojou.2020.100472
12. Simons FER, Ardusso LRF, Bilò MB, et al. World Allergy Organization anaphylaxis guidelines: Summary. *J Allergy Clin Immunol*. 2011;127(3):587-593.e22. https://doi.org/10.1016/j.jaci.2011.01.038
13. Emergency treatment of anaphylactic reactions: Guidelines for healthcare providers. Accessed November 7, 2023. https://www.resus.org.uk/library/additional-guidance/guidance-anaphylaxis/emergency-treatment

14. Kemp SF, Lockey RF, Simons FER, on behalf of the World Allergy Organization ad hoc Committee on Epinephrine in Anaphylaxis. Epinephrine: the drug of choice for anaphylaxis. A statement of the World Allergy Organization. *Allergy*. 2008;63(8):1061-1070. https://doi.org/10.1111/j.1398-9995.2008.01733.x

15. MedicinesComplete — CONTENT > BNF for Children > Drug: Hydrocortisone. Accessed November 7, 2023. https://www.medicinescomplete.com/#/content/bnfc/_164174358?hspl=hydrocostisone

16. Drowning. Accessed November 7, 2023. https://www.who.int/news-room/fact-sheets/detail/drowning

17. Global Health Estimates. Accessed November 7, 2023. https://www.who.int/data/global-health-estimates

18. World Health Organization. *Global Report on Drowning: Preventing a Leading Killer*. World Health Organization; 2014. Accessed November 7, 2023. https://iris.who.int/handle/10665/143893

19. World Health Organization. *Preventing Drowning: An Implementation Guide*. World Health Organization; 2017. Accessed November 7, 2023. https://iris.who.int/handle/10665/255196

20. Tipton MJ, Golden FStC. A proposed decision-making guide for the search, rescue and resuscitation of submersion (head under) victims based on expert opinion. *Resuscitation*. 2011;82(7):819-824. https://doi.org/10.1016/j.resuscitation.2011.02.021

21. Schmidt AC, Sempsrott JR, Hawkins SC, Arastu AS, Cushing TA, Auerbach PS. Wilderness Medical Society Practice Guidelines for the Prevention and Treatment of Drowning. *Wilderness Environ Med*. 2016;27(2):236-251. https://doi.org/10.1016/j.wem.2015.12.019

22. World Health Organization. *Injuries and Violence: The Facts 2014*. World Health Organization; 2014. Accessed November 7, 2023. https://iris.who.int/handle/10665/149798

23. Peden M, World Health Organization. World report on child injury prevention. Published online 2008:211. Accessed November 7, 2023. https://iris.who.int/handle/10665/43851

24. Primary Trauma Care Course Manual for Trauma Management in Locations with Limited Resources. Published online December 22, 2015. Accessed November 7, 2023. https://www.primarytraumacare.org/get-involved/download-resources/

25. Crisp S, Rainbow J. *Emergencies in Paediatrics and Neonatology*. OUP Oxford; 2013.

26. World Health Organization. *Pocket Book of Hospital Care for Children: Guidelines for the Management of Common Childhood Illnesses*. 2nd ed. World Health Organization; 2013. Accessed November 7, 2023. https://iris.who.int/handle/10665/81170

27. Dykes EH. Paediatric trauma. *Br J Anaesth*. 1999;83(1):130-138. https://doi.org/10.1093/bja/83.1.130

28. Ropper AH. Hyperosmolar Therapy for Raised Intracranial Pressure. *N Engl J Med*. 2012;367(8):746-752. https://doi.org/10.1056/NEJMct1206321

29. Qureshi AI, Suarez JI. Use of hypertonic saline solutions in treatment of cerebral edema and intracranial hypertension: *Crit Care Med*. 2000;28(9):3301-3313. https://doi.org/10.1097/00003246-200009000-00032

30. Poison control and unintentional poisoning. Accessed November 7, 2023. https://www.who.int/data/gho/data/themes/topics/indicator-groups/poison-control-and-unintentional-poisoning

31. Chemical safety. World Health Organisation. Accessed November 7, 2023. https://www.who.int/health-topics/chemical-safety

32. WHO Study Group on Tobacco Product Regulation. Accessed November 7, 2023. https://www.who.int/groups/intox-network-of-poisons-centres

33. Diaz JH. Poisoning by Herbs and Plants: Rapid Toxidromic Classification and Diagnosis. *Wilderness Environ Med*. 2016;27(1):136-152. https://doi.org/10.1016/j.wem.2015.11.006

34. Erickson TB, Thompson TM, Lu JJ. The Approach to the Patient with an Unknown Overdose. *Emerg Med Clin North Am*. 2007;25(2):249-281. https://doi.org/10.1016/j.emc.2007.02.004

35. Harriet Lane Service (Johns Hopkins Hospital), ed. *The Harriet Lane Handbook: A Manual for Pediatric House Officers*. Twenty second edition. Elsevier; 2021.

36. Clinical Practice Guidelines : Use of Activated Charcoal in Poisonings. The Royal Children's Hospital Melbourne. Accessed November 7, 2023. https://www.rch.org.au/clinicalguide/guideline_index/Use_of_Activated_Charcoal_in_Poisonings/

37. Buckley NA, Buckley N, Whyte IM, O'Connell DL, Dawson AH. Activated Charcoal Reduces the Need for N -Acetylcysteine Treatment After Acetaminophen (Paracetamol) Overdose. *J Toxicol Clin Toxicol*. 1999;37(6):753-757. https://doi.org/10.1081/CLT-100102452

38. Mowry JB, Spyker DA, Brooks DE, McMillan N, Schauben JL. 2014 Annual Report of the American Association of Poison Control Centers' National Poison Data System (NPDS): 32nd Annual Report. *Clin Toxicol*. 2015;53(10):962-1147. https://doi.org/10.3109/15563650.2015.1102927

Chapter 3:
Acute febrile illness

3.1 Approach to a child with fever

Fever is a physiological response characterized by an elevation of body temperature above normal daily variation[1]. It is defined as an axillary temperature of over 37.5 °C[a] for all age groups in this guideline[2].

Fever is a common presentation of many paediatric conditions in all age groups. The most common cause is infection. In children up to 3 years of age, around 80% of cases are due to a viral infection, however, the younger the child is, the higher the probability that a fever is due to a severe bacterial infection or sepsis[1]. Non-infectious causes include inflammatory, immune-mediated, and neoplastic conditions. When the cause of a fever of less than one week cannot be identified by history and clinical examination, it is classified as a 'fever without source'[3].

Fever of unknown origin (FUO) is a diagnosis of exclusion and is defined in children as a fever lasting more than one week with negative preliminary investigations (see Chapter 14, Section 14.1).

3.1.1 Identifying underlying cause

Any fever in a child should be considered as a potential symptom of an underlying infectious condition. If there are any signs of severe bacterial infection or sepsis, treat as such (see Section 3.2). In the absence of signs of severity, it is important to try to find the focus of the infection to guide treatment:

- Take a detailed medical history (including social and family history, and history of exposure), including:
  - When did the fever start and what is the pattern of the fever?
  - Have any medicines been given? If yes, which one(s), how much, and how often?
  - Is there fever every day or are there days with no fever?
  - Is the child able to perform their normal daily activities?
  - Has the child been in contact with someone who is unwell?
  - Any travel history in endemic areas for specific infectious diseases (e.g. malaria)?
  - Any insect bites or exposures to animals or abattoirs?
  - Are there associated symptoms and signs? If so, ask about onset, duration, pattern, severity, precipitating and alleviating factors, previous episodes. Table 3.1, page 78, describes commonly associated signs and symptoms and their potential diagnoses. It is not exhaustive and there may be overlap between symptoms of different pathologies, but it may help to guide the clinician to a diagnosis.
- Perform a comprehensive clinical examination (cardiac, respiratory, abdominal, neurological, musculoskeletal, ear, nose and throat (ENT), and skin).
- Consider necessary investigations.
- Check immunisation and nutritional status.

a The definition of fever is generally accepted as a core temperature of more than 38 °C. Axillary temperature is not an accurate reflection of core temperature, therefore the cut-off point is lower. It is recommended to measure temperature when the child is at rest, in a comfortable environment and not wearing excessive clothing. For accurate readings, the thermometer should be placed over the axillary artery for 3 minutes. Rectal temperature is not recommended for hygiene and safety purposes.

Table 3.1 - Potential causes of fever with associated symptoms and signs

Associated symptoms or signs	Potential common causes
Irritability, altered consciousness, meningeal signs, seizures, focal neurologic findings, refusal to feed, bulging fontanelle	Meningitis, meningoencephalitis, severe malaria
Opisthotonos, seizures	Meningitis, tetanus
Lethargy/altered consciousness, poor feeding, vomiting, cold hands and feet, pain/discomfort, tachypnoea, tachycardia, non-blanching skin rash	Sepsis, severe bacterial infection
Unilateral eye swelling, red eyelid	Orbital or peri-orbital cellulitis
Ear pain, ear discharge	Otitis media
Redness and tenderness behind the ear, swelling of ear lobe that sticks out	Mastoiditis
Sore throat, cervical lymphadenopathy, difficulty swallowing, nasal voice, white or grey tonsillar membranes, rash	Streptococcal pharyngitis, diphtheria, peritonsillar abscess, epiglottitis
Difficulty swallowing, multiple oropharyngeal papular or vesicular lesions	Gingivostomatitis, Coxsackie virus
Rhinorrhea, cough with bilateral chest wheezing, bilateral fine crackles	Viral respiratory infections
Barking cough	Croup
Cough, unilateral decreased breath sounds or crepitations, decreased appetite or vomiting, abdominal pain (if basal pneumonia), chest pain	Pneumonia
Dental ache, unilateral facial swelling	Caries, dental abscess
Chest pain, palpitations, heart murmur, arrhythmia	Pericarditis, myocarditis, endocarditis
Intense abdominal pain, vomiting, diarrhoea or constipation	Appendicitis, peritonitis, enteric fever (especially if relative bradycardia), amoebic/ bacterial liver abscess
Vomiting, diarrhoea	Gastroenteritis, enteric fever

Associated symptoms or signs	Potential common causes
Flank/back pain, dysuria, vomiting (especially in neonates and infants)	Pyelonephritis, urinary tract infections
Jaundice, hepatomegaly	Viral hepatitis, malaria, visceral leishmaniasis
Anaemia	Malaria
Skin macular rash, conjunctivitis, rhinorrhoea, Koplik's spots	Measles
Skin rash	Viral infections (non-specific, rubella, parvovirus, haemorrhagic fevers), Strep A (scarlet fever), varicella
Bleeding signs (epistaxis, gingival bleeding, haematuria), petechiae	Viral haemorrhagic fevers, leukaemia, severe malaria, visceral leishmaniasis, dengue
Skin redness, tenderness, and warmth	Bacterial skin infections (erysipelas, cellulitis), skin abscess
Limping, bone pain, decreased range of limb motion, joint pain or swelling, redness around a joint	Osteomyelitis, leukaemia, septic arthritis
Joint pain, skin rash	Rheumatic disease, dengue, chikungunya
Anaemia, jaundice, generalized body pain	Sickle cell disease, malaria, dengue
Anaemia, hepatomegaly, splenomegaly	Malaria, visceral leishmaniasis

3.1.2 Investigations and management

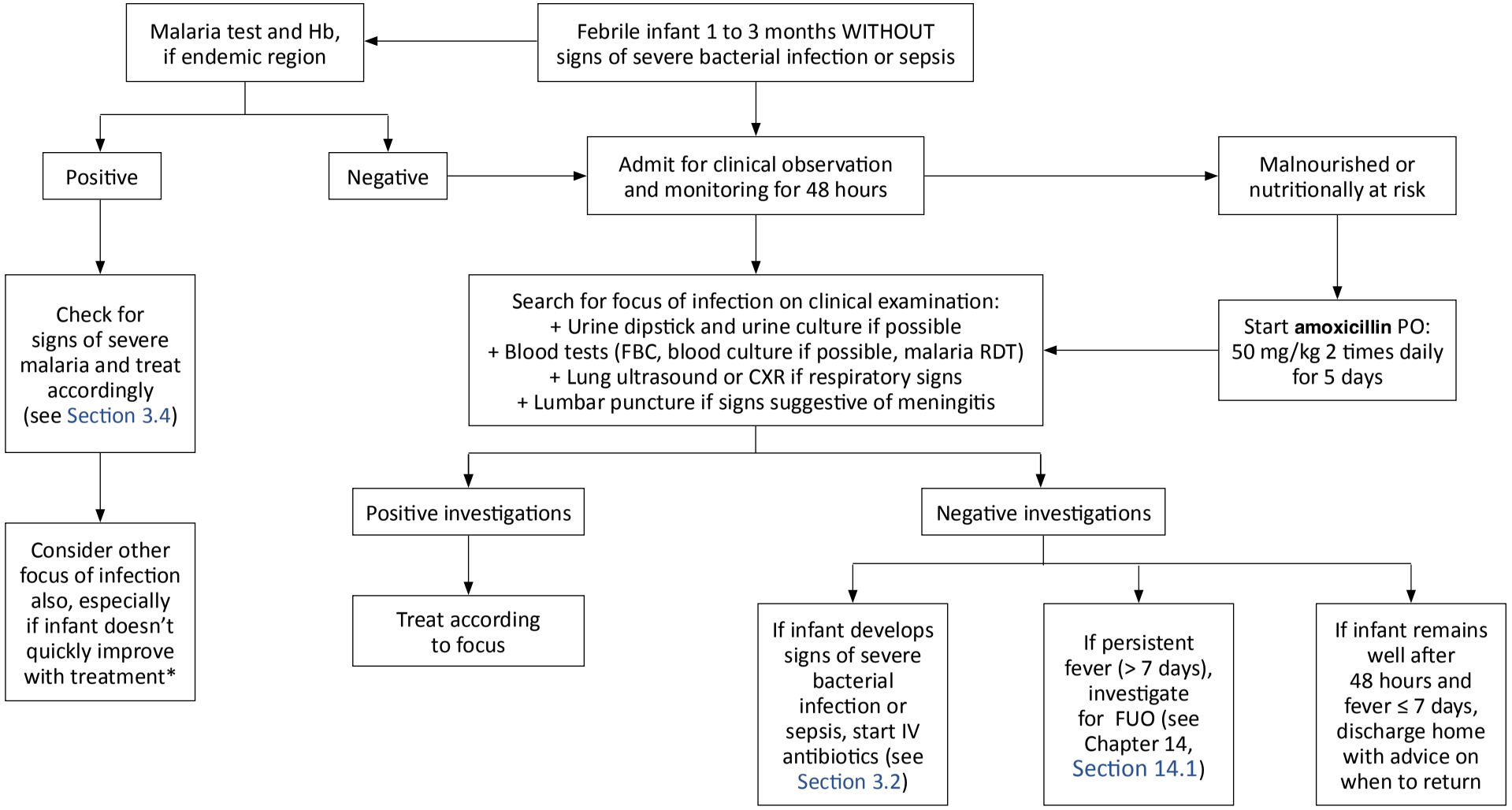
In a child who is febrile and presents with signs of severe bacterial infection or sepsis, see Section 3.2. In a child who is febrile but who does not present with any signs indicative of potential severe bacterial infection or sepsis, manage according to age group:

– < 1 month[b]: treat as a neonatal sepsis (see MSF Neonatal Care Guidelines) and try to identify a source of infection.
– 1 to 3 months: consider as high-risk for serious illness. Perform investigations based on clinical appearance and potential focus of infection (see Figure 3.1, page 80).
– Above 3 months of age: investigate based on clinical appearance and potential focus of infection (see Figure 3.2a page 81 and Figure 3.2b page 82).

These criteria are valid not only for the first clinical approach to the patient, but also for any new onset of fever during the admission period. All admitted children should have vital signs monitored and recorded as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).

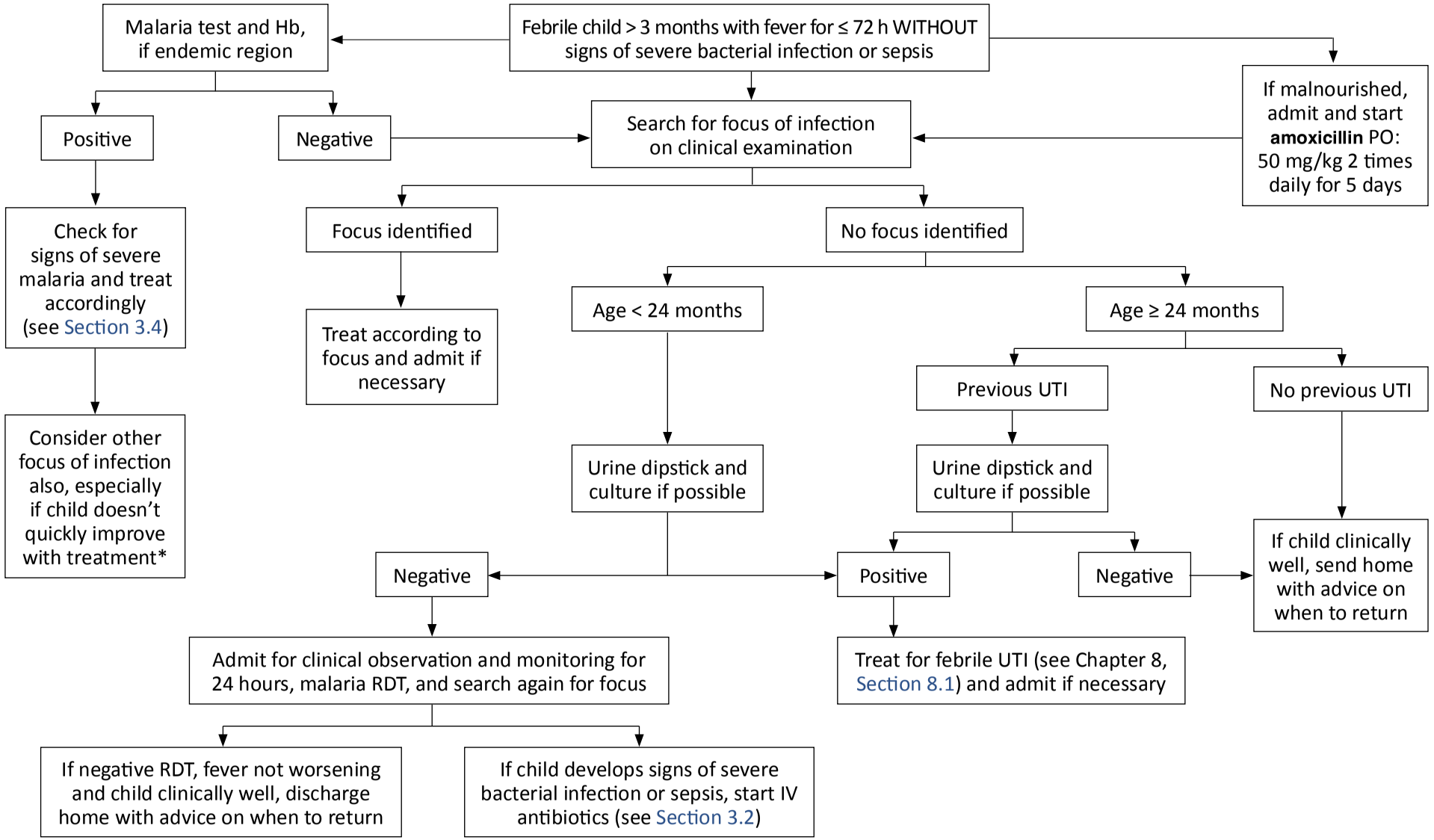
b Note that in this age group severe infections can also present without fever or with hypothermia.

Figure 3.1 - Management of febrile infants 1 to 3 months WITHOUT signs of severe bacterial infection or sepsis



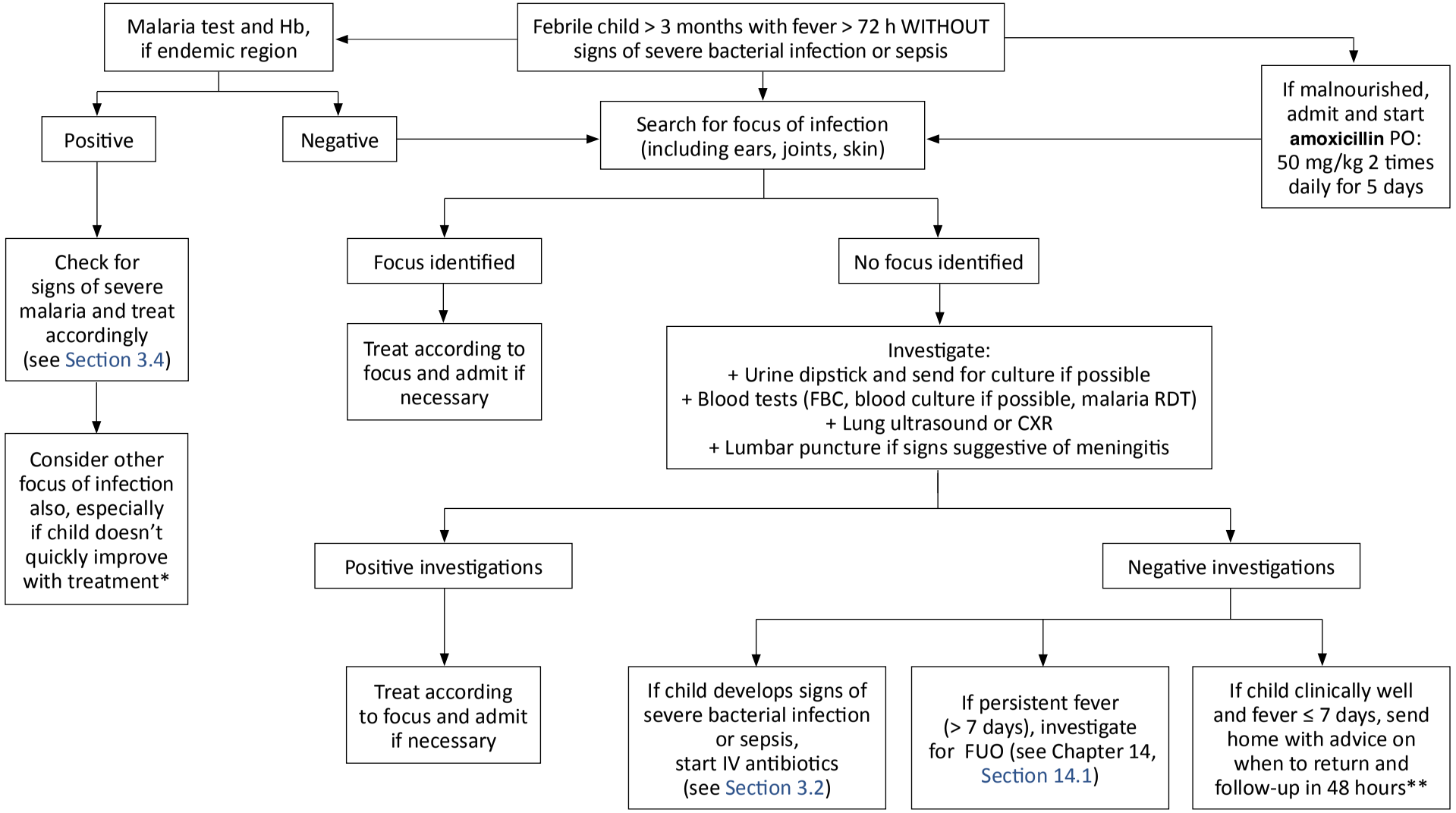
*Children in malaria endemic regions often have concomittant infections

Figure 3.2a - Management of febrile children above 3 months of age WITHOUT signs of severe bacterial infection or sepsis **with fever ≤ 72 hours**



* Children in malaria endemic regions often have concomittant infections.

Figure 3.2b - Management of febrile children above 3 months of age WITHOUT signs of severe bacterial infection or sepsis **with fever > 72 hours**



* Children in malaria endemic regions often have concomittant infections.

** If unable to return for follow-up, consider admission to hospital for observation and monitoring.

On discharge, explain to the parents/carers to seek immediate medical advice or return to hospital if the child develops any of the following signs:

- Neck stiffness or photophobia
- Non-blanching rash
- Skin pallor or cold extremities
- Profuse vomiting and refusing to drink
- Oliguria for more than 12 hours
- Increased lethargy or reduced conscious level
- Inconsolable crying, agitation or pain not relieved by medication
- Breathing difficulties
- Seizures, including febrile seizures
- Persistence or recurrence of fever for more than 3 days

3.1.3 Management of fever

The aim of management is to treat the underlying cause of the fever, not the fever itself[c]. However, if the fever is causing discomfort to the child, it should be managed symptomatically.

Non-pharmacological measures

- Undress the patient.
- Do not wrap children in wet towels or cloths (it increases their discomfort and increases risk of hypothermia).
- Encourage drinking, especially for young infants continue frequent breastfeeding.

Pharmalogical measures

Give paracetamol and/or ibuprofen as antipyretics. Prescribe for maximum of one day and re-evaluate need:

- **paracetamol** PO or via nasogastric tube (NGT): 15 mg/kg (maximum dose 1 g), every 6 to 8 hours as required (maximum 60 mg/kg/day or 4 g/day).
  - In the case of SAM: 10 mg/kg, every 8 hours as required.
  - IV paracetamol should not be used as an antipyretic, but is reserved for analgesia in the case of children who are strictly nil by mouth (NBM).
  - Paracetamol is not recommended in hepatic disorders
- **ibuprofen** PO: 10 mg/kg, every 8 hours as required (maximum 30 mg/kg/day) with milk or food (to reduce the risk of gastrointestinal irritation).
  - In the case of SAM: 5 mg/kg, every 8 hours as required. Do not give in Phase I of nutrition treatment.
  - Do not give to children younger than 6 months or with severe dehydration, renal failure, gastrointestinal bleeding, or haemorragic fevers (including dengue).

⚠ Aspirin (acetylsalicylic acid) should not be used in children as an antipyretic due to the risk of Reye's syndrome.
Use paracetamol and ibuprofen with caution in malnourished children.

c There is no evidence that reducing fever decreases the morbidity or mortality from febrile illness (even malaria) or prevents febrile seizures. Nor is there evidence that fever 40 °C or higher is associated with brain damage.

Important points to remember:
- For any fever in a malaria endemic area, malaria should be ruled out first.
- It may not be possible to find a source of infection during the first 48 hours of a febrile illness.
- Not all fevers are sepsis.
- Teething does not cause fever.
- Response to antipyretics and length of fever do not predict the cause or severity of the infection.
- Febrile seizures are common in young children during febrile illness. A simple febrile seizure is not necessarily indicative of bacteraemia or meningitis (see Chapter 7, Section 7.3 for more information on the assessment and management of febrile seizures).

3.2 Severe bacterial infection or sepsis

Sepsis is a clinical syndrome that usually results from severe bacterial infection, though may also be caused by viruses and fungi. It is an uncontrolled and toxic systemic response that includes inflammation, immune dysfunction, impaired circulation in the capillaries and oxygen deficit. It can lead to multiple organ failure and death within hours in the absence of treatment. Even with prompt and adequate administration of antibiotics, sepsis can be fatal if advanced vital organ support, such as artificial ventilation and inotropic support, is unavailable. Bacteria that commonly cause sepsis include *Neisseria meningitidis*, *Streptococcus pneumoniae*, *Escherichia coli*, *Staphylococcus aureus*, *Salmonella* and *Haemophilus influenza* type B. In infants less than 3 months old, Listeria monocytogenes should also be considered[4]. Although sepsis can also be caused by viruses and fungi, for the purposes of this chapter treatment will be focused on the management of severe bacterial infection (the most common cause of sepsis in projects where MSF works).

3.2.1 Clinical features

Severe bacterial infection or sepsis is diagnosed in any child with fever or hypothermia who is severely unwell with any of the following features:

- **General appearance and behaviour**: reduced activity, poor feeding, no smile, unfocused gaze, unresponsive stare, hypotonia, decreased response to stimuli, lethargy, weak or high-pitched cry.
- **Colour**: mottled appearance, ashen, blue, or pale skin color.
- **Breathing**: difficulty breathing (dyspnoea, tachypnoea, grunting, chest indrawing, nasal flaring) or apnoea
- **Circulation and hydration**: dry mucous membranes, persistent tachycardia despite reduction in fever, central CRT > 3 seconds, weak pulse, cool extremities, reduced skin turgor, reduced urine output.
- **Neurological**: neck stiffness, bulging fontanelle, focal neurological signs, prolonged seizures.
- **Other**: fever for more than 5 days; presence of a non-blanching rash (i.e. petechiae or purpura).

3.2.2 Initial management

Severe bacterial infection or sepsis is a medical emergency. If any of the above signs are present, stabilise and administer antibiotics immediately:

- Call for help.
- Move child to the resuscitation area and assess and manage ABCDE (see Chapter 2, Section 2.1).
- Administer **oxygen**, aiming for SpO_2 between 94 - 98%.

– Get IV access and start empirical antibiotic treatment as soon as possible, depending on availability[a]:

First choice:
ampicillin IV: 50 mg/kg every 8 hours + **gentamicin** IV: 7.5 mg/kg once daily
or **benzylpenicillin** IV: 50 000 IU/kg (30 mg/kg) every 8 hours (max. 4 MIU or 2.4 g/dose) + **gentamicin** IV: 7.5 mg/kg once daily

Second choice:
ceftriaxone IV: 80 mg/kg (max. 4 g if < 50 kg; max. 2 g if ≥ 50 kg) once daily
or **cefotaxime** IV: 50 mg/kg every 8 hours
or **cloxacillin** IV: 25 mg/kg every 6 hours + **amikacin** IV: 15 mg/kg once daily (if infection with *S. aureus* and/or gram-negative bacteria and/or antibiotic resistant bacteria is suspected)

If sepsis with signs of circulatory impairment or shock, treat as septic shock (see Chapter 2, Section 2.2).

3.2.3 Investigations

– FBC (including differential WBC if possible)
– Blood glucose level (BGL)
– C-reactive protein (CRP), if available
– Malaria RDT, if endemic
– Blood culture (especially if purpuric rash is present)
– Urine dipstick, microscopy and culture, if available
– CXR or lung US if respiratory signs
– LP, if available and not contraindicated

3.2.4 Ongoing management

– After initial stabilisation and treatment (see Section 3.2.2), move the patient to an ICU area for further management.
– Provide supportive care as needed (oxygen to maintain saturations 94 - 98%, IV maintenance fluids).
– NBM initially and insert NGT and gradually start enteral feeding after 24 to 48 hours (see Chapter 15, Section 15.5).
– Treat fever (see Section 3.1.3) if needed.
– Monitor and record vital signs and urine output as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
– Provide standard nursing care, especially if the patient is in a coma (including mouth care, positioning, physiotherapy exercises).
– Reassess and adjust antibiotic treatment once the cause is identified or according to blood culture results (where available).

a Empiric treatment with ceftriaxone/cefotaxime may be more appropriate in settings where invasive non-typhoidal *Salmonella* are a major cause of bloodstream infection.

– Duration of antibiotic treatment should be determined by the child's clinical condition and response to treatment. Continue IV/IM treatment for at least 3 days and switch to oral when the child is improving and eating and drinking. IV/IM treatment duration is likely to be longer in younger, sicker children and in malnourished children. When clinically appropriate, switch to **amoxicillin/clavulanic acid** (ratio 7:1 or 8:1) PO. Dosage expressed in amoxicillin:
  - < 40 kg: 50 mg/kg 2 times daily
  - ≥ 40 kg:
    Ratio 8:1: 3000 mg daily (2 tablets of 500/62.5 mg 3 times daily)
    Ratio 7:1: 2625 mg daily (1 tablet of 875/125 mg 3 times daily)

  Total antibiotic treatment should last for 7 - 10 days.
– If there is no improvement with antibiotic treatment, consider viral or fungal causes of sepsis.

3.3 Meningitis and encephalitis

Meningitis is inflammation of the meninges and encephalitis is inflammation of the brain parenchyma. Both are serious diseases which need prompt treatment as they can lead to death or permanent neurological disabilities.

Most cases of meningitis and encephalitis are caused by infections which can be bacterial, viral, fungal, or parasitic. The list of pathogens can vary by context, age, immunisation status, and underlying medical conditions (e.g. severe acute malnutrition, HIV infection, sickle cell disease). Immunisation with *H. influenzae* type B (Hib), pneumococcal conjugate vaccines and Meningococcal ACWY have reduced the incidence of bacterial meningitis where vaccine coverage is high, however infection by the following pathogens still affects millions of children worldwide:

- **Bacterial**: *Streptococcus pneumoniae*, Group B *Streptococcus*, *Neisseria meningitidis*, HiB, *Listeria monocytogenes*, *Escherichia coli*, *Staphylococcus aureus*, *Salmonella* spp., *Mycobacterium tuberculosis*, *Klebsiella* (< 2 months).
- **Viral**: enterovirus, measles virus, herpes viruses (including Epstein-Barr virus, herpes simplex viruses and varicella-zoster virus), mumps virus, Rubella virus, influenza virus, arboviruses, HIV, Dengue virus, Japanese encephalitis virus, rabies virus, CMV.
- **Fungal**: *Cryptococcus*, *Histoplasma*, *Blastomyces*, *Coccidioides*, *Aspergillus*, *Mucormycosis*, *Candida*.
- **Parasitic**: *Plasmodium* spp., *Naegleria fowleri*, *Angiostrongylus cantonensis*, B*aylisascaris procyonis*, *Gnathostoma spinigerum*, *Taenia solium*, *Onchocerca volvulus*, *Toxoplasma*.

Non-infectious causes include cancers, autoimmune diseases, systemic lupus erythematosus, drugs, head injury, brain surgery.

Epidemiology

The route of transmission varies by organism. Most bacteria that cause brain infections such as meningococcus, pneumococcus, and *Haemophilus influenzae* are carried in the human upper respiratory tract. They can be spread by respiratory droplets or throat secretions. The incubation period is 4 days on average but can range between 2 and 10 days[5]. The highest incidence of disease is registered in the African Meningitis Belt (region of sub-Saharan Africa), with epidemics of meningococcal (*Neisseria meningitidis* A or C or W135) and pneumococcal meningitis, generally occurring in the dry season (between October and April)[5]. Meningitis can also propagate where people are living in close quarters (refugee camps, mass gatherings, overcrowded households).

3.3.1 Clinical features

Clinical presentation may be variable and non-specific, but children older than 1 month most commonly develop the following:

- Fever, nausea, vomiting, anorexia, irritability (often the first sign in young infants), photophobia, seizures (mostly generalised), and respiratory distress
- Altered consciousness (present in most children) with lethargy, confusion, coma

– Meningeal signs (not always present, especially in young infants):
  • Back pain
  • Nuchal rigidity (absent in patients with focal neurologic deficits)
  • Kernig's sign[a]
  • Brudzinski's sign[b]
– Signs of increased intracranial pressure: headache (older children), irritability and bulging fontanelle or widening of the cranial sutures (in infants), bradycardia, hypertension, anisocoria
– Abnormal eye movements due to paralysis of the third, fourth or sixth cranial nerves
– Focal neurologic findings (hemiparesis, quadriparesis, facial palsy, visual field defects)
– Petechiae and purpura (can occur in fulminant meningococcal sepsis).

Clinical distinction between meningitis and encephalitis may be difficult but is important as causative pathogens differ. The following clinical features may help to differentiate between the two:
– Meningitis more likely: fever with absent or incomplete immunisation history, bulging fontanelle or meningeal signs, purpuric rash.
– Encephalitis more likely: fever with altered mental status and focal neurological signs or vesicular rash.

Initial empiric treatment often covers both.

Diagnosis

Based on history (including immunisations) and clinical examination (including neurological assessment).

3.3.2 Initial management

Meningitis or encephalitis is a medical emergency. If suspected, stabilise and administer antibiotics immediately:
– Call for help.
– Move child to the resuscitation area and assess and manage ABCDE (see Chapter 2, Section 2.1).
– Administer **oxygen**, aiming for SpO_2 between 94 - 98%.
– Get IV access and start empiric antibiotic treatment as soon as possible, depending on availability:

First choice:
ceftriaxone IV: 100 mg/kg every 24 hours (max. 4 g)
or **cefotaxime** IV: 50 mg/kg every 6 hours

Second choice:
ampicillin IV: 50 mg/kg every 8 hours
or **amoxicillin** IV: 50 mg/kg every 12 hours
or **benzylpenicillin** IV: 100 000 IU/kg (60 mg/kg) every 6 hours (max. 4 MIU or 2.4 mg/dose)

a Kernig sign: child is supine, one hip and knee are flexed to 90 degrees by the examiner, the examiner then attempts to passively extend child's knee: positive if there is pain along spinal cord, and/or resistance to knee extension.

b Brudzinski sign: child is supine with legs extended, the examiner grasps child's occiput and attempts neck flexion: positive if there is reflex flexion of child's hips and knees with neck flexion.

– Consider a lumbar puncture (LP, see below for more detail) if it can be done rapidly (within 30 minutes) and will not delay antibiotic administration (see Appendix 6). Ideally, the LP should be done before antibiotic administration but if there is any contraindication or likely delay, it may be performed 2 to 3 days later, once antibiotics have already been initiated[c].
– Isolate the patient (where possible), ensuring that the patient can be closely monitored.

3.3.3 Investigations

– FBC (including platelets if possible)
– CRP, if available
– BGL[d]
– Malaria RDT, if endemic
– Blood culture (especially if purpuric rash is present)
– Perform an LP for CSF microscopy, biochemistry and culture, and GeneXpert (where available).
  • Ensure that there are no contraindications to doing an LP and that consent has been given by the parent/carer.
  • Contraindications for LP:
    ▷ Severe cardiopulmonary instability that potentially requires prompt resuscitation measures (e.g. shock)
    ▷ Obvious signs of increased intracranial pressure (ICP), other than bulging fontanelle: decerebrate or decorticate posturing, absent doll's eye reflex, abnormal respiratory pattern, unequal pupil size or dilatation of pupils
    ▷ Focal neurological signs
    ▷ Focal seizures or seizures within the last 30 minutes
    ▷ Bradycardia, hypertension
    ▷ Obvious bleeding disorder and/or low platelet count (< 80 000 platelets/microlitre)
    ▷ Skin infection over the site for LP

c CSF gram stain and culture will almost certainly be negative if LP is performed 2-3 days after antibiotics have been commenced, but WBC, glucose and protein levels may remain abnormal.

d If CSF glucose is available, calculate the ratio of CSF glucose to blood glucose; in bacterial meningitis, it will be < 0.6 (glucometer cannot be used to test CSF glucose as it is not sufficiently accurate).

Table 3.2 - CSF findings and interpretation

	Opening pressure	Aspect	CSF glucose	WBC/mm^3	Protein mg/dL (Pandy test)	Other tests
Normal CSF	Normal (10-28 cm H_2O)	Clear	> 2/3 of blood glucose	< 5	< 40 Pandy test negative	
Bacterial meningitis	Usually very elevated	Turbid, cloudy	Very low:< 40 mg/dL (2.2 mmol/L)	Typically > 1000, mainly neutrophils	100-500 Pandy test positive	Gram stain shows bacteria
Viral meningitis	Normal to slight elevation	Clear	Usually normal or slightly reduced	10-700, mainly lymphocytes	50-250 Pandy test negative	Gram stain negative
TB meningitis	Elevated	Clear or yellowish	Low: 10-45 mg/dL (0.6-2.5 mmol/L)	< 500, mainly lymphocytes	> 250 Pandy test positive	Acid fast bacilli positive GeneXpert
Cryptococcal meningitis*	Very elevated	Clear	Low: 10-45 mg/dL (0.6-2.5 mmol/L)	< 800, mainly lymphocytes	Pandy test negative	India Ink positive

* Mainly in severely immunocompromised patients, such as patients with AIDS.

Note: Aseptic meningitis can be due to partially treated meningitis.
If presence of red cells: the safest interpretation of a traumatic tap is to count the total number of white cells and disregard the red cell count. If there are more white cells than the normal range for age, then the safest option is to treat. Consider subarachnoid haemorrhage when there is unexplained or persistent RBCs in CSF.

3.3.4 Ongoing management

- After initial stabilisation and treatment (see Section 3.3.2), admit for further management into ICU.
- NBM initially.
- Administer IV maintenance fluids restricted to 70% of usual maintenance volume[e] (see Chapter 15, Section 15.2).
- Insert NGT and gradually start enteral feeding as soon as possible (see Chapter 15, Section 15.5).
- Manage seizures if present (see Chapter 7, Section 7.2).
- Treat fever (see Section 3.1.3) and/or headache (see Chapter 15, Section 15.4) if needed.
- Monitor and record vital signs and urine output as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
- Neurological examination should be performed daily and head circumference measured in patients < 2 years old every 3 days, looking for hydrocephalus.
- Provide standard nursing care, especially if the patient is in a coma (including mouth care, positioning, physiotherapy exercises).
- Adjust antibiotic or change to other treatment once CSF results confirm underlying pathogen. See Table 3.2 for CSF findings and interpretation.

The length of treatment in non-epidemic situations depends on the pathogen if it is known:
- *Neisseria meningitidis*: 5 to 7 days
- *Haemophilus influenzae*: 7 to 10 days
- *Streptococcus pneumoniae*: 10 to 14 days
- Group B *streptococcus* and Listeria: 14 to 21 days
- Gram-negative bacilli: 21 days

If the pathogen is unknown, the length of treatment should be as follows:
- Children ≤ 3 months: complete 14 days of intravenous treatment after the first sterile CSF culture, or complete 21 days intravenous treatment.
- Children > 3 months: complete 10 days intravenous treatment. If fever persists past day 10, continue IV treatment and assess for alternative diagnosis or complications.

In children making a rapid and uncomplicated recovery (afebrile and neurological status fully recovered in 48 hours), if no specific organism identified, consider stopping ceftriaxone IV on day 7.

Re-examination of CSF

Consider repeating LP if:
- Poor clinical response despite 24 to 36 hours of appropriate antibiotic treatment.
- Persistent or recurrent fever

In the context of a meningitis epidemic, refer to MSF Clinical Guidelines and MSF Management of epidemic meningococcal meningitis guidelines.

Suspected viral encephalitis

- Strong suspicion based on clinical features (see above) and/or CSF findings (see Table 3.2) and/or not improving after 48 hours of antibiotic treatment.
- Treat as for bacterial meningitis and add **acyclovir** IV: 20 mg/kg every 8 hours for 21 days.

e Increased antidiuretic hormone (ADH) secretion can cause water retention, leading to fluid overload.

– Where CSF culture is available and was taken before antibiotic treatment started, in the case of a negative culture, consider stopping antibiotic treatment and continue only antiviral treatment.

Cerebral malaria

See Section 3.4.

TB meningitis

See Chapter 4, Section 4.11.6 and MSF Tuberculosis Guidelines.

Cryptococcal meningitis

See Chapter 13, Section 13.2.

3.3.5 Steroid therapy

Treatment with dexamethasone in meningitis is not recommended for children[6], due to insufficient evidence of significant benefit in low-resource settings[7], where delayed presentation and lack of identification of causative organism are common[f]. The only exception to this is TB meningitis (see Chapter 4, Section 4.11.6 and MSF Tuberculosis Guidelines).

3.3.6 Complications

– Persistent fever after 4 to 6 days of treatment, consider:
  • Nosocomial infection
  • Subdural effusion or empyema
  • Cerebral abscess or parameningeal foci of ongoing infection
  • Inadequate treatment
– Purpura fulminans and skin necrosis if associated meningococcal septicaemia
– Hearing impairment
– Neurodevelopmental impairment
– Multi-organ involvement due to primary pathogen or secondary to septic shock
– Venous sinus thrombosis
– Persistent seizures, subsequent epilepsy
– Permanent focal neurological deficit
– Hydrocephalus

It is important to explain to the family the possibility of these complications and start to treat them if they appear while the child is admitted (e.g. physiotherapy exercises to treat impaired motor function and sensory integrity).

Neuroimaging

Where there is the possibility of neurosurgical intervention, consider CT scan of the head (where available and can be read) for suspected complications including subdural empyema, brain abscess, cerebral vascular thrombosis, or hydrocephalus.

f The use of adjuvant dexamethasone has no significant impact on overall mortality in either high- or low-resource settings, though there is a favourable effect on mortality from meningitis due to *S. pneumoniae* if given early in the course of the illness. In high-income settings only, adjuvant dexamethasone has been shown to reduce hearing loss in meningitis due to *H. influenza* if given early in the course of the illness[7].

3.3.7 Chemoprophylaxis and prevention

– Close contacts of a person with meningococcal meningitis should be given a single dose of prophylactic antibiotic treatment to reduce the risk of transmission (see Table 3.3).
– Check national guidance in the case of epidemics.

Table 3.3 - Preferred regimens for antimicrobial prophylaxis in bacterial meningitis[6]

Drug	Route	Age	Dose
Ciprofloxacin	PO	1 month to 4 years	30 mg/kg (max. 125 mg)
		5 to 11 years	250 mg
		12 to 17 years	500 mg
Ceftriaxone	IM	< 15 years	125 mg
		≥ 15 years	250 mg

Although systemic fluoroquinolones are not routinely used as a first-line agent in children, it is reasonable to use a single dose of ciprofloxacin as chemoprophylaxis for meningococcal disease. Apart from chemoprophylaxis and hygiene measures in overcrowded households, the best prevention possible is to ensure that most children receive adequate vaccinations against the major pathogens causing meningitis (*Streptococcus pneumoniae*, *Neisseria meningitidis*, Hib).

3.4 Malaria

Malaria is a parasitic infection caused by the protozoa *Plasmodium* which is transmitted to humans via the bite of the female Anopheles mosquito. More rarely, malaria can also be transmitted through transfusion of infected blood and transplacentally. 5 species of Plasmodium can cause malaria in humans: *P. falciparum*, *P. vivax*, *P. ovale*, *P. malariae* and *P. knowlesi.* All species may cause uncomplicated malaria, while severe malaria is almost always due to *P. falciparum*.

Malaria remains one of the leading causes of morbidity and mortality in children, mostly in sub-Saharan Africa, despite being both preventable and treatable. In 2021, there were an estimated 247 million cases of malaria worldwide, with 617 000 estimated deaths due to malaria. 80% of these deaths were among children under 5 years old[8].

3.4.1 Clinical features

Consider malaria in any patient presenting with fever (or history of fever in the previous 48 hours) who is living in, or coming from, an endemic area. Uncomplicated malaria should be diagnosed and treated promptly as it rapidly progresses to severe malaria in the absence of adequate treatment. Severe malaria is almost always fatal without treatment.

Uncomplicated malaria

Defined as a person who presents with symptoms of malaria and has a positive parasitological test, with no features of severe malaria (below). Signs of uncomplicated malaria are non-specific with fever (or history of fever), general malaise, fatigue, headache, chills, abdominal pain and muscle aches. Diarrhoea and vomiting, and pallor (from anaemia) are common in children with malaria.

Severe malaria

In addition to the features of uncomplicated malaria above, patients present with one or more of the following clinical or laboratory complications (based on WHO criteria[9]):

- Impaired consciousness: VPU on AVPU or < 3 on Blantyre Coma Scale (see Appendix 3 and Appendix 13).
- Prostration: extreme weakness, unable to sit, stand or walk. Inability to feed in infants.
- Multiple seizures: > 2 episodes in 24 hours (generalised or focal onset)
- Acidosis: plasma bicarbonate level < 15 mmol/L or venous plasma lactate ≥ 5 mmol/L. Acidosis can be suspected clinically in the presence of Kussmaul[a] breathing.
- Hypoglycaemia: blood or plasma glucose < 2.2 mmol/L (< 40 mg/dL)[b].
- Severe malarial anaemia:
  - Children < 12 years old: Hb ≤ 5 g/dL[c] or haematocrit < 15%
  - Children ≥ 12 years old: Hb < 7 g/dL or haematocrit < 20%
- Renal impairment: Urine output < 0.5 - 1 ml/kg/hr despite adequate hydration

a Kussmaul breathing is regular, rapid, deep, laboured breathing and is highly indicative of metabolic acidosis.

b This is definition of hypoglycaemia for diagnosis of severe malaria and does not correspond to the treatment threshold, which is < 3.3 mmol/L (< 60 mg/dL).

c This definition is for the purposes of malaria severity classification according to the WHO and does not necessarily indicate the need for blood transfusion.

– Jaundice or evidence of haemolysis: yellow conjunctivae and/or palms, haemoglobinuria
– Pulmonary oedema
– Significant bleeding: recurrent or prolonged nose bleeds, haematemesis, melaena
– Shock: all 3 of weak/absent pulse or tachycardia, lower limb temperature gradient, and CRT ≥ 3 seconds
– Hyperparasitaemia: *P. falciparum* parasitaemia > 10% (this may vary according to transmission setting)

The most common manifestations of severe malaria in children in high transmission areas are cerebral malaria (impaired consciousness, prostration, seizures) and severe malarial anaemia[d]. Hypoglycaemia is also common in children with malaria. Where endemic, malaria frequently occurs concomitantly with other diseases e.g. meningitis, sepsis, severe pneumonia and enteric fever: it is therefore important to keep these in mind even when a confirmed parasitological diagnosis of malaria has been made.

3.4.2 Investigations

Parasitological diagnosis of malaria should be confirmed whenever possible using:

– Malaria rapid diagnostic test (RDT). Two different antigen tests exist, HRP2 and pan-pLDH, which can also exist in combination:
  • HRP2 tests are *P. falciparum* specific, but may stay positive for up to 42 days after the start of anti-malarial treatment, therefore important to ascertain if patient has been treated for malaria in the preceding 1-2 months and consider other causes of fever[e].
  • Pan-pLDH tests detect all species of plasmodium and are slightly less sensitive and specific than HRP2, but become negative within 2-4 days after the start of treatment.
– Microscopy (thick and thin blood films)[f]:
  • Thick blood films enable parasite detection and quantification.
  • Thin blood films enable species identification, quantification and monitoring of parasitaemia.

If testing is not available, treatment of suspected malaria (especially if severe) should not be delayed. If malaria RDT is negative in a child with a high clinical suspicion of severe malaria, treat as such but continue to look for other causes of fever and perform microscopy. If malaria RDT is negative in a child without signs of severity, repeat RDT and/or microscopy in 2-6 hours and continue to look for other causes of fever.

In addition to parasitological diagnosis, for all children with suspicion of severe malaria:
– Hb: to check for anaemia
– BGL: to check for hypoglycaemia
– Urine dipstick: to check for haemoglobinuria (indicating haemolysis)

3.4.3 Management

Uncomplicated falciparum malaria

Treatment of uncomplicated falciparum malaria is with artemisinin-based combination therapy (ACT) given orally for 3 days, and full recovery is expected with prompt treatment. ACTs are

d A child may have several episodes of malaria in one year in high-transmission areas, which quickly leads to severe anaemia as the Hb does not have time to recover to normal values between episodes.

e There are emerging strains of *P.falciparum* with genetic mutations to HRP2/3 making these tests less reliable in affected areas e.g. Sudan.

f Accuracy of interpretation and quantification can be variable depending on the experience of laboratory staff.

typically prescribed as fixed-dose combinations in blister packs to simplify treatment regimens and improve treatment adherence, and to avoid monotherapy which can lead to artemisinin resistance. The first-line ACT is chosen according to therapeutic efficacy in the area where the patient is living. If the first line ACT is unavailable, contra-indicated or has failed despite being correctly taken, use another ACT. In addition to ACT, in low malaria endemic areas, all children over 6 months who are diagnosed with *P. falciparum* malaria should also receive a single dose of **primaquine**[g] PO, 0.25 mg/kg to reduce the risk of transmission.

Treatment of uncomplicated falciparum malaria:

ACT	Presentation	Dosage
Artemether/ lumefantrine (AL)	**Co-formulated tablets** of 20 mg artemether/ 120 mg lumefantrine	On D1, the first dose is given at 0 hour and the second dose at 8-12 hours. Subsequent doses on D2 and D3 are given 2 times daily (morning and evening).
	Blister child 5 to < 15 kg, 6 tab/blister	—> 1 tab 2 times daily on D1, D2, D3
	Blister child 15 to < 25 kg, 12 tab/blister	—> 2 tabs 2 times daily on D1, D2, D3
	Blister child 25 to < 35 kg, 18 tab/blister	—> 3 tabs 2 times daily on D1, D2, D3
	Blister child ≥ 35 kg, 24 tab/blister	—> 4 tabs 2 times daily on D1, D2, D3
Artesunate/amodiaquine (AS/AQ)	**Co-formulated tablets**	
	Blister child 4.5 to < 9 kg, tab of AS 25 mg/AQ base 67.5 mg, 3 tab/blister	—> 1 tab once daily on D1, D2, D3
	Blister child 9 to < 18 kg, tab of AS 50 mg/AQ base 135 mg, 3 tab/blister	—> 1 tab once daily on D1, D2, D3
	Blister child 18 to < 36 kg, tab of AS 100 mg/AQ base 270 mg, 3 tab/blister	—> 1 tab once daily on D1, D2, D3
	Blister child ≥ 36 kg, tab of AS 100 mg/AQ base 270 mg, 6 tab/blister	—> 2 tabs once daily on D1, D2, D3
Dihydroartemisinin/piperaquine (DHA/PPQ)	**Co-formulated tablets**	
	Blister child, tab of DHA 20 mg/PPQ 160 mg, 3 tab/blister	5 to < 8 kg —> 1 tab 20/160 mg once daily on D1, D2, D3
	Blister child, tab of DHA 40 mg/PPQ 320 mg, 3 tab/blister	8 to < 11 kg —> 1½ tab 20/160 mg once daily on D1, D2, D3
	Blister child, tab of DHA 40 mg/PPQ 320 mg, 6 tab/blister	11 to < 17 kg —> 1 tab 40/320 mg once daily on D1, D2, D3
	Blister adolescent, tab of DHA 40 mg/PPQ 320 mg, 9 tab/blister	17 to < 25 kg —> 1½ tab 40/320 mg once daily on D1, D2, D3
		25 to < 36 kg —> 2 tab 40/320 mg once daily on D1, D2, D3
		36 kg to < 60 kg —> 3 tab 40/320 mg once daily on D1, D2, D3

g Caution with use of primaquine in children with G6PD deficiency as primaquine-induced haemolysis may occur.

Special note for young children and infants[10]

- Monitor administration and retention of the first dose in children as they are more likely to refuse, regurgitate or vomit oral treatment. If anti-malarial is vomited or regurgitated within 1 hour of administration, repeat the dose.
- Consider parenteral treatment (see below) early in young children and infants who do not tolerate oral treatment as they can quickly deteriorate. Complete treatment with a 3-day course of oral ACT as soon as oral medication is tolerated[h].
- There is limited evidence on the correct dosage of anti-malarials for children less than 5 kg. Dosage should be calculated in mg/kg using the same target dose range as for infants > 5 kg as follows:
  - Artemether/lumefantrine (AL) – 2 (range 1.6 to 8) mg/kg/day artemether and 12 (range 10 to 48) mg/kg/day lumefantrine
  - Artesunate/amodiaquine (AS/AQ) – 5 (range 2 to 10) mg/kg/day artesunate and 10 (range 7 to 15) mg/kg/day amodiaquine
  - Dihydroartemisinin/piperaquine (DHA/PQ) – 4 (range 2.5 to 10) mg/kg dihydroartemisinin and 24 (range 20 to 32) mg/kg piperaquine

Simplified dosing instructions for AS/AQ and AL in infants < 5 kg:

	AS/AQ	AL
Dilution	Dilute one AS/AQ tablet (25 mg artesunate/67.5 mg amodiaquine) in 2 mL of clean drinking water	Dilute one AL tablet (20 mg artemether/120 mg lumefantrine) in 10 mL of clean drinking water
Weight (kg)	**Dose (mL)**	**Dose (mL)**
2.0 to 2.4	0.7 mL once daily	2.2 mL two times daily
2.5 to 2.9	0.9 mL once daily	2.8 mL two times daily
3.0 to 3.4	1.0 mL once daily	3.2 mL two times daily
3.5 to 3.9	1.2 mL once daily	3.8 mL two times daily
4.0 to 4.4	1.3 mL once daily	4.2 mL two times daily
4.5 to 4.9	1.5 mL once daily	4.8 mL two times daily

Quinine

The use of quinine PO is no longer recommended in MSF, however continues to be recommended in some national guidelines in the absence of ACT. Follow local protocols for dosing and administration.

Non-falciparum malaria

Most malaria in children is due to falciparum, which is the predominant species in Africa. However, transmission of non-falciparum malaria is high in certain areas of the world, predominantly in Asia, Central and South America, the Middle East and the Horn of Africa. Treatment of choice for uncomplicated non-falciparum malaria is with **ACT** (see above),

h It is not necessary to continue parenteral treatment for minimum 24 hours in this case, and there is no need to wait 24 hours before starting oral ACT after giving parenteral antimalarials.

however in areas where more than 5% of malaria diagnoses are due to non-falciparum malaria and chloroquine is still effective, treatment with **chloroquine** (CQ) PO can be considered for confirmed *P. vivax* or *P. ovale* mono-infection:
– Day 1: 10 mg base/kg once daily
– Day 2: 10 mg base/kg once daily
– Day 3: 5 mg base/kg once daily

The benefits of ACT over chloroquine include: quicker parasite clearance; promotion of simplified protocols for all forms of uncomplicated malaria; longer half-lives of many ACTs which provide a longer period of suppressive post-treatment prophylaxis against relapse and reinfection; ensuring treatment of undiagnosed *P. falciparum* in possible mixed infections[i].

Relapse can occur with *P. vivax* and *P. ovale* due to dormancy of parasites in the liver, therefore treatment with **primaquine**[j] PO 0.25 to 0.5 mg/kg once daily for 14 days in children ≥ 15 kg can be given to eliminate these parasites after initial treatment with CQ or ACT in all transmission settings.

Severe malaria

Severe malaria is a medical emergency and all children with severe malaria should be hospitalised:
– Assess and manage ABCDE (see Chapter 2, Section 2.2).
– Administer **oxygen** if SpO_2 < 92% in room air or severe respiratory distress or severe anaemia (pending transfusion).
– Obtain IV/IO access and take bloods for Hb and BGL, as well as blood culture (if available).
– Treat for hypoglycaemia if BGL < 60 mg/dL (3.3 mmol/L), see Chapter 9, Section 9.3.
– Administer parenteral anti-malarial treatment as soon as possible (see below).
– Administer antibiotic for possible sepsis or severe bacterial infection (see below).
– Treat any seizures (see Chapter 7, Section 7.2).
– Manage specific complications of severe malaria (see below):
  • Severe anaemia
  • Cerebral malaria

Pre-hospital anti-malarial treatment

If the child is seen at community or primary health centre level, stabilise and administer pre-referral treatment as follows:
– Preferred: first dose of **artesunate** IV/IM or, if unavailable, first dose of **artemether** IM (see below for dosing).
– Alternative for children < 6 years old where IV/IM artesunate is not available: one dose of rectal **artesunate**, 10 mg/kg:
  • Children 2 months to < 3 years (≤ 10 kg): 1 rectal capsule (100 mg)
  • Children 3 to 6 years (≤ 20 kg): 2 rectal capsules (200 mg)

In-hospital anti-malarial treatment

– **Artesunate**[k] slow IV over 3-5 minutes (if not possible, slow IM injection):
  • Children < 20 kg: 3 mg/kg/dose
  • Children ≥ 20 kg: 2.4 mg/kg/dose

i For confirmed mixed infections (*P. falciparum* plus *P. vivax* or *P. ovale*), ACT is the treatment of choice, as chloroquine is not effective against *P. falciparum*.

j Caution with use of primaquine in children with G6PD deficiency as primaquine-induced haemolysis may occur, consider preventing relapse by giving 0.75 mg/kg once a week for 8 weeks under close medical supervision.

k Post-artemisinin delayed haemolysis (PADH) is a rare phenomenon which can occur 1-3 weeks after initiation of treatment with injectable artesunate. Clinicians should be aware of this potential complication.

– First dose on admission (H0); second dose 12 hours after admission (H12)[l]; third dose 24 hours after admission (H24); and then every 24 hours. If artesunate is unavailable, **artemether** IM (should be stored separately and clearly labelled to avoid accidental IV administration):
  • First dose: 3.2 mg/kg on admission
  • Subsequent doses: 1.6 mg/kg once daily
– The use of **quinine** IV is no longer recommended in MSF, however continues to be recommended in some national guidelines if neither artesunate nor artemether are available. Follow local protocols for dosing and administration.
– Continue parenteral treatment for a minimum of 24 hours (3 doses of artesunate; 2 doses of artemether) before switching to oral ACT to complete a 3-day course when the child is improving and able to swallow[m].
– Oral ACT can be started at any time after the last artesunate dose, it is not necessary to wait 24 hours before starting oral ACT after giving parenteral antimalarials.
– If the child is never able to tolerate oral treatment, continue parenteral treatment for 7 days.

⚠ Rectal artesunate does not count as the first dose of antimalarial treatment in severe malaria. Any child who received rectal artesunate prior to arrival in hospital should receive artesunate IV/IM (or artemether IM) as soon as possible, regardless of the time of administration of rectal artesunate, and should complete a minimum of 24 hours of IV/IM treatment.

Sepsis or severe bacterial infection

Sepsis is common in children with severe malaria and various bacteria have been identified in blood cultures, the most common of which is non-typhoidal Salmonella (NTS). Infection with invasive NTS carries higher mortality when combined with malaria, and children with severe malarial anaemia are at increased risk[11,12,13,14]. As such, treatment with antibiotics should be administered to all children presenting with severe malaria, in addition to anti-malarial treatment, until severe bacterial infection has been excluded:
– Start **ceftriaxone** IV: 80 mg/kg (max. 4g if < 50 kg; max. 2g if ≥ 50 kg) every 24 hours (or 100 mg/kg (max. 4g) if suspicion of meningitis, see Cerebral malaria, page 101).
– Switch to oral antibiotics when child is well, tolerating oral intake and has been afebrile for 24 hours to complete a total of 7 days of antibiotic treatment. Give **amoxicillin/clavulanic acid** (ratio 7:1 or 8:1) PO. Dosage expressed in amoxicillin:
  • < 40 kg: 50 mg/kg 2 times daily
  • ≥ 40 kg:
    Ratio 8:1: 3000 mg daily (2 tablets of 500/62.5 mg 3 times daily)
    Ratio 7:1: 2625 mg daily (1 tablet of 875/125 mg 3 times daily)
– Consider stopping antibiotics early in the following cases and monitor the child for a further 24-48 hours off antibiotics before discharge:
  • The child shows good clinical improvement with antimalarials, and blood/CSF cultures (where available) are negative. If cultures have not been taken, continue oral antibiotics as above to complete a total of 7 days of antibiotic treatment.
  • The child shows rapid, significant clinical improvement within 24 hours of starting malaria treatment making the original indication for starting antibiotics (i.e. diagnosis of severe malaria with sepsis or severe bacterial infection) highly unlikely.

l If the timing of the second dose does not coincide with a regular medication administration round, the second dose can be administered earlier but never later than 12 hours after the first dose.

m If the child is still on parenteral treatment on day 5, continue until 7 days rather than switching to oral ACT.

Severe malarial anaemia

Anaemia is common in malaria, especially in young children, and can be rapidly progressive as erythrocytes become infected and haemolyse. Severe malarial anaemia is defined as a Hb ≤ 5 g/dL or haematocrit < 15% in children under 12 years old (Hb < 7 g/dL or haematocrit < 20% if 12 years and over). Children with severe malarial anaemia are at risk of cardiac failure therefore should be touched/moved as little as possible to limit metabolic demand. If repeated transfusions are necessary, ideally blood from the same donor should be used to minimise risk.

Indications for blood transfusion in severe malarial anaemia (excluding infants < 2 months[n]):

- Profound anaemia: Hb < 4 g/dL, or
- Complicated severe anaemia: Hb ≥ 4 and < 6 g/dL with one or more signs of decompensation:
  - Increased work of breathing (see Chapter 4, Section 4.1.1)
  - Altered level of consciousness (see Chapter 7, Section 7.5.1)
  - Circulatory impairment/shock (see Chapter 2, Section 2.2.1)
- Complicated severe anaemia: Hb ≥ 4 and < 6 g/dL with evidence of ongoing blood loss:
  - Haemoglobinuria (indicating intravascular haemolysis)[15].
  - Visible bleeding (external bleeding, haematemesis, melaena, haematuria)

See Chapter 10, Section 10.1 for detailed guidance on monitoring and blood transfusion volumes.

Repeat Hb systematically at 8, 24 and 48 hours if Hb 4-6 g/dL with no signs of severity, and at any time if anaemia suspected clinically, especially in those with evidence of ongoing haemolysis, e.g. haemoglobinuria or high parasitaemia (> 2% in low-intensity transmission areas or > 5% in high-intensity transmission areas).

Cerebral malaria

Cerebral malaria presents with a reduced level of consciousness (LOC) or coma, which may be accompanied by seizures, and is a common presentation in young children. Seizures should be managed in the same way as seizures due to any other cause (see Chapter 7, Section 7.2), though phenobarbital should be used cautiously and only when respiratory support is available due to increased risk of respiratory arrest in cerebral malaria. An isolated seizure with full neurological recovery is likely to be a febrile seizure and is not indicative of cerebral malaria. Children with cerebral malaria who have focal neurological signs or those who have ongoing altered LOC following a seizure should be started on maintenance anticonvulsant medication (see Chapter 7, Section 7.2).

It is impossible to distinguish cerebral malaria from meningitis in the absence of lumbar puncture results, therefore all children with signs of cerebral malaria should be treated concomitantly for bacterial meningitis:

- Consider an LP if it can be done rapidly (within 30 minutes) and there are no contraindications (see Appendix 6). If not, LP can be performed after 2 - 3 days when the child has improved[o]. Antibiotics should not be delayed in order to carry out an LP.
- Start **ceftriaxone** IV: 100 mg/kg (max. 4 g) every 24 hours.
- Continue IV antibiotics for 10 days if LP confirms meningitis or if it is not possible to carry out an LP.
- If LP excludes meningitis, continue antibiotics as for sepsis (see page 100).

n Young infants < 2 months of age have a significantly higher normal Hb than older infants (see Table 10.1, page 299) therefore transfusion thresholds are higher.

o CSF gram stain and culture will almost certainly be negative if LP is performed 2-3 days after antibiotics have been commenced, but WBC, glucose and protein levels may remain abnormal.

Supportive care

- Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
- Monitor BGL regularly and treat for hypoglycaemia if BGL < 60 mg/dL (3.3 mmol/L), see Chapter 9, Section 9.3.
- Treat fever to improve comfort (see Section 3.1.3).
- Start IV maintenance fluids and/or feeds if tolerated (see Chapter 15, Section 15.2 and Section 15.5). Restrict IV maintenance fluids to 70% of usual maintenance volume in cerebral malaria due to the risk of cerebral oedema but be cautious with fluid restriction as children tend to be dehydrated more than fluid overloaded.
- Monitor and document urine output (using a urinary catheter if possible):
  - Aim for urine output ≥ 1 mL/kg/hour.
  - Check regularly for haemoglobinuria.
  - If no signs of dehydration and urine output < 1 mL/kg/hr for over 6 hours, administer trial of **furosemide** IV, 1 mg/kg.
  - If no response to furosemide, stop IV fluids and refer for management of renal failure.
- Monitor for signs of fluid overload.
- Provide specific care for children with impaired consciousness:
  - Nurse with head elevated and in neutral position.
  - Support and open the airway, clearing with suction only if necessary.
  - Administer oxygen via face mask, aiming for SpO_2 > 92%. Assist ventilation with bag-mask device if not breathing.
  - Regularly monitor neurological status (AVPU) and check pupillary response.
  - Re-position child regularly to prevent pressure sores.
  - Carry out regular mouth and eye care.

Malaria in young infants < 2 months old

Malaria can present differently in young infants compared to older children. Infants < 2 months old should be diagnosed and managed as for congenital or neonatal malaria (see MSF Neonatal Care Guidelines).

Discharge criteria

Consider discharge from hospital when child is:

- Clinically stable for at least 24 hours
- Tolerating oral ACTs (i.e. not vomiting)

3.4.4 Prognosis

Children with uncomplicated malaria can expect to make a full recovery with appropriate treatment while mortality from severe malaria is approximately 10-20% even despite prompt and adequate treatment. Left untreated, malaria is almost always fatal. Neurological sequelae occur in approximately 15% of children following cerebral malaria and include epilepsy, impaired cognitive function, neurodisabilities and behavioural disorders[16]. Children living in endemic areas are at significant risk of re-infection with malaria, with repeated infections carrying a higher likelihood of severe anaemia and a greater need for blood transfusion.

3.4.5 Prevention

Prevention of malaria through the use of long-lasting insecticide-treated bed nets and indoor residual spraying, as well as through strategies such as seasonal malaria chemoprevention (SMC) and perennial malaria chemoprevention (PMC) (previously known as intermittent preventive treatment (IPT)) in endemic areas can significantly reduce the burden of disease in children. The new malaria vaccine is an additional tool which, if used in combination with other interventions, has the potential to alter malaria epidemiology and reduce malaria morbidity and mortality over the coming years.

3.5 Tetanus

Tetanus is a vaccine-preventable disease that affects the nervous system, causing intensely painful muscle spasms. Clinical features are due to the release of a potent neurotoxin by the gram-positive, anaerobic bacterium *Clostridium tetani* which lives in soil and faeces and can contaminate wounds, minor cuts or abrasions, and the umbilical stump (in neonates).

Tetanus remains endemic in resource-limited settings with low immunisation coverage, due to poor hygiene practices during delivery and after birth, inadequate wound care, and lack of availability of post-exposure prophylaxis. Incidence of tetanus increases following natural disasters and in conflict and post-conflict contexts, due to disrupted vaccination programmes and increased tetanus-prone injuries. Globally, tetanus disease burden is underestimated, as tetanus surveillance systems are not well established in many endemic countries. While the overall incidence of tetanus is decreasing, it remains responsible for at least 30 000 to 60 000 deaths each year, the majority of which are among neonates[17,18,19]. Tetanus case fatality rate remains high in resource-limited settings[20], where access to mechanical ventilation is limited, therefore focus on vaccination programmes is essential to reduce morbidity and mortality.

Tetanus-prone injuries include puncture wounds, foreign bodies, gunshot wounds, open fractures, burns, and use of non-sterile instruments for cutting (e.g. umbilical cord), or for intramuscular or subcutaneous injections.

3.5.1 Clinical features

Incubation period for tetanus ranges between 1 and 21 days, with shorter incubation periods being associated with an elevated risk of death[21]. The further the entry point of infection is from the central nervous system, the longer the incubation period. Tetanus is most commonly generalised, affecting all muscle groups, but local tetanus and cephalic tetanus[a] can also occur. Tetanus typically lasts for 4 to 6 weeks but may last longer.

Characteristic signs

Tetanus toxin interferes with the release of inhibitory neurotransmitters, leading to unopposed muscle contraction. Initially, this manifests as stiffness before progressing to muscle spasms, giving rise to the classic features of tetanus (see Figures 3.3, page 105):

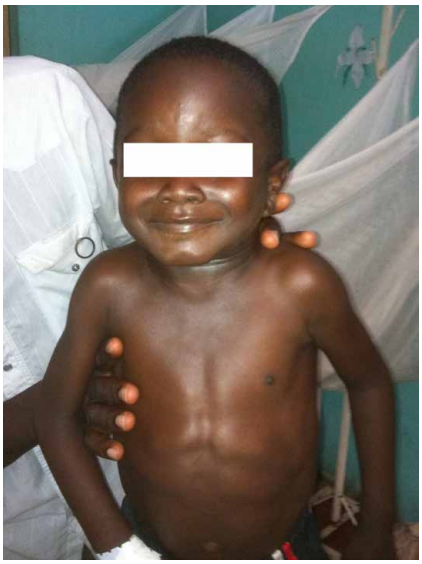
- Trismus ('lock-jaw') and risus sardonicus (rigid smile) caused by facial spasm
- Opisthotonus
- Stiff neck
- Abdominal rigidity
- Dysphagia

Muscle spasms can be long and intensely painful and are easily triggered by external stimuli (noise, touch, light). Patients with tetanus are awake and fully conscious.

a Local tetanus affects one extremity or body region and may be due to low toxin load. Cephalic tetanus is localised to the head and neck, with cranial nerve involvement, and may be misdiagnosed as a stroke. Both types usually progress to generalised tetanus.

Figure 3.3a - Opisthotonus[b]

Figure 3.3b - Risus sardonicus and abdominal rigidity[b]



Complications

- Pharyngeal and laryngeal spasms may lead to aspiration, airway obstruction, apnoeic episodes and respiratory failure.
- In advanced disease, the autonomic nervous system is also affected, causing arrhythmias, haemodynamic instability, fever, sweating, bowel and bladder dysfunction, and increased respiratory secretions. The latter can complicate airway management as suctioning may induce upper airway spasms.

Severity classification

The 'Ablett classification'[22] categorises the severity of tetanus as follows:

- Grade I: mild trismus with little or no dysphagia, general rigidity with no spasms, mild or no respiratory involvement
- Grade II: moderate trismus, marked dysphagia, fleeting spasms with moderate respiratory involvement
- Grade IIIa: severe trismus, severe dysphagia, major spasms, severe respiratory involvement
- Grade IIIb: features of Grade IIIa with autonomic disturbance

Diagnosis is based on history and classic clinical findings. In mild or localised tetanus, diagnosis can be challenging. Differential diagnosis may include poisoning (strychnine) or dystonic reactions to drugs such as phenothiazines and metoclopramide. Always consider the possibility of associated meningitis and when feasible, perform lumbar puncture for confirmation.

3.5.2 Management

Treatment consists of measures to prevent toxin production and uptake (wound care, immunoglobulins, antibiotics), control of muscle spasms, and supportive care. For neonates, see MSF Neonatal Care Guidelines.

b Photos, courtesy of Marianne Sutton, were taken and used with the consent of the respective patients/parents/carers.

Neutralisation of tetanus toxin

- Administer H**uman tetanus immunoglobulin** (**HTIG**) IM[c]: 500 IU single dose as soon as possible[d], to be injected into 2 different sites.
- Do not administer HTIG in the same syringe or at the same injection site as the tetanus vaccine (See Section 3.5.3).

Prevention of local proliferation of *C. tetani*

- Meticulously clean, irrigate and debride the wound (consider sedation and analgesia), and guarantee regular wound care with clean, non-occlusive dressings.
- Administer antibiotics to eradicate *C. tetani*[e],[23],[24]:
  - **metronidazole** IV: 10 mg/kg (max. 400 mg) every 8 hours for 7-10 days is the preferred choice.
  - Alternatively, **benzylpenicillin** (penicillin G) IV: 50 000 IU/kg (30 mg/kg) every 6 hours (max. 4 MIU or 2.4 g per dose).

Supportive care

- Admit to an intensive care unit (where available)
- Establish a quiet environment or individual room where external stimuli are minimised (light, noise and handling) without compromising surveillance and monitoring. Consider eye shades and ear plugs to reduce stimuli.
- Monitor airway, breathing and circulation closely. Keep suctioning equipment[f] and bag and mask nearby in case of airway obstruction, apnoea or respiratory failure.
- Maintain adequate hydration using IV fluids (see Chapter 15, Section 15.2), as patients will have increased fluid losses through fever and sweating and are at risk of rhabdomyolysis and renal failure.
- Ensure adequate caloric intake via NGT (see Chapter 15, Section 15.5) as muscle spasms will increase energy expenditure. Consider giving frequent, small feeds due to decreased gut motility.
- Paralytic ileus may occur in severe tetanus with autonomic disturbance (see Chapter 12, Section 12.3).
- Give adequate analgesia for muscle spasms (consider morphine), as they can be intensely painful (see Chapter 15, Section 15.4).
- Treat fever, if present, for patient comfort (see Section 3.1.3).
- Where indicated, treat other infections (skin infection, sepsis, omphalitis) and be alert for nosocomial infections which are frequent during prolonged hospitalisation.
- Administer tetanus vaccination, as recovery from tetanus infection does not confer immunity (see Section 3.5.3).

Treatment of muscle spasms

Control of muscle spasms in tetanus is extremely difficult in resource-limited settings. Doses of sedative medications must be carefully titrated to achieve spasm control without excessive respiratory depression (see Chapter 1, Section 1.2 for normal respiratory rates in children).

c Administration of antitoxin via the intrathecal route has been of interest for several decades and although some trials suggest benefit, there is currently insufficient evidence to recommend this route over IM administration.

d Some sources suggest higher doses of HTIG, refer to local or national guidelines where they exist.

e There is conflicting evidence on whether the use of antibiotics is truly beneficial in the treatment of tetanus, however it is common practice to administer them and remains part of recommended treatment.

f Suction with caution, as this can provoke spasms.

Benzodiazepines

Although benzodiazepines are generally effective in controlling rigidity and spasms, they can cause hypotension and respiratory depression and should therefore be administered under close surveillance:

- Use **diazepam emulsion**, where available, rather than diazepam solution for intravenous administration in young children, as it has fewer side effects[g]. Dosing recommendations are the same for both preparations.
- Start **diazepam**: 0.1 to 0.3 mg/kg by slow IV injection (over 3-5 minutes) every 1 to 4 hours. Start at the lowest dose and titrate upwards depending on severity and persistence of spasms, ensuring that adequate breathing is maintained.
- If IV route is not available, consider rectal administration using diazepam solution. Note: diazepam emulsion should not be used intrarectally.
- If spasms persist despite hourly diazepam at maximum dose, start continuous **diazepam infusion**: 0.1 to 0.5 mg/kg/hour. Increase cautiously by 0.1 mg/kg/hour to achieve spasm control (max. 0.8 mg/kg/hour), ensuring that adequate breathing is maintained.
- Once spasms are controlled and the patient is improving, gradually decrease diazepam (either hourly bolus or continuous infusion) as tolerated until it can be safely discontinued. Consider switching to diazepam PO/NGT while weaning as soon as the patient can tolerate oral/NGT intake. Do not stop treatment abruptly as this can trigger new onset of muscle spasms.

⚠ Benzodiazepines (especially if administered concomitantly with opioids) can cause respiratory depression[h]. Ensure increased nursing care, resuscitation equipment (bag and mask) and suction is available for immediate use if required and that antidotes are readily available for emergencies.

In the event of respiratory depression caused by benzodiazepines, administer:

- **Flumazenil** IV over 15 seconds: 10 micrograms/kg every 1 minute (max 200 micrograms/dose) as required until adequate breathing resumes.

Magnesium sulphate

Magnesium sulphate is a calcium antagonist that acts as a muscle relaxant and vasodilator and prevents catecholamine release. It can be helpful in controlling spasms in tetanus in addition to benzodiazepines[25,26] in Ablett Grade IIIa and IIIb tetanus, when benzodiazepines alone do not adequately control spasms[i]. It should be used with caution due to its potential toxicity.

- Ensure child is cared for in a closely monitored environment with ICU level nursing care.
- Administer **magnesium sulphate** IV via a syringe pump: loading dose 100 mg/kg over 30 minutes followed by continuous IV infusion at 40 mg/kg/hour. Increase infusion rate by 5 mg/kg/hour every 6 hours (max. 100 mg/kg/hour) until spasms are controlled. A syringe pump is mandatory for administration of magnesium sulphate.
- Regularly monitor and record blood pressure, respiratory rate, heart rate and other vital signs using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
- If available, monitor serum magnesium concentration to maintain levels within the therapeutic range (2 - 4 mmol/L).

g Diazepam solution can cause pain on injection, thrombophlebitis and contains benzyl alcohol, benzoic acid and propylene glycol that can be toxic for young children, especially in accumulated doses.

h Minimum respiratory rates in children: < 1 year = 30 breaths/min; 1-5 years = 25 breaths/min; 6-12 years = 20 breaths/min; > 12 years = 14 breaths/min.

i Other medications, such as chlorpromazine and phenobarbital, may be used for spasm control according to local availability and protocol.

– If it is impossible to check serum magnesium concentration, loss of the patellar reflex indicates that serum magnesium is at the upper end of the therapeutic range (4 mmol/L) and magnesium sulphate infusion should be reduced[27]. Check the patellar reflex cautiously in children with tetanus as doing so may provoke spasms.
– Other signs of magnesium toxicity and/or hypocalcaemia overlap with signs of autonomic dysfunction therefore cannot reliably be used to identify magnesium toxicity.
– If there is a strong suspicion of magnesium toxicity, stop magnesium sulphate infusion and administer **calcium gluconate 10% solution**: 0.5 mL/kg slow IV injection over 5-10 minutes.

Management of autonomic dysfunction

Magnesium sulphate can be useful for managing autonomic dysfunction in tetanus in addition to spasm control, however it should not be administered for autonomic dysfunction alone.

3.5.3 Prevention

Tetanus infection does not induce natural immunity following recovery from the acute illness and patients can get infected again. All patients with clinical tetanus should therefore receive tetanus vaccination, either at the time of diagnosis or during convalescence as follows[28]:
– Patient completely vaccinated: tetanus booster required
– Patient not vaccinated, partially vaccinated (< 3 doses) or status unknown: Begin or complete the tetanus vaccination schedule[j]

See MSF Clinical Guidelines for tetanus routine immunisation and post-exposure vaccination.

j Tetanus vaccination schedule: at least 2 doses administered 4 weeks apart, a third dose 6-12 months later, and additional doses administered according to national recommendations.

3.6 Enteric (typhoid and paratyphoid) fever

Enteric fever refers to both typhoid and paratyphoid fever which are bacteraemic febrile illnesses. Typhoid fever is caused by *Salmonella enterica* serotype Typhi (formerly *S. typhi*), while paratyphoid fever is caused by *Salmonella enterica* serotypes, Paratyphi A, B, or C[a].

Enteric fevers are endemic on the Indian subcontinent, Southeast Asia, Sub-Saharan Africa and Latin America[29] and mainly affect children under 15 years of age (with a peak between 5 and 9 years of age[30]). Millions of people are affected by enteric fever every year, with a global case fatality rate of approximately 1%[30]. The risk of mortality is 4 times higher in children under 5 compared to over 5 years of age[31]. Enteric fevers are acquired by the ingestion of food or water contaminated with excreta of symptomatic or asymptomatic carriers or by direct contact (contaminated hands), and risk of infection is higher in areas with poor water and sanitation. Climate change, urbanisation, overcrowded settings, and antibiotic resistance could potentially increase the global burden of enteric fevers[32].

3.6.1 Clinical features

The clinical features of paediatric enteric fevers are nonspecific and can overlap with other infectious diseases in endemic areas. Symptom onset occurs between 5 and 21 days after ingestion of contaminated food or water.

Prolonged fever is the predominant sign of paediatric enteric fever[33], often being the single manifestation, and may present as a fever of unknown origin. However, in young infants, enteric fevers can also present with hypothermia[31].

Along with fever, common symptoms include abdominal pain, malaise, and chills. If left untreated, the disease classically progresses in 3 phases, each with distinct features:
- First week: fever and chills (corresponding to the bacteraemic phase).
- Second week: abdominal pain with either constipation (one-third of patients) or diarrhoea (more frequent in young children). Rose-spots (salmon spots) may be seen (in 5 to 30% of patients)[b].
- Third week: hepatosplenomegaly, and serious complications in 10-15% such as bowel perforation and bleeding, secondary bacteraemia due to enteric aerobic and anaerobic microorganisms, peritonitis, and septic shock.

In patients who do not develop severe complications or die, symptoms progressively settle over weeks to months.

Other occasional associated symptoms and signs which can be seen more frequently in children than adults include[31]:
- General: arthralgia, myalgia
- Gastrointestinal: refusal to feed, paralytic ileus
- Respiratory: cough, bronchopneumonia
- Cardiac: myocarditis, endocarditis, pericarditis, pericardial effusion and relative bradycardia

a *Note*: Non-typhoidal salmonella (NTS) refers to illnesses caused by all other serotypes of *Salmonella*, and it is a frequent cause of bacteraemia and anaemia in children living in areas of high malarial transmission.

b Rose spots are 1 to 5 mm, blanching, faint-colour pink macules-papules. They are typically distributed on the chest, abdomen, and back, and they can persist for 2-3 days. They can rarely appear as haemorrhagic or vesicular.

– Neurological: febrile seizures, headache, Guillain-Barré syndrome, meningitis, brain abscess, typhoid encephalopathy, acute cerebellar ataxia, sinus thrombosis, cerebritis, pseudo tumour cerebri
– Hepatosplenic: typhoid hepatitis or "hepatitis typhosa", acalculous cholecystitis, hepatic and splenic abscesses

The symptoms of paratyphoid fever are the same as those of typhoid fever, although the illness is usually shorter and less severe.

Differential diagnosis

The differential diagnosis of enteric fever is broad, with the main differential diagnoses being malaria, bacterial gastroenteritis, amoebiasis, brucellosis, leptospirosis, leishmaniasis, tuberculosis, and dengue fever.

3.6.2 Diagnosis

Diagnosis is made based on thorough medical history and full clinical examination. Culture remains the gold standard for diagnosis but is rarely available in resource-limited settings, therefore a diagnosis of presumptive enteric fever should be made if the following are present:
– Child appears toxic or severely unwell and/or
– Lives in an endemic area and has fever lasting over 1 week without other obvious cause, and/or
– Severe abdominal pain

It is important to rule out malaria, in endemic regions, and acute abdomen e.g. appendicitis (see Chapter 5, Section 5.4).

Possible investigations that can be performed:
– Blood culture (diagnostic)
– Stool or urine culture (may indicate chronic carriage rather than acute infection)[34]
– FBC: relative leucopenia (normal or slightly low white blood cell count despite bacteraemia)[35]. Leucocytosis in the third week of illness should raise the suspicion of intestinal perforation or an alternative diagnosis. Mild anaemia and thrombocytopenia are common.
– Widal-Felix agglutination reaction: not recommended due to poor specificity and sensitivity, however this test is still used in certain endemic countries as it is cheap. It should not be performed before the second week of illness. Two samples must be collected 10-15 days apart to detect an increase in antibodies.

3.6.3 Management

Children with suspected severe enteric fever (systemic illness, unable to drink or eat, not tolerating oral medications, altered consciousness, prolonged fever, organ system dysfunction) should be admitted to hospital, and isolated if possible (see MSF Manual of Nursing Care Procedures for IPC guidance). Uncomplicated cases can be managed as outpatients, with advice on recognition of danger signs and when to seek medical attention.

Supportive care for severe cases includes:
– Oxygen if necessary to maintain saturations ≥ 92%
– Maintenance IV fluids if unable to eat or drink (see Chapter 15, Section 15.2)
– Treatment of fever (see Section 3.1.3)
– Treatment of pain if present (do not give analgesics systematically as may mask symptoms of peritonitis)

– Monitoring and recording of vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).

Antibiotic treatment

Antibiotic choice is complicated by the spread of multi-resistant strains (increasing resistance to first-line antibiotics: chloramphenicol, ampicillin and cotrimoxazole) and has led to the frequent use of fluoroquinolones. Fluoroquinolone resistance is now also increasing and is currently endemic in Asia, particularly South Asia and East Asia, with increasing resistance reported in the Middle East[36]. Data from African settings is limited but reported rates of fluoroquinolone and multidrug resistance are increasing, particularly in Democratic Republic of Congo (DRC), Tanzania, Ghana, Kenya, Uganda and Nigeria[36,37]. Culture and antibiotic susceptibility studies are therefore critical to guiding treatment, but they are rarely available in resource-limited settings: empiric treatment on the assumption of fluoroquinolone resistance is therefore prudent. If available, recent regional data on susceptibility of isolated strains can help to guide treatment where local antibiograms are not available. It is important to note that fever may persist for 4 to 5 days after the start of effective treatment, therefore ongoing fever alone is not an indication to change antibiotic treatment.

Uncomplicated cases	
First choice	**Azithromycin** PO: 10 to 20 mg/kg (max. 1 g) once daily for 7 days
Alternative	**Cefixime** PO: 10 mg/kg (max. 200 mg), 2 times daily for 10-14 days
Alternative, only where antibiotic sensitivity testing confirms susceptibility	**Amoxicillin** PO: 30 mg/kg (max. 1 g) 3 times daily to complete 14 days of total treatment
	Co-trimoxazole PO: 20 mg SMX + 4 mg TMP/kg (max. 800 mg SMX + 160 mg TMP), 2 times daily to complete 14 days of total treatment
Severe cases[c]	
No suspected or confirmed ceftriaxone resistance	**Ceftriaxone** IV: 50 to 100 mg/kg (max. 4 g) once daily
Suspected or confirmed ceftriaxone resistant or extensively drug resistant (XDR) typhoid	**Meropenem** IV: 20 to 40 mg/kg (max. 2 g) every 8 hours
Oral switch in severe cases once patient improves	
First choice	**Azithromycin** PO: 10 to 20 mg/kg (max. 1 g) once daily to complete 10-14 days of total treatment
Alternative, only where antibiotic sensitivity testing confirms susceptibility	**Amoxicillin** PO: 30 mg/kg (max. 1 g) 3 times daily to complete 14 days of total treatment
	Co-trimoxazole PO: 20 mg SMX + 4 mg TMP/kg (max. 800 mg SMX + 160 mg TMP), 2 times daily to complete 14 days of total treatment

c Start parenteral treatment and switch to oral route as soon as possible once the patient improves, to complete recommended total days of treatment.

If peritonitis is suspected, add **metronidazole** IV: 10 mg/kg (max. 500 mg) every 8 hours for 7-10 days, unless meropenem is used[d]. If no improvement in 48 hours, or perforation is suspected make the patient NBM, place an NGT and leave on free drainage and refer for surgical review where possible.

In the case of enteric fever with severe systemic symptoms (shock, coma) in children older than 3 months, add **dexamethasone** IV: initial dose 1 mg/kg followed by 0.25 mg/kg every 6 hours for a total of 48 hours (8 doses).

Relapse may occur, even in immunocompetent individuals. It usually occurs 2–3 weeks after the resolution of the fever and should be treated with a second, longer course of antibiotics.

3.6.4 Prevention

WHO recommends vaccination with the **typhoid conjugate vaccine** in endemic regions[38]:
- Routine vaccination: a single dose of 0.5 ml IM at the same time as other vaccines administered at the age of 9 months or in the second year of life.
- Catch-up vaccination (same dose) up to 15 years of age: according to national recommendations.

d Meropenem covers anaerobes therefore no need to add metronidazole in this case.

3.7 Measles

Measles is an epidemic-prone, highly contagious viral infection that mainly affects children. It is caused by a paramyxovirus virus (*Morbillivirus*) and is spread by the airborne route via large respiratory droplets. Measles is a vaccine-preventable disease and immunisation against measles is included in all vaccination calendars worldwide. Despite this, measles was responsible for more than 140 000 deaths in 2018, the majority of whom were children under 5 years old[39]. Children with malnutrition are especially vulnerable to measles and at risk of developing severe complications, with measles mortality as high as 15%[40].

Measles is a notifiable disease, and all cases should be reported to local or national public health authorities.

3.7.1 Clinical features

Incubation period for measles is between 10 to 14 days from exposure to onset of fever.

Prodromal phase

- High fever (39-40 °C)
- Classic triad of cough (usually non-productive), coryza (runny nose) and conjunctivitis (red, watery eyes).
- Koplik's spots: tiny bluish-white spots on an erythematous base found on the inside of the cheeks which are pathognomonic of measles. They typically appear 1-2 days before the onset of rash but can be hard to see and may not be observed in all patients with measles.
- Usually lasts for 2 to 4 days.

Eruptive phase

- Erythematous, blanching maculopapular rash that starts on the face and spreads in a descending manner to the neck, trunk, abdomen and lower limbs over the course of 3 to 4 days.
- Fever subsides as the rash reaches the feet, and the rash subsequently recedes in the same order as it appeared.
- Usually lasts for 4 to 7 days.
- Desquamation (peeling) of the skin around 1 to 2 weeks after the rash is common.

Any child presenting with fever, rash and one of cough, coryza or conjunctivitis should be considered a clinical measles suspect.

Complications

Acute complications of measles are frequent and are the cause of the majority of deaths from measles. The most common acute complications affecting children are:

- Respiratory: pneumonia (with or without empyema), otitis media, croup (laryngotracheo-bronchitis)
- Gastrointestinal: diarrhoea (with or without dehydration), stomatitis
- Ocular: purulent conjunctivitis, keratitis, xerophthalmia (due to vitamin A deficiency exacerbated by measles)
- Neurological: febrile seizures, encephalitis (rare)

Post-infectious complications occur after initial resolution of measles but may also be fatal:
– Malnutrition: provoked or exacerbated by measles
– Immunosuppression: temporary immune depression following measles that increases the risk of severe illness from respiratory infections and diarrhoea.
– Noma (gangrenous gingivostomatitis): a non-specific complication of measles associated with extremely high mortality rates (see Chapter 14, Section 14.3).
– Subacute sclerosing pan-encephalitis (SSPE): a rare complication of measles, this progressive degenerative disease occurs several years (average 7 years) after infection with measles.

Investigations

– Collect samples (usually serum, throat swab or urine sample) to send to relevant reference laboratory (see MSF Collection, storage and transport of samples from field to reference laboratory) for detection of IgM antibodies. Check local protocols for sample collection prior to sampling.
– After confirmation of measles outbreak, it is not necessary to take samples from every suspected case if they meet the clinical case definition and have had contact with known measles cases.

3.7.2 Management

Uncomplicated measles

Most children with measles can be managed at home with advice on eye, nose and mouth care, nutrition, fever management and recognition of signs of complications.

Antibiotics

Systematic antibiotic prophylaxis for uncomplicated cases is not recommended by WHO. However, systematic antibiotic prophylaxis[a] for uncomplicated measles in children under 5 years old is recommended by MSF in most projects where they work due to the additional risks inherent to such contexts i.e. situations where identification and/or treatment of superimposed bacterial infections may not be possible (due to difficult access to healthcare, limited capacity of health services) and where there is a high prevalence of vulnerable people.

Vitamin A

Give **vitamin A** to all acute measles cases under 5 years old, regardless of previous recent vitamin A administration:
– Infants < 6 months: 50 000 IU once daily for 2 days
– Infants 6 to 11 months: 100 000 IU once daily for 2 days
– Children 12 to 59 months: 200 000 IU once daily for 2 days

This is usually the only systematic treatment required for children with uncomplicated measles. A third dose should be given to children with signs of vitamin A deficiency (xeropthalmia, corneal ulceration), 4 to 6 weeks later[b].

Conjunctivitis

Non-purulent conjunctivitis with clear, watery discharge does not require specific treatment, simply wash the eyes 2 times daily with clean water. If purulent or cloudy discharge present, treat for superimposed bacterial infection with **tetracycline 1% eye ointment** 2 times daily for 7 days.

a Antibiotic prophylaxis in measles is with amoxicillin PO for 5 days.

b If, for practical reasons, the patient is unlikely to receive their 3rd dose 4-6 weeks later, it is possible to give the 3rd dose from day 8 onwards.

Complicated measles

Admit all children with measles who have malnutrition and those with acute symptoms that cannot be managed at home, including:
- Moderate or severe respiratory distress
- Stridor
- Inability to feed (due to extensive oral lesions, vomiting, lethargy)
- Altered consciousness or seizures
- Moderate or severe dehydration
- Corneal lesions (pain, erosion, opacity, photophobia)

Infection prevention and control measures

- Isolate suspected cases to a single room with dedicated nursing staff and equipment to reduce the risk of cross-infection.
- Ensure transmission-based precautions are taken, including correct use of personal protective equipment (PPE).
- If multiple cases, group together with other cases in a separated area from other patients (cohorting).
- Cases should remain isolated until 4 days after the appearance of the rash, as they are still infectious during this time.

Supportive care

- Administer **oxygen** if SpO_2 < 92% in room air or severe respiratory distress.
- Ensure adequate fluid and calorie intake (risk of weight loss). Give small and frequent oral feeds if possible. Some patients need NGT feeding or IV maintenance fluids (see Chapter 15, Section 15.2 and Section 15.5).
- Give **vitamin A** PO systematically, as above.
- Test for malaria in endemic areas, and treat if RDT positive.
- Treat fever, if required, for patient comfort (see Chapter 3, Section 3.1.3).
- Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
- If conjunctivitis, wash the eyes with clean water 2 times daily.
- Administer **tetracycline 1% eye ointment**, as above, if purulent or cloudy eye discharge present.
- Wash the mouth with salted water 4 times daily, if possible.
- Keep skin clean and dry and monitor for signs of infection.
- Manage pain with adequate analgesia (see Chapter 15, Section 15.4).

Treatment of specific complications

Empiric antibiotic treatment should be started early if there is a suspicion of a superimposed bacterial infection[40]. Refer to the relevant chapter for management of specific complications:
- Pneumonia (see Chapter 4, Section 4.5)
- Empyema (see Chapter 4, Section 4.6)
- Croup (laryngotracheobronchitis, see Chapter 4, Section 4.2)
- Dehydration (see Chapter 5, Section 5.3)
- Seizures (see Chapter 7, Section 7.2)
- Sepsis or severe bacterial infection (see Chapter 3, Section 3.2)
- Urinary tract infection (see Chapter 8, Section 8.1)

Refer to MSF Management of a measles epidemic for:
- Outbreak investigation and surveillance methods
- Mass vaccination campaigns

3.7.3 Prevention

– Vaccination is highly effective at preventing infection with measles and two doses confers life-long immunity.
– Measles vaccine can be monovalent but is frequently combined with rubella and mumps in a single MMR vaccine.
– Measles vaccine is part of routine childhood immunisation (as part of the Expanded Programme on Immunisation) with primary dose at 9-12 months and second dose at 15-18 months.
– Catch-up vaccination (missed routine vaccination) should be done at any opportunity in unvaccinated individuals.

3.8 Orbital and peri-orbital cellulitis

Orbital cellulitis is an infection within the orbit of the eye, affecting the muscular and adipose tissues posterior to the orbital septum (therefore called post-septal). It is a clinical emergency requiring urgent referral for surgical management where possible. Major complications include intracranial infection (abscess, empyema, meningitis), irreversible damage to the optic nerve, loss of vision, or venous sinus thrombosis[41].

Predisposing factors include sinusitis, otitis media, complicated periorbital cellulitis, orbital trauma (e.g. fractured orbit) and foreign body[a].

Peri-orbital cellulitis is an infection of the eye lid and surrounding skin anterior to the orbital septum (therefore called pre-septal)[42]. Predisposing factors include upper respiratory tract infections, sinusitis, local trauma, insect bites and foreign body[b].

Neither orbital nor peri-orbital cellulitis involve the ocular globe itself.

The most common causes of both conditions are *Streptococcus pneumoniae*, *H. influenzae* type B (Hib), *Moraxella catarrhalis*, *Staphylococcus aureus*, *Group-A beta haemolytic Streptococcus,* anaerobes (especially when odontogenic source) and Gram-negative bacilli (especially post-trauma)[43]. Consider *Neisseria gonorrhoea* and *Chlamydia trachomatis* infections in neonatal presentation (see MSF Neonatal Care guidelines). Consider *Mucorales*, *Aspergillus*, *Mycobacterium tuberculosis*, in immunosuppressed children.

3.8.1 Clinical features

Diagnosis is based on history, clinical features, and full examination. Overlapping clinical features in peri-orbital and orbital cellulitis can make differentiation difficult. See also Figure 3.4 page 119 for guidance on diagnosis and management of eye swelling and/or pain.

Both conditions typically present with:
- Unilaterally affected eye
- Eyelid erythema and oedema
- Eye/eyelid pain or tenderness (more common in orbital cellulitis)
- Fever or general malaise in more severe cases

In addition, certain features are only present in orbital cellulitis:
- Limited eye movements due to pain or severe oedema
- Inability to open the eye due to severe oedema
- Proptosis
- Globe displacement
- Visual impairment with reduced acuity, diplopia, and relative afferent pupillary defect
- Severe headache, or other features suggesting intracranial involvement

Assessment of both acuity and eye movements are essential. If the patient is not able to open the eye due to significant oedema, manage the condition as orbital cellulitis.

a Educational video available on: https://www.youtube.com/watch?v=lMXFDSTgK7U
b Educational video available on: https://www.youtube.com/watch?v=Z-Jf4Kw7owY

Differential diagnosis

– Allergic reaction (bilateral findings and/or painless oedema in a non-febrile child)
– Insect bite (unilateral macular spot on the eyelid)
– Conjunctivitis (mild oedema, eye secretions)

3.8.2 Management

If the patient presents with symptoms or signs of potential severe bacterial infection or sepsis, treat as such (see Section 3.2).

Orbital cellulitis

– This is a medical emergency and requires urgent treatment.
– Admit and start IV antibiotic treatment as soon as possible:

> **ceftriaxone** IV: 100 mg/kg loading dose on D1, then 50 mg/kg every 12 hours (daily max. 4 g if < 50 kg; max. 2 g if ≥ 50 kg)
> +
> **cloxacillin** IV: < 40 kg: 25 to 50 mg/kg every 6 hours (max. 8 g daily)
> ≥ 40 kg: 2 g every 6 hours

– Refer for surgical intervention urgently (where possible) for all cases of severe orbital cellulitis or if there is suspected intracranial involvement.
– If signs of clinical improvement (reduction in swelling, erythema) after at least 5 days of IV antibiotics, switch to **amoxicillin/clavulanic acid** (ratio 7:1 or 8:1) PO to complete 10 to 14 days of treatment (until erythema resolves). Dosage expressed in amoxicillin:
  • < 40 kg: 50 mg/kg 2 times daily
  • ≥ 40 kg:
    Ratio 8:1: 3000 mg daily (2 tablets of 500/62.5 mg 3 times daily)
    Ratio 7:1: 2625 mg daily (1 tablet of 875/125 mg 3 times daily)
– Where surgery is not available and there is no clinical improvement after 48 hours of treatment, suspect an orbital abscess and seek ophthalmological expert advice.

In case of pain or fever, give paracetamol (see Section 3.1.3).

Peri-orbital cellulitis

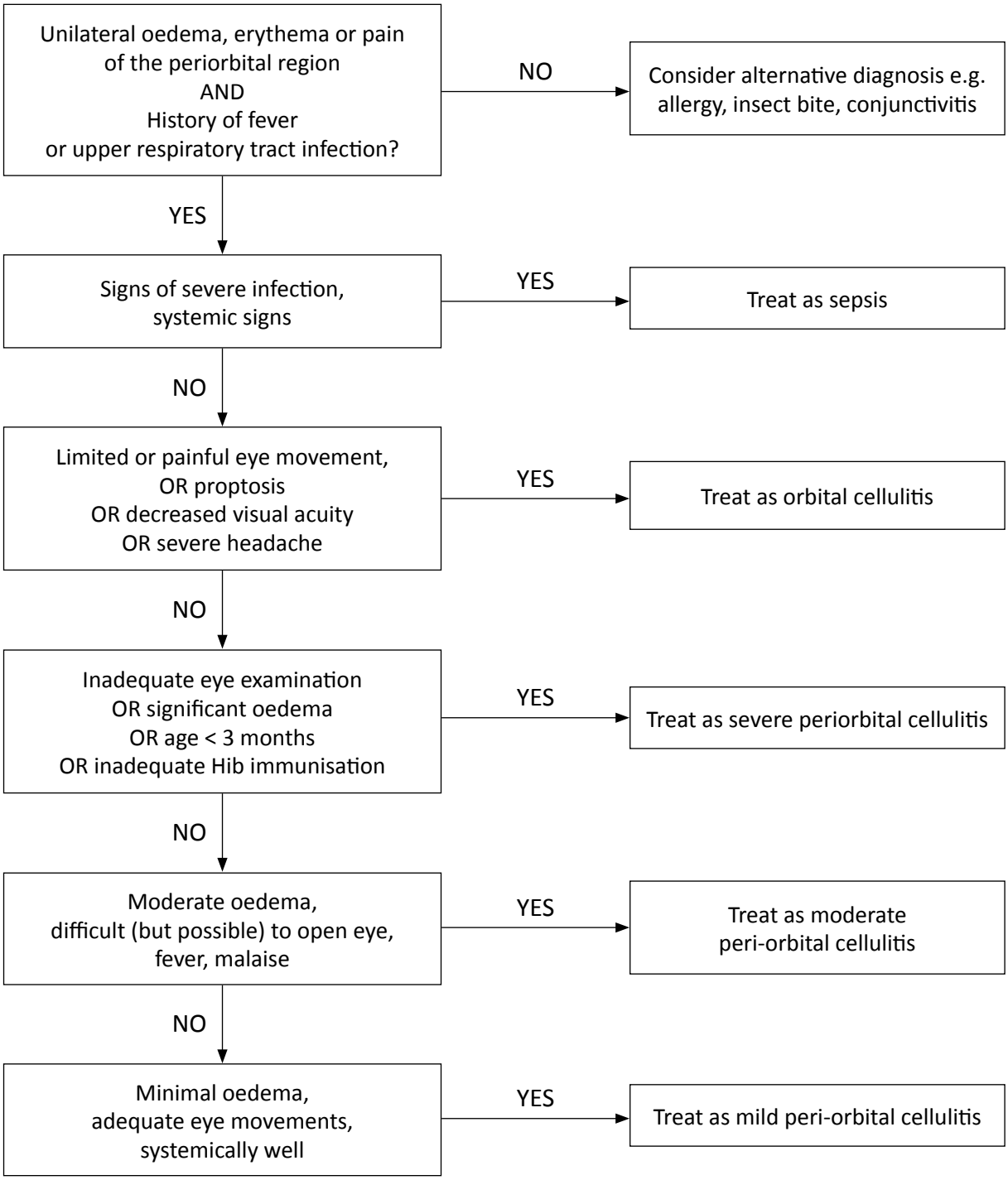
Mild: treat with oral **amoxicillin/clavulanic acid** (ratio 7:1 or 8:1) PO for 7 to 10 days. Dosage expressed in amoxicillin:
– < 40 kg: 50 mg/kg 3 times daily
– ≥ 40 kg:
  • Ratio 8:1: 3000 mg daily (2 tablets of 500/62.5 mg 3 times daily)
  • Ratio 7:1: 2625 mg daily (1 tablet of 875/125 mg 3 times daily)

Monitor as outpatient and explain to parent/carer signs of increasing severity and when to seek immediate medical consultation.

Moderate: moderate swelling, difficult (but possible) to open the eye, systemically unwell (fever, malaise). Treat with **ceftriaxone** IV: 50 mg/kg (max. 4 g if < 50 kg; max. 2 g if ≥ 50 kg) once daily. Switch to oral treatment as above when clinically improving (after at least 48 hours of IV treatment) to complete 7-10 days total treatment.

Severe: < 3 months age, significant swelling, unable to do adequate eye exam, no Hib vaccine. Treat as per orbital cellulitis (above).

Figure 3.4 - Algorithm for management of eye swelling/pain
(adapted from Royal Children's Hospital Melbourne, Clinical Practice Guidelines[41])



References Chapter 3

1. National Collaborating Centre for Women's and Children's Health (UK). *Feverish Illness in Children: Assessment and Initial Management in Children Younger Than 5 Years*. Royal College of Obstetricians and Gynaecologists (UK); 2013. Accessed November 20, 2023. http://www.ncbi.nlm.nih.gov/books/NBK247907/
2. Barbi E, Marzuillo P, Neri E, Naviglio S, Krauss B. Fever in Children: Pearls and Pitfalls. *Children*. 2017;4(9):81. https://doi.org/10.3390/children4090081
3. Arora R, Mahajan P. Evaluation of Child with Fever Without Source. *Pediatr Clin North Am*. 2013;60(5):1049-1062. https://doi.org/10.1016/j.pcl.2013.06.009
4. Overview | *Fever in under 5s: Assessment and Initial Management | Guidance | NICE*. NICE; 2019. Accessed November 20, 2023. https://www.nice.org.uk/guidance/ng143
5. Meningitis. World Health Organisation. Accessed November 20, 2023. https://www.who.int/news-room/fact-sheets/detail/meningitis
6. Kimberlin DW, Barnett ED, Lynfield R, Sawyer MH, eds. *Red Book (2021): Report of the Committee on Infectious Diseases*. 32nd ed. American Academy of Pediatrics; 2021. https://doi.org/10.1542/9781610025225
7. Brouwer MC, McIntyre P, Prasad K, Van De Beek D. Corticosteroids for acute bacterial meningitis. Cochrane Acute Respiratory Infections Group, ed. *Cochrane Database Syst Rev.* 2015;2018(11). https://doi.org/10.1002/14651858.CD004405.pub5
8. Fact sheet about malaria. Accessed November 20, 2023. https://www.who.int/news-room/fact-sheets/detail/malaria
9. World Health Organization. *Guidelines for the Treatment of Malaria*. 3rd ed. World Health Organization; 2015. Accessed November 20, 2023. https://iris.who.int/handle/10665/162441
10. *WHO Guidelines for Malaria*. World Health Organization; 2023. Accessed November 20, 2023. https://www.who.int/publications-detail/guidelines-for-malaria
11. Nyirenda TS, Mandala WL, Gordon MA, Mastroeni P. Immunological bases of increased susceptibility to invasive nontyphoidal Salmonella infection in children with malaria and anaemia. *Microbes Infect*. 2018;20(9-10):589-598. https://doi.org/10.1016/j.micinf.2017.11.014
12. Takem EN, Roca A, Cunnington A. The association between malaria and non-typhoid Salmonella bacteraemia in children in sub-Saharan Africa: a literature review. *Malar J*. 2014;13(1):400. https://doi.org/10.1186/1475-2875-13-400
13. Mooney JP, Galloway LJ, Riley EM. Malaria, anemia, and invasive bacterial disease: A neutrophil problem? *J Leukoc Biol*. 2019;105(4):645-655. https://doi.org/10.1002/JLB.3RI1018-400R
14. Church J, Maitland K. Invasive bacterial co-infection in African children with Plasmodium falciparum malaria: a systematic review. *BMC Med*. 2014;12(1):31. https://doi.org/10.1186/1741-7015-12-31

15. Maitland K, Olupot-Olupot P, Kiguli S, et al. Transfusion Volume for Children with Severe Anemia in Africa. *N Engl J Med*. 2019;381(5):420-431. https://doi.org/10.1056/NEJMoa1900100

16. Christensen SS, Eslick GD. Cerebral malaria as a risk factor for the development of epilepsy and other long-term neurological conditions: a meta-analysis. *Trans R Soc Trop Med Hyg*. 2015;109(4):233-238. https://doi.org/10.1093/trstmh/trv005

17. Tetanus. World Health Organisation. Accessed November 20, 2023. https://www.who.int/news-room/fact-sheets/detail/tetanus

18. Yen LM, Thwaites CL. Tetanus. *The Lancet*. 2019;393(10181):1657-1668. https://doi.org/10.1016/S0140-6736(18)33131-3

19. Kyu HH, Mumford JE, Stanaway JD, et al. Mortality from tetanus between 1990 and 2015: findings from the global burden of disease study 2015. *BMC Public Health*. 2017;17(1):179. https://doi.org/10.1186/s12889-017-4111-4

20. Thwaites L. Tetanus. UpToDate. Published June 2022. https://www.uptodate.com/contents/tetanus

21. Pinkbook: Tetanus | CDC. Published October 19, 2022. Accessed November 20, 2023. https://www.cdc.gov/vaccines/pubs/pinkbook/tetanus.html

22. Cook TM, Protheroe RT, Handel JM. Tetanus: a review of the literature. *Br J Anaesth*. 2001;87(3):477-487. https://doi.org/10.1093/bja/87.3.477

23. Rodrigo C, Fernando D, Rajapakse S. Pharmacological management of tetanus: an evidence-based review. *Crit Care*. 2014;18(2):217. https://doi.org/10.1186/cc13797

24. Tetanus. One Health Trust. Accessed November 20, 2023. https://africaguidelines.onehealthtrust.org/treatment/neonatal-and-pediatric/tetanus/

25. Shanbag P, Mauskar A, Masavkar S. Intravenous magnesium sulphate infusion as first-line therapy in the control of spasms and muscular rigidity in childhood tetanus. *Paediatr Int Child Health*. 2019;39(3):201-207. https://doi.org/10.1080/20469047.2018.1542884

26. Thwaites C, Yen L, Loan H, et al. Magnesium sulphate for treatment of severe tetanus: a randomised controlled trial. *The Lancet*. 2006;368(9545):1436-1443. https://doi.org/10.1016/S0140-6736(06)69444-0

27. Ceneviva GD, Thomas NJ, Kees-Folts D. Magnesium sulfate for control of muscle rigidity and spasms and avoidance of mechanical ventilation in pediatric tetanus: *Pediatr Crit Care Med*. 2003;4(4):480-484. https://doi.org/10.1097/01.PCC.0000090015.03962.8B

28. World Health Organization. *Current recommendations for treatment of tetanus during humanitarian emergencies : WHO technical note*. Published online 2010. Accessed November 20, 2023. https://iris.who.int/handle/10665/70219

29. Crump JA, Mintz ED. Global Trends in Typhoid and Paratyphoid Fever. *Clin Infect Dis*. 2010;50(2):241-246. https://doi.org/10.1086/649541

30. Stanaway JD, Reiner RC, Blacker BF, et al. The global burden of typhoid and paratyphoid fevers: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet Infect Dis*. 2019;19(4):369-381. https://doi.org/10.1016/S1473-3099(18)30685-6

31. Britto C, Pollard AJ, Voysey M, Blohmke CJ. An Appraisal of the Clinical Features of Pediatric Enteric Fever: Systematic Review and Meta-analysis of the Age-Stratified Disease Occurrence. *Clin Infect Dis*. 2017;64(11):1604-1611. https://doi.org/10.1093/cid/cix229

32. Typhoid. World Health Organisation. Accessed November 20, 2023. https://www.who.int/health-topics/typhoid

33. Azmatullah A, Qamar FN, Thaver D, Zaidi AK, Bhutta ZA. Systematic review of the global epidemiology, clinical and laboratory profile of enteric fever. *J Glob Health*. 2015;5(2):020407. https://doi.org/10.7189/jogh.05.020407

34. Basnyat B, Qamar FN, Rupali P, Ahmed T, Parry CM. Enteric fever. *BMJ*. Published online February 26, 2021:n437. https://doi.org/10.1136/bmj.n437

35. Kumar S, Rizvi M, Berry N. Rising prevalence of enteric fever due to multidrug-resistant Salmonella: an epidemiological study. *J Med Microbiol*. 2008;57(10):1247-1250. https://doi.org/10.1099/jmm.0.2008/001719-0

36. Wain J, Hendriksen RS, Mikoleit ML, Keddy KH, Ochiai RL. Typhoid fever. *The Lancet*. 2015;385(9973):1136-1145. https://doi.org/10.1016/S0140-6736(13)62708-7

37. Browne AJ, Kashef Hamadani BH, Kumaran EAP, et al. Drug-resistant enteric fever worldwide, 1990 to 2018: a systematic review and meta-analysis. *BMC Med*. 2020;18(1):1. https://doi.org/10.1186/s12916-019-1443-1

38. Burki T. Typhoid conjugate vaccine gets WHO prequalification. *Lancet Infect Dis*. 2018;18(3):258. https://doi.org/10.1016/S1473-3099(18)30087-2

39. Measles. World Health Organisation. Accessed November 20, 2023. https://www.who.int/news-room/fact-sheets/detail/measles

40. World Health Organization. *Guide for Clinical Case Management and Infection Prevention and Control during a Measles Outbreak*. World Health Organization; 2020. Accessed November 20, 2023. https://iris.who.int/handle/10665/331599

41. Clinical Practice Guidelines : Periorbital and orbital cellulitis. The Royal Children's Hospital Melbourne. Accessed November 20, 2023. https://www.rch.org.au/clinicalguide/guideline_index/Periorbital_and_orbital_cellulitis/

42. Wald ER. Periorbital and Orbital Infections. *Pediatr Rev*. 2004;25(9):312-320. https://doi.org/10.1542/pir.25-9-312

43. Sanford Guide | Antimicrobial Stewardship. Accessed November 20, 2023. https://www.sanfordguide.com/

Chapter 4:
Respiratory conditions

4.1 Approach to a child with a respiratory complaint

Children of all age groups frequently present with respiratory symptoms, however, the most common causes vary significantly between age groups and in the presence of underlying conditions. Acute respiratory infection is the most common cause, with pneumonia accounting for over 800,000 deaths in under 5-year-olds worldwide every year[1]. Additionally, annually over 1 million children become symptomatic with tuberculosis[2]. Malnutrition, poor hygiene and sanitation, and indoor and outdoor air pollution are all factors that may exacerbate respiratory conditions in children.

Children presenting with a respiratory emergency, including acute respiratory distress, obstructed upper airway, acute exacerbation of asthma, and hypoxia, need urgent assessment and prompt management as critical deterioration can be rapid.

This chapter will cover the most common respiratory conditions that require hospital-level care. For simple respiratory and ear, nose and throat (ENT) conditions that can be managed in an out-patient department (OPD) setting and/or at home, refer to MSF Clinical Guidelines. For OPD follow-up for longer term management of asthma, see Section 4.10.2.

4.1.1 Respiratory symptoms and signs

Diagnosis is often based on clinical history, descriptive factors of symptoms and signs, and clinical examination.

History

- Take a comprehensive history of the presenting symptoms or signs, including onset, duration, pattern, severity, precipitating and alleviating factors, associated features, previous episodes, etc.
- Use direct questioning to gather descriptive factors relevant to the symptom:

Symptom	Descriptive factors
Dyspnoea (difficult or laboured breathing) and/or tachypnoea (fast breathing)	On exertion/at rest. Ability to speak in full sentences. Impact on feeding (especially in infants).
Cough	Dry or productive; sputum volume, colour, consistency. Sporadic or in bouts; barking or 'whooping' Exacerbating factors; worse/better at what time of day. Duration.
Wheeze	Triggering factors; worse/better at what time of day.
Sore throat	Impact on swallowing, drinking. Change to voice or cry. Bad breath.

Symptom	Descriptive factors
Ear pain or hearing loss	Rubbing ears (infants), discharge from ear
Haemoptysis (blood in sputum)	Duration, volume, colour.
Chest pain	Sharp/stabbing, dull/ache, site, radiation.
Systemic symptoms	Fever; rigors; night sweats; loss of appetite; headache; vomiting and diarrhoea; weight loss
ENT symptoms	Nasal congestion/discharge, sneezing, vertigo, tinnitus, facial pain and swelling

- Ask about past medical history including asthma, chronic respiratory or cardiac conditions, surgical history and other medical co-morbidities as well as vaccination history (particularly diphtheria, pertussis, measles, *Haemophilus influenzae* type B, pneumococcus vaccines).
- Family history: ask if there are any household members diagnosed with TB (or been in contact with someone with TB); any smokers; parental HIV status; known cystic fibrosis.
- Social history: living conditions (draughts, damp, overcrowding, sanitation), indoor/outdoor air pollution (check if cooking fire within living quarters), smoking.

Examination

Perform a full clinical examination (Chapter 1) and specific respiratory examination:

- General: overall appearance, position, activity level, ability to speak or cry, any obvious acute respiratory distress or cyanosis, and vital signs.
- Expose the child's chest and, where possible, position them at a 45-degree angle (semi-sitting position).
- Observation: look for deformities, asymmetry, scars or signs of trauma; and rate, rhythm and depth of breathing.
- Palpation: tracheal position, bilateral chest expansion, bone tenderness. Palpate for any enlarged lymph nodes (adenopathy) in the retro-auricular, submandibular, supraclavicular, and axillary areas.
- Percussion: across chest including supraclavicular, infraclavicular, bilateral chest wall (upper, middle and lower), axillary regions for dullness or hyper-resonance.
- Auscultation: listen throughout both lung fields for presence or absence of breath sounds and any additional sounds.
- Conduct a brief full-body examination paying attention to face, neck, hands and legs.
- Test for sinus tenderness by tapping the upper molars or the frontal or maxillary sinuses with one finger.
- Use an otoscope to examine the tympanic membranes and the throat.

– Check for signs indicative of underlying respiratory cause or condition:

Sign	Likely cause
On observation	
Central cyanosis: blue discolouration seen on the tongue and lips.	Low levels of oxygen in central arterial blood
Peripheral cyanosis: blue discolouration seen in nail beds of hands and/or feet.	Low levels of oxygen in peripheral arterial blood
Signs of respiratory distress: • Grunting: a low, short repetitive noise on expiration • Nasal flaring: nostrils widen on inspiration • Intercostal retraction: muscles between ribs pull inwards during inspiration. • Subcostal retraction (chest wall retractions): inferior thoracic wall depresses on inspiration as the superior abdomen expands. • 'Head bobbing' due to use of accessory muscles: use of muscles in neck/ abdomen to assist inspiration.	Pathologies of lung tissue or airways e.g. pneumonia (Section 4.5), asthma (Section 4.10), bronchiolitis (Section 4.7), empyema (Section 4.6) or Cardiac pathologies (Chapter 6)
Barking cough	Croup (Section 4.2)
Stridor: abnormal, high pitched sound on inspiration.	Upper airway obstruction e.g. croup, epiglottitis (Section 4.3)
Barrel shaped chest: a rounded or bulging chest.	Chronic respiratory disease e.g. asthma (Section 4.10), cystic fibrosis, tuberculosis (Section 4.11)
Clubbing: thickening of the tissue at the base of the fingernails.	Tuberculosis (Section 4.11), chronic respiratory disease
On palpation	
Tracheal deviation	Tension pneumothorax
Enlarged lymph nodes of neck, supraclavicular, axillary.	Indicate inflammatory process in region e.g. infection or malignancy.
On percussion	
Dull percussion	Increased tissue density e.g. empyema, pleural effusion, pneumonia, haemothorax
Hyper-resonant percussion	Reduced tissue density e.g. pneumothorax

Sign	Likely cause
On auscultation	
Absence of breath sounds	Pleural effusion, pneumonia (Section 4.5), pneumothorax, haemothorax
Bronchial breathing: harsh breath sounds with a gap between inspiratory and expiratory sounds.	Pneumonia
Crepitations: crackling or rattling sounds.	Pneumonia, bronchiolitis, pulmonary oedema
Pleural rub: squeaking or grating sound	Empyema (Section 4.6), pleural effusion
Wheeze: continuous coarse whistling sound most commonly heard on expiration	Asthma, bronchiolitis

Evaluate severity of respiratory distress (if present) using clinical signs. The Clinical Respiratory Score, (see Table 4.1 and Appendix 7) is a simple scoring system that can be used to guide the assessment of respiratory distress and response to treatment. Based on the total score obtained, the child can be classified as having mild, moderate or severe respiratory distress.

Table 4.1 - Clinical Respiratory Score (CRS) (adapted for the purposes of these guidelines from: see references[3,4])

Assess	Score 0	Score 1	Score 2
Respiratory rate (breaths/minute)	Age < 2 months: < 50 Age 2-11 months: < 40 Age 1-5 years: < 30 Age > 5 years: < 20	Age < 2 months: 50-60 Age 2-11 months: 40-50 Age 1-5 years: 30-40 Age > 5 years: 20-30	Age < 2 months: > 60 Age 2-11 months: > 50 Age 1-5 years: > 40 Age > 5 years: > 30
Auscultation	Good air movement, expiratory scattered wheezing or loose rales/crackles	Depressed air movement inspiratory and expiratory wheezes or rales/crackles	Diminished or absent breath sounds, severe wheezing or rales/ crackles or marked prolonged expiration
Use of accessory muscles	Mild to no use of accessory muscles, mild to no retractions or nasal flaring on inspiration	Moderate intercostal retractions, mild to moderate use of accessory muscles, nasal flaring	Severe intercostal and subcostal retractions, nasal flaring
Mental status	Normal to mildly irritable	Irritable, agitated, restless	Lethargic
Room air SpO_2	> 95%	90-95%	< 90%
Colour	Normal	Pale to normal	Cyanotic, dusky

Based on the total score obtained, 3 categories of respiratory distress are possible:
Mild (≤ 3), Moderate (4-7), Severe (8-12)

Investigations

Peak flow assessment, chest X-ray or sputum samples can help to confirm or guide diagnosis. Where relevant, these are described in further detail in disease-specific texts throughout the chapter.

Consider cardio-pulmonary Point-of-Care Ultrasound (POCUS):
- Requires dedicated intensive training and should not be performed by untrained or inexperienced clinicians.
- Indications: dyspnoea, hypoxia
- Perform 12-zone lung ultrasound (LUS) to evaluate for signs of consolidation, pleural effusion/ empyema, pulmonary oedema, and to rule out pneumothorax.
- Can also be used for ultrasound-guided procedures (thoracocentesis) with appropriate training only. Include 5-view cardiac exam if applicable.

4.1.2 Management

Refer to disease or syndrome specific management in respective sub-chapters.

Emergency management of an acutely unwell child with respiratory symptoms

Treat in emergency department or area with resuscitation equipment.
- Assess and manage ABCDE (Chapter 2, Section 2.2)
- Aim to keep child in a position that alleviates respiratory distress, e.g. sitting with support at 45 degrees, or in the case of infants, sitting on a parent/carer's lap.
- Administer **oxygen** via face mask, aiming for SpO_2 between 94 - 98%.
- Conduct a rapid examination to assess for upper airway obstruction, severity of respiratory distress/hypoxia, or tracheal deviation to manage any life-threatening emergency immediately.
- If signs of epiglottitis (septic, sitting upright, drooling), do not examine throat or do any procedures that may agitate child. Call anaesthetist if available for possible upper airway intervention.
- For signs of upper airway obstruction, refer to:
  - Choking (see Chapter 2, Section 2.3)
  - Croup (Section 4.2)
  - Epiglottitis (Section 4.3)
  - Bacterial tracheitis (Section 4.4)
  - Diphtheria (Section 4.8)
- Signs of tension pneumothorax, refer to Chapter 2, Section 2.7.
- Depending on severity of respiratory distress and/or hypoxia, provide necessary respiratory support.

4.1.3 Respiratory support

See also MSF Manual of Nursing Care Procedures, Chapter 7: Respiratory Care, for comprehensive nursing guidance for respiratory support.

Oxygen therapy

Essential treatment for hypoxia and is indicated when oxygen saturation (SpO_2) is < 92% in stable patients, aiming to maintain $SpO_2 \geq 92\%$. A higher threshold is used in emergency management of critically unwell children and for specific conditions where there is impaired delivery of oxygen to body tissues, such as in severe anaemia, severe sepsis, sickle cell disease

and severe heart failure[5], where the aim is to maintain SpO_2 ≥ 94%. Oxygen can be delivered via a simple oxygen mask, a non-rebreathing mask, or via nasal cannulae (see Chapter 15, Section 15.1 for more information on when to use each oxygen delivery method). Always use the minimum flow of oxygen possible to achieve desired oxygen saturations according to the device used. Weaning should be considered in children who are stable or clinically improving when SpO_2 is consistently ≥ 92%, if continuously monitored, or ≥ 92% on at least two separate consecutive readings taken several hours apart. Oxygen should be prescribed, with target SpO_2 indicated to allow for nurse-led weaning and adjustment of flow rates to meet the desired target. See also MSF Manual of Nursing Care Procedures, Procedure: Oxygen therapy.

Humidification

No humidification is needed for standard oxygen flow rates. Humidification is only needed if the patient receives high flow rates for more than 2 hours. High flow rates are > 2 L/min for 1 month to < 2 years old, > 4 L/min for 2 to 12 years old, and > 6L/min for over 12 years old.

Standard flow rates via nasal cannula by age

Age	Standard oxygen nasal cannula flow rate
1 month to < 2 years	1 to 2 L/min
2 to 12 years	2 to 4 L/min
Over 12 years	4 to 6 L/min

High-flow nasal cannula (HFNC)[a]

Effective, safe, non-invasive method to provide acute respiratory support in moderate to severe respiratory distress when oxygen therapy alone is insufficient[6]. HFNC systems consist of a flow generator, an air-oxygen blender, a humidifier and wide-bore nasal cannula. Flow and oxygen requirements can be titrated independently to meet the patient's needs, and flow rates of 8 - 20L/min in infants, up to 30 - 50 L/min in children 12-18 years can be achieved[7]. The heated, humidified gas is well tolerated as it avoids drying of nasal mucosa. High flow rates wash out pharyngeal dead space and improve functional residual capacity (FRC) while humidification helps to remove secretions, leading to reduced work of breathing[8]. Follow local protocols for further guidance on implementation where HFNC is available.

Non-invasive ventilation: continuous positive airway pressure (CPAP)[b]

CPAP enables delivery of a continuous level of positive airway pressure which helps to splint airways open and prevent collapse of alveoli. In addition to continuous flow of oxygen, this improves diffusion of oxygen into the blood, which reduces the work of breathing and thus provides comfort to the child.

CPAP is indicated in severe respiratory distress, when HFNC (where available) has failed. It can only be used in spontaneously breathing patients, since it delivers a continuous low pressure and does not initiate breaths. CPAP should be reserved for children with reversible respiratory conditions, and is unlikely to be beneficial in children whose respiratory distress is secondary to a non-respiratory cause (e.g. cardiac condition, shock).

a HFNC is not yet widely available in MSF projects. It should be noted that standard oxygen concentrators alone cannot be used to administer safe and effective HFNC.

b *Note*: 'Home-made', improvised or locally-adapted bubble CPAP devices should not be used in MSF projects. Only validated CPAP machines that have been designed for this purpose should be used.

Administer CPAP only where intensive medical care is available with appropriately trained staff, medical devices, and a validated local user protocol. The use of CPAP with certain patient groups or where intensive medical care is limited carries a risk and may be harmful[9]. Ensure all safety precautions are implemented as per local protocol.

Invasive ventilation: intubation

Requires specialised facilities and staff and is considered outside the scope of these guidelines. It is, therefore, not included as a management option in disease-specific text.

General management tips for common respiratory complaints

- Saline nose drops and/or a bulb syringe can be used to clear accumulated nasal secretions (see MSF Manual of Nursing Care Procedures, Procedure: Naso-Oropharyngeal suctioning).
- Ensure child gets adequate daily fluid intake and maintains a good hydration status avoiding over or dehydration.
- Vitamin C, cough or cold medications, are not effective at reducing either the symptoms or the duration of respiratory disease.
- Antihistamines are only recommended if there is an allergic component to the symptoms or in the history.
- Antibiotics should only be used if a bacterial infection is suspected.
- Steroids should be used with caution and reserved for conditions where clear benefit has been demonstrated, e.g. asthma, croup.
- Many respiratory diseases are infections. In such cases, depending on the aetiology, appropriate transmission-based precautions (e.g. droplet precautions) should be adopted by parent/carer, medical staff and other close contacts to limit risk of transmission. These are detailed in disease-specific texts.
- All children presenting with respiratory disease should have their vaccination status checked. If incomplete, refer the family to the local EPI (Expanded Program on Immunisation) or vaccinate the child during admission if possible.

4.2 Croup (laryngotracheitis and laryngotracheobronchitis)

Common respiratory infection amongst children with peak incidence between 6 months and 3 years (though may rarely occur in infants as young as 3 months old and in older children up to 7 years of age), with a characteristic inspiratory stridor and barking cough. It is most often caused by parainfluenza virus type 1, but also by respiratory syncytial virus (RSV) or adenovirus; other viral infections have been known less commonly to cause croup (including measles, influenza, coronaviruses). In most cases it is mild and self-limiting, though secondary bacterial infection, significant upper airway obstruction or respiratory distress may occur.

Croup is also called laryngotracheitis, or laryngotracheobronchitis if accompanied by wheezing. It is called laryngitis when hoarseness is the only symptom, as in older children. Spasmodic croup is characterised by the sudden onset of inspiratory stridor at night, short duration (several hours) and sudden cessation. Spasmodic croup recurs frequently and is also called "allergic croup."

4.2.1 Clinical features

Diagnosis based on clinical history and presentation.
- Initial symptoms of common cold with nasal discharge.
- Develops fever, hoarseness, barking cough and stridor over 12 to 48 hours.
- With worsening airway obstruction, stridor may get louder and child may develop other signs of respiratory distress. If significant airway obstruction, the 'loud' stridor may become absent and paradoxically replaced by a 'quiet' stridor indicating severe croup.
- Indication of higher risk of severity: sudden onset or rapidly progressing symptoms (inspiratory stridor at rest after < 12 hours of illness); previous episodes of croup.

Symptoms are exacerbated when the child gets distressed – try to keep child comfortable while examining, e.g. sitting on parent/carer's lap, examine oropharynx without using a tongue depressor to avoid triggering the gag reflex.

4.2.2 Management

- Administer **oxygen** if SpO_2 < 92% in room air or severe respiratory distress.
- Manage according to severity of croup.
- Treat fever for the child's comfort.
- Antibiotic treatment is not routinely required as most croup cases are of viral aetiology. Consider antibiotic treatment in clinical conditions where a secondary bacterial infection is suspected.

Mild croup

- No stridor at rest, no signs of severe respiratory distress, drinking well, SpO_2 > 94%.
- Give one dose of **dexamethasone** PO: 0.15 - 0.6 mg/kg[a] (maximum dose 16 mg) or alternatively **prednisolone** PO: 1 mg/kg.
- Discharge home with advice to parents/carers to ensure adequate hydration and to return if condition deteriorates.

a 0.15 mg/kg of dexamethasone is the preferred dose for children who are easily able to return to hospital in case of deterioration or return of symptoms. If access to healthcare is difficult, the higher dose of 0.6 mg/kg should be used.

– Consider admission for observation in any of the following situations:
  • Infants < 6 months of age
  • Dehydration present
  • Live far from health facility

Moderate and severe croup

– Stridor present at rest (either intermittent or persistent), signs of severe respiratory distress, unable to drink, hypoxia.
– Administer **oxygen** if SpO_2 < 92% in room air or severe respiratory distress.
– Give **dexamethasone** PO: 0.6 mg/kg (maximum dose 16 mg) or alternatively **prednisolone** PO: 1 mg/kg. Administer IV or IM if unable to tolerate oral treatment.
– Administer **epinephrine** via a nebulizer every 20 minutes as needed. Prepare the epinephrine (0.5 mg/kg/dose, max. 5 mg), diluting with sodium chloride 0.9% if necessary to obtain a total of 4 to 5 mL in the nebulizing chamber. If severe tachycardia (HR > 200 beats per min) develops, stop epinephrine until it resolves.
– Admit child, preferably to an ICU. Monitor closely for need of respiratory support.
– Ensure adequate calorie and fluid intake.
– Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).

Differential diagnoses

Ensure other causes of stridor and/or respiratory distress are differentiated, including epiglottitis, bacterial tracheitis, diphtheria, peritonsillar and retropharyngeal abscesses and foreign body aspiration (see Table 4.2 and Figure 4.1a to Figure 4.1c, pages 134 and 135).

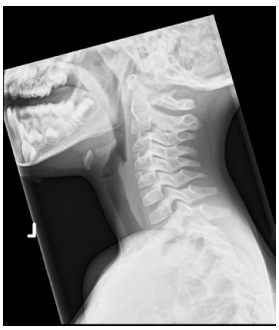
Table 4.2 - Comparative table of upper airway conditions (adapted for the purposes of these guidelines from: see references[10,11])

	Croup	Epiglottitis	Bacterial tracheitis
Incidence	Common	Rare	Less common
Aetiology	Parainfluenza type 1 Respiratory syncytial virus (RSV) Adenovirus	*H. influenzae* type B	*S. aureus, Moraxella catarrhalis,* *M. pneumoniae,* *S. pyogenes,* *S. pneumoniae*
Age	6 months - 3 years	1-7 years	6 months - 14 years
Onset of stridor	Progressive	Very rapid	Rapid
Fever	Low grade/variable	High	High
Cough	Common	Less common	Common
Dysphagia	No	Yes	Rare
Drooling	No	Yes	Rare
Voice	Hoarse	Muffled, dull	Normal to very hoarse

	Croup	Epiglottitis	Bacterial tracheitis
Preferred position	Variable	Tripod	Variable
X-ray findings[b]	Steeple sign; Hypopharyngeal dilatation with subglottic narrowing	Pre-stenotic dilatation and distinctive 'thumb sign'[c]	Oedematous tracheal walls with narrowing
Response to nebulised epinephrine	Very good	No response	No/partial response
Response to corticosteroids	Very good	Unclear	No/minimal response
Response to antibiotics	No response	Very good	Very good

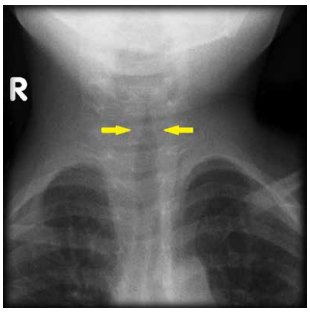
Figures 4.1 - Neck x-ray features of conditions causing stridor **a**) normal **b**) croup **c**) epiglottitis

4.1a - Normal lateral neck x-ray, child[d]



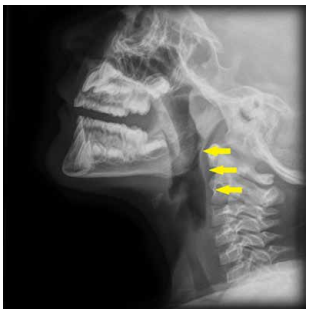
4.1b - Croup

AP neck x-ray, child[e]:



Characteristic tapering of the upper trachea (steeple sign) suspicious of croup

Lateral neck x-ray, child[f]:



Demonstrates distension of the hypopharynx consistent with croup

b X-rays are not usually indicated in croup or bacterial tracheitis, however findings may support diagnosis when unclear. See also Figure 4.1a to Figure 4.1c.

c Oedematous and enlarged epiglottis which is seen on lateral soft-tissue radiograph of the neck and has the shape of a thumb.

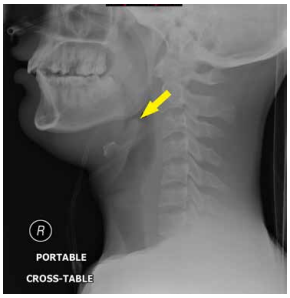
d Case courtesy of Ian Bickle (image reversed from original), Radiopaedia.org, rID: 80232. https://radiopaedia.org/cases/80232

e Case courtesy of Michael Sargent, Radiopaedia.org, rID: 6086. https://radiopaedia.org/cases/6086

f Case courtesy of Frank Gaillard (image reversed from original), Radiopaedia.org, rID: 6258. https://radiopaedia.org/cases/6258

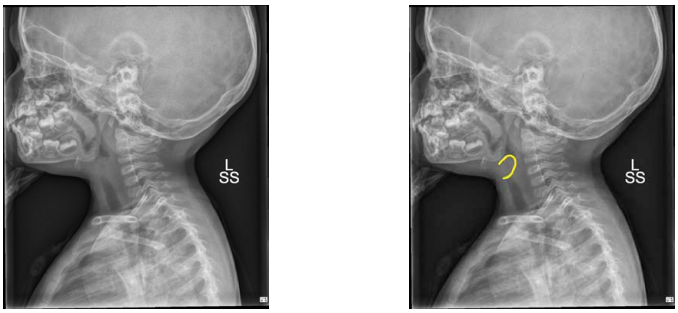
4.1c - Epiglottitis

Lateral neck x-ray, adult[g]:



Classic 'thumbprint sign' in adult characterised by thickening of the epiglottis, reflecting oedema and inflammation (compare to normal thin epiglottis in Figure 4.1a).

Lateral neck x-ray, child[h]:



Thickened epiglottis in child (compare to normal thin epiglottis in Figure 4.1a). Image duplicated on right with mark-up to demonstrate 'thumbprint'.

g Case courtesy of Andrew Ho, Radiopaedia.org, rID: 22906. https://radiopaedia.org/cases/22906

h Case courtesy of Jonathan Muldermans, Radiopaedia.org, rID: 54890. https://radiopaedia.org/cases/54890

4.3 Epiglottitis

Inflammation of the epiglottis and supraglottic tissue which can rapidly progress to upper airway obstruction and become life-threatening.

⚠ This is an upper airway medical emergency. Call for a senior clinician or an anaesthetist where available.

Aetiology

- Bacterial infection[12]: *Haemophilus influenzae* type B (Hib) most common (unless Hib vaccine coverage is high), *S. aureus* including MRSA are increasingly the most common cause where Hib vaccination coverage is high, other *H. influenzae* strains, and streptococci.
- Less commonly viral (influenza A[13]) or fungal infection.
- Non-infectious causes: injury due to burns/inhalation of smoke or toxic substances, or ingestion of a foreign body or toxic substance.

Epiglottitis caused by infection occurs mostly in younger children between 1 and 7 years of age, though again, Hib vaccine coverage may shift this to older age groups.

4.3.1 Clinical features

- Sudden onset high fever, very sore throat, drooling and difficulty swallowing. Symptoms progress very rapidly (in less than 12 to 24 hours), and child can develop severe breathing difficulties[14].
- Child adopts typical 'tripod' position: sitting up and leaning forward on outstretched arms for support.
- Visible distress: mouth open, appearing anxious, and 'looks toxic or septic'[15].
- Stridor and "hot potato voice" (muffled voice or aphonia) may be present (but, as opposed to croup, hoarse voice and cough are usually absent).
- Signs of critical condition: weak grunting or crying, drowsiness, difficult to arouse, unconjugate or anxious gaze, pallor or cyanosis, general hypotonia.

See also Table 4.2 and Figures 4.1 for differentiation between other causes of stridor.

Allow the child to sit in a comfortable position or on the parent/carer's lap. Do NOT lie the child down (may precipitate airway obstruction and respiratory arrest). Avoid any examination that will upset the child, including examination of the mouth and throat.

4.3.2 Management

Airway management

Securing the airway is a life-saving intervention in epiglottitis with airway obstruction but carries significant risk. Senior medical staff (anaesthesia and intensive care) with extensive

experience in paediatric airway management should be consulted early. In the absence of the required skills and/or equipment, refer the patient to a facility with such capacity as soon as possible.

Initial basic airway management

- Manage patient in an intensive care or resuscitation area where staff have capacity to carry out emergency resuscitation, if necessary.
- Ensure close observation and monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
- Keep the child calm with minimal disturbance.
- Do not lie the child down, keep in a seated position.
- Administer oxygen, if possible, without distressing the child (see Chapter 15, Section 15.1).
- Get IV access and start IV **maintenance fluids** (see Chapter 15, Section 15.2), and administer antibiotic treatment (see below). Avoid agitating the child with multiple attempts at IV access.
- Consider a trial of nebulised epinephrine (see Section 4.2.2 for dosing). Stop immediately if any deterioration or if the nebulisation upsets and aggravates the child[a]. Consider croup as differential diagnosis if significant response to epinephrine nebuliser.
- If the child stops breathing, administer bag and mask ventilation with high-flow oxygen until airway is secured.

Advanced airway management

- In the case of imminent airway obstruction, endotracheal intubation should be attempted only under the following conditions:
  - By senior medical staff with extensive experience in paediatric airway management.
  - In an operating theatre under general anaesthesia.
  - In the presence of a surgeon capable of performing an emergency surgical airway should intubation attempts fail.
- Patients recovering from epiglottitis may be extubated when repeated direct laryngoscopy at 24- to 48-hour intervals indicates reduced size and inflammation of the epiglottis.

Antibiotic treatment

- Administer IV **ceftriaxone** and IV **clindamycin**, or alternatively high-dose IV **amoxicillin/clavulanic acid** for 5 days.
- Avoid IM route (may agitate the child and precipitate a respiratory arrest), consider only if unable to obtain prompt IV access.
- Switch to PO **amoxicillin/clavulanic acid** treatment to complete a total of 7 to 10 days treatment, when child tolerating oral intake, has reduced fever and respiratory distress, and SpO_2 stable.

ceftriaxone	IV	50 mg/kg (max. 4 g if < 50 kg; max. 2 g if ≥ 50 kg) every 24 hours
clindamycin	IV	10 mg/kg every 8 hours (max. 2700 mg/day or 900 mg/dose)

a Evidence of efficacy is very limited, however in contexts where advanced airway interventions are limited, a nebuliser can be attempted, assessing carefully for any positive effect and any signs of worsening airway obstruction. Nebulised epinephrine may cause a rebound deterioration of airway obstruction so should be trialled with caution and very close monitoring.

amoxicillin/clavulanic acid (dosage expressed in amoxicillin)	IV	• < 3 months: 50 mg/kg every 12 hours • ≥ 3 months and < 40 kg: 50 mg/kg every 8 hours (max. 6 g daily) • ≥ 40 kg: 2 g every 8 hours
amoxicillin/clavulanic acid ratio 7:1 or 8:1 (dosage expressed in amoxicillin)	PO	• < 40 kg: 50 mg/kg 2 times daily • ≥ 40 kg: Ratio 8:1: 3000 mg daily (2 tabs of 500/62.5 mg 3 times daily) Ratio 7:1: 2625 mg daily (1 tab of 875/125 mg 3 times daily)

4.3.3 Prevention

H. influenzae type B (Hib) vaccine should be administered according to the national immunisation programme (commonly at 2, 4 and 6 months, plus booster at 12 to 15 months). The Hib vaccine does not cover all strains that may cause epiglottitis, but it is 90 to 95% effective[14].

4.4 Bacterial tracheitis

Secondary bacterial infection of the trachea resulting in mucopurulent exudates that may cause obstruction of the upper airway and become life-threatening[11]. It is uncommon, but may occur as a secondary infection following an acute viral respiratory illness. Consider as a differential in young children presenting with upper airway obstruction or viral croup that is not improving.

Commonly isolated bacterial pathogens include: *S. aureus* (including MRSA)[16], *S. pneumoniae*, group A *Streptococcus*, and *Haemophilus influenzae* strains[17,18,19]. Viral pathogens isolated that may have been the primary infection include parainfluenza, influenza A and B, measles, RSV[20].

Occurs primarily between 6 months and 14 years of age, most commonly between 3 and 8 years[11].

4.4.1 Clinical features

- Critically unwell, high fever and signs of upper respiratory obstruction (stridor, hoarseness, cough, tachypnoea)[11].
- Usually presenting with a history of several days of a viral respiratory infection (e.g. croup) with acute deterioration. (To differentiate with epiglottitis which is acute onset with no gradual history, and child prefers to lie down in bacterial tracheitis).
- Systemic features including weak grunting or crying, drowsiness/impaired level of consciousness/difficulty to arouse, anxious gaze, pallor or cyanosis, general hypotonia.
- In severe cases there is a risk of complete airway obstruction, especially in very young children, sepsis and toxic shock syndrome, pulmonary oedema, and acute respiratory distress syndrome[21].

Investigations

Concurrent pneumonia or chest x-ray (CXR) abnormalities are found in at least 50% of case series[22]. Consider a chest and lateral neck x-ray where it may be useful.

CXR: recommended once child is stable enough to exclude concurrent pneumonia.
Lateral neck x-ray: oedematous tracheal walls with subglottic narrowing, with or without intraluminal membranes[11].

4.4.2 Management

- Assess and manage for ABCDE as needed. Secure airway if necessary.
  - If severe airway obstruction or impending respiratory failure, consider intubation if advanced ICU and airway management available (see Section 4.3.2).
- Administer **oxygen** if SpO_2 < 92% in room air or severe respiratory distress.
- Administer bag and mask ventilation if necessary.

– If stridor present, administer a trial of nebulised **epinephrine**[a] (see Section 4.2.2 for dose).
– If wheezing, administer a trial of nebulised **salbutamol** (see Section 4.10.1 for dose).
– Stop immediately if any deterioration or if the nebulisation upsets and aggravates the child. Consider croup as differential diagnosis if significant response to epinephrine nebuliser.
– Get IV access and start IV **maintenance fluids** to ensure adequate hydration. Avoid agitating the child with multiple attempts at IV access.
– Administer combined antibiotic treatment with IV **ceftriaxone** and **clindamycin**[23]. Avoid IM route (may agitate the child and precipitate a respiratory arrest), consider only if unable to obtain prompt IV access.
– Treat high fever with antipyretics for the comfort of the child.
– Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
– Continue IV antibiotic treatment for at least 5 days. If the clinical condition has improved (low or no fever, less respiratory distress, improved SpO_2) and child tolerating oral intake, switch to oral antibiotic treatment with **amoxicillin/clavulanic acid** PO (ratio 7:1 or 8:1) to complete 10 days of treatment[24].

ceftriaxone	IV	50 mg/kg (max. 4 g if < 50 kg; max. 2 g if ≥ 50 kg) every 24 hours
clindamycin	IV	10 mg/kg every 8 hours (max. 2700 mg/day or 900 mg/dose)
amoxicillin/clavulanic acid ratio 7:1 or 8:1 (dosage expressed in amoxicillin)	PO	• < 40 kg: 50 mg/kg 2 times daily • ≥ 40 kg: Ratio 8:1: 3000 mg daily (2 tabs of 500/62.5 mg 3 times daily) Ratio 7:1: 2625 mg daily (1 tab of 875/125 mg 3 times daily)

a Evidence of efficacy is very limited, however in contexts where advanced airway interventions are limited, a nebuliser can be attempted, assessing carefully for any positive effect and any signs of worsening airway obstruction. Nebulised epinephrine may cause a rebound worsening of airway obstruction so should be trialled with caution and very close monitoring.

4.5 Pneumonia

Pneumonia is an acute infection of the lower respiratory airways, resulting in inflammation, fluid or pus in the alveoli and alveolar walls. This causes cough, fever, and difficulty in breathing. Globally, pneumonia remains one of the main causes of mortality amongst children under 5 years of age, accounting for 14% of worldwide under-5 mortality in 2019[25].

Aetiology

Pneumonia in children is most commonly community acquired. Infectious organisms can be viral, bacterial, fungal or parasitic. Common pathogens vary widely by context, region, age, and underlying clinical conditions (e.g. severe acute malnutrition (SAM), HIV infection, sickle cell anaemia). Immunisation with *H. influenzae* type B (Hib) and pneumococcal conjugate vaccines have reduced pneumonia where vaccine coverage is high, however the following infections still impact millions of children worldwide:

- Bacterial: *Hib*, *Streptococcus pneumoniae*, *Salmonella* spp., *Klebsiella pneumonia*, *Staphylococcus aureus*, *Streptococcus pyogenes*, *Mycobacterium tuberculosis*
- Viral: Respiratory syncytial virus (RSV), Influenza A and B, adenoviruses, parainfluenza, measles, coronaviruses, human metapneumovirus
- Atypical bacteria: *Mycoplasma pneumoniae*, *Chlamydia pneumoniae*, *Legionella pneumophila* (common in older children)
- Opportunistic fungal: *Pneumocystis jirovecii* (in HIV infected), *Aspergillus* spp
- Aspiration pneumonia caused by oral anaerobic flora

Non-infectious causes include foreign body inhalation, acid or other toxic fluid aspiration, or exposure to chemical toxins.

Diagnosis is based on history, clinical features and examination, and where available, a chest x-ray and/or lung ultrasound may be supportive. Assess the severity of pneumonia and respiratory signs using the CRS (see Table 4.1 and Appendix 7) to promptly provide respiratory support if needed and administer antibiotic treatment.

4.5.1 Clinical features

- Cough: can vary from very mild to deep/chesty and may be productive of green or yellow coloured sputum, or even rarely be blood-stained.
- Difficulty in breathing: may present as tachypnoea, dyspnoea, cyanosis/hypoxia, respiratory distress.
- Fever: is often high (≥ 39 °C), but may be low-grade or absent.
- Infants and younger children often present also with difficulty in feeding, restlessness or irritability, vomiting and diarrhoea.
- Older children may complain of chest pain on deep breathing or coughing (pleuritic chest pain) and occasionally abdominal pain.
- Children with SAM or underlying immunocompromise (HIV infection) are at high risk of developing pneumonia but may not elicit a cough or fever.
- For persistent cough and fever for > 2 weeks duration, check for any other signs of TB, any contact history with TB, and exclude TB with careful clinical assessment and follow-up.

Atypical pneumonia (due to *Mycoplasma pneumoniae*, *Chlamydia pneumoniae*, *Legionella pneumophila*) has a slightly different presentation, with symptoms often being insidious in onset and non-specific. It is common in school-age and older children and should be considered in special populations, such as children with sickle cell disease, where it can lead to acute chest syndrome (see Chapter 10, Section 10.2).

Typical symptoms include:
- Low grade fever
- Fatigue
- Malaise and myalgia
- Headache
- Non-productive cough: typically slow onset and gradually worsening, can last for several weeks or even months

Examination

Perform a full clinical assessment and examination, including:
- Adequacy of oxygenation (vital signs, SpO_2, cyanosis, neurological state/level of consciousness).
- Level of respiratory distress (see Table 4.1), effort/exhaustion, need for respiratory support.
- Percussion: dullness appears on the affected side.
- Auscultation: decreased breath sounds, bronchial breath sounds, inspiratory crackles (crepitations) may appear over the affected lobe or lung.

Signs of severe pneumonia include:
- Central cyanosis or oxygen saturations (SpO_2 < 90% in room air)
- Severe respiratory distress (see Table 4.1)
- Altered level of consciousness
- Inability to drink or breast feed
- Vomiting everything (all foods and liquids)
- Appears severely ill, toxic or septic

Examine and/or investigate for any underlying causes including tuberculosis (see Section 4.11), malnutrition, malaria (see Chapter 3, Section 3.4). In children with recurrent pneumonia or poor response to treatment, check for HIV infection.

Complications

If the child has bacterial pneumonia (such as staphylococcal pneumonia), it can lead to empyema (see Section 4.6). Dehydration can also be a complication of severe pneumonia if the child becomes too lethargic to drink.

4.5.2 Investigations

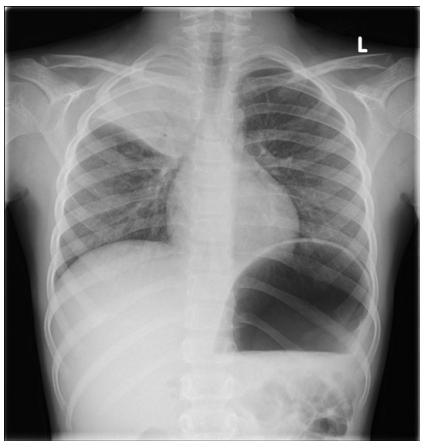
- FBC, Hb, blood glucose level (BGL)
- CRP, if available
- Chest X-ray (CXR), or lung ultrasound:
  - There is significant overlap in radiographic findings between different aetiologies of pneumonia (e.g. viral vs bacterial pneumonia), and findings are often non-specific.
  - A lobar pneumonia (homogeneous consolidation of an entire lobe of lung) is most commonly bacterial (see Figure 4.2).

- Consider follow-up CXR (or lung ultrasound) if there is no improvement with antibiotics, clinical deterioration, or suspicion of complications (such as empyema).
- Note that immunocompromised children may have normal chest radiographs despite having severe pneumonia.

– Consider sickle cell disease screening in high prevalence contexts.
– Malaria RDT in endemic areas
– TB screening: microscopy and culture, or GeneXpert, if available (see Section 4.11 for further investigations if TB suspected)
– HIV testing: see note above
– Blood culture (if severe pneumonia or signs of systemic illness)

Figure 4.2 - CXR features of lobar pneumonia

Frontal CXR, child[a]:



Dense homogeneous consolidation in the right upper lobe with air bronchograms, highly suggestive of bacterial pneumonia.

4.5.3 Management

Indications to admit for hospitalisation:
– Less than 6 months of age
– Clinically severe pneumonia
– Severe acute malnutrition
– Concerns regarding the ability of the parents/carers to treat or if the parents/carers cannot bring the child back for a follow-up examination

Severe pneumonia

– Assess and manage ABCDE (see Chapter 2, Section 2.2) and admit for close observation, ideally to an ICU, if available.
– Administer **oxygen** via face mask, aiming for SpO_2 between 94 - 98%.
– If necessary, increase level of respiratory support (see Section 4.1.2).
– Administer antibiotics (see following page).
– Treat fever and pain to improve comfort (see Chapter 15, Section 15.4).
– Administer anti-malarial treatment if malaria test positive.
– Monitor and record vital signs and BGL as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).

a Case courtesy of Ian Bickle, Radiopaedia.org, rID: 74630. https://radiopaedia.org/cases/74630

Antibiotic treatment

– Administer **ampicillin** (or **amoxicillin**) IV (or IM) 50 mg/kg every 8 hours + **gentamicin** IV (or IM) 7.5 mg/kg every 24 hours.
– For children over 5 years old or if suspicion of atypical pneumonia in any age group, add **azithromycin** PO 10 mg/kg once daily for 5 days.
– Continue IV antibiotic treatment for 48 hours and re-assess clinical condition:
  • Child clinically improved[b] and tolerating oral intake: replace IV with PO **amoxicillin/clavulanic acid** (ratio 7:1 or 8:1) to complete 7 days treatment. Dosage expressed in amoxicillin:
    ▷ < 40 kg: 50 mg/kg 2 times daily
    ▷ ≥ 40 kg:
    Ratio 8:1: 3000 mg daily (2 tablets of 500/62.5 mg 3 times daily)
    Ratio 7:1: 2625 mg daily (1 tablet of 875/125 mg 3 times daily)
  • If child not clinically improved after 48 hours, change to **cefotaxime** IV 50 mg/kg every 8 hours or **ceftriaxone** IV (or IM) 80 mg/kg (max. 4 g if < 50 kg; max. 2 g if ≥ 50 kg) every 24 hours. Consider treating for empyema (see Section 4.6) in children with measles complicated by pneumonia who do not improve quickly with antibiotics.
  • If condition deteriorates, or if MRSA suspected, add **clindamycin** IV 10 mg/kg every 8 hours. If atypical pneumonia suspected add **azithromycin** PO 10 mg/kg once daily for 5 days. Switch to oral antibiotic (as above) when child has improved and is tolerating oral intake. If IV clindamycin administered, oral switch to **clindamycin** PO, 10 mg/kg 3 times daily.

Suspected aspiration pneumonia:
– Administer **ceftriaxone** IV (dose as above) + **metronidazole** IV 10 mg/kg every 8 hours for 72 hours.
– Alternatively, administer **clindamycin** IV 10 mg/kg every 8 hours as an alternative to metronidazole, or **amoxicillin/clavulanic acid** IV:
  • 1 to 3 months of age: 30 mg/kg every 12 hours
  • > 3 months of age: 30 mg/kg every 8 hours
– If clinical improvement and tolerating oral intake, replace IV with PO **amoxicillin/clavulanic acid** (dose as above) to complete 7 days treatment.

HIV exposed or infected:
– Add **trimethoprim-sulfamethoxazole** IV/PO to cover for *Pneumocystis jirovecii* (see also Chapter 13).

Fluid and nutritional intake support

– Ensure adequate fluid intake (monitor oral intake)
  • If unable to drink sufficiently or showing signs of dehydration, support with oral or nasogastric feeds (see Chapter 15, Section 15.5).
  • If enteral feeding is not tolerated or the clinical condition is unstable, cautiously start IV maintenance fluids (see Chapter 15, Section 15.2), ensuring careful monitoring of fluid balance. Fluid restriction should be considered for severe cases[c].
  • In the case of severe respiratory distress, nil-by-mouth for first 24 hours to avoid risk of aspiration and start IV maintenance fluids as outlined above. Begin to give frequent small feeds after 24 hours, as tolerated. Show parent/carer how to support child upright at 30 degrees after feeds.

b Improvement is indicated by the following: improved respiratory distress, diminished fever, improvement in SpO_2 level or less oxygen is required to maintain saturation, improved ability to drink and or eat and improved activity.

c Increased ADH secretion in respiratory conditions can cause water retention, leading to fluid overload.

Discharge criteria

Consider discharge from hospital when child is:
– Clinically improving, with no fever for at least 24 hours
– Able to tolerate oral intake
– Maintaining oxygen saturations ≥ 92% in room air
– Tolerating oral antibiotics
– Going home to an environment where completion of treatment can be assured

Pneumonia with no signs of severity

Children older than 6 months:
– Give oral **amoxicillin** 30 mg/kg 3 times daily.
– Treat for fever if the child is uncomfortable.
– Follow-up after 48 to 72 hours and assess clinical condition:
  • Improvement: complete amoxicillin PO for a total of 5 days.
  • No improvement: complete amoxicillin PO for a total of 5 days and add **azithromycin** PO: 10 mg/kg once daily for 5 days.
  • Clinically worse: admit for further investigations and management.

4.6 Empyema

Empyema is a collection of pus in the space between the lung and the inner surface of the chest wall (pleural space). It is a complication of a bacterial pneumonia, most often staphylococcal pneumonia and can often occur as a complication of measles. In children presenting with empyema, evaluate with history and examination if there are any indications of underlying tuberculosis (TB) as a differential diagnosis.

4.6.1 Clinical features

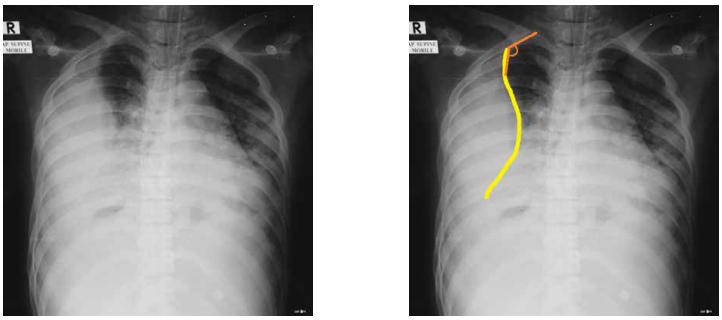
- Persistent fever and/or cough, chest pain, dyspnoea and oxygen requirement.
- May prefer to lie on the affected side to reduce pain.
- Consider if no improvement after 48 to 72 hours of treatment for community-acquired pneumonia, or if a child diagnosed with pneumonia has additional signs such as:
  - Shallow respirations to minimise pain.
  - Decreased air movement heard on auscultation.
  - Dullness to percussion.
  - Increased resonance of voice sounds (due to enhanced transmission).
  - Rarely severe respiratory distress, sepsis and shock.
  - Possibly a pleural rub on the side of the fluid collection.

Investigations

- CXR and/or lung ultrasound, if available, to visualise fluid (see Figure 4.3). Check for any radiological signs of TB.
- Pleural aspiration (ultrasound-guided ideally): check fluid appearance (colour, blood-stained, straw-coloured, translucency, etc) and perform Gram stain and culture, if available.
- Tuberculosis screening: microscopy and culture or GeneXpert where available.
- Malaria RDT (in endemic areas).
- Check Hb
- CRP, where available
- Blood culture

Figure 4.3 - CXR features of a loculated pleural effusion (empyema)

Supine AP CXR, adult[a]:



Lenticular shaped loculated pleural collection forming an obtuse angle with the chest wall (marked-up on right-hand image), characteristic of empyema.

a Case courtesy of Ian Bickle, Radiopaedia.org, rID: 48160. https://radiopaedia.org/cases/48160

4.6.2 Management

- Admit, preferably to an ICU facility, for treatment and stabilisation.
- Treat any fever to improve the patient's comfort and give analgesia if pain (such as chest pain) is present (see Chapter 15, Section 15.4).
- Administer **oxygen** if SpO_2 < 92% in room air or severe respiratory distress.
- If the child is in severe respiratory distress, nil-by-mouth is recommended.
- Administer antibiotic treatment.
- Ensure adequate fluid and calorie intake and monitor BGL over the first 24 to 48 hours, as there is a risk of dehydration and hypoglycaemia.
- Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).

Antibiotic treatment

- Administer **ceftriaxone** IV 80 mg/kg (max. 4g if < 50 kg; max. 2g if ≥ 50 kg) every 24 hours (or **cefotaxime** IV 50 mg/kg every 8 hours) and **cloxacillin** IV 25 mg/kg every 6 hours.
- Alternatively, administer **amoxicillin/clavulanic acid** IV (dosage expressed in amoxicillin):
  - 1 to 3 months of age: 30 mg/kg every 12 hours
  - > 3 months of age: 30 mg/kg every 8 hours
- Continue for at least 7 days of parenteral (IV) treatment and until afebrile for 3 days.
- Then switch to oral antibiotic treatment (if able to take oral medication):
  amoxicillin/clavulanic acid (ratio 7:1 or 8:1) PO to complete a minimum of 14 days of treatment[b].
  Dosage expressed in amoxicillin:
  - < 40 kg: 50 mg/kg 2 times daily
  - ≥ 40 kg:
    Ratio 8:1: 3000 mg daily (2 tablets of 500/62.5 mg 3 times daily)
    Ratio 7:1: 2625 mg daily (1 tablet of 875/125 mg 3 times daily)
- If confirmed MRSA or no improvement after 48 hours: replace cloxacillin with **clindamycin** IV 10 mg/kg every 8 hours.
- If slow improvement despite antibiotics, consider tuberculosis (see Section 4.11 and MSF Tuberculosis Guidelines).

Surgical drainage

Small empyemas[c] do not require surgical drainage. However, for large empyemas[d] or empyema that does not respond to antibiotics, the definitive treatment is removal of pus through the placement of a chest tube (thoracostomy)[26]:

- If clinician familiar with the procedure and anaesthesia/surgery is available, proceed to insert a chest drain under anaesthesia in the operating room.
- If surgery/anaesthesia is not available but a clinician trained to perform the procedure is, insert a chest drain under sedation. Refer to MSF Standards for Paediatric Procedural Sedation.
- If there is no possibility to insert a chest drain due to lack of trained staff, consider referral.
- As a last option, if no trained staff are available and referral is not an option, perform repeated pleural punctures for pus drainage.
- Upright chest x-ray (if available and the child is stable) is recommended after placement of a chest drain or after pleural puncture to confirm position of the drain and exclude a pneumothorax.

b Extend total duration of antibiotic treatment to 3 weeks for large empyemas.

c Less than 10 mm on lateral decubitus x-ray or opacifying less than ¼ of the hemithorax.

d Opacifying more than ½ of the hemithorax.

4.7 Bronchiolitis

Acute inflammation and oedema of the smaller airways (bronchioles) of the lower respiratory tract that occurs commonly in young children up to 2 years of age. The majority of cases are caused by an infection with the respiratory syncytial virus (RSV), though other viral infections may also trigger it (e.g. rhinovirus, parainfluenza, adenovirus, coronavirus)[27,28]. Though bronchiolitis is a self-limiting illness which is usually uncomplicated in previously healthy children RSV-associated lower respiratory tract infections are one of the most common reasons for hospital admission and a significant cause of mortality amongst children[29]. Infants at risk of severe bronchiolitis or complications include those with a history of being preterm or low birth weight, < 3 months of age, and those with underlying respiratory, cardiac or neurological conditions[30].

4.7.1 Clinical features

- Fever, cough, respiratory distress (tachypnoea, wheezing, crepitations), associated with reduced appetite and irritability.
- Often starts with nasal discharge or congestion for a couple days prior to peak of symptoms above around day 3.
- Severe signs include lethargy, increasing respiratory distress (worsening tachypnoea, use of accessory muscles, chest indrawing/retractions), unable to feed, frequent or prolonged apnoea, and hypoxia.
- Uncommonly, the child may develop respiratory exhaustion and a silent chest which requires emergency intervention.
- Most cases resolve in 7 to 10 days, though the cough may persist for several weeks.
- Diagnosis is usually clinical.

Investigations

Chest x-ray: not routinely recommended; consider if there is clinical deterioration, if there is a suspected superimposed bacterial infection or pneumonia, or if other differential diagnosis suspected.
Lung ultrasound: consider if available and trained staff present.

4.7.2 Management

There is no specific treatment for the viral infection triggering bronchiolitis, however some children may need hospital admission for supportive management.

Children with clinical signs of severe illness should be admitted:
- Inability to feed (feeding less than 50% of usual volume) or dehydration
- Apnoea
- Moderate to severe respiratory distress (see Table 4.1)
- Oxygen saturations persistently below 92% (at rest, when feeding or when sleeping)
- Lethargy
- Central cyanosis[31].

Consider admission if feasible for all children at risk of severe disease: chronic lung disease, prematurity (particularly < 32 weeks), congenital heart disease, < 3 months of age, neuromuscular disorders.

Respiratory support

- Position the child around 10 to 30 degrees upright to support breathing.
- Administer **oxygen** if SpO_2 < 92% in room air or severe respiratory distress.
- More advanced respiratory support, such as HFNC or CPAP, may be required if there is no improvement with oxygen via nasal prongs (see Section 4.1.3).
- Continuous or near-continuous monitoring (RR, HR, SpO_2) where feasible and if nursing ratios allow, especially in very young infants or those with severe respiratory distress.
- Saline nasal drops and gentle nasal suctioning, especially pre-feeds (see MSF Manual of Nursing Care Procedures, Procedure: Nasopharyngeal and Oropharyngeal Suctioning).
- Bronchodilators are not routinely recommended in the treatment of bronchiolitis, as infant airways are not usually responsive to this treatment. However, in severe respiratory distress, a trial of inhaled bronchodilators (salbutamol or epinephrine, see Section 4.10.1 and Section 4.2.2, respectively, for dosing) can be administered and continued if there is clear evidence of improvement.
- Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).

Fluid and nutritional intake support

- Ensure adequate fluid intake (monitor oral intake)
  - If unable to drink sufficiently or showing signs of dehydration, support with oral or nasogastric feeds (see Chapter 15, Section 15.5).
  - If enteral feeding is not tolerated, cautiously start IV maintenance fluids, ensuring careful monitoring of fluid balance. Fluid restriction should be considered for severe cases[a].
  - In the case of severe respiratory distress, nil-by-mouth for first 24 hours to avoid risk of aspiration and start IV maintenance fluids as outlined above. Begin to give frequent small feeds after 24 hours, as tolerated. Show parent/carer how to support child upright at 30 degrees after feeds.

Suspected secondary bacterial infection or co-infection

- Routine antibiotic treatment is not recommended.
- Examine for secondary bacterial infection, co-infection or pneumonia if:
  - Appears septic and/or very high fevers.
  - New onset of fever and clinical deterioration after 2 days of hospitalisation.
  - New onset of fever or increased work of breathing after re-starting oral feeds.
  - Radiographic indications or changes (on CXR).
- Start antibiotic treatment for pneumonia (Section 4.5)
- Monitor RR and SpO_2 carefully and be alert to signs of exhaustion.

Infection prevention and control measures

- Ensure transmission-based precautions are taken, including correct use of personal protective equipment (PPE).
- Admit to a separated area or with physical distance from other admitted children with dedicated nursing staff and equipment to reduce the risk of cross-infection.
- If multiple cases, group together with other cases in a separated area from other patients (cohorting).

a Increased ADH secretion in respiratory conditions can cause water retention, leading to fluid overload.

Discharge criteria

Consider discharge from hospital when the child is[30,32]:

- Maintaining oxygen saturations persistently ≥ 92% without supplemental oxygen (for at least 4 hours), including during sleep.
- Tolerating feeds.
- Clinically stable with no signs of moderate or severe respiratory distress.

4.8 Diphtheria

Diphtheria is a bacterial infection due to *Corynebacterium diphtheriae*, spread from person to person through inhalation of infected respiratory droplets of symptomatic or asymptomatic individuals, or direct contact with contaminated objects or diphtheria skin lesions[33,34]. The incubation period is 1 to 5 days (maximum 10 days) during which *C. diphtheriae* multiplies in the upper respiratory tract and secretes a toxin that causes local and systemic inflammation and complications. Mortality may result from upper airway obstruction or systemic damage from the toxin, including damage to the myocardium and neurological system.

Diphtheria is a notifiable disease, and all cases should be reported to local or national public health authorities.

Diphtheria is a vaccine-preventable disease and vaccination is part of routine childhood immunisation programmes (EPI).

4.8.1 Clinical features

Respiratory and upper airway signs include:
- Pharyngitis, rhinopharyngitis, tonsillitis or laryngitis with tough, greyish, firmly adherent pseudo-membranes of the pharynx, nasopharynx, tonsils, or larynx.
- Dysphagia and cervical adenitis, at times progressing to massive swelling of the neck.
- Airway obstruction and possible suffocation when the infection extends to the nasal passages, larynx, trachea and bronchi.

Systemic signs resulting from the toxin:
- Low-grade fever
- Cardiac dysfunction (tachycardia, arrhythmias), severe myocarditis with heart failure and possibly cardiogenic shock 3 to 7 days or 2 to 3 weeks after onset of the disease.
- Neuropathies in 2 to 8 weeks after the onset of disease leading to nasal voice and difficulty with swallowing (paralysis of the soft palate), vision (ocular motor paralysis), breathing (paralysis of respiratory muscles) and ambulation (limb paralysis).
- Oliguria, anuria and acute renal failure.

Differential diagnoses include epiglottitis (Section 4.3), bacterial tracheitis (Section 4.4), and acute pharyngitis (see MSF Clinical Guidelines).

Investigations

- Collect swab samples before starting antibiotic treatment (see MSF Collection, storage and transport of samples from field to reference laboratory):
  - Swab affected areas: throat (tonsils, pharyngeal mucosa, soft palate, exudate, ulcer, etc.) and nasopharynx, for culture (and sensitivity) to isolate *C. diphtheriae*.
- PCR test (detection of diphtheria toxin gene) if available.

4.8.2 Management

Infection prevention and control measures

- Ensure transmission-based precautions are taken, including correct use of personal protective equipment (PPE).
- Admit to a separated area or with physical distance from other admitted children with dedicated nursing staff and equipment to reduce the risk of cross-infection.
- If multiple cases, group together with other cases in a separated area from other patients (cohorting).
- Cases can remain infectious up to 8 weeks after initial infection. Antibiotic treatment can reduce infectiousness to 6 days.

Diphtheria antitoxin (DAT)

- Administer **diphtheria antitoxin** (**DAT**) (derived from horse serum) as soon as possible:
  - Ensure close monitoring and immediate availability of resuscitation equipment as there is a risk of an anaphylactic reaction to DAT, especially in children with asthma.
  - Administer with the Besredka method: inject 0.1 mL SC and wait 15 minutes. If there is no allergic reaction (no erythema at the injection site or a flat erythema of less than 0.5 cm in diameter), inject a further 0.25 mL SC. If there is no reaction after 15 minutes, inject the rest of the product IM or IV depending on the volume to be administered.
  - Dosing is according to severity and extent:

Clinical signs	Dose in units	Administration route
Laryngitis or pharyngitis or duration < 48 hours	20 to 40 000	IM or IV infusion in 250 mL of sodium chloride 0.9% in 2 to 4 hours for doses of more than 20 000 units.
Rhinopharyngitis	40 to 60 000	
Severe disease (respiratory distress, shock), cervical oedema or duration ≥ 48 hours	80 to 100 000	

Antibiotic treatment

- Start as soon as possible without waiting for bacteriological confirmation.
- Give for 14 days or according to length of treatment recommended by the national protocol:

First-line:
azithromycin PO 10 to 12 mg/kg once daily (max. 500 mg daily)

Alternatively:
erythromycin PO
< 40 kg: 10 to 15 mg/kg (max. 500 mg) 4 times daily
≥ 40 kg: 500 mg 4 times daily
or
phenoxymethylpenicillin (**penicillin V**) PO:
< 40 kg: 10 to 15 mg/kg (max. 500 mg) 4 times daily
≥ 40 kg: 500 mg 4 times daily

– Administer via IV or IM if the child is unable to take oral treatment. Switch to oral antibiotic treatment as soon as possible. Complete a total of 14 days of treatment.

> **benzylpenicillin** (**penicillin G**) IM or slow IV
> 25 000 IU/kg (15 mg/kg) every 6 hours (max. 4 MIU or 2.4 g per day)
>
> Alternatively:
> **procaine benzylpenicillin** IM
> < 25 kg: 50 000 IU/kg (50 mg/kg) once daily (max. 1.2 MIU or 1.2 g daily)
> ≥ 25 kg: 1.2 MIU (1.2 g) once daily
> Never administer procaine benzylpenicillin by IV injection or infusion.
>
> If penicillin-allergy:
> **erythromycin** IV infusion (60 minutes)
> 12.5 mg/kg every 6 hours (max. 2 g daily)

– Evaluate and manage respiratory distress or any airway obstruction. In case of stridor and/or respiratory distress and/or bull neck, administer **dexamethasone** IV, 0.6 mg/kg loading dose followed by 0.1 mg/kg every 6 hours (max. 10 mg per dose). Intubation or tracheotomy may be necessary with severe upper airway obstruction (see local protocols).
– Update vaccination status before hospital discharge. If the patient has been administered DAT and can receive adequate home-based follow-up after hospital discharge, wait 3 weeks after administration of DAT before vaccination.

Refer to MSF Clinical Guidelines, Diphtheria for:
– Management of close contacts and antibiotic prophylaxis
– Outbreak surveillance methods

4.8.3 Prevention

– Vaccination prevents severe disease though it does not prevent transmission.
– Clinical disease does not confer immunity, therefore vaccination should be part of case management.
– Diphtheria vaccine is part of routine childhood immunisation (EPI):
  • 3 doses of conjugate vaccine containing the higher potency (D) formulation of diphtheria toxoid as soon as possible as of 6 weeks of age and at 4 week intervals.
  • D booster: between 12 and 23 months, then between 4 and 7 years.
  • Booster with a vaccine containing a reduced dose (d) of diphtheria toxoid: between 9 and 15 years[35].
– Catch-up vaccination (missed routine vaccination):
  • 1 to 6 years: 3 doses of D conjugate vaccine at least 4 weeks apart.
  • 7 years and above: 3 doses of d conjugate; 4 weeks between dose 1 and 2, then at least 6 months between dose 2 and 3. Administer 2 subsequent booster doses containing d at least 4 weeks apart.

4.9 Pertussis (whooping cough)

A highly contagious, acute respiratory illness caused by the bacterium *Bordetella pertussis*, with a high mortality in infants. The incubation period for *B. pertussis* is usually 9 to 10 days and it is transmitted via airborne droplets[36]. The risk of transmission is greatest during the catarrhal phase and patients with pertussis are considered infectious until they have completed 5 days of appropriate antibiotic treatment or 21 days if not treated.

Pertussis is a vaccine-preventable disease and immunisation against pertussis is included in all vaccination calendars worldwide.

Pertussis is a notifiable disease, and all cases should be reported to local or national public health authorities.

4.9.1 Clinical features

The classic presentation of pertussis includes paroxysms of coughing, an inspiratory whoop and post-tussive vomiting. The illness evolves in 3 stages:

- Catarrhal stage (1 to 2 weeks): Symptoms similar to the common cold (runny nose, cough). In contrast to the common cold, the cough in pertussis gradually worsens instead of improving.
- Paroxysmal stage (1 to 6 weeks):
  - Typical presentation: increase severity of cough, occurring in characteristic bouts (paroxysms), followed by a laboured inspiration causing a distinctive sound (whoop), or vomiting. Fever is absent or moderate, and clinical examination is normal between coughing bouts; however, the patient becomes more and more fatigued.
  - Atypical presentations:
    - Infants < 6 months: paroxysms are poorly tolerated, with apnoea, cyanosis; coughing bouts and whoop may be absent.
    - Older children: prolonged cough, often without other symptoms.
  - Complications:
    - Major: in infants, secondary bacterial pneumonia (new-onset fever is an indicator); apnoea (frequent cause of death in infants); severe weight loss and dehydration secondary to feeding difficulties; rarely, seizures, encephalopathy; sudden death.
    - Minor: subconjunctival haemorrhage, petechiae, hernias, rectal prolapse.
- Convalescent stage: symptoms gradually resolve over weeks or months.

4.9.2 Management

Admit children who[37]:

- Are 3 months or younger.
- Have signs of severe illness (severe respiratory distress, apnoea, cyanosis, pneumonia, seizures/impaired consciousness).
- Are unable to feed.

Infection prevention and control measures

- Ensure transmission-based precautions are taken, including correct use of personal protective equipment (PPE).
- Admit to a separated area or with physical distance from other admitted children with dedicated nursing staff and equipment to reduce the risk of cross-infection.
- If multiple cases, group together with other cases in a separated area from other patients (cohorting).
- Contact with young children and women in late pregnancy should be avoided until at least 5 days of antibiotics completed.

For children who do not need admission: explain to parents/carers the signs that should lead to re-consultation (fever, deterioration in general condition, apnoea, cyanosis, inadequate oral intake or dehydration).

Antibiotic treatment

Indications include:
- Infants < 6 months
- Within 3 weeks of onset of cough
- Consider antibiotic treatment if child requires admission:

azithromycin PO:
< 6 months: 10 mg/kg once daily for 5 days
≥ 6 months: 10 mg/kg (max. 500 mg) single dose on day 1, then 5 mg/kg (max. 250 mg) once daily from day 2 to day 5

Alternative:
co-trimoxazole PO: 20 mg/kg SMX + 4 mg/kg of TMP 2 times daily for 14 days
or
erythromycin PO: 15 mg/kg 3 times a day for 7 to 14 days[a]

Supportive care

- Place the child in a semi-reclining position.
- Administer respiratory support via bag and mask ventilation in case of apnoea that does not quickly resolve with external stimulation.
- Administer **oxygen** if SpO_2 < 92% in room air, in severe respiratory distress or if recurrent apnoeas[b].
- Do not perform any deep suction (as it increases the risk of paroxysmal cough). If secretions are present, gently wipe the mouth and the nose with gauze.
- Ensure adequate fluids and calorie intake (risk of weight loss). Give small and frequent oral feeds if possible. Some patients need nasogastric feeding or IV maintenance fluids (see Chapter 15, Section 15.2 and Section 15.5).
- Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
- Record weight, and strictly monitor urine output and oral intake.
- Do not administer salbutamol, corticosteroids or antitussives.

a 7 days of treatment with erythromycin is sufficient in the majority of cases though there is a small risk of relapse compared to 14 days of treatment.

b Use of oxygen via nasal prongs may provide enough stimulation to prevent apnoea, however oxygen itself is not an adequate treatment for apnoea.

Discharge criteria

Most infants will continue to have coughing spells after discharge. Minimum criteria for discharge include the following:
– No apnoea or oxygen supplementation needed in last 48 hours.
– Coughing episodes tolerated without becoming hypoxic and/or bradycardic.
– Ability to feed enough to gain weight.
– Family can care for child at home and are comfortable with the child's condition.

Consider food supplements for several weeks after discharge, especially if weight loss occurs during hospital stay.

4.9.3 Post-exposure prophylaxis

Antibiotic prophylaxis (same as antibiotic treatment) is recommended, regardless of vaccination status, for all household and close contacts of confirmed cases, and for exposed individuals in high-risk groups who are at risk of developing severe or complicated disease. Prophylaxis is most effective if given within 21 days of the onset of cough in the confirmed case.

High-risk groups include[38]:
– Infants less than 1 year old, particularly those less than 4 months old.
– Pregnant women[c], particularly in the 3rd trimester[39].
– People with pre-existing medical conditions that may be exacerbated by pertussis infection, e.g. immunocompromise, chronic lung disease, moderate to severe asthma, cystic fibrosis.
– People who have contact with any of the high-risk individuals described above.

4.9.4 Prevention

Routine vaccination with polyvalent vaccines containing pertussis antigens (e.g. DTP, or DTP + Hep B, or DTP + Hib + Hep B) from the age of 6 weeks or according to national protocol.
Neither vaccination nor natural disease confers lasting immunity. Booster doses are necessary to reinforce immunity and reduce the risk of developing disease and transmitting it to young children.

c Macrolides should be used with caution in pregnancy and avoided in the first trimester of pregnancy due to increased risk of congenital malformations.

4.10 Asthma

Consider asthma in a child that presents with cough, wheeze and shortness of breath or difficulty breathing. Asthma is a chronic disorder that can have an acute and severe presentation, or present with a longer history of recurring or persisting mild symptoms. Children or parents/carers may have noticed that the symptoms are present or worse at night or during exercise. Although asthma-like symptoms with cough and wheezing present frequently in younger children in association with a viral respiratory illness, the diagnosis of asthma is generally considered in children over 5 years of age.

Asthma is a chronic inflammatory process of the airways in which smooth muscle constriction, mucous plugs and/or wall thickening causes narrowing of the airways, thereby restricting the flow of air in the lungs. Treatment is with bronchodilators (to re-open the airways) and steroids (for their anti-inflammatory effects) to reverse the symptoms. Longer term management and prevention of acute attacks should be supported with patient and family education.

Asthma often coexists with atopy and allergies[40].

4.10.1 Acute exacerbation of asthma

Assess the severity of an acute exacerbation based on clinical features (see Table 4.3). Mild exacerbations may be managed in an outpatient or home setting, but moderate to severe asthma should be managed in an emergency care setting. All patients presenting with severe or life-threatening asthma should be admitted to hospital, while those with mild or moderate exacerbations may be managed as outpatients if they show a good response to treatment (see below for details).

Table 4.3 - Acute asthma exacerbation severity assessment[41,42]

	Mild	Moderate	Severe or life-threatening
Shortness of breath	While walking	At rest Infant: difficulty feeding	At rest Infant: unable to feed
Oxygen saturation in air	> 94%	90 to 94%	< 90%
Ability to verbalise (age-appropriate)	Talking in sentences/ Long strong cry	Talking in short sentences/ Shortened cry	Only using single words/Weak cry Unable to speak/cry
Wheeze	Mild, at end of expiration	Loud, throughout expiration	Loud, throughout inspiration and expiration, or absent (silent chest)

	Mild	Moderate	Severe or life-threatening
Respiratory rate	Mild increase	Moderate increase	Severe increase
Heart rate	Normal range for age	Mild to moderate tachycardia for age	Tachycardia (or bradycardia) for age
Mental state	Normal	Normal	Agitated, drowsy or confused
Accessory muscle use	None	Mild to moderate	Moderate to maximal (or exhaustion)
Cyanosis	None	None	Any cyanosis of concern

Immediate management of severe or life-threatening exacerbation

- Stabilise in the Emergency Room (ER) before transferring the patient.
- Keep child seated at around 45 degrees upright (if necessary, keep child sitting on parent/carer's lap) to achieve most comfortable position to help breathing.
- Administer nebulised **salbutamol** combined with **ipratropium bromide** over 20 minutes and repeat to administer 3 doses in total (start a new dose every 20 minutes):

> **salbutamol** nebuliser solution (5 mg = 2.5 mL)
> ≤ 5 years: 2.5 mg (1.25 mL)
> > 5 years: 5 mg (2.5 mL)
>
> **ipratropium bromide** nebuliser solution (0.25 mg/mL = 1 vial)
> ≤ 5 years: 0.25 mg (1 mL)
> > 5 years: 0.5 mg (2 mL)

- Administer **oxygen** via nasal cannula at the same time as the nebuliser[a], aiming for SpO_2 between 94 - 98%.
- After 3 combined nebulisers, continue with nebulised salbutamol alone every 20 minutes (i.e. continuously), assessing for improvement between each dose without stopping the continuous nebuliser.
- If a nebuliser is not available, administer inhaled bronchodilators via a spacer, ensuring that every puff is inhaled separately and effectively. Repeat combined inhalers every 10 to 20 minutes up to 3 times in total, then continue with salbutamol inhaler alone:

> **salbutamol** metered dose inhaler (MDI):
> ≤ 10 kg: 4 to 8 puffs
> > 10 kg: 10 puffs
>
> **ipratropium bromide** metered dose inhaler (MDI), if available:
> 4 puffs

a Unless nebuliser driven by oxygen, in which case supplementary administration of oxygen via nasal cannula is not necessary.

– Start IV **maintenance fluids** (and consider adding potassium, see Chapter 15, Section 15.2.3).
– Start corticosteroids[b] as soon as possible[43,44]:

> **prednisolone** PO: 2 mg/kg (max. 60 mg) once daily
>
> Alternative, if prednisolone unavailable:
> **dexamethasone** PO: 0.6 mg/kg once daily (max. 16 mg)
>
> If unable to take oral medication:
> **dexamethasone** IV/IM*: 0.6 mg/kg once daily (max. 16 mg)
> Switch to oral prednisolone as soon as possible.
>
> * **hydrocortisone** IV: 4 mg/kg every 6 hours may be used as an alternative if dexamethasone IM/IV unavailable.

– After stabilisation, or in case of need of magnesium sulphate, transfer the child to ICU immediately.
– If no improvement or deterioration despite nebulisers and corticosteroid, administer **magnesium sulphate** IV: 40 mg/kg (max. 2 g) diluted in sodium chloride 0.9% over 20 minutes using a syringe pump:
  • Continuous monitoring (or every 10 minutes) including BP must be available and feasible (risk of hypotension).
  • Assess neurological status every 10 minutes for at least first hour.
  • In case of hypotension, add a bolus of **Ringer lactate** IV: 10 mL/kg over 20 minutes.
– If no improvement after 20 minutes of magnesium sulphate, administer **epinephrine** IM/SC: 0.01 mg/kg (see MSF Vasopressor Therapy - Adrenaline protocol). Repeat after 20 minutes if needed.
– When the child starts to improve, stop continuous nebuliser and start weaning down the salbutamol (follow weaning steps described below in management of moderate exacerbation) and oxygen while monitoring SpO_2. Duration of prednisolone at discharge is to complete 5 days total as for management of moderate exacerbation.
– Monitor and record vital signs at least every 30 minutes using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
– If the child deteriorates again within 1 hour of stopping continuous salbutamol, restart continuous salbutamol every 20 minutes for 1 hour and then reassess.

Moderate exacerbation

– Administer combined nebulised or inhaled bronchodilators using the same dosing as for severe exacerbation, and repeat every 20 minutes until clinical improvement, up to 3 doses in total.
– Administer **oxygen** via nasal cannula, aiming for SpO_2 between 94 - 98%.
– Give **prednisolone** PO: 1 to 2 mg/kg (max. 40 mg). Alternatively, **dexamethasone** PO: 0.3 to 0.6 mg/kg (max. 16 mg).
– Reassess clinical condition and severity after each combined bronchodilator dose.

⚠ Inhaled bronchodilators are preferred for moderate exacerbations if correct, effective delivery using a spacer can be guaranteed. If inhaler delivery technique is in doubt, nebulisers should be administered.

b Oral corticosteroids are preferred to IM/IV where oral route is possible. Only administer parenteral corticosteroids if the child is vomiting, or respiratory distress is too severe to allow safe administration of oral medication.

Response to bronchodilator treatment

Marked clinical improvement (diminished or absent wheezing, significant reduction in the use of accessory muscles, increased air entry) within the first hour of bronchodilator treatment:
- Stop bronchodilators and wean off oxygen, stopping if $SpO_2 \geq 92\%$ in room air.
- If sustained improvement for at least one hour after completing the last bronchodilator treatment, reassess hourly. If the child shows sustained improvement without the need for bronchodilator treatment for up to 4 hours after initial treatment, discharge home with an Asthma Action Plan (see Appendix 8) and oral corticosteroid (as above) to complete 5 days (or 2 days if **dexamethasone** used).

Good improvement after completion of second or third combined bronchodilator dose, but with persisting symptoms:
- Wean off oxygen, stopping if $SpO_2 \geq 92\%$ in room air.
- Wean down salbutamol under observation, reassessing hourly:
  - Administer 4 to 6 puffs of **salbutamol** inhaler via spacer 2-hourly, twice.
  - If child remains stable, continue with 4 to 6 puffs of **salbutamol** inhaler 3-hourly, twice.
  - If child remains stable, continue with 4 to 6 puffs of **salbutamol** inhaler 4-hourly (goal frequency), twice.
- If no improvement or child worsens at any stage, keep the same space between doses, i.e. if child is on 2-hourly salbutamol, continue on 2-hourly until there is improvement, and then wean to 3-hourly intervals.
- When child remains stable on 4-hourly salbutamol, can be discharged home with an Asthma Action Plan (see Appendix 8) and oral corticosteroid (as above) to complete 5 days ((or 2 days if **dexamethasone** used).

Slight improvement, symptoms still moderate after completion of third combined bronchodilator dose:
- Administer salbutamol nebuliser or inhaler alone (doses as above) every 30 to 60 minutes, depending on response after each dose. Reassess after each treatment.
- Continue oxygen if $SpO_2 < 92\%$ in room air but aim to wean down to stop oxygen when $SpO_2 \geq 92\%$.
- Good improvement: start weaning salbutamol following above management.
- No improvement or deteriorating despite salbutamol every 30 to 60 minutes for 3 hours, treat as for severe exacerbation and transfer to ICU for IV magnesium sulphate and IV fluids.

Mild exacerbation

- Administer **salbutamol** inhaler 4 to 6 puffs via spacer and reassess.
- Repeat same dose of **salbutamol** inhaler every 20 minutes if child remains symptomatic, up to 3 doses total and reassess:
  - No improvement and/or child requires oxygen, treat as for moderate exacerbation.
  - Improvement: aim to administer salbutamol inhaler at 4-hourly intervals and observe for any symptoms between treatments. If needed, administer salbutamol inhaler earlier and note the interval spacing.
- When child has remained stable with minimal or no wheeze 4 hours after the last salbutamol inhaler treatment, review for discharge home.
- On discharge, provide an Asthma Action Plan (see Appendix 8) and oral **prednisolone** 1 to 2 mg/kg (max 40 mg) to complete 3 days, or oral **dexamethasone** 0.3 to 0.6 mg/kg (max 16 mg) to complete 2 days.

Note: At any suitable moment, complete history, perform full clinical examination and relevant diagnostics to identify potential underlying trigger, e.g. infection, and treat accordingly.

Discharge home

Clinical criteria:
– Stable in room air and minimal respiratory distress on 4-hourly salbutamol (ideally at least 2 doses at 4-hourly interval).

Medication:
– Oral corticosteroids to complete 3 or 5 days according to severity.
– **Salbutamol** inhaler (4 to 6 puffs):
  • Home on 4-hourly during waking hours and as needed or up to 4-hourly during sleeping hours for first 48 to 72 hours.
  • Wean down salbutamol inhaler as tolerated, aiming to stop between days 5 and 7 after discharge.
  • Ensure spacer given together with inhaler and that child/family know how to use it correctly (see Appendix 9 and Appendix 10).
– Assess need for controller medication and provide if necessary.

Follow-up:
– Organise outpatient follow-up (see Section 4.10.3).
– Provide basic asthma education (recognition of exacerbation, management, when to seek medical consultation).
– Provide an Asthma Action Plan (see Appendix 8).

4.10.2 General management of asthma

Children may present with history, signs and symptoms indicating asthma or require follow-up management after an episode of acute exacerbation of asthma.
– Typical symptoms include:
  • Dry cough (often prominent at night and early morning)
  • Wheezing on expiration
  • Shortness of breath or difficulty breathing
– Symptoms may not be present all the time but may be recurring.
– Symptoms may present or get worse at night or during exercise, or other triggers may have been noticed by the child or parents/carers.
– Atopic disorders or a personal or family history of atopy (eczema, allergic rhinitis/conjunctivitis) or a family history of asthma increases probability of asthma (though their absence does not exclude asthma).

On examination, respiratory signs indicating asthma include:
– Decreased air entry or wheezing either on auscultation or without auscultation when severe
– Prolonged expiratory phase on auscultation
– Increased anterior-posterior diameter of the chest due to air trapping
Note that between exacerbations, respiratory examination may be completely normal and signs and symptoms absent.

Diagnosis of asthma

– Presence of typical symptoms and history characteristic of asthma, after excluding other diagnoses.
– Response to inhaled bronchodilators e.g. salbutamol inhaler or nebuliser.
– It is recommended to determine a diagnosis of asthma only in children 5 years of age and above.

– In children under 5 years, viral upper respiratory tract infections can cause similar symptoms to asthma (recurrent wheezing, cough) without the child necessarily having asthma. Consider a diagnosis of asthma and whenever possible refer for further evaluation in children < 5 years with recurrent wheezing if[45]:
  • Cough or wheezing during sleep or associated with environmental irritants.
  • Symptoms exacerbated by exercise, laughing, or without a concomitant upper respiratory infection.
  • History of allergy.
  • Response after 2 to 3 months of controller treatment (suggested trial of beclomethasone 0.05 mg/puff, 1 puff 2 times daily, and refer for further management if good response seen).

Differential diagnoses to consider or exclude:
– Bronchiolitis (if < 2 years; usually not responsive to salbutamol)
– Bacterial tracheitis (more inspiratory stridor than expiratory wheezing)
– Foreign body aspiration (often unilateral or focal wheezing, history or CXR diagnosis)
– Cardiac disease and congestive heart failure
– Pulmonary oedema
– TB
– Congenital anomalies (CCAM, bronchomalacia, tracheomalacia)
– Gastro-oesophageal reflux (infants)
– Lymphocytic Interstitial Pneumonia in HIV positive children

Investigations

– CXR, if available: non-specific findings include hyperinflation of the lungs, bronchial wall thickening, and patchy atelectasis; CXR can also be normal.
– Lung ultrasound (if available and trained clinicians present) to exclude other differential diagnoses (e.g. pneumonia, pulmonary oedema).

Management

– Assess symptom frequency and start treatment with **salbutamol** inhaler, with or without a low-dose inhaled corticosteroid (ICS) such as **beclomethasone**, according to frequency (see Table 4.4).
– Ensure spacer given together with inhaler and that child/family know how to use it correctly (see Appendix 9 and Appendix 10).
– Check and eliminate trigger factors if possible.
– Evaluate after 4 to 8 weeks to assess asthma control and response.
– Adjust therapy according to clinical evaluation plus a stepwise treatment approach.

Table 4.4 - Assessment and initial treatment of asthma[45]

	Asthma symptoms			
	Infrequent	Frequent	Troublesome	Severe
Symptoms	< 2 days/month	≥ 2 days/month but not daily	Most days	Most days, throughout the day
Night-time awakenings	-	-	≥ 1/week	≥ 1/week
Initial treatment step	**Step 1**	**Step 2**	**Step 3**	**Step 3 or 4**
	Follow-up and assess in 4 to 8 weeks. Adjust treatment according to asthma control and response.			

Asthma medications (see Table 4.5)

- Short-acting beta 2-agonist (SABA): **salbutamol** inhaler
- Long-acting beta 2-agonist (LABA): **salmeterol** inhaler (should be used in combination with ICS)
- **Montelukast** can be used as an alternative to a LABA.
- Inhaled corticosteroid (ICS): **beclomethasone**
- Combination LABA-ICS may also be available.

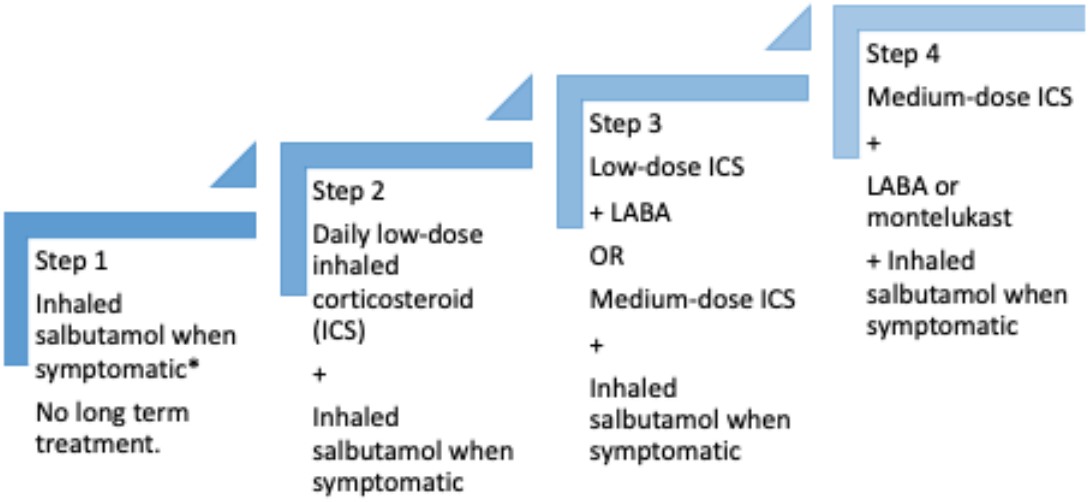
Table 4.5 - Asthma maintenance treatment drug table for children > 5 years old

Asthma medication	Dosing and indication
Salbutamol Short-acting beta 2-agonist (SABA) bronchodilator	Metered dose inhaler (0.10 mg/puff) Rapid relief of asthma symptoms and bronchoconstriction: • Onset of action: within minutes • Duration of action: ± 4 hours • 4 puffs as needed; maximum 4 times daily Prophylaxis of exercise-induced bronchoconstriction: 2 puffs, 5 to 20 minutes before exercise.
Salmeterol Long-acting beta 2-agonist (LABA) bronchodilator	Metered dose inhaler (0.025 mg/puff) • 5 to 11 years: 2 puffs 2 times daily • 12 years and older: 2 puffs 2 times daily, up to maximum 4 puffs 2 times daily if severe Must always be used with an ICS (risk if used alone)[46]
Beclomethasone dipropionate Inhaled corticosteroid (ICS)	Metered dose inhaler (0.05 mg or 0.10 mg/puff) • Low-dose ICS: 0.05 mg/puff, 1 to 2 puffs 2 times daily 0.10 mg/puff, 1 puff 2 times daily • Medium-dose ICS: 0.05 mg/puff, 2 to 4 puffs 2 times daily 0.10 mg/puff, 1 to 2 puffs 2 times daily ICS is the most effective long-term control therapy but may have long-term adverse effects at high doses. Patients should be maintained on the lowest possible dose of ICS. Reduce dose slowly, 25 to 50% at a time.
Montelukast Leukotriene receptor antagonist (LTRA)	Oral tablet (as alternative to LABA if poor response to LABA) • 5 years: 4 mg once daily in the evening • 6 to 12 years: 5 mg once daily in the evening • > 12 years: 10 mg once daily in the evening
Budesonide/Formoterol Combination ICS-LABA	Budesonide 80 micrograms/Formoterol 4.5 micrograms/puff, for use in children over 5 years. • Low dose: 1 puff = 80 micrograms budesonide/4.5 micrograms formoterol, 2 times daily • Medium dose: 2 puffs = 160 micrograms budesonide/9 micrograms formoterol, 2 times daily

Stepwise treatment approach[45]

– Start treatment at the step most appropriate to the child's condition, and then maintain control by stepping treatment up or down if necessary.
– For children aged 5 to 12 years, refer to Figure 4.4. For children over 12 years, refer to the adolescent and adult stepwise treatment table in the MSF Clinical Guidelines.

Figure 4.4 - Stepwise treatment approach for children 5 to 12 years



* Alternative treatment in Step 1 is to give low-dose ICS whenever salbutamol is given[45,47].

– Assess understanding and acceptance of use of inhalers and provide counselling and information where there are misconceptions or concerns.
– Check inhaler and spacer technique – all inhaler treatments in children should be administered via a spacer (see Appendix 9 and Appendix 10).
– Do not step-up if the child is unwell or breathless during the visit - treat as an acute exacerbation.
– Step-up asthma treatment if there are persistent symptoms (e.g. persistent cough), between every 4 to 8 weeks.
– Step-up if asthma is poorly controlled i.e. using a reliever inhaler > 3 times per week, waking at night with symptoms more than once a week.
– If asthma still not well controlled with Step 4 treatment, seek or refer for specialist advice.
– Step-down if well controlled for 3 months. Decision on which drug to stop first and at what rate depends on the severity of asthma, treatment side effects, time on current dose, beneficial effects achieved, and patient preference.
– Inhaled corticosteroids are the most effective long-term control therapy[c]. When able to step down, reduce dose gradually 25 to 50% at a time until lowest dose of inhaled steroids reached with child stable.

4.10.3 Asthma education and action plan

At each visit review the following:

1. **Self-monitoring**: Ensure the child and/or the parents/carers are able to recognise symptoms of deteriorating control. Agree on treatment goals. Include an Asthma Action Plan.

c Note that antihistamines, antitussives, mucolytics, oral salbutamol/salbutamol syrup are not recommended for asthma treatment.

2. **Medication**: Explain how and when to take prescribed medication.
   - Long-term "preventer" medications reduce inflammation and should be taken daily. They do not provide quick relief but prevent/reduce exacerbations that interfere with daily life or require hospitalisation.
   - "Reliever" medications relax airway muscles and provide fast symptom relief. If used more than three times per week, may need to start/increase long-term preventer medication.
   - Check inhaler technique.
3. **Adherence**: Explain the importance of continuing to take their inhalers and medication as prescribed and continue to use their "preventer" medications even when symptoms improve, are mild, or infrequent.
4. **Avoid/reduce exposure to triggers** that worsen asthma. Cooking on open fires indoors should also be avoided or adequate ventilation for the smoke to leave the building should be set up. For children with severe asthma, recommend possible environmental measures to eliminate triggers where possible.
5. **Involve** family and other healthcare providers (pharmacist, nurse etc), provide encouragement.
6. Explain the importance of attending **follow-up appointments**.
7. **Encourage exercise** on a regular basis.

Manage comorbidities: eczema, gastro-oesophageal reflux, obstructive sleep apnoea, rhinitis and sinusitis, stress, or depression. Treatment of these conditions may improve asthma control.

Exercise induced bronchospasm (EIB): Encourage physical activity. EIB should not limit child's participation in sport. Include advice in Action Plan to take 2 puffs of **salbutamol** 30 minutes before exercise. EIB is often a marker of inadequate asthma control so consider adding/increasing dose of inhaled corticosteroid.

Asthma Action Plan

– Where available, use the national or local Asthma Action Plan, otherwise use the MSF Asthma Action Plan (see Appendix 8).
– Complete the Asthma Action Plan so that the child and/or family are prepared in the case of an exacerbation and able to manage their symptoms.
– Include daily actions to control asthma, how and when to adjust medications in response to worsening asthma, when to seek medical care.
– Ensure child has a copy of their Asthma Action Plan and that it is shared with their school and other sites outside of home where the child spends time (particularly for those with severe asthma).

4.11 Tuberculosis

Tuberculosis (TB) is an infectious disease caused by *Mycobacterium tuberculosis*. It is transmitted person to person through tiny infectious droplets that are spread by patients with pulmonary or largyneal TB through coughing, speaking or sneezing. TB typically attacks the lungs, but can also affect other parts of the body, especially in children. Although TB disease has become rare in high-income countries, it remains a major public health problem in low- and middle-income countries where approximately 10 million new cases of TB occur each year. Globally, WHO estimates that more than 1 million children have TB every year[48] and that 60% of cases are not diagnosed or unreported[49]. The risk of death from TB is high in children under 2 years or children with malnutrition or HIV infection. Almost all of deaths due to TB in children occur in those not receiving TB treatment, the vast majority in children under 5 years[50].

4.11.1 Stages of infection

Primary infection and latent TB infection

After transmission via inhaled droplet nuclei, *M. tuberculosis* multiplies slowly, in most cases in the terminal alveoli of the lungs (primary focus) and in the lymph nodes of corresponding drainage areas: this is the primary infection. Over the course of one to two months, the primary focus is contained and encapsulated by a healthy immune response and is usually undetectable on chest x-ray. In most cases, the pulmonary lesions gradually heal, and the majority of patients with a primary TB infection are asymptomatic.

During primary infection, specific immunity develops and may persist without clinical signs of TB – the patient is infected by *M. tuberculosis* but does not develop the disease. This is referred to as latent tuberculosis infection (LTBI). In 5-10% of infected people, primary infection and/or LTBI progresses to active TB.

Active TB

Before immunity is established, bacilli from the primary focus or from a nearby lymph node can be transported and disseminated throughout the body. Secondary foci can develop in this way, particularly in the lungs, lymph nodes, serous membranes, meninges, bones and kidneys. As for primary infection, these foci usually resolve or are contained by an effective immune response.

Different factors can reduce the immune response and lead to reactivation of TB and multiplication of the bacilli in one or more of these foci. This reactivation or progression of primary or secondary foci results in active TB[51]. After exposure, the risk of TB infection and progression to active TB is high in children under 5 years old[52]. Progression to active TB is rapid (within 12 months) in children under 2 years[53], and HIV is a significant risk factor for developing TB in children under 1 year[54].

4.11.2 Clinical features

Pulmonary TB (PTB) is the most common presentation in both adults and children, but children (especially those who are malnourished or HIV-infected) also commonly present with extrapulmonary or disseminated TB due to their relative immunodeficiency. They may have symptoms of both pulmonary and extra-pulmonary TB.

Pulmonary TB

Signs of pulmonary TB in children include:
– Prolonged cough (more than 2 weeks), often without sputum production
– Weight loss
– Anorexia
– Fatigue
– Haemoptysis
– Shortness of breath
– Fever
– Night sweats

Signs and symptoms generally evolve in a chronic, insidious manner. In endemic areas, the diagnosis of PTB should be considered in any child presenting with respiratory symptoms lasting more than 2 weeks. Children less than 10 years old are not considered infectious unless they have extensive lung involvement and/or cavitary PTB.

Extrapulmonary TB

Extrapulmonary TB (EPTB) occurs when there is active TB infection in areas of the body outside of the lung parenchyma, including the lymph nodes, meninges, bones and joints, abdomen, serous membranes and kidneys. In young children, miliary and meningeal TB are more frequently seen, while in older children TB lymphadenitis and osteoarticular TB are more common.

Lymph node TB

Particularly common in older children, with the following characteristics:
– Painless, non-inflammatory adenopathy
– Frequently cervical, but axillary and mediastinal also common
– Multiple (often bilateral), or single, enlarged nodes
– Chronic evolution leading to fistulation

Tuberculous pleural effusion

One of the most common forms of EPTB, it is often asymptomatic if small and frequently occurs concurrently with PTB. Constitutional symptoms are as for PTB, and shortness of breath and unilateral chest pain occur when the effusion is large.

TB meningitis

Most common in children under 2 years old and in HIV-infected patients. Typically has subacute, insidious course over days or weeks. Symptoms include:
– Headaches
– Irritability
– Fever
– Vomiting
– Altered mental status
– Meningeal syndrome (stiff neck, photophobia and headache)

TB of bones and joints

TB can affect the vertebrae and intervertebral disks, causing destruction and deformation of the spine (Pott's disease), most commonly affecting the thoracic spine. Localised back pain is the main symptom, and neurological complications can develop. TB may also affect the joints (commonly the hips, knees, elbows and wrists) causing a chronic painless mono-arthritis accompanied by joint destruction.

Abdominal TB

Less common and difficult to diagnose. Presents as ascites resulting from peritoneal TB infection, sometimes accompanied by an abdominal mass (often in the right lower quadrant), pain and diarrhoea. Constitutional symptoms may be present.

Disseminated or miliary TB

Generalised massive infection caused by haematogenous diffusion of *M. tuberculosis* throughout the body. It occurs most commonly in children, young adults and HIV-infected patients. In children, the risk of meningitis is high[55]. Clinical picture is characterised by:
- Deterioration over days or weeks
- Simultaneous involvement of multiple organs
- Marked wasting
- Headache
- Constant high fever
- Miliary findings on CXR
- Moderate hepatosplenomegaly (occasional)

4.11.3 Diagnostic approach

Diagnosis and approach to TB in older children is similar to that for adults, see MSF Tuberculosis guideline. This section relates only to the diagnosis of TB in children less than 10 years old, where diagnosis is more challenging and adult-based algorithms are not applicable.

Children with TB usually have non-specific symptoms. Clinicians should therefore look for TB, particularly in children:
- Under 2 years of age
- With HIV infection or severe acute malnutrition (SAM)
- In contact with a TB case
- Not responding to antibacterial and/or nutritional treatment.

The diagnosis of TB is often made without bacterial confirmation as:
- Children under 5 years have low bacillary load and bacteriological tests are often negative. Bacterial load is generally higher in older children.
- Collection of respiratory and extrapulmonary (EP) specimens is challenging in young children.

Therefore, history of exposure to TB, repeated clinical assessment and investigations including radiography if available, are key components of the diagnosis of TB in children.

To facilitate the diagnosis of PTB and enable rapid treatment in children at high risk of death from TB, WHO has developed evidence-based diagnostic algorithms which should be used to help reach a diagnosis in any child with a suspicion of TB (see Section 4.11.5). The diagnosis of EPTB uses the same diagnostic approach, however there are no evidence-based algorithms currently available.

A trial of treatment with TB drugs is not recommended as a method to diagnose TB - once a decision is made to treat TB in a child, a full course of treatment should be given.

History of exposure to TB

Establish if the child has had contact with a confirmed or presumed index case. Children are at higher risk of TB if:
- The index case is a household or close contact
- The index case has PTB, sputum smear-positive or with cavities on chest x-ray
- The exposure to the index case occurred in the past 12 months.

If a TB index case is identified, their resistance profile should be assessed, as children often have the same resistance profile as the index case.

Whenever TB is diagnosed in children, it is important to detect the index case if not already identified, as well as any other undiagnosed cases in the household or close contacts.

Ask for symptoms suggestive of TB:
– Cough for more than 2 weeks
– Fever for more than 2 weeks
– Night sweats that soak the bed or clothes
– Weight loss or poor/no weight gain
– Fatigue, reduced playfulness, loss of appetite
– Haemoptysis (rare in children)
– Non-painful, enlarged cervical, submandibular, or axillary lymph nodes
– Rapid breathing

Clinical examination

Carry out a thorough physical examination, looking specifically for the following suggestive signs:
– Fever, tachypnoea, tachycardia
– Weight loss, growth curve flattening, underweight or malnourished according to weight for height and/or mid-upper arm circumference
– Abnormal pulmonary auscultation
– Signs of respiratory distress (see Section 4.1).
– Lethargy, altered mental status (may indicate TB meningitis)
– Signs of EPTB:
  • Highly suggestive: angular deformity of the spine; loss of ability to walk, cervical lymph node with fistula formation.
  • Requiring further investigation: sub-acute meningitis not responding to antibiotic treatment; ascites; lymph node without fistula formation; non-painful enlarged joint.

HIV status should be assessed in all children with presumed or confirmed TB.

4.11.4 Investigations

The following investigations should be performed in children suspected of PTB or EPTB whenever possible. For children at high risk of TB or death from TB and for whom investigations are unavailable (or results are not immediately available) treatment should not be delayed:

– **HIV status** should be assessed in all children with presumed or confirmed TB.

– **Bacteriological tests**: Rapid molecular tests (RMTs) should be performed on respiratory, stool or extrapulmonary (EP) specimens as the initial diagnostic test. As the sensitivity of Xpert MTB/RIF Ultra is higher than that of Xpert MTB/RIF, preferably use this for the detection of TB and rifampicin-resistance.
  • Sputum samples can be difficult to collect in children who may be unable or unwilling to spontaneously expectorate. Explanation and encouragement are important. Chest clapping may help expectoration, but if unsuccessful, respiratory specimens can be obtained by invasive procedures such as sputum induction or gastric aspiration (see Appendix 11). These procedures should only be used if the specimen is collected for rapid molecular tests, culture or genome sequencing. These procedures should not be performed for smear microscopy.

  - Stool specimens (which may contain swallowed sputum) are an alternative to respiratory specimens for the diagnosis of PTB in children. Respiratory specimens are more likely to give positive results but the use of stool specimens can avoid invasive collection procedures.
  - For children at risk of drug-resistant TB (DR-TB) i.e. those with contact with a DR-TB case or coming from a high DR-TB prevalence area, multiple specimens (respiratory, stool and EP) should be tested with RMTs. Every effort should be made to perform culture and phenotypic drug susceptibility test.
- **Lateral flow urine lipoarabinomannan assay (LF-LAM)**: LF-LAM should be performed in HIV-infected children: with signs and symptoms of TB; with advanced HIV disease who are seriously ill or hospitalised; or with low CD4 count.
- **Medical imaging**:
  - Chest x-ray (CXR) is particularly useful when bacteriological tests are not available or negative. CXR is also useful to assess the severity of TB and to determine the eligibility for the 4-month drug-susceptible regimen. Children with PTB usually have abnormalities on CXR, however a normal CXR does not rule out TB. Children who do not have CXR as part of their initial evaluation should have a CXR done as soon as possible if started on treatment for TB to assist with evaluation and treatment duration.
  - Ultrasound: can be useful in the diagnosis of EP-TB including lymph node TB, pleural TB, abdominal TB and pericardial TB.

Tuberculin skin test (TST): a positive test may be one element among many to establish the diagnosis of active TB, however it is has many limitations, especially in children who have received the BCG vaccination where false positives are common[56].

For more information on sampling and testing procedures, see MSF Tuberculosis Guidelines.

4.11.5 Paediatric diagnostic algorithms

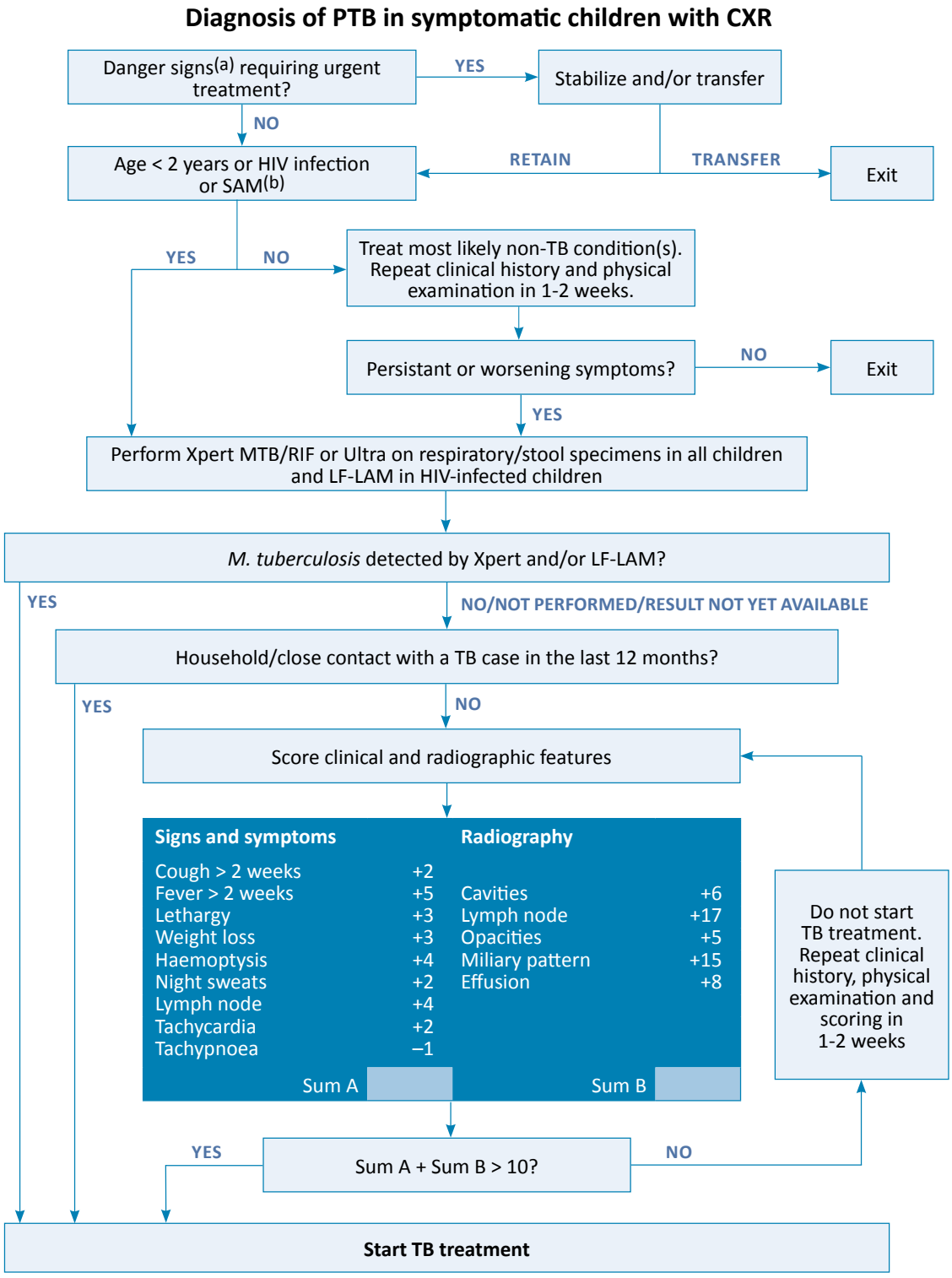
Paediatric diagnostic algorithms are invaluable in the diagnosis of TB in children. Two evidence-based WHO algorithms exist, one incorporating CXR findings (Figure 4.5) and one that does not include CXR (Figure 4.6), to guide the diagnosis of PTB in symptomatic children.

Clinical follow-up

The diagnosis may not be made at the first consultation. Follow-up after one to two weeks is often needed including reassessment of symptoms suggestive of TB, physical examination and growth assessment (see Section 4.11.3).

Particularly suggestive of TB are:
- Persistent of worsening pneumonia despite non-TB antibiotic treatment
- No weight gain or weight loss despite nutritional support or treatment
- Persistent fever after other causes have been ruled out or treated (e.g. malaria)
- Persistent or worsening fatigue, reduced playfulness, loss of appetite.

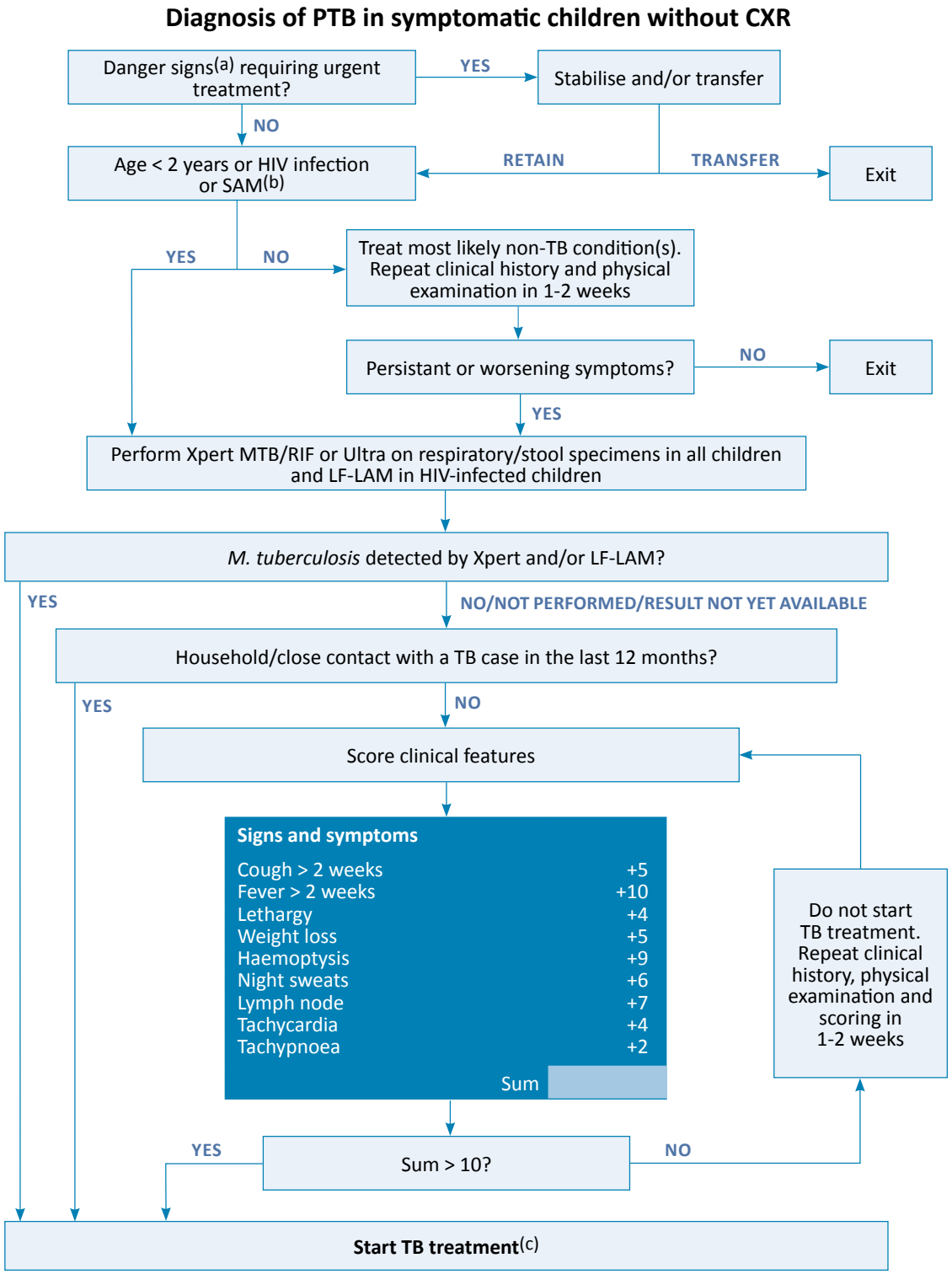
Figure 4.5 - Modified WHO Algorithm A: diagnosis of PTB in symptomatic children for settings with CXR (copied from MSF Tuberculosis guidelines, Chapter 5.3.1)



(a) Danger signs:
Children < 5 years: age < 2 months; unable to eat or drink; vomiting up everything; severe dehydration; severe pallor; stridor; SpO_2 < 90%; respiratory distress; seizures; profound lethargy or coma; restless, continuously irritable; neck stiffness or bulging fontanelle; fever > 39 °C; SAM.
Children ≥ 5 years: diarrhoea with severe dehydration; severe pallor; shock (cold extremities, capillary refill time > 3 seconds, weak and fast pulse); obstructed or absent breathing; respiratory distress; central cyanosis; coma (or seriously altered level of consciousness); seizures; restless, continuously irritable; fever > 39 °C; SAM.

(b) SAM: severe acute malnutition is defined as weight-for-height in Z-score less than –3 or mid-upper arm circumference less than 115 mm.

Figure 4.6 - Modified WHO Algorithm B: diagnosis of PTB in symptomatic children for settings without CXR (copied from MSF Tuberculosis guidelines, Chapter 5.3.1)



(a) Danger signs:
Children < 5 years: age < 2 months; unable to eat or drink; vomiting up everything; severe dehydration; severe pallor; stridor; SpO_2 < 90%; respiratory distress; seizures; profound lethargy or coma; restless, continuously irritable; neck stiffness or bulging fontanelle; fever > 39 °C; SAM.
Children ≥ 5 years: diarrhoea with severe dehydration; severe pallor; shock (cold extremities, capillary refill time > 3 seconds, weak and fast pulse); obstructed or absent breathing; respiratory distress; central cyanosis; coma (or seriously altered level of consciousness); seizures; restless, continuously irritable; fever > 39 °C; SAM.

(b) SAM: severe acute malnutition is defined as weight-for-height in Z-score less than –3 or mid-upper arm circumference less than 115 mm.

(c) Once a decision to treat for TB is made, every effort should be made to obtain a CXR to assess the severity of TB.

4.11.6 Management

A combination of several anti-tuberculous drugs is needed to treat TB and prevent the emergence of resistance. The following section outlines the initial conventional treatment regimen for children under 10 years old with drug-susceptible TB (DS-TB). For further information on the treatment of TB in children including individual drug profiles, alternative regimens and drug-resistant TB (DR-TB) regimens, as well as for all treatment regimens in older children, see MSF Tuberculosis Guidelines.

Fixed dose combinations and paediatric formulations

DS-TB drugs (also referred to as first-line drugs) include Isoniazid (H); Rifampicin (R); Pyrazinamide (Z); Ethambutol (E); Rifabutin (Rfb); and Rifapentine (P). Paediatric formulations should be used where possible, and fixed dose combinations (FDCs) of several TB drugs are preferred due to improved adherence. The following two quality assured FDC formulations exist for children:

- Isoniazid/Pyrazinamide/Rifampicin (HZR): **H**50 mg/**Z**150 mg/**R**75 mg
- Isoniazid/Rifampicin (HR): **H**50 mg/**R**75 mg

Where paediatric formulations are not available, manipulation of adult formulations is required:

- Preferably use scored tablets.
- Ensure that tablets/capsules can be split, crushed or opened.
- If tablets must be crushed (or capsules opened) a fraction of the powder corresponding to the required dose should be mixed with food or liquids immediately before giving the drug. Any remaining powder should be discarded.

Treatment of drug-susceptible TB

DS-TB treatment is indicated:

- When susceptibility to rifampicin and isoniazid is confirmed by drug susceptibility testing (DST), or
- If the probability of resistance to rifampicin and/or isoniazid is low:
  - While waiting for DST results for rifampicin and/or isoniazid,
  - When susceptibility to rifampicin is confirmed and susceptibility to isoniazid cannot be tested.

The probability of resistance is considered low in the following situations:

- No previous TB treatment
- No contact with a DR-TB patient
- The patient comes from an area of low prevalence of resistance according to drug resistance surveys.

Conventional DS-TB regimens in children vary according to the severity of disease and the infection site (see Table 4.6, page 174). 4-month regimens should be used for non-severe TB in children and adolescents aged between 3 months and 16 years. In eligible children, if there is not complete resolution of symptoms after 4 months of treatment and/or there is no weight gain, further investigation is needed. Treatment can be extended to 6 months if causes of non-response to treatment (including DR-TB, non-adherence and non-TB disease) are ruled out or unlikely. For dosing, see Table 4.7, page 174.

Table 4.6 - Conventional DS-TB regimens

Regimen	Duration (total)	Eligibility
2(HRZE)/2(HR)	4 months	Children > 3 months to < 16 years with[52]: PTB • Microscopy smear-negative or Xpert result 'negative', 'trace', 'very low' and 'low', or • Clinically diagnosed with TB lesions confined to one lobe and no cavities on CXR EPTB non-severe i.e. • Pleural effusion without complications (e.g. no empyema, pneumothorax or fistula) If bacteriological testing and/or CXR are not available: • Signs and symptoms **not** requiring hospitalisation[a] • Extra-thoracic lymph node TB without involvement of other EP sites
2(HRZE)/4(HR)	6 months	PTB and EPTB (except miliary TB, TB meningitis and bone and joint TB)[57] Children and adolescents < 16 years not eligible for the 4-month regimen or when the national protocol does not include the 4-month regimen.
2(HRZE)/10(HR)	12 months	Miliary TB and TB meningitis in all children and adolescents.
2(HRZE)/7-10(HR)	9-12 months	Bone and joint TB in all children and adolescents.

Ethambutol can be removed from the 4- and 6-month regimens in non-HIV infected children living in areas where the prevalence of HIV and/or isoniazid resistance is low with:
– PTB microscopy smear-negative, or
– Extra- or intra-thoracic lymph node TB[58].

For spinal TB, rest and back support bracing are indicated in addition to drug therapy.

Table 4.7 - Dosing of TB drugs

Drug[b]	Dose
Isoniazid (H)	Child < 30 kg: 10 mg/kg (7 to 15 mg/kg) once daily (max. 300 mg daily Child ≥ 30 kg: 5 mg/kg (4 to 6 mg/kg) once daily (max. 300 mg daily)
Rifampicin (R)	Child < 30 kg: 15 mg/kg (10 to 20 mg/kg) once daily (max. 600 mg daily Child ≥ 30 kg: 10 mg/kg (8 to 12 mg/kg) once daily (max. 600 mg daily)
Pyrazinamide (Z)	Child < 30 kg: 35 mg/kg (30 to 40 mg/kg) once daily (max. 2000 mg daily Child ≥ 30 kg: 25 mg/kg (20 to 30 mg/kg) once daily (max. 2000 mg daily)
Ethambutol (E)	15 to 25 mg/kg once daily (max. 1200 mg daily)

See MSF Tuberculosis Guidelines for dosing charts according to weight, contraindications and side effects of TB drugs.

a Symptoms requiring hospitalisation include signs of severe respiratory disease or distress, severe acute malnutrition, fever > 39C, severe pallor, irritability or lethargy.

b Dose reduced in renal or hepatic insufficiency, see MSF Tuberculosis Guidelines for details.

Adjunctive therapy

– Pyridoxine (vitamin B6) prophylaxis is indicated for all patients at risk of peripheral neuropathy i.e. children with HIV, malnutrition, diabetes, chronic hepatic disease or renal impairment.
– Corticosteroid therapy is indicated for:
  • TB meningitis[59] and pericarditis[60]
  • Treatment and prevention of TB-associated immune reconstitution inflammatory syndrome (TB-IRIS), see Chapter 13, Section 13.4.3 for more detail.

TB meningitis:
dexamethasone IV: 0.6 mg/kg (max. 16 mg) once daily for 4 weeks, tapered off over 4 weeks

TB pericarditis:
prednisolone PO: 1.5 mg/kg (max. 60 mg) once daily for 4 weeks, tapered off over 6 weeks

For information on monitoring response to treatment and modifications to treatment, see MSF Tuberculosis Guidelines.

4.11.7 Prevention and screening

Globally, up to 30% of TB cases are estimated to be undetected and consequently untreated[61]. Screening for active TB (also referred to as 'intensive case finding for TB') aims to identify, within high TB-risk groups, individuals most at risk of TB who should undergo a TB diagnostic test. It also identifies individuals who are eligible for TB preventive treatment (TPT) once TB disease is ruled out. Screening allows for early diagnosis and treatment, which contributes to improved treatment outcomes and reduced TB transmission. It should only be undertaken if diagnostic and treatment capacities are available.

Screening for active TB should be routinely offered to the following groups:
– HIV-infected patients (outpatient or inpatient)
– Household and close contacts[c] of a patient with TB (index case) if:
  • Contact is HIV-infected
  • Contact is under 5 years old
  • Index case has bacteriologically confirmed PTB or a multi-resistant PTB. Can also be considered when the index case has EPTB or clinically diagnosed PTB.
– Prisoners
– Miners and other persons with current or past exposure to silica and patients with silicosis

Screening for active TB can be considered in patients with malnutrition, chronic disease, over 60 years, previously treated with TB, pregnant women, staff of health facilities exposed to TB, populations living in slums, homeless, general population in areas with high TB prevalence.

Screening includes evaluation of any current symptoms (current cough, fever, poor weight gain, night sweats etc.), contact with a TB case and imaging, depending on the high-risk group the person belongs to. For specific screening strategies, refer to the MSF Tuberculosis Guidelines.

c WHO definitions[61]: A household contact is a person who shared the same enclosed living space for one or more nights or for frequent or extended periods during the day with the index patient during the 3 months before the start of treatment; A close contact is a person who does not live in the household but who shared an enclosed space, such as a social gathering place, workplace or facility, with a TB case for extended periods during the day during the 3 months before the current disease episode commenced.

Patients who screen positive i.e. have symptoms or signs of TB, should be referred for active TB diagnosis (see Section 4.11.3, Section 4.11.4 and Section 4.11.5). Patients who screen negative are unlikely to have active TB and should be referred for latent TB diagnosis and/or treatment. To demonstrate LTBI, either a tuberculin skin test (TST) or an interferon gamma release assay may be performed. These tests are not mandatory in children under 5 years who are a household contact of a TB case, or in HIV-infected children. In such cases, treatment for LTBI can be commenced without confirmation. Recommended and alternative treatment regimens for LTBI are outlined in Table 4.8.

Table 4.8 - LTBI regimens in children

Age	Recommended regimens	Dosing	Alternative regimens
Child < 2 years	**isoniazid** daily for 6 months (6H)	**isoniazid** PO once daily: < 30 kg: 10 mg/kg (7 to 15 mg/kg) ≥ 30 kg: 5 mg/kg (4 to 6 mg/kg) (max. dose 300 mg daily)	**rifampicin** PO once daily for 4 months (4R): < 30 kg: 15 mg/kg ≥ 30 kg: 10 mg/kg (max. dose 600 mg)
	OR **isoniazid** and **rifampicin** daily for 3 months (3HR)	**isoniazid** PO once daily: < 30 kg: 10 mg/kg (7 to 15 mg/kg) ≥ 30 kg: 5 mg/kg (4 to 6 mg/kg) (max. dose 300 mg daily) + **rifampicin** PO once daily: < 30 kg: 15 mg/kg ≥ 30 kg: 10 mg/kg (max. dose 600 mg daily)	
Child ≥ 2 years and adolescent	**isoniazid** daily for 6 months (6H)	As above	**rifampicin** PO once daily for 4 months (4R): as above OR **isoniazid** and **rifapentine** daily for 1 month (1HP), if ≥ 13 years: **isoniazid** PO once daily: ≥ 13 years: 300 mg + **rifapentine** PO once daily: ≥ 13 years: 600 mg
	OR **isoniazid** and **rifapentine** weekly for 3 months (3HP)	**isoniazid** PO once weekly: < 30 kg and ≥ 2 years: 20 to 30 mg/kg ≥ 30 kg: 900 mg + **rifapentine** PO once weekly: 10 to 14 kg and ≥ 2 years: 300 mg 14.1 to 25 kg and ≥ 2 years: 450 mg 25.1 to 32 kg: 600 mg 32.1 to 49.9 kg: 750 mg ≥ 50 kg: 900 mg max	
	OR **isoniazid** and **rifampicin** daily for 3 months (3HR)	As above	

4.12 Mastoiditis

Infection in the mastoid cavities that is usually a secondary complication of acute otitis media (AOM). Like AOM, it is most common in children under 2 years of age. Often there is a history of AOM or recurrent AOM, though mastoiditis can be the first presentation of AOM. If severe and untreated, it may lead to life-threatening complications.

Common pathogens are *S. pneumoniae*, *S. pyogenes*, and *Staphylococcus aureus* (including methicillin-resistant *S. aureus*).

4.12.1 Clinical features

Presents like acute otitis media with fever, irritability, ear pain, and an abnormal tympanic membrane on otoscopy.

Typically:
- The affected ear appears like it is sticking out or protruding.
- The area behind the ear is swollen, tender, and erythematous and feels like there is a fluctuant mass. A draining fistula may be present.

May present with complication of mastoiditis due to spread of infection into intra- or extra-cranial spaces. Complications include:
- Meningitis
- Intracranial abscesses
- Facial nerve paralysis
- Hearing loss
- Labyrinthitis: tinnitus, hearing loss, nausea, vomiting, vertigo, dizziness, nystagmus
- Osteomyelitis

4.12.2 Management

- Admit to hospital for IV antibiotic treatment and management of any complications.
- Refer to Ear, Nose, Throat specialist where possible for advice and to determine if surgical intervention is necessary.
- Clean the ear canal: wipe any drainage with a cotton swab or clean tissue or gauze.
- Treat fever and pain.
- First line antibiotics recommended are **ceftriaxone** IV: 80 mg/kg (max. 4g if < 50 kg; max. 2 g if ≥ 50 kg) every 24 hours and **clindamycin** IV: 10 mg/kg every 8 hours.
  - If clindamycin is not available, add **cloxacillin** IV: 50 mg/kg every 6 hours.
  - If pseudomonas confirmed on culture, add **ciprofloxacin** PO: 15 mg/kg (max. 750 mg) 2 times daily.

– Switch to oral antibiotic when there is clear improvement (no fever for at least 24 hours, reduced pain and swelling) and continue treatment for a total of 4 weeks:

amoxicillin/clavulanic acid (ratio 7:1 or 8:1) PO
Dosage expressed in amoxicillin:
- < 40 kg: 50 mg/kg 2 times daily
- ≥ 40 kg:
  Ratio 8:1: 3000 mg daily (2 tablets of 500/62.5 mg 3 times daily)
  Ratio 7:1: 2625 mg daily (1 tablet of 875/125 mg 3 times daily)

+

clindamycin PO: 10 mg/kg 3 times daily

References Chapter 4

1. Pneumonia in Children Statistics - UNICEF DATA. UNICEF DATA. Accessed November 20, 2023. https://data.unicef.org/topic/child-health/pneumonia/
2. Tuberculosis (TB). World Health Organisation. Accessed November 20, 2023. https://www.who.int/news-room/fact-sheets/detail/tuberculosis
3. Nayani K, Naeem R, Munir O, et al. The clinical respiratory score predicts paediatric critical care disposition in children with respiratory distress presenting to the emergency department. *BMC Pediatr.* 2018;18(1):339. https://doi.org/10.1186/s12887-018-1317-2
4. Asthma/Recurrent Wheezing Clinical Guideline | Clinical Standards | Texas Children's Hospital. Texas Children's Hospital. Published January 2019. Accessed November 20, 2023. https://www.texaschildrens.org/sites/default/files/uploads/documents/outcomes/standards/AcuteAsthma.pdf
5. World Health Organization. *Oxygen Therapy for Children: A Manual for Health Workers*. World Health Organization; 2016. Accessed November 20, 2023. https://iris.who.int/handle/10665/204584
6. Brink FT, Duke T, Evans J. High-Flow Nasal Prong Oxygen Therapy or Nasopharyngeal Continuous Positive Airway Pressure for Children With Moderate-to-Severe Respiratory Distress?*: *Pediatr Crit Care Med*. 2013;14(7):e326-e331. https://doi.org/10.1097/PCC.0b013e31828a894d
7. Kwon JW. High-flow nasal cannula oxygen therapy in children: a clinical review. *Clin Exp Pediatr*. 2020;63(1):3-7. https://doi.org/10.3345/kjp.2019.00626
8. Hardavella G, Karampinis I, Frille A, Sreter K, Rousalova I. Oxygen devices and delivery systems. *Breathe*. 2019;15(3):e108-e116. https://doi.org/10.1183/20734735.0204-2019
9. McCollum ED, Mvalo T, Eckerle M, et al. Bubble continuous positive airway pressure for children with high-risk conditions and severe pneumonia in Malawi: an open label, randomised, controlled trial. *Lancet Respir Med*. 2019;7(11):964-974. https://doi.org/10.1016/S2213-2600(19)30243-7
10. Rosquelles PV, Cubells CL. Diagnóstico y tratamiento de la laringitis en Urgencias. https://www.aeped.es/sites/default/files/documentos/06_laringitis.pdf
11. Al-Mutairi B, Kirk V. Bacterial tracheitis in children: Approach to diagnosis and treatment. *Paediatr Child Health*. 2004;9(1):25-30. https://doi.org/10.1093/pch/9.1.25
12. McEwan J, Giridharan W, Clarke RW, Shears P. Paediatric acute epiglottitis: not a disappearing entity. *Int J Pediatr Otorhinolaryngol*. 2003;67(4):317-321. https://doi.org/10.1016/S0165-5876(02)00393-2
13. O'Bryant SC, Lewis JD, Cruz AT, Mothner BA. Influenza A–Associated Epiglottitis and Compensatory Pursed Lip Breathing in an Infant. *Pediatr Emerg Care*. 2019;35(11):e213-e216. https://doi.org/10.1097/PEC.0000000000001589
14. Baiu I, Melendez E. Epiglottitis. *JAMA*. 2019;321(19):1946. https://doi.org/10.1001/jama.2019.3468

15. Woods CR. Epiglottitis (supraglottitis): Clinical features and diagnosis. UpToDate. Published November 2022.
https://www.uptodate.com/contents/epiglottitis-supraglottitis-clinical-features-and-diagnosis

16. Hopkins A, Lahiri T, Salerno R, Heath B. Changing Epidemiology of Life-Threatening Upper Airway Infections: The Reemergence of Bacterial Tracheitis. *Pediatrics*. 2006;118(4): 1418-1421.
https://doi.org/10.1542/peds.2006-0692

17. Jones R, Santos JI, Overall JC. Bacterial tracheitis. *JAMA*. 1979;242(8):721-726.
https://doi.org/10.1001/jama.1979.03300080019018

18. Liston SL. Bacterial Tracheitis. *Arch Pediatr Adolesc Med*. 1983;137(8):764.
https://doi.org/10.1001/archpedi.1983.02140340044012

19. Kasian GF, Bingham WT, Steinberg J, et al. Bacterial tracheitis in children. *CMAJ Can Med Assoc J J Assoc Medicale Can*. 1989;140(1):46-50.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1268533/pdf/cmaj00182-0048.pdf

20. Edwards KM, Dundon MC, Altemeier WA. Bacterial tracheitis as a complication of viral croup: *Pediatr Infect Dis J*. 1983;2(5):390-391.
https://doi.org/10.1097/00006454-198309000-00015

21. Britto J, Habibi P, Walters S, Levin M, Nadel S. Systemic complications associated with bacterial tracheitis. *Arch Dis Child*. 1996;74(3):249-250.
https://doi.org/10.1136/adc.74.3.249

22. Han B, Dunbar J, Striker T. Membranous laryngotracheobronchitis (membranous croup). *Am J Roentgenol*. 1979;133(1):53-58.
https://doi.org/10.2214/ajr.133.1.53

23. Woods CR. Bacterial tracheitis in children: Treatment and prevention. *UpToDate*. Published January 2023.
https://www.uptodate.com/contents/bacterial-tracheitis-in-children-treatment-and-prevention

24. DeBlasio D, Real FJ. Tracheitis. *Pediatr Rev*. 2020;41(9):495-497.
https://doi.org/10.1542/pir.2019-0181

25. Pneumonia in children. World Health Organisation. Accessed November 20, 2023.
https://www.who.int/news-room/fact-sheets/detail/pneumonia

26. Bradley JS, Byington CL, Shah SS, et al. The Management of Community-Acquired Pneumonia in Infants and Children Older Than 3 Months of Age: Clinical Practice Guidelines by the Pediatric Infectious Diseases Society and the Infectious Diseases Society of America. *Clin Infect Dis*. 2011;53(7):e25-e76.
https://doi.org/10.1093/cid/cir531

27. Mansbach JM, McAdam AJ, Clark S, et al. Prospective Multicenter Study of the Viral Etiology of Bronchiolitis in the Emergency Department. *Acad Emerg Med*. 2008;15(2):111-118.
https://doi.org/10.1111/j.1553-2712.2007.00034.x

28. Gökçe Ş, Kurugöl Z, Koturoğlu G, Çiçek C, Aslan A. Etiology, Seasonality, and Clinical Features of Viral Respiratory Tract Infections in Children Hospitalized With Acute Bronchiolitis: A Single-Center Study. *Glob Pediatr Health*. 2017;4:2333794X1771437.
https://doi.org/10.1177/2333794X17714378

29. Nair H, Nokes DJ, Gessner BD, et al. Global burden of acute lower respiratory infections due to respiratory syncytial virus in young children: a systematic review and meta-analysis. *The Lancet*. 2010;375(9725):1545-1555. https://doi.org/10.1016/S0140-6736(10)60206-1

30. Piedra PA. Bronchiolitis in infants and children: Clinical features and diagnosis. UpToDate. Published October 2023. https://www.uptodate.com/contents/bronchiolitis-in-infants-and-children-clinical-features-and-diagnosis

31. *Recommendations | Bronchiolitis in Children: Diagnosis and Management | Guidance | NICE*. NICE; 2015. Accessed November 20, 2023. https://www.nice.org.uk/guidance/ng9/chapter/1-Recommendations

32. Caffrey Osvald E, Clarke JR. NICE clinical guideline: bronchiolitis in children. *Arch Dis Child - Educ Pract Ed*. 2016;101(1):46-48. https://doi.org/10.1136/archdischild-2015-309156

33. *Diphtheria: Vaccine Preventable Diseases Surveillance Standards.* World Health Organization; 2018. Accessed November 20, 2023. https://www.who.int/publications/m/item/vaccine-preventable-diseases-surveillance-standards-diphtheria

34. Plotkin SA, Orenstein WA, Offit PA, eds. *Plotkin's Vaccines*. Seventh edition. Elsevier; 2018.

35. Diphtheria vaccines: WHO position paper – August 2017. Accessed November 20, 2023. https://www.who.int/publications/i/item/who-wer9231

36. *Pertussis: Vaccine Preventable Diseases Surveillance Standards*. World Health Organization; 2018. Accessed November 20, 2023. https://www.who.int/publications/m/item/vaccine-preventable-diseases-surveillance-standards-pertussis

37. Yeh S. Pertussis infection in infants and children: Treatment and prevention. *UpToDate*. Published December 2021. https://www.uptodate.com/contents/pertussis-infection-in-infants-and-children-treatment-and-prevention

38. Pertussis and Postexposure Antimicrobial Prophylaxis (PEP) | CDC. Published September 16, 2022. Accessed November 20, 2023. https://www.cdc.gov/pertussis/pep.html

39. Fan H, Gilbert R, O'Callaghan F, Li L. Associations between macrolide antibiotics prescribing during pregnancy and adverse child outcomes in the UK: population based cohort study. *BMJ*. Published online February 19, 2020:m331. https://doi.org/10.1136/bmj.m331

40. Van Aalderen WM. Childhood Asthma: Diagnosis and Treatment. *Scientifica*. 2012;2012:1-18. https://doi.org/10.6064/2012/674204

41. Scarfone RJ. Acute asthma exacerbations in children younger than 12 years: Emergency department management. *UpToDate*. Published November 2022. https://www.uptodate.com/contents/acute-asthma-exacerbations-in-children-younger-than-12-years-emergency-department-management

42. New South Wales Health Clinical Practice Guidelines: Infants and Children - Acute Management of Asthma. New South Wales Government. Accessed November 20, 2023. https://www1.health.nsw.gov.au/pds/Pages/doc.aspx?dn=PD2012_056

43. Alangari A. Corticosteroids in the treatment of acute asthma. *Ann Thorac Med*. 2014;9(4):187. doi:10.4103/1817-1737.140120.
Available at: https://pubmed.ncbi.nlm.nih.gov/25276236/

44. Becker JM, Arora A, Scarfone RJ, et al. Oral versus intravenous corticosteroids in children hospitalized with asthma. *J Allergy Clin Immunol*. 1999;103(4):586-590.
https://doi.org/10.1016/S0091-6749(99)70228-9

45. *2021 GINA Report, Global Strategy for Asthma Management and Prevention*. Global Initiative for Asthma; 2021. Accessed November 20, 2023.
https://ginasthma.org/archived-reports/

46. *2020 GINA Pocket Guide for Asthma Management and Prevention*. Global Initiative for Asthma; 2020.
https://ginasthma.org/archived-reports/

47. Scottish Intercollegiate Guidelines Network, British Thoracic Society. *SIGN 158 | British Guideline on the Management of Asthma | A National Clinical Guideline*; 2019. Accessed November 21, 2023.
https://www.brit-thoracic.org.uk/quality-improvement/guidelines/asthma/

48. *WHO Consolidated Guidelines on Tuberculosis: Module 5: Management of Tuberculosis in Children and Adolescents*. World Health Organization; 2022. Accessed November 21, 2023.
https://www.who.int/publications-detail-redirect/9789240046764

49. *Global Tuberculosis Report 2021*. World Health Organization; 2021. Accessed November 21, 2023.
https://www.who.int/publications-detail-redirect/9789240037021

50. Dodd PJ, Yuen CM, Sismanidis C, Seddon JA, Jenkins HE. The global burden of tuberculosis mortality in children: a mathematical modelling study. *Lancet Glob Health*. 2017;5(9):e898-e906.
https://doi.org/10.1016/S2214-109X(17)30289-9

51. Ai JW, Ruan QL, Liu QH, Zhang WH. Updates on the risk factors for latent tuberculosis reactivation and their managements. *Emerg Microbes Infect*. 2016;5(1):1-8.
https://doi.org/10.1038/emi.2016.10

52. *WHO Operational Handbook on Tuberculosis: Module 5: Management of Tuberculosis in Children and Adolescents*. World Health Organization; 2022. Accessed November 21, 2023.
https://www.who.int/publications-detail-redirect/9789240046832

53. Marais BJ, Gie RP, Schaaf HS, et al. The natural history of childhood intra-thoracic tuberculosis: a critical review of literature from the pre-chemotherapy era [State of the Art]. *Int J Tuberc Lung Dis*. 2004;8(4):392-402.
https://www.ingentaconnect.com/content/iuatld/ijtld/2004/00000008/00000004/art00002

54. Hesseling AC, Cotton MF, Jennings T, et al. High Incidence of Tuberculosis among HIV-Infected Infants: Evidence from a South African Population-Based Study Highlights the Need for Improved Tuberculosis Control Strategies. *Clin Infect Dis*. 2009;48(1):108-114.
https://doi.org/10.1086/595012

55. Sharma SK, Mohan A, Sharma A. Miliary tuberculosis: A new look at an old foe. *J Clin Tuberc Mycobact Dis*. 2016;3:13-27.
https://doi.org/10.1016/j.jctube.2016.03.003

56. Farhat M, Greenaway C, Pai M, Menzies D. False-positive tuberculin skin tests: what is the absolute effect of BCG and non-tuberculous mycobacteria? [Review Article]. *Int J Tuberc Lung Dis*. 2006;10(11):1192-1204. https://www.ingentaconnect.com/content/iuatld/ijtld/2006/00000010/00000011/art00003

57. World Health Organization. *Guidelines for Treatment of Drug-Susceptible Tuberculosis and Patient Care*. 2017 update. World Health Organization; 2017. Accessed November 21, 2023. https://iris.who.int/handle/10665/255052

58. World Health Organization. *Guidance for National Tuberculosis Programmes on the Management of Tuberculosis in Children*. 2nd ed. World Health Organization; 2014. Accessed November 21, 2023. https://iris.who.int/handle/10665/112360

59. Prasad K, Singh MB, Ryan H. Corticosteroids for managing tuberculous meningitis. *Cochrane Database Syst Rev*. 2016;2016(4). https://doi.org/10.1002/14651858.cd002244.pub4

60. Wiysonge CS, Ntsekhe M, Thabane L, et al. Interventions for treating tuberculous pericarditis. Cochrane Infectious Diseases Group, ed. *Cochrane Database Syst Rev.* 2017;2017(9). https://doi.org/10.1002/14651858.CD000526.pub2

61. *WHO Consolidated Guidelines on Tuberculosis: Module 2: Screening: Systematic Screening for Tuberculosis Disease*. World Health Organization; 2022. Accessed November 21, 2023. https://www.who.int/publications-detail-redirect/9789240022676

Chapter 5:
Gastrointestinal conditions

5.1 Vomiting

Vomiting can be caused by a multitude of underlying conditions. Acute gastroenteritis, which is usually viral, is a common cause among younger children and may be associated with diarrhoea and complicated by dehydration. However, vomiting may also be a sign of a serious or life-threatening disorder such as acute bowel obstruction or raised intracranial pressure.

5.1.1 Assessment

– Evaluate the history and clinical condition carefully to identify the cause of vomiting.
  - Consider: age of child; duration of vomiting; characteristics (projectile, episodic/waves, continuous), associated nausea, diarrhoea, abdominal pain, headaches; colour of vomit (bilious, yellowish, blood-stained), presence of fever.
  - Relevant medical history e.g. diabetic ketoacidosis, recent head injury, possible ingestion of toxins, poisons or traditional/herbal medicines.

– Assess for presence of any signs of concern (see Table 5.1).

Table 5.1 - Characteristics of vomiting and possible aetiology

Characteristic of vomit or vomiting	Potential indication or cause
Signs of concern	
Bilious (greenish-yellow)	Acute bowel obstruction, see Section 5.7
Projectile	Pyloric stenosis (infants < 6 weeks), see Section 5.8
Blood-stained	Oesophageal varices, oesophageal injury (Mallory-Weiss tear due to repetitive vomiting), gastritis or gastric ulcer.
Protracted vomiting and acute abdominal distension/tenderness and fever	Enteric (typhoid and paratyphoid) fever, see Chapter 3, Section 3.6
Rapid onset, associated with other signs of anaphylaxis (skin, respiratory, cardiac)	Anaphylaxis (post ingestion), see Chapter 2, Section 2.4
Associated headache or when waking up	Raised intracranial pressure
Associated head injury	Intracranial haemorrhage causing raised ICP[a]
Associated with blood in stools	Intussusception (infants), see Section 5.5
Associated with fever	Appendicitis (see Section 5.6), gastroenteritis (see Section 5.2), urinary tract infection (see Chapter 8, Section 8.1), malaria (see Chapter 3, Section 3.4), acute pharyngitis
Vomit contains abnormal contents	Ingestion of toxin, poison, traditional/herbal medicine (see Chapter 2, Section 2.9); severe helminth infection

a ICP = Intracranial pressure

Characteristic of vomit or vomiting	Potential indication or cause
Less concerning	
Short duration; associated with watery diarrhoea, nausea, loss of appetite, abdominal cramps; other close contacts affected	Acute gastroenteritis (see Section 5.2)
After feeds in young infants (small volume)	Gastro-oesophageal reflux (GOR)
Associated with unilateral or spasmodic localised headache	Migraine (adolescents)
Early morning	Pregnancy (adolescents)

– Assess for any secondary complications:
  • Dehydration
  • Hypoglycaemia
  • Signs of electrolyte imbalance
  • Excess weight loss or malnutrition (especially if vomiting over several days/weeks)

Investigations

– Haemoglobin (Hb)
– Blood glucose level (BGL)
– Malaria test, if endemic
– Electrolytes, if available

Conduct specific investigations according to differential diagnosis based on history and clinical presentation.

5.1.2 Management

– Treat the underlying cause (see Table 5.1, page 187).
– Urgently refer any child suspected of acute bowel obstruction, intussusception, appendicitis, or raised intracranial pressure for surgical consideration.
– Correct any dehydration and electrolyte abnormalities.
– Antiemetics are rarely necessary unless vomiting is incessant and/or causing significant dehydration or electrolyte imbalance. A single dose of **ondansetron** PO, 100 to 150 micrograms/kg (max. 8 mg) can be given if the following conditions are met:
  • Acute surgical abdomen excluded (see Section 5.4)
  • Failed trial of ORS
  • Confident in diagnosis of acute gastroenteritis

5.2 Diarrhoea

Diarrhoea is defined as passage of 3 or more loose or watery stools in a 24-hour period. It is the second leading cause of under-5 deaths in children worldwide and the main underlying cause of malnutrition. Children may present critically unwell with severe dehydration or bacterial sepsis associated with diarrhoea. Malnourished or immune-compromised children (such as due to HIV infection) are particularly at risk of death[1].

In resource-limited settings, infectious gastroenteritis is the main pathology causing diarrhoea (often associated with vomiting). Less commonly, children may present with diarrhoea as an associated symptom of another illness, such as:
– Influenza, measles, haemorrhagic fever, HIV and malaria.
– Serious bacterial infections: pneumonia, urinary tract infection, meningitis and sepsis.
– Surgical emergencies: intussusception or appendicitis.
Diarrhoea is also a common side effect of antibiotics in children, therefore it is important to ask about current or recent antibiotic use.

In all children presenting with diarrhoea, take a comprehensive history and always include assessment of dehydration in the clinical examination. Examine a fresh stool to determine whether the diarrhoea is watery or bloody (containing visible blood).

Diarrhoea that has continued for ≥ 14 days is classified as persistent diarrhoea (Section 5.2.3).

5.2.1 Acute diarrhoea

– Rapid onset, frequent stools, duration usually a few hours to days.
– Common pathogens of infectious gastroenteritis vary by context and age group. Refer to Table 5.2 for a list of common causes in children.

Table 5.2 - Causes of acute diarrhoea in children[2]

	Acute watery diarrhoea	Acute bloody diarrhoea
Viruses	Rotavirus (most common < 2 years) Enteric adenovirus (enterovirus) Measles	
Bacteria	Enterotoxigenic *E.coli* (≥ 2 years) *Campylobacter jejuni* *Vibrio cholera* *Yersinia enterocolitica* *Aeromonas*	*Shigella* species (most common in 2 to 5 years) Enterohaemorrhagic *E. coli* *Campylobacter* spp *Salmonella* species (typhoid fever, non-typhoid Salmonella) *Clostridium difficile*
Parasites	*Giardia lamblia* *Cryptosporidium* (< 2 years; HIV infection)	*Entamoeba histolytica* Schistosomiasis (in endemic areas)

Assessment

– Evaluate the history and clinical condition carefully to try to identify the cause of the acute diarrhoea.
  • Consider: frequency per day, consistency of stool (loose, watery, mucous or blood-streaked, rice-water appearance), associated with fever, vomiting, abdominal pain.
  • Relevant medical history e.g. HIV infection, recent use of antibiotics, traditional medicines.
  • Epidemiological factors such as other members of household with same symptoms, or in context of known epidemic.
– Assess for presence of dehydration and severity (refer to Section 5.3).
– Assess for any secondary complications:
  • Hypoglycaemia
  • Signs of electrolyte imbalance
  • Excess weight loss or malnutrition

Investigations

Most children with acute diarrhoea do not need any investigations, however the following may be helpful:
– Hb, BGL
– Malaria test, if endemic
– Stool examination, with or without culture, if symptoms not typical of acute gastroenteritis.

Management

– Take and note the baseline weight (if not already done).
– If breastfeeding, continue if child keen to drink and alert.
– Admit children with severe diarrhoea[a] or signs of critical illness, even if no evidence of dehydration, especially if malnourished.
– Assess degree of dehydration and manage according to severity (see Section 5.3).
– Prevent dehydration in children with no dehydration (see below).
– Prevent malnutrition: continue with unrestricted usual diet. See below for breastfed infants.
– Do not give anti-diarrhoeal drugs or antiemetics.
– Treat the underlying condition, if known.
– Give **zinc sulfate** (see page 191 for dosing).
– Antibiotic treatment:
  • Not indicated in most cases of acute watery diarrhoea, with the exception of suspected cholera in certain cases only (see Management of a cholera epidemic, MSF).
  • Indicated in acute bloody diarrhoea, as Shigellosis is the most common cause.

Prevention of dehydration

Children with simple diarrhoea and no dehydration can be treated at home with measures to prevent dehydration:
– Explain to parents/carers how to replace fluids lost in diarrhoea by giving **ORS** 10 mL/kg (5 mL/kg in children with SAM) after each loose stool (see Table 5.3 and Appendix 12).
– Breastfed children: encourage frequent feeds for as long as the child wants. ORS should be given between feeds.
– Non-breastfed children: encourage the child to take additional ORS or clean water if the child seeks it in addition to recommended amount of ORS.

a Profuse or dehydrating stool losses, fever or illness.

Table 5.3 - Volume of ORS after each loose stool

Weight	Non-malnourished mL of ORS to be given (10 mL/kg)	SAM mL of ORS to be given (5 mL/kg)
< 5 kg	50	25
5 to < 10 kg	100	50
10 to 20 kg	200	100
> 20 kg	300	200

Zinc supplementation

Zinc sulfate is given in combination with ORS in order to reduce the duration and severity of diarrhoea, as well as to prevent further recurrences in the 2 to 3 months following treatment:

zinc sulfate PO
- < 6 months: 10 mg once daily for 10 days
- 6 months to 5 years: 20 mg once daily for 10 days

Place the half-tablet or full tablet on a teaspoon, add a bit of water to dissolve it, and give the entire spoonful to the child.

In malnourished children who are receiving therapeutic milk or RUTF, supplementation with zinc sulfate is unnecessary.

Antibiotic treatment

– Diarrhoea without blood:
  - Most are caused by viruses unresponsive to antibiotics.
  - Antibiotic treatment is indicated in the case of cholera or giardiasis:
    - ▷ Cholera: the most important part of treatment is rehydration. In the absence of resistance (perform antibiotic-sensitivity testing at the beginning of an outbreak), antibiotic treatment shortens the duration of diarrhoea. See Management of a cholera epidemic, MSF.
    - ▷ Giardiasis: give **tinidazole** PO 50 mg/kg (max. 2 g) single dose or **metronidazole** PO 30 mg/kg once daily for 3 days.

– Diarrhoea with blood:
  Treat empirically for Shigellosis (amoebiasis is much less common).
  - If the child is unwell:
    - ▷ Admit and stabilise.
    - ▷ Administer **ceftriaxone** IV/IM: 50 to 100 mg/kg once daily (max. 4 g if < 50 kg; max. 2 g if ≥ 50 kg) for 3 days.
    - ▷ If no improvement (treatment failure defined by persistent fever, grossly bloody stools or unchanged stool frequency by day 3 of treatment), consider antibiotic-resistant infection or an alternative cause such as amoebiasis (see Section 5.2.3) or *C. difficile*.

- If child appears well:
  - ▷ Treatment can be given at home.
  - ▷ Give **ciprofloxacin** PO 15 mg/kg (max. 750 mg) 2 times daily for 3 days.
  - ▷ If resistance or contraindication to ciprofloxacin, or if no improvement after 48 hours, switch to ceftriaxone (as above) or give **azithromycin** PO, 12 mg/kg on D1 then 6 mg/kg once daily from D2 to D5.
  - ▷ If no improvement, consider an alternative diagnosis such as amoebiasis and add **tinidazole** PO 50 mg/kg (max. 2 g daily) for 3 days or **metronidazole** PO 15 mg/kg 3 times daily for 5 days.

Prevention

– Breastfeeding reduces infant morbidity and mortality from diarrhoea and the severity of diarrhoea episodes.
– When the child is weaned, preparation and storage of food are associated with the risk of contamination by faecal micro-organisms: discourage bottle-feeding; food must be cooked well; milk or porridge must never be stored at room temperature.
– Access to sufficient amounts of clean water and personal hygiene (washing hands with soap and water before food preparation and before eating, after defecation etc.) are effective methods of reducing the spread of diarrhoea.
– In countries with a high rotavirus diarrhoea fatality rate, the WHO recommends routine rotavirus vaccination in children between 6 weeks and 24 months of age[3].

5.2.2 Specific considerations for children with malnutrition

Children with malnutrition may have additional reasons for diarrhoea that are not infective. In malnourished children, the lining of the small intestine is atrophied, the production of gastric acid, digestive enzymes and bile is absent or reduced, and gut bacterial overgrowth is frequent, all of which increase the frequency of diarrhoea in children with malnutrition. Re-nutrition or osmotic diarrhoea is also common in children receiving therapeutic feeds (see Chapter 12, Section 12.2).

If diarrhoea persists for more than 72 hours, in the absence of another obvious explanation for diarrhoea (e.g. otitis media, pneumonia, UTI), consider other infective causes of diarrhoea and treat accordingly (see Section 5.2.1).

5.2.3 Persistent diarrhoea

Persistent diarrhoea is defined as at least 3 episodes of diarrhoea per day for ≥ 14 days despite treatment. Persistent diarrhoea can lead to malnutrition, dehydration, and increases susceptibility to other infections such as pneumonia, indirectly contributing to increased risk of mortality in young children.

Children with acute malnutrition or who are immunocompromised, such as with HIV infection, are more at risk of persistent diarrhoea (see Chapter 13).

Parasitic infections such as giardiasis and amoebiasis may cause persistent diarrhoea in children. However, in younger children, repeated acute diarrhoeal episodes with insufficient recovery between episodes may often be the cause of persistent diarrhoea.

– Giardiasis:
  • More common in children < 5 years.
  • Suspect *G. lamblia* in cases of diarrhoea (sudden in onset; initially may be watery), malaise, nausea/vomiting, foul-smelling and fatty stools (steatorrhea), abdominal cramps and bloating and weight loss; fever occurs occasionally.
– Amoebiasis:
  • Can cause both persistent and bloody diarrhoea in children, but it is not common.

Investigations

– Examine stools for *Giardia*, *Cryptosporidium*, and *Entamoeba histolytica*.

Management

– Same admission criteria as for acute diarrhoea.
– Prevent and/or treat dehydration if present according to severity (see above and Section 5.3).
– Assess for malnutrition and refer for management of acute malnutrition if identified.
– Prevent malnutrition by encouraging good dietary intake and breastfeeding for infants.
– Give zinc sulfate (as page 191).
– Give empiric antiparasitic treatment:

albendazole PO:
12 - 23 months: 200 mg once daily for 3 days[b]
≥ 24 months: 400 mg once daily for 3 days

mebendazole PO:
≥ 12 months and > 10kg: 100 mg 2 times daily for 3 days

Amoebiasis

– Antiparasitic treatment should be given when motile *Entamoeba histolytica* amoebae are found in stools or if a correct shigellosis treatment has been ineffective.
– Give **tinidazole** PO 50 mg/kg (max. 2 g daily) for 3 days or **metronidazole** PO 15 mg/kg 3 times daily for 5 days
– Refer to MSF Clinical Guidelines, Chapter 3 for further information.

Giardiasis

– Give **tinidazole** PO 50 mg/kg (max. 2 g) single dose or **metronidazole** PO 30 mg/kg once daily for 3 days.
– Refer to MSF Clinical Guidelines, Chapter 6 for further information.

If diarrhoea lasts for more than 4 weeks (chronic diarrhoea), consider non-infectious causes.

b Albendazole is not systematically recommended to children less than 12 months, but can be given on a case-by-case basis according to clinician assessment at the same dose as for children 12 - 23 months.

5.3 Dehydration

Dehydration results from loss of water and salt from the body in excess of replacement. Young children are at greater risk of dehydration as they are unable to independently replace their fluid losses or to clearly communicate their needs. Dehydration may be associated with electrolyte disturbance and, if prolonged, can lead to reduced end-organ perfusion and shock. The most common causes of dehydration in children are diarrhoea and vomiting, with dehydration being the main contributor to death from diarrhoea. In addition, children are particularly susceptible to dehydration from severe burns due to their large body surface area relative to their weight.

Management of dehydration depends on the underlying cause and degree of dehydration. For children with fluid loss due to burns refer to MSF Clinical Guidelines, Chapter 10 and for diabetic ketoacidosis refer to Chapter 9, Section 9.1.

5.3.1 Non-malnourished children

Clinical features and assessment

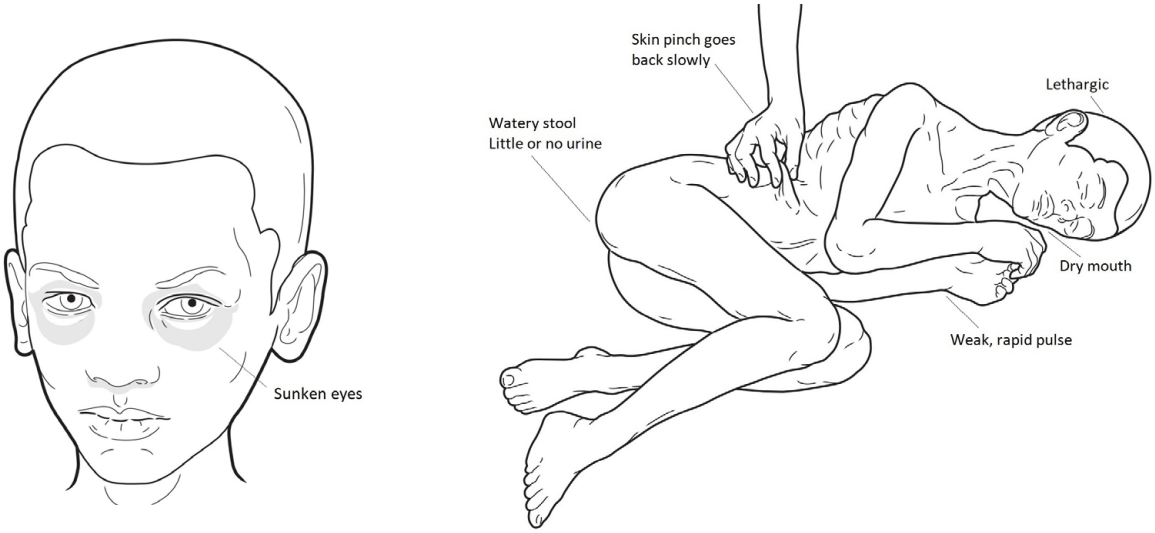
The degree of dehydration is difficult to assess accurately, even more so in malnourished children. Taking a focused and detailed history of the current illness is therefore paramount.

- Ask about frequency and duration of watery diarrhoea and/or vomiting; ability to drink or feed; urine output/wet nappies; concurrent illness, fever.
- Check for dry lips or mouth, absence of tears.
- Examine for presence and degree of dehydration. Classify according to the more severe degree of dehydration based on the presence of two or more signs in the same category (see Table 5.4, Figure 5.1 and Figure 5.2).
- Check for any signs of circulatory impairment.
- Monitor if there are any ongoing losses e.g. profuse diarrhoea.

Table 5.4 - Classification of degree of dehydration (adapted from WHO[4])

Clinical features (Two or more of the following signs)	**Classification**		
	No dehydration	**Some dehydration**	**Severe dehydration**
Mental status	Normal	Restless, irritability	Lethargic or unconscious
Eyes	Normal	Sunken	Sunken
Skin pinch	< 1 second	Goes back slowly	Goes back very slowly (≥ 2 sec)
Thirst	No thirst, drinks normally	Thirsty, drinks eagerly	Unable to drink or drinks poorly
Urine output	Normal	Reduced	Absent for several hours

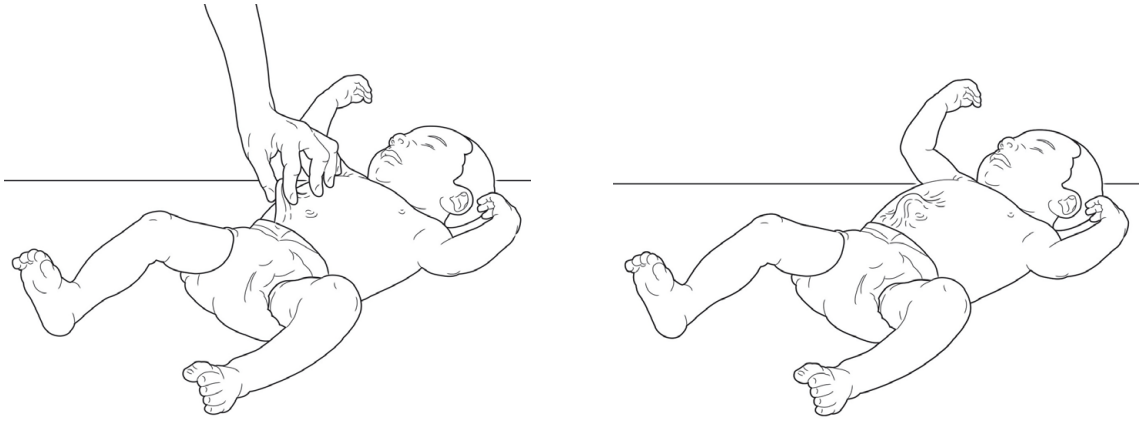
Figure 5.1 - Clinical features of dehydration



How to assess skin pinch

– Pinch the abdominal skin to assess skin turgor. Skin pinch goes back very slowly (≥ 2 seconds) in severe dehydration.

Figure 5.2 - Skin pinch assessment in infants



Management

Children with no dehydration do not require admission. Most children with some dehydration can be managed at home after an initial period of observation (4 to 6 hours) to ensure that they are able to tolerate adequate oral rehydration therapy.

Admit:

– All children with severe dehydration.
– Children < 4 months of age and/or < 4 kg weight with some dehydration.
– Children with some dehydration if there is no possibility for short-term observation while starting rehydration treatment.

Manage according to degree of dehydration using WHO treatment plan A, B or C[4] (see also Appendix 12). Reassess the child's hydration and clinical condition regularly – clinical improvement is the best indicator of treatment response.

Severe dehydration (WHO treatment plan C)

– Assess and manage ABCDE. If signs of circulatory impairment or shock are present, stabilise and manage accordingly (Chapter 2, Section 2.2).

– Obtain IV/IO access.

– Mark liver border with pen.

– Administer IV **Ringer lactate** (RL) (or alternatively **sodium chloride 0.9%** if RL not available) according to the following table:

Age	First administer 30 mL/kg[a] over:	Then administer 70 mL/kg over:
< 12 months	1 hour	5 hours
≥ 12 months	30 minutes	2½ hours

– Monitor urine output.

– Check BGL and correct hypoglycaemia if present (see Chapter 9, Section 9.3).

– Check Hb and blood electrolytes (where available), and treat anaemia if present (see Chapter 10, Section 10.1).

– Monitor and record signs of dehydration and vital signs every 15 to 30 minutes using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).

– If not improving, re-evaluate the child, consider other differential diagnoses (e.g. diabetic ketoacidosis, shock, sepsis), assess fluid losses and increase the rate of IV fluids accordingly.

– Monitor continuously for signs of fluid overload:
  - Increased RR by ≥ 10 breaths/min from initial RR, or
  - Increased HR by ≥ 20 beats/min from initial HR.

  Plus any one of the following:
    - ▷ New or worsening hypoxia (decrease in SpO_2 by > 5%)
    - ▷ New onset of rales and/or pulmonary oedema (fine crackles in lung fields)
    - ▷ New galloping heart rhythm
    - ▷ Increased liver size (liver size must have been marked with pen on arrival)
    - ▷ New peripheral oedema and/or puffy eyelids.

  Management if signs of fluid overload present:
  - Stop IV fluids.
  - Administer **furosemide** IV: 0.5 mg/kg (repeat once if necessary).
  - Place child into semi-sitting position and ensure high-flow oxygen via non-rebreathing mask.
  - Monitor every 15 minutes until child has been stable for at least one hour.

– As soon as the child is awake, alert, and can tolerate a nasogastric tube (NGT) or take oral fluids, start **ORS** at 5 mL/kg/hour in addition to the ongoing IV fluid resuscitation and encourage breastfeeding (if relevant).

a Repeat this volume if radial pulse remains weak or absent

– In addition, if tolerated, give extra ORS to replace fluids lost with each loose stool according to plan A (below).
– Assess the degree of dehydration at the end of the fluid resuscitation (3 hours for children, 6 hours for infants). Continue further rehydration according to degree of dehydration following the appropriate treatment plan (A, B or C).
– If hypokalaemia or, where potassium monitoring not available, if child develops signs of hypokalaemia including general fatigue, muscle cramps and weakness, abdominal distension and polyuria, treat for moderate hypokalaemia with **7.5% potassium chloride** syrup for 2 days (see also Chapter 15, Section 15.3):

> **7.5% potassium chloride** syrup (1 mmol of K+/mL) PO
> < 45 kg: 2 mmol/kg (2 mL/kg) daily
> ≥ 45 kg: 30 mmol (30 mL) 3 times daily

Some dehydration (WHO treatment plan B)

– If breastfeeding, encourage continuation if the child is keen and alert.
– Prescribe **ORS** 75 mL/kg over 4 hours:

Weight (kg)	< 6	6 to < 10	10 to < 12	12 to < 19	19 to < 30
Total ORS (mL) over 4 hours	200-400	400-700	700-900	900-1400	1400-2200

– Show the parent/carer how to give ORS in small, frequent quantities e.g. using a teaspoon or syringe for infants and young children (5 ml every 5 minutes), regular sips from a cup for older children.
– If child vomits ORS, encourage child to take smaller volumes or sips.
– In addition to rehydration with treatment plan B, give extra ORS to replace fluids lost with each loose stool according to plan A (below).
– Reassess degree of dehydration after 4 hours and continue with appropriate treatment plan. If dehydration has resolved, management with plan A can continue at home.

No dehydration (WHO treatment plan A)

– Encourage oral fluids e.g. frequent breastfeeds, if breastfeeding; clean water, clear soups, rice water, if not breastfeeding.
– Give **ORS** 10 ml/kg after each loose stool to prevent dehydration:

Weight (kg)	< 5	5 to < 10	10 to 20	> 20
ORS (mL) to be given after each loose stool	50	100	200	300

– Explain to the parent/carer how to reassess regularly for signs of dehydration and continue treatment with ORS after loose stools at home.

5.3.2 Children with severe acute malnutrition (SAM)

Clinical features and assessment

Dehydration is difficult to assess clinically in severely malnourished children because malnutrition may mask signs of dehydration or cause over-diagnosis of severe dehydration:
- Signs of hypovolaemia or circulatory impairment can be masked by oedema.
- Skin pinch assessment has no value if the subcutaneous tissue has completely disappeared because the persistent and doughy character applies to this subcutaneous tissue (deep pinch).
- Sunken eyes can be present without dehydration.

Therefore, to diagnose dehydration and assess for severity in children with SAM, the following criteria are more reliable (see also Table 5.5):
- A detailed history of losses (frequency and duration of vomiting and/or watery diarrhoea).
- Recent weight loss (compared to weight prior to onset of vomiting or diarrhoea, can be measured on scales or from parent/carer history).
- Clinical features that can be measured, including mental status, thirst, urine output.

Table 5.5 - Classification of degree of dehydration adapted for SAM

Clinical features (Two or more of the following signs)	**Classification**		
	No dehydration	**Some dehydration**	**Severe dehydration**
Mental status	Normal	Restless, irritability	Lethargic or unconscious
Thirst	No thirst, drinks normally	Thirsty, drinks eagerly	Unable to drink or drinks poorly
Urine output	Normal	Reduced	Absent for several hours
Recent frequent watery diarrhoea and/or vomiting	Yes	Yes	Yes
Recent obvious rapid weight loss	No	Yes	Yes

Management

Children with SAM and no dehydration do not require admission, unless diarrhoea is severe[b] or there are signs of critical illness. In this case, admit for monitoring and management with 'Plan A SAM'. Admit children with SAM and some or severe dehydration for close monitoring, and manage according to degree of dehydration using treatment plans specifically adapted for SAM (see below and Figure 5.3)[c]. Ideally, continue therapeutic milk at scheduled feeding hours in addition to rehydration fluids.

Oral rehydration should be used in preference to IV fluids in the management of dehydration of any severity in children with SAM. Target weights are used to guide treatment and are

b Profuse or dehydrating stool losses, fever or illness.

c Except in the case of cholera where more aggressive fluid management is required. See Management of a cholera epidemic, Chapter 5.8 for advice on fluid management in children with malnutritiSF on and cholera.

calculated on the basis of assumed percentages of body water lost depending on the degree of severity of dehydration. Reassess the child's hydration and clinical condition regularly – clinical improvement is the best indicator of treatment response.

Severe dehydration: 'Plan C SAM'

- Assess and manage ABCDE.
- Assess specifically for signs of circulatory impairment or shock and stabilise accordingly (Chapter 2, Section 2.2).
- Weigh the child.
- Calculate target weight = current weight x 1.1[d]; or recent previously recorded weight.
- Mark liver border with pen.
- Check BGL and correct hypoglycaemia if present (see Chapter 9, Section 9.3).
- Check Hb and blood electrolytes (where available), and treat anaemia if present (see Chapter 10, Section 10.1).
- Monitor urine output.
- Monitor and record signs of dehydration and vital signs every 15 to 30 minutes using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).

If no signs of circulatory impairment or shock and not vomiting:

- If breastfeeding, continue if child keen and alert.
- Give **ReSoMal** PO/NGT: 20 mL/kg over 1 hour.
- Reassess patient after 1 hour.
- If improving, not vomiting and still no signs of circulatory impairment/shock, move to treatment algorithm for 'Plan B SAM' (without modifying target weight).
- If at any point the child deteriorates and develops signs of circulatory impairment/shock, treat with IV fluids +/- blood transfusion (see below).
- If at any point the child begins to vomit, but there are no signs of circulatory impairment, treat with IV fluids as follows:
  - Administer **glucose** (**dextrose**) **5%** - **Ringer lactate** (G5%-RL) IV: 10 mL/kg/hour for 2 hours.
  - Reassess patient after 2 hours of IV fluids. If no improvement at all or still vomiting, continue **G5%-RL** IV: 10 mL/kg/hour for another 2 hours.
  - When the child begins to improve and/or is not vomiting, stop IV fluids and switch to 'Plan B SAM' (without modifying target weight) starting with **ReSoMal** PO/NGT: 20 mL/kg/hr for 2 hours.

If signs of circulatory impairment/shock:

- Administer **ceftriaxone** IV: 80 mg/kg (max. 4 g if < 50 kg; max. 2 g if ≥ 50 kg) single dose. Revise necessity of further antibiotic treatment once underlying cause identified.
- Immediately administer **G5%-RL** IV: 10 mL/kg/hour for 2 hours.
- Reassess patient after 2 hours of IV fluids. If deterioration or no improvement at all, check Hb[e] and administer a blood transfusion[5] (see Chapter 2, Section 2.2.3 and Chapter 10, Section 10.1.2), and continue **G5%-RL** IV: 10 mL/kg/hour for another 2 hours.
- Do not stop IV fluid rehydration, continue IV fluids as above at the same time as blood transfusion using a separate IV line.
- If at any point the child begins to improve and is not vomiting, stop IV fluids and begin **ReSoMal** PO/NGT: 20 mL/kg/hr, following 'Plan B SAM' (without modifying target weight).

d Assumes approximately 10% dehydration.

e Blood transfusion for shock is not strictly dependent on Hb, however if Hb is above 10 g/dL transfusion may not be beneficial and decision to transfuse should be based on the balance of potential risks and benefits.

Some dehydration: 'Plan B SAM'

- If breastfeeding, encourage continuation if child keen and alert.
- Weigh the child.
- Calculate target weight = current weight x 1.06[f] or recent previously recorded weight
- Give **ReSoMal** PO/NGT: 20 mL/kg/hour for 2 hours.
- In addition, if tolerated, give extra **ReSoMal** to replace fluids lost with each loose stool according to 'Plan A SAM' (below).
- Reassess patient and reweigh after 2 hours.
- If improving, give **ReSoMal** PO/NGT: 10 mL/kg/hr until:
  - No signs of dehydration and/or
  - Target weight reached
- Start **F75** at standard volumes and times in addition to **ReSoMal**, if tolerated.
- Reassess and reweigh every 2 hours.
- Once there are no signs of dehydration and/or target weight is reached, continue with 'Plan A SAM' to prevent recurrence of dehydration.
- If after 2-4 hours there are no signs of improvement, or there is continuous diarrhoea with inability to keep up with stool losses using oral rehydration with ReSoMal, consider management with **G5%-RL** IV as for severe dehydration with circulatory impairment.

No dehydration: 'Plan A SAM'

- Encourage oral fluids (e.g. frequent breastfeeds, if breastfeeding; clean water, if not breastfeeding).
- Give **ReSoMal** PO: 5 ml/kg after each loose stool or vomit to prevent dehydration:

Weight (kg)	< 5	5 to < 10	10 to 20	> 20
ReSoMal (mL) to be given after each loose stool	25	50	100	200

- If the child is ready for discharge, explain to the parent/carer how to reassess regularly for signs of dehydration and continue treatment with **ORS**[g] after loose stools at home.

Fluid overload

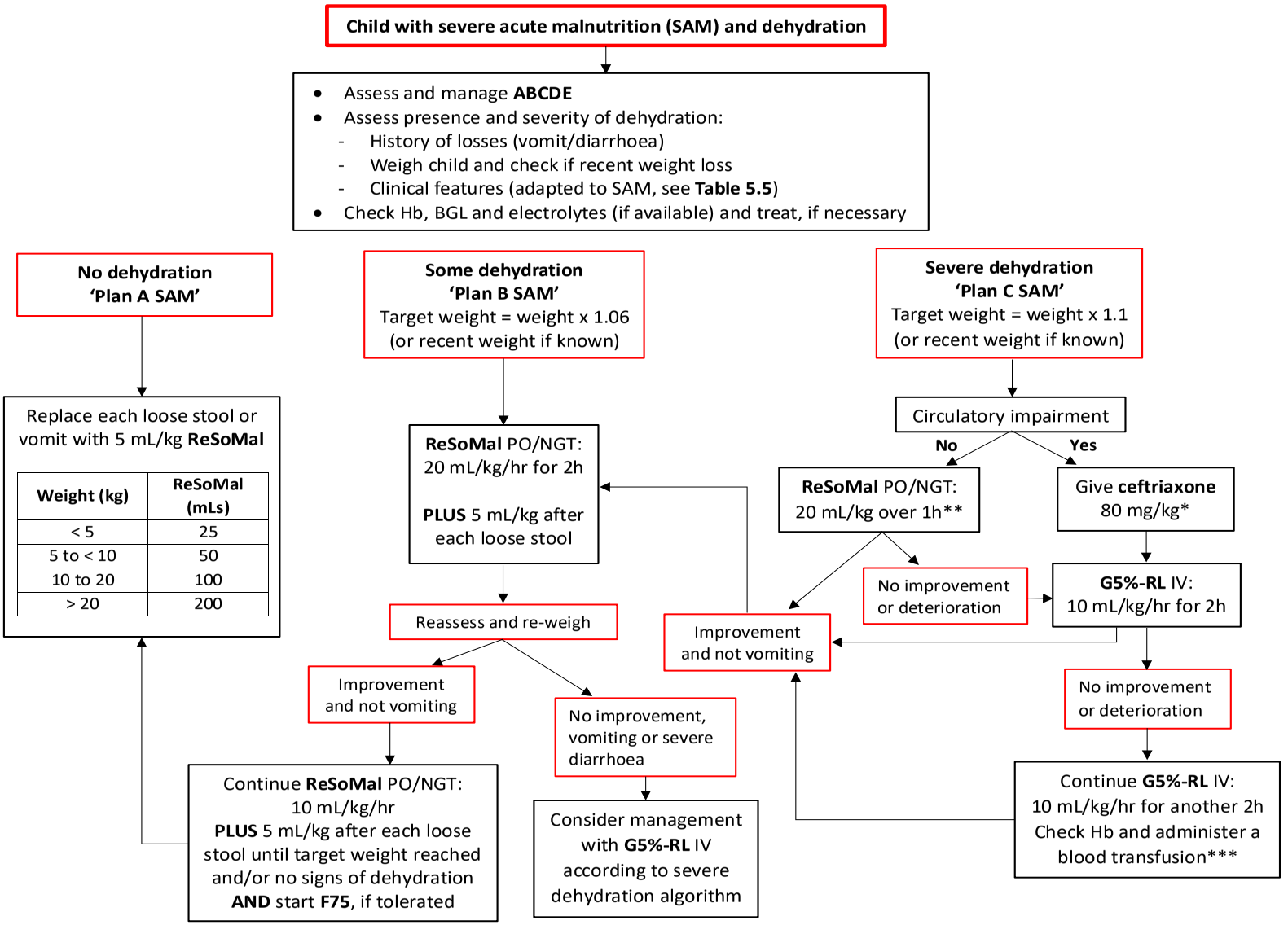
- Monitor continuously for signs of fluid overload:
  - Increased RR by ≥ 10 breaths/min from initial RR, or
  - Increased HR by ≥ 20 beats/min from initial HR.

  Plus any one of the following:
  - New or worsening hypoxia (decrease in SpO_2 by > 5%)
  - New onset of rales and/or pulmonary oedema (fine crackles in lung fields)
  - New galloping heart rhythm
  - Increased liver size (liver size must have been marked with pen on arrival)
  - New peripheral oedema and/or puffy eyelids.
- Management if signs of fluid overload present:
  - Stop IV fluids or ReSoMal.
  - Consider administration of **furosemide** IV: 0.5 mg/kg, especially if IV fluids given (repeat once if necessary).
  - Place child into semi-sitting position and ensure high-flow oxygen via non-rebreathing mask.
  - Monitor every 15 minutes until child has been stable for at least one hour.

f Assumes approximately 6% dehydration.

g ReSoMal should only be used for short periods in hospital under medical supervision, therefore for ongoing treatment at home ORS is used.

Figure 5.3 - Management of dehydration in children with SAM (excluding cholera cases)



* Revise necessity of further antibiotic treatment once underlying infection identified.
** If vomiting, give **G5%-RL** IV for 2h, reassess and repeat if ongoing vomiting.
*** If Hb is above 10 g/dL transfusion may not be beneficial and decision to transfuse should be based on the balance of potential risks and benefits.

5.4 Approach to a child with acute abdominal pain

Abdominal pain is a common presentation in children and has a wide range of medical and surgical causes. Gastroenteritis is the most common non-surgical cause of abdominal pain in children (see Section 5.1 and Section 5.2), but surgical causes must be ruled out early to prevent unnecessary morbidity and mortality. This chapter will focus on the 'acute abdomen' – sudden and severe abdominal pain that may indicate a surgical emergency. It is estimated that around 30% of global disease burden could be addressed surgically, however the provision of available, affordable, timely and safe paediatric surgical care is often scarce in resource-limited settings[6,7,8].

5.4.1 Identifying underlying cause

Emergency stabilisation and pain management is often necessary before an assessment can take place due to significant pain (see Section 5.4.2). Once the patient is comfortable and stable, a focused history and examination should be done.

Important points in the history include:
- Onset of symptoms
- Detailed description of the pain: onset, nature (dull/aching/sharp/colicky), intensity, radiation, localisation (localised/diffuse/radiating)
- Associated symptoms: fever, nausea and/or vomiting (bilious/bloodstained/faecal), anorexia, stool pattern alterations (diarrhoea/constipation), dysuria, cough, rashes
- Possible trauma (accidental or non-accidental)
- Gynaecological history in adolescent girls (onset of menstruation/sexual activity)
- Past medical/surgical history (previous abdominal surgery, recurrent blood transfusions)

Complete a comprehensive clinical examination (Chapter 1, Section 1.3). Focus on abdominal and extra-abdominal signs that may help identify underlying cause of pain. Assess the inguinal region and genitalia. Consider a perianal inspection or digital rectal examination, if necessary – this should only be done once and with the consent of the child and parent/carer.

Identify the likely underlying cause and differentiate between surgical and non-surgical causes (see Table 5.6). Common surgical causes of acute abdominal pain in children include intussusception, malrotation and volvulus, and acute appendicitis. Ectopic pregnancy should be considered in all sexually active adolescent girls. Many non-surgical causes can mimic an acute abdomen, including DKA, sickle cell crisis, haemolytic uraemic syndrome (HUS) and pneumonia. In children, mesenteric adenitis[a] is commonly mistaken for acute appendicitis.

If there is any doubt about the diagnosis, a surgical review should be sought early to rule out a surgical cause before a non-surgical diagnosis is made.

a Mesenteric adenitis is a benign lymphadenopathy of the abdominal lymph nodes that commonly occurs after a viral infection.

Table 5.6 - Common surgical causes of acute abdominal pain

Suggestive clinical features	Diagnosis	Origin of acute abdomen
Redcurrant jelly stool; intermittent colicky severe abdominal pain	Intussusception (see Section 5.5)	**Surgical:** Refer for emergency surgical evaluation and intervention
Pain initially peri-umbilical then localising to right iliac fossa, associated with nausea/vomiting, anorexia	Acute appendicitis (see Section 5.6)	
Acute colicky pain; not passing gas per rectum; abdominal distension; bilious vomiting	Bowel obstruction (see Section 5.7)	
Fixed, firm, painful swelling in groin or umbilicus; vomiting	Incarcerated hernia (see Section 5.7.2)	
Acute, severe, focal pain; vomiting	Ovarian/testicular torsion	
Abdominal rigidity; signs of systemic illness/sepsis	Bowel perforation (due to typhoid or ischaemic enteritis) with peritonitis	
Mass felt on palpation, variable location depending on underlying cause	Masses: abdominal tuberculosis, tumours, intra-abdominal abscess	**Non-surgical:** Refer to specific medical management in relevant chapters. Some conditions may eventually require surgical intervention.
Periumbilical or subxiphoid pain radiating to back; right upper quadrant pain	Pancreatitis or cholecystitis	
Prodrome of polydipsia, polyuria and weight loss, ketotic breath	Diabetic ketoacidosis (see Chapter 9, Section 9.2)	
Other signs of vaso-occlusive disease	Sickle cell crisis (see Chapter 10, Section 10.2)	
Prodrome of diarrhoea, often affecting other members of family; may have evidence of low platelets e.g. petechiae	Haemolytic uraemic syndrome (HUS)	

Investigations

- FBC including haemoglobin (Hb)
- BGL
- Electrolytes, if available
- Urine for microscopy
- Consider pregnancy test, if applicable
- Abdominal x-ray: obtain supine and left lateral decubitus views to evaluate acute conditions.
- Consider POCUS, if equipment and trained staff available: can be helpful in detecting free fluid in the abdomen, especially when there is sudden clinical deterioration[9].

Note that while the presence of x-ray and/or US signs may confirm pathology or support a diagnosis, their absence does not rule it out.

5.4.2 Initial management

- Assess and manage ABCDE.
- Administer **oxygen**, aiming for SpO_2 between 94 - 98%.
- Start IV maintenance fluids. If there are signs of dehydration, treat accordingly (see Section 5.3).
- Check BGL and correct hypoglycaemia if present (see Chapter 9, Section 9.3).
- Administer adequate analgesia: note that early analgesia, including morphine 0.05 - 0.1 mg/kg will not affect diagnostic accuracy[10].
- Give antispasmodics with caution in children due to their anticholinergic side-effects, and limit their use to treat active spasms. Not to be given to children under 6 years old. Give **hyoscine butylbromide** PO:
  - Child 6 - 11 years: 10 mg, up to 3 times daily
  - Child 12 years and over: 20 mg, up to 4 times daily
- Place the child nil-by-mouth (NBM) and consider insertion of NGT (conical tip) to be kept on free drainage with regular aspiration. Record quantity and aspect (bilious, bloody) of gastric aspirates.
- If suspected peritonitis or perforation, start antibiotic treatment to cover both aerobes and anaerobes:
  - Administer **ceftriaxone** IV: 80 mg/kg (max. 4 g if < 50 kg; max. 2 g if ≥ 50 kg) every 24 hours and **metronidazole** IV: 10 mg/kg every 8 hours.
  - Continue for 3-10 days, depending on severity and eventual diagnosis.

Refer for urgent surgical review, identify the underlying cause and treat accordingly (see Section 5.5, Section 5.6 and Section 5.7).

5.5 Intussusception

Intussusception occurs when one segment of the intestine invaginates into a more distal segment. In approximately 90% of cases, this occurs at the ileocaecal junction[11]. It is the most common cause of bowel obstruction in infants, with a mean incidence of 74 per 100,000[12]. Although mostly seen in infants and young children (typical age range is 6 to 36 months), it can occur in older children as well, when there is a pathologic 'lead point' such as lymphoma, Meckel's diverticulum, polyps, parasites or Henoch-Schönlein purpura[a]. If the obstruction is not corrected, the vascular supply of the bowel may become compromised, resulting in intestinal ischemia and possible perforation. In high-income countries, death from intussusception is rare, generally less than 1%, but in low- and middle-income countries (LMICs), between 6 and 25% of children who reach surgical care die[13].

5.5.1 Clinical features

Typical presentation:
- Sudden onset, intermittent abdominal pain. The child appears to have episodic cramps, drawing up the knees and crying inconsolably.
- Vomiting, typically non-bilious initially and progressing to bilious
- Pallor and lethargy (episodic)
- Abdomen may be distended and diffusely tender but may also be normal, especially between episodes.
- Sometimes an elongated 'sausage-shaped' mass can be palpated in the right middle or upper part of the abdomen, or even in the left upper quadrant. With more extended duration of symptoms the mass may be palpable on rectal examination.
- Blood ('red-currant jelly') or mucus per rectum is a late sign.

The classic triad of colicky abdominal pain with a palpable mass and 'red-currant jelly' stool appears in < 25% of cases.

Occasionally, children present generally unwell with lethargy and pallor, but without obvious abdominal signs or symptoms and may be mistaken for sepsis.

Investigations

- Consider POCUS, if equipment and trained staff available[b]: typically, a 'target sign' lesion (concentric circles resembling a doughnut) is seen in ileocolic intussusception, with one segment of bowel telescoping into another part. The outer wall is thickened and hypoechoic in transverse axis[14].

a Henoch-Schönlein purpura (HSP) is a common systemic vasculitis in children of unknown cause, that presents with a rash and arthritis/arthralgia, abdominal pain or nephritis.

b Although ultrasound has high diagnostic accuracy for intussusception, positive results are user-dependent and require high levels of training.

5.5.2 Management

– Assess and manage ABCDE.
– Ensure initial stabilisation as for acute abdomen (see Section 5.4.2).
– Refer for surgical review and definitive treatment with either:
  • Radiographic barium or air enema
  • Surgical reduction: in LMICs reduction is typically only partially accomplished due to progressive ischaemia of the intussuscepted bowel, which ultimately requires resection.
  • Hydrostatic reduction by warm saline enema under real-time sonography guidance, if there are no contraindications (such as perforation, or ischemia on Doppler) and if the ultrasonographer is skilled[15,16].

In LMIC, treatment with radiological reduction is less available and operative intervention is more common (nearly 90%)[12,17]. Additionally, if the patient has had symptoms of abdominal pain for more than 24 hours, the risk of perforation of the intestine on attempted reduction by air, barium or warm saline enema increases considerably.

Ileo-ileal intussusception of the small intestine is often transient in nature and may reduce spontaneously without intervention, especially in younger children.

5.6 Acute appendicitis

Appendicitis is one of the most common causes of acute abdomen in children worldwide. Typical age of presentation is 5 to 15 years with less than 5% of patients being under 5 years old. Intraluminal obstruction of the appendix (by faecal matter, lymph nodes, foreign bodies, parasites), leads to bacterial overgrowth and infection of the appendix. The classic pain of appendicitis is due to local peritonitis overlying the inflamed appendix. Perforation is a common complication if left untreated.

5.6.1 Clinical features

Classical presentation includes:
- Peri-umbilical pain initially that migrates to the right iliac fossa[a] and localises there
- Pain on movement (walking, changing position) or inability to walk
- Signs of peritoneal irritation: rebound tenderness, guarding, pain on jumping/hopping, coughing
- Anorexia
- Nausea and/or vomiting
- Fever

Inability to walk, lower abdominal pain and nausea are the most frequent symptoms in children under 12 years old, while the presence of a fever should raise suspicion of perforation[18].

In retrocaecal appendicitis, pain may be elicited on extension of the right hip (iliopsoas sign). Similarly, when the inflamed appendix is located in the pelvis, pain may be elicited on flexion and internal rotation of the right hip (obturator sign).

Diagnosis is usually clinical, based on classic features.

Investigations

- WBCs may be elevated
- CRP, if available
- Consider POCUS, if equipment and trained staff available: an experienced sonographer or POCUS practitioner may identify an inflamed enlarged appendix on ultrasound, however sensitivity is low therefore this may be used to confirm the diagnosis, but not to exclude it.

5.6.2 Management

- Assess and manage ABCDE.
- Ensure initial stabilisation as for acute abdomen (see Section 5.4.2).

a Pain may also localise to the pelvis or suprapubic region, depending on the exact position of the appendix.

– Refer for urgent surgical review:
  • Appendicectomy is indicated in all cases of early, acute appendicitis within 24 hours of diagnosis to prevent perforation. Delay of appendicectomy can lead to gangrene or perforation, increasing the risk of intra-abdominal infection and sepsis, as well as intra- and post-operative complications and leading to higher mortality[19].
  • A single prophylactic dose of antibiotics should be administered prior to surgery with **ceftriaxone** IV: 80 mg/kg (max. 4 g if < 50 kg; max. 2 g if ≥ 50 kg).
  • If there are signs of peritonitis or perforation prior to surgery, administer **ceftriaxone**, as above, and **metronidazole** IV: 10 mg/kg and continue for 3 10 days, depending on severity and eventual diagnosis. In LMIC settings, a high percentage of patients have already perforated at first presentation.
– In insecure settings or where referral and/or transport is not possible, antibiotic treatment for uncomplicated early cases of appendicitis may be considered.
– For cases that present more than 3-4 days after symptom onset who are not clinically toxic or septic, consider a trial of ceftriaxone and metronidazole (as above) and interval appendicectomy 6-8 weeks after presentation.

5.7 Bowel Obstruction

This is a paediatric surgical emergency. In sub-Saharan Africa, the overall mortality rate of acute intestinal obstruction has been reported around 15%, with higher rates in neonates (20-70%)[20]. Prognosis of acute bowel obstruction is improved by prompt diagnosis and management, including good peri-operative care.

5.7.1 Clinical features

Symptoms:
- Vomiting (bilious): frequent and early vomiting indicates proximal obstruction
- Colicky abdominal pain
- Unable to pass gas or stool
- Abdominal distension: severe distension indicates distal obstruction

Signs:
- Diffusely tender abdomen, though early in the course of the obstruction, tenderness may be minimal until progressive intestinal ischaemia sets in
- Visible peristalsis
- Bowel sounds high-pitched (early sign) then absent (late, critical sign).

Signs of development of gut ischaemia: peritonitis, septic shock (tachycardia, fever, hypotension), abdominal guarding.

Common causes include:
- Intussusception (see Section 5.5)
- Malrotation and volvulus
- Incarcerated or strangulated hernia
- Intestinal helminthiasis (ascariasis)
- Abdominal tuberculosis (see Chapter 4, Section 4.11)
- Adhesive disease (post-operative)
- Tumours

Occasionally, foreign bodies (e.g. through pica and bezoar formation[a]) may cause intestinal obstruction.

Diagnostic investigations

- Abdominal X-ray (supine and erect, or left lateral decubitus for infants and patients unable to stand): dilated bowel loops with air-fluid levels may indicate obstruction but can also be seen with an ileus. Assess for pneumoperitoneum in case of perforation (see Figure 5.4).
- Consider POCUS, if equipment and trained staff available: may show fluid filled (hypoechoic), dilated (> 2.5 cm) bowel loops with abnormal peristalsis.

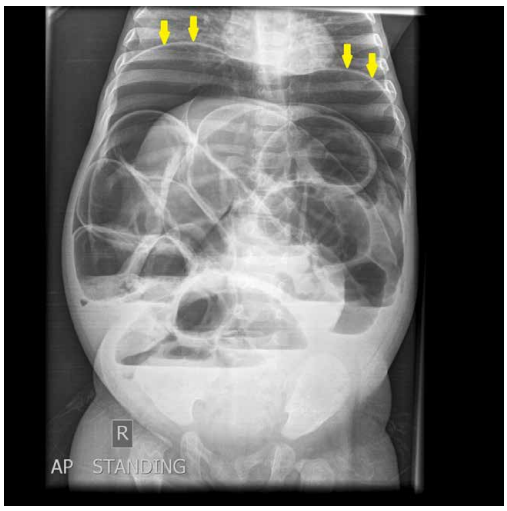
a Pica is an eating disorder that causes people to eat items that are not usually considered as food, such as dirt, clay and paper. This can lead to the formation of a tightly packed mass of partially digested or undigested foreign material, known as a bezoar.

Management

Emergency stabilisation as for acute abdomen in Section 5.4.2 and definitive treatment depending on underlying cause.

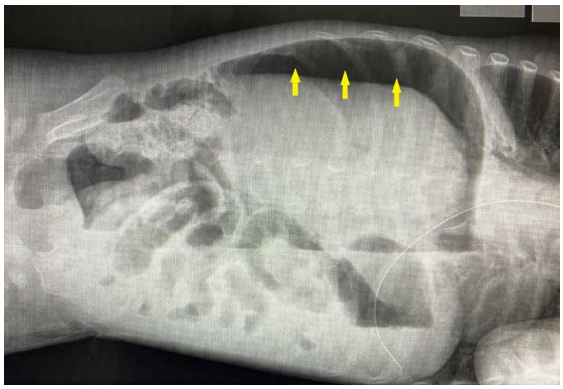
Figure 5.4 - AXR showing pneumoperitoneum secondary to intestinal perforation

5.4a - Upright AP view[b], infant[c]



Free air can be seen under the diaphragm (arrows)

5.4b - Left lateral decubitus view, infant[d]



Free air can be seen between the liver and right lateral abdominal wall (arrows)

5.7.2 Causes of acute bowel obstruction

Intussusception

Ssee Section 5.5.

Malrotation and volvulus

Malrotation occurs due to abnormal rotation and/or fixation of the gastrointestinal (GI) tract during embryonic development. This results in unusually positioned intestines, with the caecum/colon fixed in the mid-upper abdomen and the entire midgut (from jejunum to mid-transverse colon) attached to a narrow mesenteric pedicle. Most children with malrotation present in early infancy with classic signs of bowel obstruction either due to bands of peritoneal tissue (Ladd's bands) compressing the duodenum externally, or due to midgut volvulus. In volvulus, the intestine twists on the narrow vascular pedicle, resulting in midgut vascular compromise. When sudden volvulus occurs, patients often have disproportionate pain compared to physical examination findings, and unless corrected, bowel ischemia and necrosis ensue. A small percentage of children are asymptomatic or diagnosed in later childhood after having chronic episodic abdominal pain and intermittent vomiting.

Abdominal x-ray may show signs of obstruction (dilated bowel loops, air fluid levels), but is often non-specific. In volvulus, ultrasound may demonstrate a 'whirlpool sign', (where the superior

b If an upright view cannot be obtained (e.g. in neonates or infants), a left lateral decubitus view is needed to exclude pneumoperitoneum. Pneumoperitoneum cannot be excluded on a supine view.

c Case courtesy of Hidayatullah Hamidi, Radiopaedia.org, rID: 60388, https://radiopaedia.org/cases/60388.

d Image courtesy of Juno Min.

mesenteric vein and artery are wrapped around each other[21]) which is a highly sensitive and specific indicator of midgut volvulus[22], though diagnosis is rarely made on ultrasound. After stabilisation, urgent surgical intervention is required to de-torse the volvulus and reposition the caecum/colon and small intestines to prevent recurrence. Time spent in stabilisation or transport to a surgical centre should be minimised, as ischaemia of the entire midgut can progress to necrosis within 1-2 hours.

Incarcerated or strangulated hernia

Inguinal hernias occur when part of the bowel herniates through the internal inguinal ring. They are more common in male, premature infants and occur more often on the right side. Inguinal hernias appear as a bulge in the inguinal or scrotal area during any activity that increases abdominal cavity pressure e.g. crying, straining. They are usually easily reducible, allowing bowel contents to be pushed back into the abdominal cavity with minimal effort. Inguinal hernias may become incarcerated (stuck) and eventually strangulated (reduced blood supply leading to ischemia) requiring emergency treatment to prevent loss of bowel. Umbilical hernias are common in children, predominantly affecting Afro-Caribbean and premature children. The umbilical ring usually closes spontaneously by 4 years old, and strangulation or incarceration are uncommon.

An incarcerated hernia presents as an irreducible, tender mass which is firm on examination. It may be accompanied by signs of bowel obstruction (vomiting, abdominal distension) if left untreated, and is intensely painful if it becomes strangulated. In the early stages of incarceration, if there are no signs of peritonitis, obstruction or strangulation/necrosis, manual reduction should be attempted. This may require procedural analgesia/sedation. If manual reduction is unsuccessful or there are signs of bowel compromise or obstruction, treatment is emergency inguinal exploration, including verification of bowel viability[23].

Ascaridial intestinal obstruction

An estimated 1.5 billion people are infested globally with Ascaris lumbricoides, representing a quarter of the world's population[24]. Annually there are nearly 730,000 cases of Ascaris-related bowel obstruction, the majority of which occur in children due to smaller luminal diameter[25]. Worms may be seen in vomit or stool, and can also be visualised on plain x-ray and ultrasound. This may be diagnosed by actually seeing worms in vomitus or stool.

The majority of cases can be treated conservatively following emergency management of obstruction. Normal saline or hypertonic saline enemas can be used to disentangle and expulse colonic worms if there are no features of peritonitis present. Antihelminth treatment should be given 24 hours after symptoms have settled:

albendazole PO
12 – 23 months: 200 mg once daily for 3 days[e]
≥ 24 months: 400 mg once daily for 3 days

mebendazole PO
≥ 12 months and > 10kg: 100 mg 2 times daily for 3 days

If conservative management is unsuccessful, diagnosis is uncertain or the obstruction complete, surgical intervention may be necessary.

e Albendazole is not systematically recommended to children less than 12 months, but can be given on a case-by-case basis according to clinician assessment at the same dose as for children 12 – 23 months.

Adhesive small bowel obstruction

Adhesive small bowel obstruction is seen as a complication of previous abdominal surgery. It is most common within the first year after surgery but can occur at any time after abdominal surgery. Children present with signs of bowel obstruction and a history of previous abdominal surgery. Management may be either surgical or conservative, depending on the location and severity of adhesions, and whether or not any complications have occurred. Stabilisation includes making the child NBM and placing an NGT on free drainage while providing maintenance IV fluids. Analgesics and antibiotics are typically not appropriate in the initial management.

5.8 Pyloric stenosis

Infantile hypertrophic pyloric stenosis (IHPS) is a common surgical cause of vomiting in infants. It occurs in 2 to 3.5 per 100 live births, though overall incidence is lower in African and Asian populations. It is more common in preterm infants, and boys are affected 4 to 5 times more frequently than girls[26]. There is a genetic predisposition, with cases occurring more often if a parent or sibling (especially twin) also had IHPS. It usually presents in the first 2 to 12 weeks of life, with a peak incidence at 5 weeks of age. Delay in the presentation will be seen in infants who are premature, with vomiting typically initiating at 42 weeks corrected gestational age.

5.8.1 Clinical features

So-called 'projectile' vomiting after feeds is the hallmark of pyloric stenosis. Progressive hypertrophy of the pyloric muscle leads to obstruction of gastric emptying and increasingly forceful expulsion of gastric contents immediately after feeding. Vomit is non-bilious. Infants appear voraciously hungry but fail to gain weight despite feeding well. The hypertrophied pyloric muscle may be palpable as an 'olive' in the abdomen.

If untreated, IHPS leads to dehydration and hypochloraemic, hypokalaemic metabolic alkalosis.

Investigations

- BGL
- Electrolytes, if available
- Creatinine, if available
- Consider POCUS, if equipment and trained staff available: Ultrasound has a high diagnostic accuracy for pyloric stenosis but positive results are user dependent and require a high level of training. A hypertrophic pyloric muscle of > 3 mm and a pyloric canal length of ≥ 15 mm are considered diagnostic[27].

5.8.2 Management

- Assess and manage ABCDE.
- Check BGL and correct hypoglycaemia if present (see Chapter 9, Section 9.3).
- Start IV maintenance fluids if no signs of dehydration, with added potassium if evidence of urine output. Correct any dehydration and/or electrolyte disturbance (see Section 5.3 and Chapter 15, Section 15.3).
- Place the child NBM and insert NGT (conical tip) to be kept on free drainage.
- Refer for urgent surgical review and definitive treatment once fully rehydrated and electrolyte disturbance corrected:
  - Surgical pyloromyotomy is the gold standard and should be performed as soon as the child has received adequate fluid resuscitation and abnormalities of electrolytes have been corrected.

– Conservative treatment with **atropine** IV is an alternative option where surgical management is not possible[28], as follows:
  - Starting dose 0.01 to 0.06 mg/kg/day, administered in 6-8 divided doses
  - Increase daily dose by 0.01 mg/kg/day (maximum 0.1 mg/kg/day) until vomiting ceases or adequate volume of milk feeds is tolerated.
  - Switch to **atropine** PO at twice the effective IV dose, and continue for 2-4 weeks.

References Chapter 5

1. Diarrhoeal disease: WHO fact sheet. World Health Organisation. Accessed December 1, 2023. https://www.who.int/news-room/fact-sheets/detail/diarrhoeal-disease
2. Kotloff KL, Nataro JP, Blackwelder WC, et al. Burden and aetiology of diarrhoeal disease in infants and young children in developing countries (the Global Enteric Multicenter Study, GEMS): a prospective, case-control study. *The Lancet*. 2013;382(9888):209-222. https://doi.org/10.1016/S0140-6736(13)60844-2
3. Weekly epidemiological record/Relevé épidémiologique hebdomadaire 1st February 2013, 88th year/1er février 2013, 88e année. 2013;5(88):49-64. https://www.nitag-resource.org/sites/default/files/989018b9e380f70ab07522155f36c9f8c9515d9a_1.pdf
4. World Health Organization. *Pocket Book of Hospital Care for Children: Guidelines for the Management of Common Childhood Illnesses*. 2nd ed. World Health Organization; 2013. Accessed November 7, 2023. https://iris.who.int/handle/10665/81170
5. *Guideline: Updates on Paediatric Emergency Triage, Assessment and Treatment: Care of Critically-Ill Children*. World Health Organization; 2016. Accessed December 1, 2023. http://www.ncbi.nlm.nih.gov/books/NBK350528/
6. Shrime MG, Bickler SW, Alkire BC, Mock C. Global burden of surgical disease: an estimation from the provider perspective. *Lancet Glob Health*. 2015;3:S8-S9. https://doi.org/10.1016/S2214-109X(14)70384-5
7. Meara JG, Leather AJM, Hagander L, et al. Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development. *The Lancet*. 2015; 386(9993):569-624. https://doi.org/10.1016/S0140-6736(15)60160-X
8. Poenaru D. The burden of pediatric surgical disease in low-resource settings: Discovering it, measuring it, and addressing it. *J Pediatr Surg*. 2016;51(2):216-220. https://doi.org/10.1016/j.jpedsurg.2015.10.065
9. Singh Y, Tissot C, Fraga MV, et al. International evidence-based guidelines on Point of Care Ultrasound (POCUS) for critically ill neonates and children issued by the POCUS Working Group of the European Society of Paediatric and Neonatal Intensive Care (ESPNIC). *Crit Care*. 2020;24(1):65. https://doi.org/10.1186/s13054-020-2787-9
10. Green R, Bulloch B, Kabani A, Hancock BJ, Tenenbein M. Early Analgesia for Children With Acute Abdominal Pain. *Pediatrics*. 2005;116(4):978-983. https://doi.org/10.1542/peds.2005-0273
11. Salazar JH, Nghia "Jack" Vo. Intussusception in children. *UpToDate*. Published July 2022. https://www.uptodate.com/contents/intussusception-in-children
12. Jiang J, Jiang B, Parashar U, Nguyen T, Bines J, Patel MM. Childhood Intussusception: A Literature Review. Cameron DW, ed. *PLoS ONE*. 2013;8(7):e68482. https://doi.org/10.1371/journal.pone.0068482

13. Clark AD, Hasso-Agopsowicz M, Kraus MW, et al. Update on the global epidemiology of intussusception: a systematic review of incidence rates, age distributions and case-fatality ratios among children aged < 5 years, before the introduction of rotavirus vaccination. *Int J Epidemiol*. 2019;48(4):1316-1326.
https://doi.org/10.1093/ije/dyz028

14. Lin-Martore M, Kornblith A, Kohn M, Gottlieb M. Diagnostic Accuracy of Point-of-Care Ultrasound for Intussusception in Children Presenting to the Emergency Department: A Systematic Review and Meta-analysis. *West J Emerg Med*. 2020;21(4).
https://doi.org/10.5811/westjem.2020.4.46241

15. Flaum V, Schneider A, Gomes Ferreira C, et al. Twenty years' experience for reduction of ileocolic intussusceptions by saline enema under sonography control. *J Pediatr Surg*. 2016;51(1):179-182.
https://doi.org/10.1016/j.jpedsurg.2015.09.022

16. Talabi AO, Famurewa OC, Bamigbola KT, Sowande OA, Afolabi BI, Adejuyigbe O. Sonographic guided hydrostatic saline enema reduction of childhood intussusception: a prospective study. *BMC Emerg Med*. 2018;18(1):46.
https://doi.org/10.1186/s12873-018-0196-z

17. Steele AD, Patel M, Cunliffe NA, Bresee JS, Borgstein E, Parashar UD. Workshop on intussusception in African countries – Meeting report. *Vaccine*. 2012;30:A185-A189.
https://doi.org/10.1016/j.vaccine.2011.10.004

18. Colvin JM, Bachur R, Kharbanda A. The Presentation of Appendicitis in Preadolescent Children: *Pediatr Emerg Care*. 2007;23(12):849-855.
https://doi.org/10.1097/pec.0b013e31815c9d7f

19. Seyi-Olajide JO, Ezidiegwu U, Ameh EA. Burden of Complicated Intra-Abdominal Infections in Children in Nigeria: Recent Experience and Systematic Review. *Surg Infect*. 2020;21(6):501-508.
https://doi.org/10.1089/sur.2020.118

20. Adamou H, Magagi IA, Habou O, Adakal O, Ganiou K, Amadou M. Acute Mechanical Intestinal Obstruction in Children at Zinder National Hospital, Niger: Aetiologies and Prognosis. *Afr J Paediatr Surg AJPS*. 2017;14(3):49-52. doi:10.4103/ajps.AJPS_96_16.
Available at: https://pubmed.ncbi.nlm.nih.gov/29557351/

21. Sivitz AB, Lyons R. Mid-Gut Volvulus Identified by Pediatric Emergency Ultrasonography. *J Emerg Med*. 2013;45(5):e173-e174.
https://doi.org/10.1016/j.jemermed.2013.05.048

22. Nguyen HN, Kulkarni M, Jose J, et al. Ultrasound for the diagnosis of malrotation and volvulus in children and adolescents: a systematic review and meta-analysis. *Arch Dis Child*. 2021;106(12):1171-1178.
https://doi.org/10.1136/archdischild-2020-321082

23. Koizumi M, Sata N, Kaneda Y, et al. Optimal timeline for emergency surgery in patients with strangulated groin hernias. *Hernia*. 2014;18(6):845-848.
https://doi.org/10.1007/s10029-014-1219-7

24. Soil-transmitted helminth infections. Accessed December 1, 2023.
https://www.who.int/news-room/fact-sheets/detail/soil-transmitted-helminth-infections

25. Mishra P, Agrawal A, Joshi M, Sanghvi B, Shah H, Parelkar S. Intestinal obstruction in children due to Ascariasis: A tertiary health centre experience. *Afr J Paediatr Surg*. 2008;5(2):65. doi:10.4103/0189-6725.44178.
Available at: https://journals.lww.com/ajps/fulltext/2008/05020/intestinal_obstruction_in_children_due_to.2.aspx

26. MacMahon B. The Continuing Enigma of Pyloric Stenosis of Infancy: A Review. *Epidemiology*. 2006;17(2):195-201.
https://doi.org/10.1097/01.ede.0000192032.83843.c9

27. Vinycomb T, Vanhaltren K, Pacilli M, Ditchfield M, Nataraja RM. Evaluating the validity of ultrasound in diagnosing hypertrophic pyloric stenosis: a cross-sectional diagnostic accuracy study. *ANZ J Surg*. 2021;91(11):2507-2513.
https://doi.org/10.1111/ans.17247

28. Wu SF, Lin HY, Huang FK, et al. Efficacy of Medical Treatment for Infantile Hypertrophic Pyloric Stenosis: A Meta-analysis. *Pediatr Neonatol*. 2016;57(6):515-521.
https://doi.org/10.1016/j.pedneo.2016.02.005

Chapter 6: Cardiology

6.1 Introduction

The diagnosis and management of cardiac conditions in children in resource-limited settings are challenging, with lack of access to tools to confirm diagnosis, delayed presentation, and when specialised paediatric cardiac surgery is required for definitive treatment. Where available and feasible for the family to access, referral to a paediatric cardiologist is recommended as early as possible. Consider early involvement of a paediatric cardiologist for consultation, even at a distance, including remote support for imaging interpretation for diagnosis. For example, healthcare staff trained in point of care ultrasound (POCUS) can take key images of the heart and share these by telemedicine or other communication tools with a cardiologist who can make the diagnosis and provide management guidance[1].

In these guidelines, the focus is on guiding diagnosis and supportive management for acute cardiac presentations within the means of lower-resource settings.

6.2 Cardiac failure

Outside of contexts with access to advanced medical diagnostic capacity, the true incidence of cardiac failure amongst children is not well documented. However, as many children do not have access to early diagnosis, presentation is often in the late stages of cardiac failure, with a significant burden in terms of morbidity and mortality[2].

Underlying causes that lead to cardiac failure include cardiac, extra-cardiac or iatrogenic conditions:

- Cardiac conditions: congenital heart disease (CHD), cardiomyopathies (inherited or acquired)[a], acute rheumatic fever, cardiac arrhythmias.
- Extra-cardiac conditions: sepsis, severe anaemia, thiamine deficiency, severe acute malnutrition (particularly in young infants).
- Iatrogenic: fluid overload due to large parenteral fluid administration over a short period.

6.2.1 Clinical signs and assessment

Cardiac failure typically presents with fast breathing and respiratory distress, but can have the following features:

Table 6.1 - Clinical features of cardiac failure in children by age group[3]

	Common symptoms	Less common symptoms
Infants and young children (0-2 years)	Tachypnoea Respiratory distress Feeding difficulty Sweating Pallor Wheezing	Cyanosis Palpitations Syncope Oedema Ascites Clubbing
Older children and adolescents	Fatigue Effort intolerance Dyspnoea Orthopnea Abdominal pain Nausea & vomiting	Palpitations Chest pain Oedema Ascites Clubbing

Diagnosis is based on history and clinical examination. Radiological and laboratory investigations can support diagnosis, identify underlying cause, and/or determine prognosis.

6.2.2 Investigations

- Haemoglobin (Hb): to assess for anaemia

Where readily available and of reliable quality, the following investigations can aid diagnosis, management and/or prognosis:

- Electrolytes, renal function and liver function tests.

a Abnormality of the ventricular myocardium resulting from overload or congenital heart disease.

– Chest x-ray: to assess heart size, pulmonary oedema, septal lines[b] (or Kerley B lines) and pleural effusions.
– Point-of-Care ultrasound (POCUS): perform 12-zone lung exam to evaluate for signs of bilateral pulmonary oedema and/or pleural effusions. Perform 5-view cardiac exam to evaluate for signs of acute volume overload and/or decreased cardiac function[4].
– Cardiac ultrasound: to assess cardiac structure, chamber volumes/diameters, wall thickness, ventricular systolic/diastolic function, and pulmonary pressures.
– Throat swab or streptococcal serology.

6.2.3 Management

– Assess and manage ABCDE (see Chapter 2, Section 2.1).

Supportive management

– Start oxygen therapy (or non-invasive ventilation (NIV) if needed – see Chapter 4, Section 4.1.3) when SpO_2 < 90% in children with acyanotic CHD or with cardiomyopathy. Note that in cyanotic CHD, oxygen may have little effect in raising SpO_2, oxygen therapy (if required) should be guided by target saturations as indicated by the clinician.
– Start IV maintenance fluids if unable to tolerate adequate oral or nasogastric tube (NGT) fluid intake, restricted to 70% of usual maintenance volume (see Chapter 15, Section 15.2). Switch to PO/NGT fluids as soon as child can safely tolerate oral intake (see Chapter 15, Section 15.5).
– Ensure nutritional support and nutrition supplementation.
– Reduction of salt is recommended for children with oedema and fluid retention.

Diuretics

– Fluid retention can be treated with diuretics.
– Give oral **furosemide**, gradually increasing the dose if necessary. In the case of severe oedema and/or the child cannot tolerate oral medication, administer furosemide IV:

furosemide PO
- 1 month to 11 years: 1 mg/kg 2 times daily
  Increased if necessary up to 2 mg/kg up to 4 times daily if required[c].
- ≥ 12 years: 20 to 40 mg once daily

furosemide IV
- 1 month to 11 years: 0.5 to 1 mg/kg every 8 hours (max. 40 mg/dose)
  Increased if necessary up to 2 mg/kg every 8 hours (max. 40 mg/dose)[c].
- ≥ 12 years: 20 to 40 mg every 8 hours as required.

– If symptomatic despite maximum furosemide, consider adding oral spironolactone:

spironolactone PO
0.5 to 1.5 mg/kg up to 2 times daily

b Horizontal lines reaching out from peripheral edge of lung, seen in the costophrenic angle, representing thickened interlobular septa that result from chronic congestive cardiac failure.

c For high doses of > 3 mg/kg/day, ensure potassium monitoring, if available. If potassium monitoring is not possible, consider providing routine oral potassium supplementation (2 mmol/kg/day).

Angiotensin converting enzyme (ACE) inhibitor

- Recommended if ventricular systolic dysfunction confirmed by cardiac ultrasound.
- Give **enalapril**, starting at low doses and subsequently titrating to the target dose. Carefully monitor blood pressure, renal function and serum potassium.

enalapril PO		
Weight	**Initial dose**	**Dose increase as tolerated**
< 5 kg	1.25 mg once daily	No increase
5 to < 10 kg	1.25 mg 2 times daily for 1 week	2.5 mg 2 times daily
10 to < 20 kg	2.5 mg 2 times daily for 1 week	5 mg 2 times daily
≥ 20 kg	2.5 mg 2 times daily for 1 week	10 mg 2 times daily (maximum up to 20 mg 2 times daily)

Note: there is an increased risk of hyperkalaemia when introducing enalapril treatment - discontinue or reduce dose of spironolactone and oral potassium if prescribed.

6.2.4 Follow-up

- Discharge of the child can be considered once the child is stable on oral treatment, not requiring supplemental oxygen and able to eat and drink.
- For children discharged on cardiac medication, arrange follow-up within 3 to 6 months. Where available, arrange follow-up with a cardiology specialist.
- Most children will require lifelong medical management of cardiac failure if corrective surgery or cardiac transplantation is not feasible or available.
- Regular follow-up is required to assess the need for increasing or adjusting dosage of medication as the cardiac condition progresses.
- Inform parents/carers to bring child back to hospital if there are signs of increased respiratory distress, cyanosis, and/or oedema.

6.2.5 Treatment of any reversible causes

- Treat any underlying systemic causes, e.g. sepsis (see Chapter 3, Section 3.2), electrolytic imbalance (particularly hypocalcemia) (Chapter 15, Section 15.3).
- Treatment of acute rheumatic fever (see Section 6.3)
- Consider thiamine deficiency in breastfed infants or children with severe acute malnutrition (see Section 6.4)[5].

Corrective treatment of CHDs is rarely available in resource-limited settings but should be explored if possible. Without corrective surgery, many of these cases have a poor prognosis and medical management is indicated with a focus on symptom management and palliative care (see Chapter 15, Section 15.6).

6.3 Acute rheumatic fever

Acute rheumatic fever (ARF) is an acute inflammatory disorder caused by a reaction to infection[a] with group A streptococcal bacteria (GAS), resulting in inflammation of the heart, joints, skin and/or brain. Clinical symptoms and signs usually develop 2 to 3 weeks following GAS infection and can range from very mild to severe. Inflammation of the heart can cause long-term damage, resulting in rheumatic heart disease (RHD).

ARF most commonly affects children aged 5 to 20 years and in low-and middle-income countries[6]. Most deaths attributable to RHD usually result from the complications of RHD, including infective endocarditis, arrhythmias, heart failure and stroke. Where regular access to diagnosis and antibiotics for secondary prophylaxis is limited, this is more pronounced.

6.3.1 Diagnosis

ARF is a clinical diagnosis based on the identification of specific major and minor features of the illness, known as the Jones criteria (see Table 6.2). A positive throat culture or serology confirming group A streptococcal infection is helpful if available (elevated anti-streptolysin O or other streptococcal antibody).

Table 6.2 - Jones criteria for diagnosis of acute rheumatic fever

Major manifestations	Minor manifestations
• Carditis[b] • Polyarthritis • Aseptic monoarthritis or polyarthralgia • Sydenham chorea[c] • Erythema marginatum[d] • Subcutaneous nodules	• Fever ≥ 38 °C • Monoarthralgia • ESR[e] ≥ 30 mm/h or CRP ≥ 30 mg/L • Prolonged PR interval on ECG
Definite initial episode of ARF:	
2 major manifestations + evidence of GAS infection, or 1 major + 2 minor manifestations + evidence of GAS infection	
Probable or possible ARF: likely diagnosis as above, but lacking either:	
• One major or one minor manifestation • No evidence of preceding GAS infection	
Recurrent episode of ARF	
As above, or 3 minor manifestations + evidence of GAS infection	

a Mostly upper respiratory and skin infections due to GAS.

b Cardiac inflammation causing tachycardia, dyspnoea, and fatigue.

c A rheumatic chorea characterized by involuntary, random, irregular movements of the face, tongue, limbs, with hypotonia. This chorea alone can be diagnostic if other causes of chorea have been excluded.

d Annular erythema occurring on trunk and proximal extremities.

e Erythrocyte Sedimentation Rate

6.3.2 Management

– If heart failure is present, follow management in Section 6.2.
– Eradicate GAS infection with antibiotics:

benzathine benzylpenicillin IM once (single dose)
- < 30 kg: 600 000 IU
- ≥ 30 kg: 1.2 MIU

Alternative:
phenoxymethylpenicillin (**penicillin V**) PO 2 times daily for 10 days
- < 30 kg: 250 mg
- ≥ 30 kg: 500 mg

(or erythromycin if penicillin allergy)

– Treat associated arthritis with NSAID[f] for at least 2 to 3 weeks and then decrease the dose progressively over 2 weeks.

aspirin PO
50 to 100 mg/kg once daily

If unable to take aspirin or cardiac signs persist, replace with a steroid:
prednisolone PO
1 to 2 mg/kg once daily

6.3.3 Prevention

– Children who have had ARF have a high risk of another episode of ARF, and with each recurrence severity of RHD is increased causing further valvular damage.
– In children with recurrent episodes of ARF, long-term antibiotic prophylaxis with a monthly injection of **benzathine benzylpenicillin** or oral **penicillin** 2 times daily (doses above) is recommended up to 5 or 10 years where it is feasible (refer to national protocol where available).

f Aspirin is recommended for use in children only in the setting of anti-platelet action and for the treatment of arthritis associated with acute rheumatic fever. It is not recommended in children for fever or pain.

6.4 Infantile beriberi

Acute heart failure in breastfed infants caused by maternal thiamine deficiency.

Pernicious or acute cardiac form (Classic Beriberi)[7,8]

- Symptoms present usually between 1 to 3 months of age in breastfed infants.
- May start with non-specific symptoms: refusal to feed, vomiting, constipation, colic, 'piercing cry'[9].
- Progressing to oedema, cyanosis, and acute congestive cardiac failure.
- Shoshin beriberi, a fulminant form of congestive heart failure without oedema may occur in infants with lactic acidosis[10].
- Rapid deterioration to death may occur within 2 to 4 hours without treatment.

Aphonic form

- Less severe and usually presents later between 4 to 7 months of age.
- Starts with cough and dyspnoea. The crying becomes hoarse until there is a loss of voice.
- Untreated cases advance into acute congestive cardiac failure and respiratory distress, and eventually death within days.

Management

- Treat promptly with injectable thiamine which can rapidly reverse clinical signs[5]:

thiamine IV/PO

- **Loading dose** < 15 years: 100 mg slow IV infusion over 30 minutes once daily for 48 hours
  If IV not possible: Give PO/via NGT at the same dose.
- **Maintenance** dose to be started after 48 hours of IV treatment:
  - ≤ 12 years: 25 mg PO once daily for 1 month
  - > 12 years: 25 mg PO 2 times daily for 1 month

References Chapter 6

1. Muhame RM, Dragulescu A, Nadimpalli A, et al. Cardiac point of care ultrasound in resource limited settings to manage children with congenital and acquired heart disease. *Cardiol Young*. 2021;31(10):1651-1657. https://doi.org/10.1017/S1047951121000834
2. Ahmed H, VanderPluym C. Medical management of pediatric heart failure. *Cardiovasc Diagn Ther*. 2021;11(1):323-335. https://doi.org/10.21037/cdt-20-358
3. Kantor PF, Lougheed J, Dancea A, et al. Presentation, Diagnosis, and Medical Management of Heart Failure in Children: Canadian Cardiovascular Society Guidelines. *Can J Cardiol.* 2013;29(12):1535-1552. https://doi.org/10.1016/j.cjca.2013.08.008
4. Russell FM, Ehrman RR, Cosby K, et al. Diagnosing Acute Heart Failure in Patients With Undifferentiated Dyspnea: A Lung and Cardiac Ultrasound (LuCUS) Protocol. Stahmer SA, ed. *Acad Emerg Med*. 2015;22(2):182-191. https://doi.org/10.1111/acem.12570
5. Dinicolantonio JJ, Lavie CJ, Niazi AK, O'Keefe JH, Hu T. Effects of thiamine on cardiac function in patients with systolic heart failure: systematic review and metaanalysis of randomized, double-blind, placebo-controlled trials. *Ochsner J*. 2013;13(4):495-499. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3865826/
6. Ralph AP, Noonan S, Wade V, Currie BJ. The 2020 Australian guideline for prevention, diagnosis and management of acute rheumatic fever and rheumatic heart disease. *Med J Aust*. 2021;214(5):220-227. https://doi.org/10.5694/mja2.50851
7. Hiffler L, Rakotoambinina B, Lafferty N, Martinez Garcia D. Thiamine Deficiency in Tropical Pediatrics: New Insights into a Neglected but Vital Metabolic Challenge. *Front Nutr.* 2016;3. https://doi.org/10.3389/fnut.2016.00016
8. Thiamine deficiency and its prevention and control in major emergencies. Published online 1999. https://www.who.int/publications/i/item/WHO-NHD-99.13
9. Duggan C, Watkins JB, Walker WA, eds. *Nutrition in Pediatrics: Basic Science, Clinical Application*. 4th ed. BC Decker; 2008. https://openlibrary.org/books/OL11988152M/Nutrition_in_Pediatrics
10. Shah S, Wald E. Type B Lactic Acidosis Secondary to Thiamine Deficiency in a Child With Malignancy. *Pediatrics*. 2015;135(1):e221-e224. https://doi.org/10.1542/peds.2014-2289

Chapter 7:
Neurological disorders

7.1 Neurological assessment

For a child presenting with a possible neurological impairment or deficit, perform a more detailed neurological examination in addition to a full clinical examination (Chapter 1, Section 1.3).
In the case of reduced level of consciousness, seizures, any neck stiffness (nuchal rigidity), manage as a medical emergency and refer to Chapter 2 for initial resuscitation and management.

In young children, cooperation for a neurological examination can be challenging. In a well child, start by observing the child play and interact with their parents/carers.
- Assess development for age: speech, behaviour, gross motor (crawling, walking), fine motor (playing with small objects). See Appendix 1 for more detail on developmental milestones.
- If the child can walk, ask to walk around, walk heel-to-toe, stand on one leg. Note any abnormalities.
- Observe for any abnormal movements, fasciculations, obvious weakness or asymmetry of movement.
- Examine pupils and eye movements.

Carry out a complete neurological examination, by assessing tone, power and reflexes. Consider examination of cranial nerves if relevant.

Tone

- Tone is the inherent resistance of the muscle to passive movement and is involuntary. Usually a person's limb can be freely moved around by an examiner, with only slight resistance.
- Muscles with low tone show no resistance to passive movement and are usually described as hypotonic or flaccid, while muscles with increased tone show high resistance to passive movement and are described as hypertonic or spastic.
- Infants[1]: In infants muscle tone and strength are assessed together. Assess position of the infant when supine, usually arms and legs are flexed when at rest and move spontaneously. Pull gently by the arms to a sitting position and check for head lag, usually the head will lag initially and then come into the midline once in a seated position. Hold the infant under the arms, the infant with normal muscle tone and strength will flex their hips to 90 degrees (as though in a seated position). Normal truncal and shoulder girdle tone and strength will prevent the infant from slipping through the examiner's hands.
- Children: Assess tone by passively flexing and extending a patient's limb and assessing the resistance or opposed muscle contraction. Usually, resistance to extension of limbs is felt beyond 90 degrees.

Power

- Power is the strength of the muscle when maximally contracted and is voluntary.
- Assess power by asking the patient to move their limb against resistance, starting with gravity then an active external resistance, e.g. opposition by the examiner[2]. Assessing power in young infants is difficult and often assessed along with tone (see above).

- Power is graded as a score out of 5:
  - 0/5 – no muscle movement
  - 1/5 – Flicker of movement in muscle
  - 2/5 – Horizontal movement (without gravity)
  - 3/5 – Movement against gravity
  - 4/5 – Movement against some external pressure
  - 5/5 – Movement against strong external pressure (normal)

Reflexes

- Tendon reflexes are used to identify possible upper or lower motor neuron lesions.
- Assess tendon reflexes by tapping lightly on the tendon with a tendon hammer, with the limb relaxed and the joint at a 90 degree angle.
- Common tendon reflexes that can be tested in children include the patellar reflex (knee) and the achilles reflex (ankle). Biceps, triceps, brachioradialis (wrist) and jaw reflexes can also be tested.
- Tendon reflexes are described as normal, absent/diminished or exaggerated/brisk.
- Primitive or developmental reflexes, e.g. Moro reflex and asymmetric tonic neck reflex, should be assessed in young infants. These are indicators of brain maturation and abnormalities may indicate specific conditions such as cerebral palsy[2].

7.2 Acute symptomatic seizures

In children, a seizure may occur due to epilepsy, but more commonly it is provoked or triggered by acute conditions, such as infections (severe malaria, meningitis), metabolic disorders (hypoglycaemia, hyponatraemia), head injury, poisoning, intracranial tumours or other space-occupying lesions, bleeding, or stroke. For seizures associated with a fever > 38 °C in young children, see Febrile seizures in Section 7.3.

7.2.1 Terminology

Seizure: a paroxysmal disorder presenting as intermittent, repetitive involuntary movements of part of or the entire body, usually accompanied with loss of consciousness or awareness. Seizures result from a temporary disturbance in brain function "due to abnormal excessive or synchronous neuronal activity in the brain"[3].

Epilepsy: at least 2 unprovoked (or reflex) seizures occurring > 24 hours apart[4]. Unprovoked means a seizure that occurs without an acute or reversible cause.

Status epilepticus (SE): a condition in which a seizure lasts for more than 5 minutes without self-termination, therefore requiring treatment with anti-epileptic drugs (AEDs)[5]. If seizures persist beyond 30 minutes despite the use of two AEDs, patients are considered to have refractory SE which can have long-term consequences including neuronal death, neuronal injury, and alteration of neuronal networks[6]. Non-convulsive status epilepticus is when altered conscious level is the main manifestation of a prolonged seizure without visible convulsions (not the same as post-ictal state).

Post-ictal state: altered consciousness, drowsiness, confusion, nausea, hypertension, hemiparesis, headache, or other disorienting symptoms immediately after a seizure. This may last for 5 to 30 minutes. Usually the child does not remember the seizure episode.
The use of anticonvulsants, e.g. phenobarbital, during the seizure may leave the child sedated for longer after the seizure.

Acute repetitive seizures: 3 or more seizures in 24 hours.

7.2.2 Clinical features

Symptoms and signs

– Vary according to the type of seizure (see Section 7.4.2).
– Common features include:
  - Eye deviation, staring or rapid eye blinking.
  - Lip smacking or biting down (clonic)
  - Loss of tone (atonic)
  - Stiff extended limbs (tonic)
  - Rhythmic jerking of limbs or nodding of head (tonic-clonic)

  - Loss of consciousness or impaired awareness
  - Appearing confused or notion of absence
  - Respiratory distress or apnoeic spells
  - Loss of bladder or bowel control
  - Epigastric sensation, sweating
  - Vocalisation, arrest of speech
- Some children may experience an aura or a 'warning' sign just before a seizure is about to happen. These can be feelings (e.g. fear, impending doom, déjà vu) or changes in vision/flashing lights, hearing or sense of smell, or hallucinations.
- Older children over 6 years usually have similar seizures to adults, while infants and young children are more likely to have focal seizures with impairment of awareness.
- Often seizures are short and the child may present in a post-ictal state, with a clear history of a seizure event from the parents/carers.

Investigations

- Malaria RDT
- Blood glucose level (BGL)
- Full blood count (FBC) including haemoglobin (Hb)
- Electrolytes, if available
- Blood culture if febrile and/or suspicion of sepsis
- Lumbar puncture (LP), if suspicion of meningitis: perform only when child is stable and no longer having seizures (see Appendix 6 for details on how to perform an LP).

7.2.3 Management

Aim to quickly and simultaneously provide care that stabilises the patient, identify any precipitating conditions, stop any ongoing seizure, and/or manage the post-ictal state.

Most seizures are self-limiting and last a few seconds or minutes, but anticonvulsant treatment is required for ongoing seizures when:
- Seizure lasts ≥ 5 minutes (or ongoing and duration unknown).
- 2 or more seizures within 5 minutes.

If no current ongoing seizure

- Take a full history from child and/or parents/carers.
  Ask about:
  - Onset: time, duration, signs/clinical features.
  - What the child was doing at the time of onset and what happened afterwards.
  - Warning symptoms. Dizziness or visual warnings are rare in epileptic seizures.
  - Loss of consciousness.
  - Recent or current illness, injury or behavioural changes.
  - Previous episodes and past medical history, including birth history.
  - Medication taken or given, consider illicit drugs or alcohol in adolescents.
- Perform a clinical examination including cardiac and neurological examination.
- Perform investigations if not already done: malaria RDT, BGL and blood culture if febrile and/or suspicion of sepsis.

If ongoing seizure

See also Figure 7.1 page 239.

During first 5 minutes of a seizure

Evaluate ABCDE and call for help.
Start a timer (or check time on watch/clock).

A. Open airway and clear secretions. Do not open the mouth by force if seizure is tonic-clonic.
B. Start oxygen therapy and monitor oxygen saturations (aim > 94%). Use bag and mask ventilation if required.
C. Establish IV access and assess/treat for shock.
D. Check BGL: if < 60 mg/dL (< 3.3 mmol/L) administer 2 mL/kg **glucose** (**dextrose**) **10%** IV. Check malaria RDT and initiate anti-malarials and appropriate antibiotics if indicated.
E. Check for rashes, bruises, signs of sepsis or trauma. Prevent and manage hypothermia; treatment of fever is not a priority.

Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).

If seizures stop at any point, manage as for post-ictal state (see Section 7.2.5).

Seizure ongoing at 5 minutes

Administer first line anticonvulsant treatment with a benzodiazepine (ensure bag-mask available):

– No IV/IO access: **midazolam** 0.3 mg/kg (buccal) or 0.15 mg/kg (IM), max. 10 mg/dose (see MSF Manual of Nursing Care Procedures, SOP Buccal Midazolam Administration,) or rectal (PR) **diazepam** 0.5 mg/kg (< 12 years: max. 10 mg/dose; ≥ 12 years: max. 20 mg/dose).
– IV/IO access: **diazepam** IV 0.3 mg/kg (max. 10 mg/dose).

Seizure ongoing at 10 minutes

Repeat same dose of **diazepam** or **midazolam** (same max. doses as above).

Seizure ongoing at 15 minutes

Administer second line anticonvulsants[a].

– Children < 2 years, girls > 12 years, or suspicion of liver disease:

> **levetiracetam** 40 mg/kg (max. 3 g) slow IV infusion over 10 minutes.
> If seizure persists at the end of the infusion, repeat with half dose:
> **levetiracetam** 20 mg/kg (max. 1.5 g) over 10 minutes (max. total levetiracetam 60 mg/kg or 4.5 g)
>
> Alternative:
> **phenobarbital** 20 mg/kg (max. 1 g) slow IV infusion via syringe pump over 20 minutes
> If seizure persists at the end of the infusion, repeat with half dose:
> **phenobarbital** 10 mg/kg over 20 minutes

a Programmatic considerations include cost (levetiracetam is more expensive than phenobarbital), safe administration of phenobarbital, availability of drug, validation by MoH, and comparative ease of administration.

– Children ≥ 2 years (except girls > 12 years)[b]:

> **sodium valproate** IV
> 20 mg/kg (max. 1.5 g) over 5 minutes.
>
> If seizure persists at the end of the injection, repeat once at the same dose (max. total sodium valproate 40 mg/kg or 3 g)[7].

Seizure ongoing 5 minutes after end of infusion

Administer alternative anticonvulsant:

– Children < 2 years, girls > 12 years of age, or suspicion of liver disease:
  • If levetiracetam was administered, administer **phenobarbital** IV: 20 mg/kg
  • If phenobarbital was administered, administer **levetiracetam** IV: 40 mg/kg
– Children ≥ 2 years:
  • If sodium valproate was administered, administer **levetiracetam** 40 mg/kg or **phenobarbital** IV: 20 mg/kg
– If other anticonvulsants are not available administer **phenytoin** IV: 20 mg/kg over 20 to 30 minutes, where cardiac monitoring is feasible. Phenytoin can cause hypotension and cardiac arrhythmias. Do not exceed an infusion rate of 1 mg/kg/minute and monitor and record HR, BP and RR every 15 minutes during and after administration using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).

For children with known or suspected epilepsy, refer to Section 7.4.

Caution: anticonvulsants can cause respiratory depression and apnoea. Admit immediately to an emergency or intensive care unit for close monitoring. Basic resuscitation equipment must be kept at the bedside including bag and mask, oxygen and suction.

Maintenance treatment when acute seizures terminate

Short-term maintenance treatment is beneficial for the following indications and respective duration. Use the anticonvulsant that terminated the seizure.

Indications

– Use of a non-benzodiazepine anticonvulsant for a patient who does not have an acute reversible condition (e.g. electrolyte disturbance or severe malaria with seizures[c]): continue with maintenance therapy for 48 to 72 hours if seizures under control and then reassess.
– Acute repetitive seizures (3 or more seizures in 24h): continue with maintenance therapy for 48 to 72 hours if seizures under control and then reassess.
– Persistent focal neurological signs and/or impaired level of consciousness past the expected post-ictal period: duration of maintenance treatment will depend on evolution and medical condition.
– Known or suspected epilepsy: continue long term (see Section 7.4).
– Known or suspected head injury if within 24 hours of injury: continue for 7 days.

b Sodium valproate is contraindicated in girls and women of child-bearing age due to increased risk of neural tube defects and other congenital malformations. Sodium valproate is not recommended in children less than 2 years old due to an increased risk of fatal hepatotoxicity.

c Note that if the patient has an acute reversible condition but meets one of the other indications, they should be started on maintenance treatment as recommended for that indication.

Table 7.1 - Maintenance treatment dosage after acute seizure

Drug	Maintenance dose (PO whenever possible)	Side effects[d]	Comments
phenobarbital PO/IV	1-11 months: 5 to 6 mg/kg once daily 1-5 years: 6 to 8 mg/kg once daily 6-12 years: 4 to 6 mg/kg once daily > 12 years: 1 to 3 mg/kg once daily Start 12 hours after the loading dose If age unknown, start at 5 mg/kg once daily (or divided into 2 times daily) for children estimated < 12 years	Respiratory depression Apnoea Hypotension Lethargy Hepatic dysfunction	Decrease dosage by 50% if severe acute kidney injury
phenytoin PO/IV	2.5 mg/kg 2 times daily Start 12 hours after the loading dose	Hypotension Bradycardia, arrhythmia Hepatitis Hyperglycaemia Anaemia Hypersensitivity reactions, including skin rash	Contraindication: cardiopathy Consider only if none of the other recommended medicines are available, due to its poor safety profile and the need for cardiac monitoring
levetiracetam PO/IV	< 6 months: 7 mg/kg 2 times daily 6 months-15 years: 10 mg/kg 2 times daily Start 12 hours after the loading dose	Irritability Nausea & vomiting	Decrease dosage by 50% if severe acute kidney injury
sodium valproate	PO: 5 to 7.5 mg/kg 2 times daily (max. 600 mg/dose) IV: 2.5 to 4 mg/kg every 6 hours Start 6-8 hours after the loading dose	Hepatotoxicity (hyperammonaemia, mild elevation of liver enzymes) Teratogenic	Contraindication: liver disease (or suspected metabolic disease), children < 2 years, girls of child-bearing age[e]

d Several anticonvulsant medications (namely carbamazepine, phenobarbital, phenytoin and levetiracetam) can cause a rare but serious syndrome known as DRESS (drug reaction with eosinophilia and systemic symptoms). It is important to be aware of this reaction which appears several weeks after the initiation of treatment and can be fatal.

e Sodium valproate is contraindicated in girls and women of child-bearing age due to increased risk of neural tube defects and other congenital malformations. Sodium valproate is not recommended in children less than 2 years old due to an increased risk of fatal hepatotoxicity.

7.2.4 Management if acute seizures resume

Adjust treatment as follows if these scenarios occur:
- Seizure recurs > 6 hours after first seizure resolved: restart management from first step in treatment algorithm. Ensure to record the administered dose of each anticonvulsant so as not to exceed their respective maximum dosage in a 24-hour period.
- Seizure recurs < 6 hours after last seizure: continue to next step in treatment algorithm (no need to restart treatment from top of algorithm).
- Recovery from seizure is not clear (child remains in coma and/or unclear if status resolved), continue to next step in treatment algorithm (no need to restart).
- Maintenance treatment not given but treatment algorithm had to re-start more than 3 times in 48 hours due to recurrence of acute seizures, treat as unresolved focal neurological insult and start maintenance treatment.
- Maintenance treatment started but only partially effective (seizures resume before next maintenance dose is due; number of intermittent seizures has decreased but the seizures do not stop), seek expert advice where possible.

7.2.5 Management of post-ictal state

- Ensure airways patent and monitor oxygen saturations.
- Administer oxygen, aiming for SpO_2 > 92%.
- Check BGL and treat if hypoglycaemia.
- Repeat neurological examination (any asymmetry or focal signs). If post-ictal state continues for more than 30 to 60 mins, full re-evaluation including pupils, considering non-convulsive status as a possibility.
- Start treatment of underlying cause.
- Treat fever if present.
- Monitor vital signs and observe for further seizures.

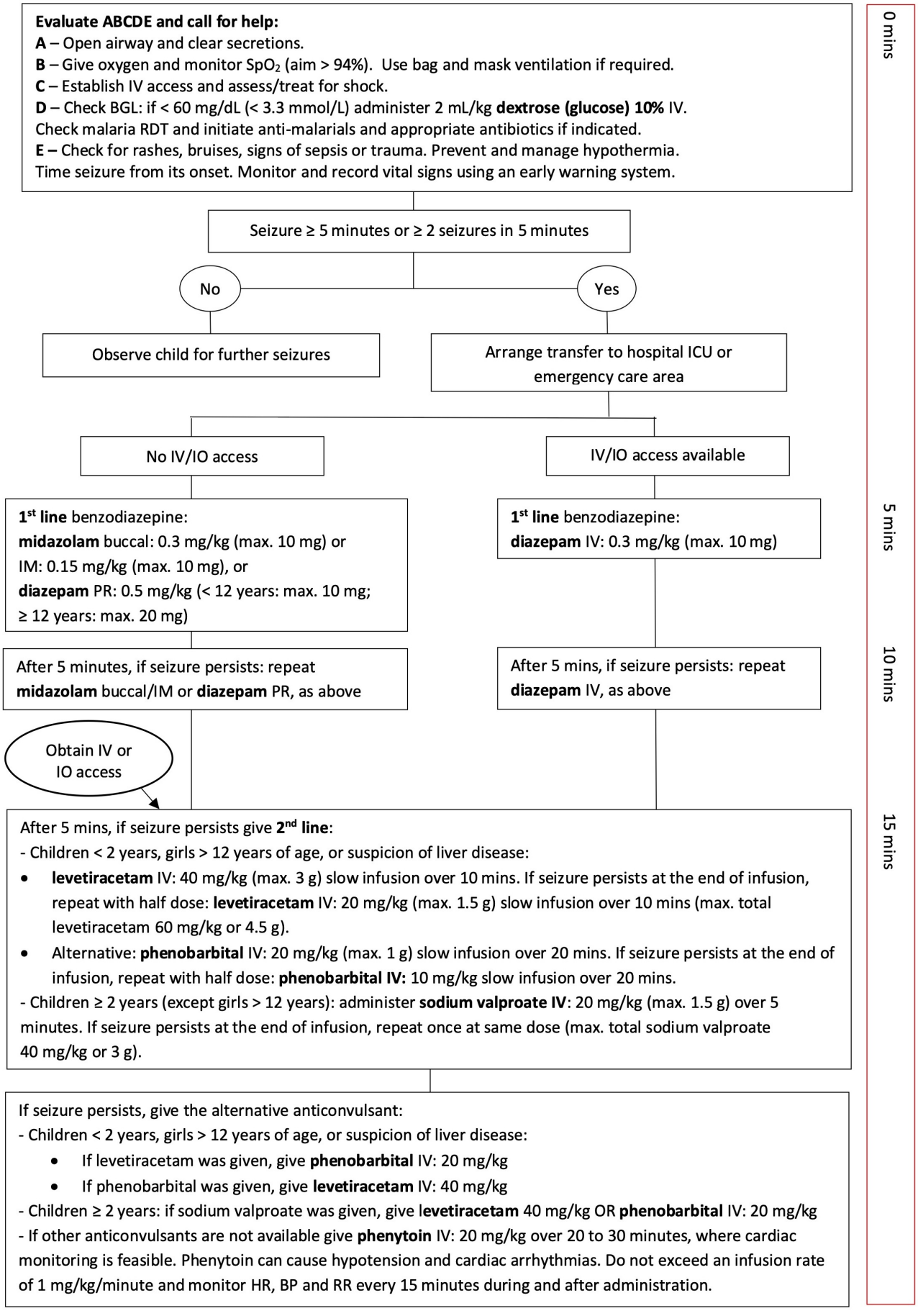
Monitoring

- Place child in recovery position and ensure airways patent.
- Monitor and record vital signs (including conscious level and SpO_2) every 15 minutes initially then as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts). Careful attention should be given to respiratory monitoring, especially if anticonvulsants were administered.
- Cardiac monitoring (HR, rhythm, BP) every 15 minutes if phenytoin administered.

7.2.6 Follow-up

- Short seizures that respond to treatment usually do not result in any complications and do not need follow-up. Prolonged seizures (> 1 hour) can be fatal or result in long-term neurologic sequelae (e.g. cerebral palsy).
- Long-term anticonvulsant treatment may not always be necessary in a first unprovoked seizure in a child[8], but inform parents/carers to monitor carefully for further seizure events and seek medical care if they occur.
- Arrange follow-up for further management if the child:
  - Requires prolonged maintenance therapy (> 72 hours for some indications and > 7 days for those with neurological injury)
  - Continues to have recurrent unprovoked seizures
  - Has a suspected severe acute neurological insult.

Figure 7.1 - Acute seizure treatment algorithm



7.3 Febrile seizures

Seizure associated with a fever > 38 °C usually in children 6 months to 5 years[9]. The fever is usually caused by a concurrent illness (commonly a viral infection) or recent vaccination, but the seizure itself is not directly linked to the trigger of the fever.

Febrile seizures are common, occurring in 2 to 4% of children under 5, but usually self-limiting with no long-term neurologic consequences. There may be a family history. Seizures may occur before, during or after a high fever and controlling the fever has no effect on preventing a febrile seizure occurring. Most are simple, do not last longer than 15 minutes, are generalised and will occur only once in 24 hours. Complex febrile seizures may occur where the child can have focal signs, prolonged seizures (> 15 minutes), or have multiple seizures within a 24-hour period.

7.3.1 Diagnosis

- Take a full history from parents/carers about the seizure (onset, duration, signs, awareness) and of any recent or current illness (or signs and symptoms) including presence of fever.
- Ask about any previous febrile seizures and any other medical history.
- Take a medication history including antipyretics given (dose and timing).
- Once seizure stopped, perform a complete clinical examination to identify cause of fever.

Investigations

- FBC, Hb, BGL
- Malaria RDT, if endemic
- Consider LP if child < 1 year, has meningeal signs or appears severely unwell.

7.3.2 Management

Most febrile seizures will stop spontaneously within 5 minutes.

- Manage ABCDE and administer oxygen via face mask. Place child in recovery position.
- If not breathing, start resuscitation (see Chapter 2, Section 2.1).
- Check BGL: if < 60 mg/dL (< 3.3 mmol/L) administer 2 mL/kg **glucose** (**dextrose**) **10%** IV.
- Administer anticonvulsant treatment as per seizure algorithm in Figure 7.1 page 239 if:
  - Seizure lasts ≥ 5 minutes (or ongoing and duration unknown).
  - 2 or more seizures within 5 minutes.
- If seizures stop, treat as per post-ictal state (see Section 7.2.5).
- Treat fever and start treatment of the source of the fever.
- If no anticonvulsant treatment was needed, observe for at least 6 hours. Child can be discharged home with paracetamol, treatment of source of fever if applicable, and information on fever management.
- Prophylactic long-term anticonvulsants are not indicated in simple febrile seizures, even if they are recurrent.

In the case of complex febrile seizures, provide counselling to the parents/carers to monitor further episodes as they require evaluation for epilepsy if there is recurrence[10].

7.4 Epilepsy

Chronic neurological disorder characterised by recurrent seizures that occur without an acute or reversible cause (unprovoked). Epilepsy is diagnosed after two or more seizures that occurred with no link to any acute medical condition. Long-term anticonvulsant treatment is necessary to manage further recurrences of seizures. Most (70% to 80%) of cases of epilepsy are idiopathic in nature (cause is unknown but presumed to be genetic). Cerebral damage due to congenital infections (e.g. rubella), or previous infections (e.g. meningitis), and cerebral tumours are additional causes.

Approximately 50 million people are living with epilepsy worldwide. Almost 80% of them are in low- and middle-income countries. People with epilepsy have an overall risk of premature death that is 3 times higher than the general population[11].

7.4.1 Assessment and diagnosis

- Conduct a detailed history and clinical examination (refer to Chapter 1).
- Refer to Section 7.2.3 to ask specific questions on the seizure event.
- Assess developmental milestones for age and conditions co-existing with epilepsy, e.g. cerebral palsy.
- Include cardiac and neurological examination, including fundi to look for signs of raised intracranial pressure.
- Examine for potential underlying causes of provoked seizures (e.g. acute illness/infection, head trauma, hypoglycaemia).
- Exclude other disorders such as syncope (sudden and brief loss of consciousness associated with loss of postural tone and spontaneous recovery), breath-holding spells and psychogenic seizures.

7.4.2 Classification of seizures

Classification of a seizure type is useful to describe seizures in a patient with epilepsy with a common terminology and to choose the optimal treatment for that type of seizure. The type of seizure is classified by their origin in the brain (onset). The person's awareness during the seizure and the presence and type of muscle movement (motor activity) can help identify the onset (Table 7.2).

Table 7.2 - Clinical assessment of seizure onset

Characteristic	Generalised onset (throughout the brain)	Focal onset (localised to part of the brain)
Awareness	Impaired	Normal or impaired
Motor activity (muscle movement)	• Tonic-clonic: jerking movements of all limbs • Myoclonic: brief jerks in some muscles • Atonic: loss of muscle tone • Absence: brief impaired awareness without muscle movement (except some eyelid flickering)	• Specific motor activity in some muscles – tonic, myoclonic, atonic. Typical features include: turning of the eyes, head and/or trunk; vocalisation or arrest of speech • Non-motor activity – sensory, emotional, behavioural changes • Can become bilateral tonic-clonic

Investigations

- FBC, Hb, BGL
- Electrolytes, if available
- Malaria RDT, if endemic
- Cranial US
- Electroencephalogram (EEG), if available but not routinely needed. A normal EEG does not rule out epilepsy but an EEG can support the classification of seizure type outlined in Table 7.2.
- Electrocardiogram (ECG), if available, for older children.

7.4.3 Management

Treatment is long-term or life-long with the goal to minimise seizure occurrence and maintain quality of life. Support and counselling for the child and their family is required for effective management, as strict adherence to antiepileptic drugs (AEDs) is the best way to minimise seizure occurrence. Most seizures occur randomly and are unprovoked, but in some cases there is a specific trigger to seizures e.g. flashing lights or loud noises. In these rare cases, identification and avoidance of the trigger can help to control seizure occurrence. Lack of sleep, acute illness and use of mind-altering substances can lower the seizure threshold in children with epilepsy.

Guiding principles to starting antiepileptic drug (AED) treatment (see Table 7.3):

- Establish the diagnosis and type or classification of seizure.
- Start initially with the preferred AED according to the seizure type and age of the child (see Table 7.3).
- If seizures continue despite an optimal dose of first-line AED, consider changing to second choice AED.
- Combination therapy should be considered when treatment with 2 different AEDs used separately (in monotherapy) has failed.
- If the AED needs to be changed, introduce the new AED at its starting dose and slowly increase to its mid-range, then start to slowly decrease the dose of the first AED.
- If a patient is seizure-free for 2 years, consider stopping the AED slowly (over 3 months) with close supervision. If seizures recur at home, ask the patient to resume the AED at the last dose taken and seek medical attention.

Table 7.3 - Antiepileptic drug choice by seizure type

<table>
<tr><th rowspan="4">Drug choice</th><th colspan="2">Generalised onset</th><th>Focal onset</th></tr>
<tr><th colspan="2">Impaired awareness</th><th>Normal/impaired awareness</th></tr>
<tr><th>Motor</th><th>Non-motor</th><th>Motor/non-motor</th></tr>
<tr><th>Tonic-clonic, myoclonic, atonic</th><th>Absence</th><th>Focal to bilateral tonic-clonic</th></tr>
<tr><td rowspan="2">1st choice</td><td>< 2 years old: levetiracetam</td><td rowspan="2">≥ 2 years old: sodium valproate</td><td rowspan="2">carbamazepine</td></tr>
<tr><td>≥ 2 years old: sodium valproate or levetiracetam (if girl of childbearing age[a])</td></tr>
</table>

a Sodium valproate is contraindicated in girls and women of child-bearing age due to increased risk of neural tube defects and other congenital malformations. Sodium valproate is not recommended in children less than 2 years old due to an increased risk of fatal hepatotoxicity.

Drug choice	Generalised onset		Focal onset
	Impaired awareness		Normal/impaired awareness
	Motor	Non-motor	Motor/non-motor
	Tonic-clonic, myoclonic, atonic	Absence	Focal to bilateral tonic-clonic
2nd choice	< 2 years old: phenobarphital	No alternative[b]	sodium valproate[c] or levetiracetam
	≥ 2 years old: levetiracetam		
3rd choice	carbamazepine, phenytoin or phenobarbital		phenytoin or phenobarbital

For antiepileptic drug starting and maintenance dosing, see Table 7.4[12,13].

Carbamazepine: give 2 times daily, morning and evening. After starting initial dosing, maintenance dose should be reached within 8 days.

Phenobarbital: ideally aim to give once daily at bedtime (reduces drowsiness as adverse effect during the day). Daily administration for 14 to 21 days is needed for a steady phenobarbital level in the blood. Seizures occurring during this period do not indicate treatment failure.
- Child ≤ 11 years: start with 2 times daily dosing for 2 weeks before increasing dose. Aim to move to once daily dosing when seizures controlled.
- Child ≥ 12 years: start with once daily dosing for 2 weeks before increasing the dose.

Phenytoin: give 2 times daily, morning and evening, for children 11 years and younger. Can be given once daily for children 12 years and older. Small increments in the dosing can lead to significant changes in concentration, therefore increases should be by 25 to 30 mg.

Table 7.4 - Antiepileptic drug and dosages

AED[d]	Child 1 month to 11 years		
	Initial	Step-up	Maintenance
carbamazepine	2.5 mg/kg 2 times daily	Increase by 2.5 to 5 mg/kg every 3-7 days	5 mg/kg 2-3 times daily (up to max. 20 mg/kg/day)
phenobarbital	1 to 1.5 mg/kg 2 times daily	Increase by 2 mg/kg daily	2.5 to 4 mg/kg 1-2 times daily
phenytoin	1.5 to 2.5 mg/kg 2 times daily	Adjusted according to response	2.5 to 5 mg/kg 2 times daily (max. 300 mg daily)
sodium valproate[c]	5 to 7.5 mg/kg 1-2 times daily (max. 600 mg/dose)	Increase gradually	12.5 to 15 mg/kg 2 times daily

b Certain AEDs can exacerbate absence seizures or are known to be ineffective therefore there is no place for carbamazepine, phenytoin or phenobarbital in the treatment of absence epilepsy.

c Sodium valproate is contraindicated in girls and women of child-bearing age due to increased risk of neural tube defects and other congenital malformations. Sodium valproate is not recommended in children less than 2 years old due to an increased risk of fatal hepatotoxicity.

d Several anticonvulsant medications (namely carbamazepine, phenobarbital, phenytoin and levetiracetam) can cause a rare but serious syndrome known as DRESS (drug reaction with eosinophilia and systemic symptoms). It is important to be aware of this reaction which appears several weeks after the initiation of treatment and can be fatal.

AED[e]	Adolescent 12 years and above	
	Initial	Maintenance
carbamazepine	100 to 200 mg once daily or 50 to 100 mg 2 times daily	200 to 400 mg 2-3 times daily (max. 1.8 g/day)
phenobarbital	1 mg/kg (max. 60 mg) once daily	1 mg/kg to 3 mg/kg (max. 180 mg) once daily
phenytoin	75 to 150 mg 2 times daily	150 to 200 mg 2 times daily (max. 600 mg/day)
sodium valproate[f]	300 mg 2 times daily or 600 mg once daily	500 to 1000 mg 2 times daily (max. 2.5 g/day)

AED	Age or weight	Dosage[14] for oral treatment Increase dosage based on response and tolerance
levetiracetam	1 to 5 months	7 mg/kg once daily Increase dose every 2 weeks by 7 mg/kg/dose Maximum: 21 mg/kg 2 times daily
	6 months to 17 years (< 50 kg)	10 mg/kg once daily Increase dosage every 2 weeks by 10 mg/kg/dose Maximum: 30 mg/kg 2 times daily
	12 to 17 years (or ≥ 50 kg)	250 mg 2 times daily Increase by 500 mg 2 times daily every 2-4 weeks Maximum: 1.5 g 2 times daily

7.4.4 Follow-up and monitoring

- Review one month after any change in medications.
- Review every 6 months if the patient is stable.

At each follow-up visit:
- Check seizure frequency (review seizure diary if available) since last assessment and impact, e.g. time off school.
- Check growth and development.
- Adjust medication if seizures are not controlled i.e. if the child is still having seizures despite adherence to prescribed medication.
- Check treatment adverse effects.
- Review adherence. Adherence can deteriorate when symptoms become mild or less frequent.
- Address any concerns, anxiety/depression if present.

e Several anticonvulsant medications (namely carbamazepine, phenobarbital, phenytoin and levetiracetam) can cause a rare but serious syndrome known as DRESS (drug reaction with eosinophilia and systemic symptoms). It is important to be aware of this reaction which appears several weeks after the initiation of treatment and can be fatal.

f Sodium valproate is contraindicated in girls and women of child-bearing age due to increased risk of neural tube defects and other congenital malformations. Sodium valproate is not recommended in children less than 2 years old due to an increased risk of fatal hepatotoxicity.

7.5 Altered level of consciousness

An altered level of consciousness (LOC) is any deviation from being fully awake and responsive. There are many underlying medical conditions or traumatic events that can cause a change in the level of consciousness. It represents an acute and potentially life-threatening emergency, requiring prompt intervention to preserve life and brain function.

In children, the most common causes include infections (meningitis, malaria), metabolic disturbances (hypoglycaemia, diabetic ketoacidosis (DKA), electrolyte imbalance), seizures, poisoning (toxins or medications) and head injury.

7.5.1 Clinical features and assessment

- An altered LOC may range from being fully awake but disorientated or agitated[a], to completely unresponsive. Coma refers to the most profound level of unconsciousness.
- Approach a child with an altered LOC assessing ABCDE while checking for any obvious underlying cause.
- Assess the level of consciousness (D) and note the level according to a scoring scale:
  - AVPU is a simple and rapid score for initial assessment (see also Appendix 3):
    - **A**lert
    - **V**oice: responds to vocal stimuli
    - **P**ain: responds to painful stimuli[b]
    - **U**nresponsive
  - Paediatric and Adult Glasgow Coma Scale (GCS). See Appendix 13.1.
  - Blantyre Coma Scale (often used for cerebral malaria). See Appendix 13.2.

Consciousness score	Altered consciousness	Coma
AVPU	V, P or U	P or U
Blantyre score	< 5	< 3
GCS	< 15	≤ 8

Assess for the underlying cause taking a history while stabilising the child:
- Recent medical history: excess irritability, headache, fever, malaria, infection/illness, head trauma/accidents
- Past medical history: epilepsy/seizures, diabetes, birth asphyxia, developmental delay.
- Drug history: any medication, traditional remedies, exposure to toxins

a Agitation in children is a symptom that requires a full history, examination (where possible) and diagnosis. Medical and social history are particularly important to identify potential contributing factors which may include a combination of medical, surgical and/or emotional factors.

b A painful stimulus can be given by applying supra-orbital pressure at the supraorbital notch or by applying pressure to the nailbed.

7.5.2 Management

Initial emergency management

- Assess and manage ABCDE and note vital signs including temperature.
- Support and open the airway (stabilise cervical spine if trauma is suspected).
- Clear airways (suction) only if necessary.
- Administer oxygen via mask (aim for SpO_2 > 92%). Assist ventilation with bag-mask device if not breathing.
- Obtain vascular access (IV/IO) and administer IV fluids if signs of circulatory impairment or shock present (Chapter 2, Section 2.2).
- Perform a quick evaluation of neurological status (using AVPU scale, see above) and check pupillary response.
- Check BGL:
  - BGL < 60 mg/dL (3.3 mmol/L), treat for hypoglycaemia (Chapter 9, Section 9.3).
  - BGL > 200 mg/dL or known diabetes, consider diabetic ketoacidosis and manage accordingly (Chapter 9, Section 9.1). Check urine for ketones.
- Expose the entire body and look for signs of sepsis, meningitis, trauma, etc.

Once stable, conduct a full clinical examination to identify the underlying cause and treat.

Specific management

- If V, P, or U, evaluate GCS and further neurological assessment including posture/tone, movements, reflexes. Check for signs of meningitis or encephalitis. Recheck AVPU (or GCS) every 30 minutes; if GCS 12 to 14, recheck every hour.
- If head trauma suspected, see Chapter 2, Section 2.8 for further management after stabilisation.
- If seizures are present or known epilepsy, treat accordingly (Section 7.2).
- Check haemoglobin if any pallor present.
- Check RDT malaria in endemic areas and start treatment if positive (Chapter 3, Section 3.4).
- Perform a lumbar puncture if meningitis suspected (and no contraindications).
- If high fever and/or sepsis/meningitis suspected, obtain blood cultures and start antibiotic treatment with **ceftriaxone** IV/IM 100 mg/kg (max. 4 g) every 24 hours. Adjust antibiotic treatment if needed once specific cause and/or pathogen identified. (See Chapter 3, Section 3.2 for sepsis and Section 3.3 for meningitis).
- Admit the patient to the ICU and provide supportive care (nursing care, oxygen, fluid maintenance, monitoring).
- If poisoning suspected (pin-point pupils, excess salivation, flushing, severe agitation, hypertension, vomiting), refer to Chapter 2, Section 2.9).

Agitation

Children who are agitated require specific and cautious assessment and management[15]:

- Try to calm the situation by moving to a safe, quiet space.
- Remain calm and maintain a neutral but empathetic tone.
- Use clear, simple language that is adapted to the child's age and developmental stage.
- Be honest and explain in advance what you are doing or what is going to happen.

- Communicate at the child's eye level.
- Keep parent/carer together with the child.
- Validate the child's feelings and acknowledge their fear, anger or sadness. Do not minimise their feelings, insult, or humiliate them.
- Ask child and parent/carer if there is a preferred toy/comforter, food, drink or other familiar item that they may like to have.
- Ensure that the child is not in pain and treat if necessary.
- Try to determine if there may be an underlying medical or surgical condition that is contributing to the agitation and treat if possible.
- Remove any sharp or dangerous objects.
- Identify any possible medications or substances that may have triggered agitation.
- Avoid physical restraint unless deemed necessary for the safety of the patient or others, as this is traumatic for the child and carries significant risk of adverse events such as positional asphyxia.

Special attention is required for children with developmental delay (DD) or known behavioural disorders, where early involvement of parents/carers who know the child well is usually very helpful. In addition to the above:

- Ensure that the child has received any usual medications for potential agitation.
- Elicit specific triggers for agitation (via discussion with parents/carers and through close observation) and reduce/minimise these.
- Minimise any unpleasant and/or unfamiliar sensations such as pain, overstimulation, bright lights, loud noises etc.
- Have a high index of suspicion for an underlying medical or surgical condition that may be causing pain or discomfort to the child, e.g. otitis media, especially in non- or minimally verbal children, and treat as necessary.
- Record triggers and mitigation tactics in patient file to allow transfer of information between medical and nursing staff.
- Ask parents/carers about previous side effects from sedative or antipsychotic medications[c].

Medications

If these methods do not help to calm the situation and there is significant agitation, with a risk of harm to the patient or others, consider administration of sedative or antipsychotic medications[d]. Provide age-appropriate information to the child or adolescent prior to medication administration, taking into account the level of agitation. The goal of medication is calming, not sedating, so that the child can be further evaluated. The choice of medication is dependent on underlying cause.

Oral route is preferred whenever possible, and oral **risperidone** or **diazepam** are usually sufficient to manage agitation in children. Parenteral administration should be reserved for violent or uncooperative patients or if there is no response to oral medication[e]:

c Children with developmental disabilities are particularly vulnerable to side effects from sedative and antipsychotic medications.

d Caution with all sedative and antipsychotic medication if renal or hepatic impairment suspected.

e Administration of parenteral medication to children for behavioural disturbance involves significant and serious risks, both medical and psychological, and should only be done under the supervision and guidance of an experienced clinician.

Route	Medication	Indication	Dose	Side-effects
PO	**Promethazine**	Agitation due to psychosis, use in combination with haloperidol. Use only if 15 years and above.	≥ 15 yrs: 25 to 50 mg	Drowsiness, headache, anticholinergic e.g. dry mouth, blurred vision, restlessness
	Diazepam	Severe anxiety, trauma, substance intoxication or withdrawal (except alcohol intoxication), unknown cause with moderate agitation	Child > 6 mths: 1 to 2.5 mg Adolescent: 5 to 10 mg (max. 20 mg/day)	Respiratory depression, rebound agitation, disinhibition and/or delirium (especially in young or children with DD)
	Risperidone	Delirium, agitation in children with DD or known behavioural disorder	< 12 yrs: 0.25 to 0.5 mg ≥ 12 yrs: 1 mg	Extra-pyramidal e.g. acute dystonia, akathisia, bradykinesia, rigidity, tremor
IM	**Promethazine**	Agitation due to psychosis, use in combination with haloperidol. Use only if 15 years and above.	≥ 15 yrs: 25 to 50 mg (max. 100 mg/day)	Drowsiness, headache, anticholinergic e.g. dry mouth, blurred vision, restlessness
	Haloperidol	Agitation due to psychosis. Use with promethazine over 15 years.	< 12 yrs: 0.05 to 0.1 mg/kg/dose (max. 2.5 mg/dose and 6 mg/day) ≥ 12 yrs: 2.5 mg (max. 15 mg/day)	Extra-pyramidal e.g. acute dystonia, akathisia, bradykinesia, rigidity, tremor. **High incidence of acute dystonia – use with caution**
Slow IV (over 3-5 minutes)	**Diazepam**	Severe anxiety, trauma, substance intoxication or withdrawal (except alcohol intoxication), unknown cause with severe agitation	0.05 to 0.1 mg/kg/dose (max. 40 mg/day)	Respiratory depression, rebound agitation, disinhibition and/or delirium (especially in younger children and those with DD)

Adolescents and children may have more severe reactions to medications used for rapid sedation, therefore they should be closely monitored after administration, with vital signs measurement every 15 minutes for the first hour. Ensure that a clear explanation of any urgent medication administration is given to the child or adolescent after the acute agitation has passed and their mental state has improved.

In the event of respiratory depression caused by benzodiazepines, administer:

– **Flumazenil** IV over 15 seconds: 10 micrograms/kg every 1 minute (max. 200 micrograms/dose) as required until adequate breathing resumes.

References Chapter 7

1. Bodamer OA. Approach to the infant with hypotonia and weakness. *UpToDate*. Published online August 2021. https://www.uptodate.com/contents/approach-to-the-infant-with-hypotonia-and-weakness
2. Kotagal S, Morse AM. Detailed neurologic assessment of infants and children. *UpToDate*. Published online August 2022. https://www.uptodate.com/contents/detailed-neurologic-assessment-of-infants-and-children
3. Fisher RS, Boas WVE, Blume W, et al. Epileptic Seizures and Epilepsy: Definitions Proposed by the International League Against Epilepsy (ILAE) and the International Bureau for Epilepsy (IBE). *Epilepsia*. 2005;46(4):470-472. https://doi.org/10.1111/j.0013-9580.2005.66104.x
4. Fisher RS, Acevedo C, Arzimanoglou A, et al. ILAE Official Report: A practical clinical definition of epilepsy. *Epilepsia*. 2014;55(4):475-482. https://doi.org/10.1111/epi.12550
5. *Epilepsies in Children, Young People and Adults*. National Institute for Health and Care Excellence (NICE); 2022. Accessed October 9, 2023. http://www.ncbi.nlm.nih.gov/books/NBK581165/
6. Trinka E, Cock H, Hesdorffer D, et al. A definition and classification of status epilepticus - Report of the ILAE Task Force on Classification of Status Epilepticus. *Epilepsia*. 2015; 56(10):1515-1523. https://doi.org/10.1111/epi.13121
7. Singh A, Stredny CM, Loddenkemper T. Pharmacotherapy for Pediatric Convulsive Status Epilepticus. *CNS Drugs*. 2020;34(1):47-63. https://doi.org/10.1007/s40263-019-00690-8
8. Wilmshurst JM, Gaillard WD, Vinayan KP, et al. Summary of recommendations for the management of infantile seizures: Task F orce R eport for the ILAE Commission of Paediatrics. *Epilepsia*. 2015;56(8):1185-1197. https://doi.org/10.1111/epi.13057
9. Millichap JJ. Clinical features and evaluation of febrile seizures. *UpToDate*. Published online May 2021. https://www.uptodate.com/contents/clinical-features-and-evaluation-of-febrile-seizures
10. Patterson KP, Baram TZ, Shinnar S. Origins of Temporal Lobe Epilepsy: Febrile Seizures and Febrile Status Epilepticus. *Neurotherapeutics*. 2014;11(2):242-250. https://doi.org/10.1007/s13311-014-0263-4
11. Epilepsy. Accessed October 9, 2023. https://www.who.int/news-room/fact-sheets/detail/epilepsy
12. World Health Organization. *mhGAP Intervention Guide for Mental, Neurological and Substance Use Disorders in Non-Specialized Health Settings: Mental Health Gap Action Programme (mhGAP)*. version 2.0. World Health Organization; 2016. Accessed October 9, 2023. https://iris.who.int/handle/10665/250239

13. MedicinesComplete - CONTENT > BNF for Children > Drug: Phenobarbital. Accessed October 9, 2023. https://www.medicinescomplete.com/#/content/bnfc/_197439058?hspl=phenobarbital

14. MedicinesComplete - CONTENT > BNF for Children > Drug: Levetiracetam. Accessed October 9, 2023. https://www.medicinescomplete.com/#/content/bnfc/_695768521?hspl=lecetiracetam

15. Gerson R, Malas N, Feuer V, et al. Best Practices for Evaluation and Treatment of Agitated Children and Adolescents (BETA) in the Emergency Department: Consensus Statement of the American Association for Emergency Psychiatry. *West J Emerg Med*. 2019;20(2):409-418. https://doi.org/10.5811/westjem.2019.1.41344

Chapter 8:
Renal and genitourinary tract

8.1 Upper urinary tract infection (pyelonephritis)

Upper urinary tract infection (UTI), or pyelonephritis, is an infection of the kidney and is a common cause of fever in infants and young children. It is more common in children with underlying anatomical or obstructive abnormalities, therefore investigation is always required. The most common causative pathogen is *Escherichia coli*, followed by other enterobacteria.

Cystitis, which is an infection of the lower urinary tract (i.e. the bladder and urethra), is more common in uncircumcised male infants, and in females under the age of 4. It is not associated with fever or other systemic signs and does not usually require admission, therefore is not discussed here.

8.1.1 Clinical features

The manifestations of upper UTIs vary with age. In infants, signs and symptoms are non-specific and include fever, vomiting, diarrhoea, poor feeding and irritability. Upper UTI in infants can be an occult cause of sepsis and should be considered in any febrile, generally unwell child under 2 years old.

In children 2 years and over, along with fever, symptoms usually become more localised to the urinary tract:
- Dysuria, frequency, or both
- Urinary incontinence in a previously toilet-trained child
- Foul-smelling urine
- Vomiting
- Lower back or loin pain, particularly on percussion of the flanks

⚠ Any child presenting with urinary signs or symptoms who is febrile should be considered to have pyelonephritis and treated accordingly.

Signs of severe pyelonephritis include:
- Vomiting
- Lethargy
- Reduced oral intake/poor feeding
- Irritability
- Fever > 38.5 °C
- Rigors

Complications

Recurrent upper UTIs can lead to scarring of the kidneys and decreased kidney function. Usually, there is an underlying structural abnormality or dysfunctional reason for recurrent upper UTIs.

8.1.2 Investigations

- Urine dipstick[a] (see Table 8.1 for interpretation of results). To avoid contamination of the sample and false positive results, obtain urine specimens using the most sterile technique possible[1] in one of the following ways:
  - 'Clean-catch' sample: wash hands and clean the child's genital area with a clean, water-soaked gauze. Ask the parent/carer to watch and wait until the child starts to urinate and then catch the urine directly into a sterile container (see Appendix 14.1 for more detail). Offer drinks to encourage the child to pass urine. This is the preferred method in children who are not severely unwell, but in practice can be difficult to successfully achieve. Contamination rates are approximately 25%.
  - Urine collection bag: after cleaning (as above), affix the paediatric urine collection bag and wait until the child passes urine (see Appendix 14.2 for more detail). Bag specimens can be used to rule out UTI, but if positive, another method should be used to verify results due to the possibility of false positives. Urine from a bag specimen should not be sent for culture as contamination rates can be high depending on the quality of cleaning.
  - In-out catheter: after cleaning (as above), use a urinary catheter to collect urine directly into a sterile container by briefly inserting it and removing it as soon as urine is obtained (see Appendix 14.3 for full procedure). This is the preferred method if non-invasive 'clean-catch' is unsuccessful; contamination rates are approximately 10%.
  - Suprapubic aspirate (SPA): collect urine directly from the bladder by inserting a needle through the abdominal wall under ultrasound guidance (see Appendix 15 for full procedure). This is the preferred method in severely unwell young children but should only be performed by staff trained in the procedure; contamination rates are approximately 1%.
- Urine microscopy and culture, if available – identify and quantify pyuria (white blood cells (WBC) in urine) and/or bacteriuria (bacteria in the urine).
- Blood culture if under 2 years old.
- CRP, if available.
- Urea and electrolytes, if available and signs of severe infection.
- Consider renal ultrasound (US), see below for criteria.

Table 8.1 - Interpretation of urine dipstick results (adapted from NICE[2])

Dipstick results	Under 3 months	3 months - < 3 years	3 years and older
Leukocyte esterase and nitrite positive	Treat as UTI and send urine for microscopy and culture		
Leukocyte esterase negative and nitrite positive	Treat as UTI and send urine for microscopy and culture		
Leukocyte esterase positive and nitrite negative	Treat as UTI and send urine for microscopy and culture		Treat as UTI only if clinical symptoms strongly suggest it, otherwise send urine for microscopy and culture to confirm before starting treatment

a In areas where urinary schistosomiasis is endemic, consider this as a diagnosis in children with macroscopic or microscopic haematuria detected by urine dipstick.

Dipstick results	Under 3 months	3 months - < 3 years	3 years and older
Leukocyte esterase and nitrite negative	Treat as sepsis and send urine for microscopy and culture	Do not treat as UTI and do not send urine for microscopy and culture	

8.1.3 Management

Infants less than 3 months old

Admit all infants less than 3 months old with a febrile upper UTI to hospital:
- Administer **ceftriaxone** IV/IM: 80 mg/kg (max. 4 g if < 50 kg; max. 2 g if ≥ 50 kg) every 24 hours (or **cefotaxime** IV 50 mg/kg every 8 hours).
- Alternatively, administer **gentamicin** IV: 7.5 mg/kg every 24 hours or **amikacin** 15 mg/kg every 24 hours. If the infant is very unwell, consider concomitant administration of ceftriaxone (or cefotaxime) and gentamicin (or amikacin).
- Start IV maintenance fluids if not tolerating oral intake (see Chapter 15, Section 15.2).
- Give paracetamol as antipyretic and analgesic, as required for comfort (see Chapter 15, Section 15.4).
- Monitor and record vital signs and urine output as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
- Reassess and adjust antibiotic treatment according to urine and blood culture results, if/when available.
- Duration of parenteral antibiotic treatment should be determined by the infant's clinical condition and response to treatment. Continue IV/IM treatment for at least 48-72 hours and when the infant is improving and feeding well, switch to:
  - **amoxicillin-clavulanic acid** (**co-amoxiclav**) PO (ratio 7:1 or 8:1) 50 mg/kg of the amoxicillin component, 2 times daily, or
  - **ciprofloxacin** PO: 10 to 20 mg/kg (max. 750 mg) 2 times daily.
- Total antibiotic treatment should last for 7 days.

Infants and children 3 months and over

Most infants and children 3 months and over with a febrile upper UTI can be treated with oral antibiotics for 7 days[3]:
- Give **amoxicillin-clavulanic acid** (**co-amoxiclav**) PO (ratio 7:1 or 8:1) 50 mg/kg of the amoxicillin component, 2 times daily.
- Alternatively, give **ciprofloxacin** PO 15 mg/kg (max .750 mg) 2 times daily or **cefixime** PO 8 mg/kg once daily.

If the child is vomiting or there are any signs of severity (see above) or sepsis (see Chapter 3, Section 3.2) they should be admitted for IV antibiotics, as for infants less than 3 months old.

Renal imaging

Where feasible, renal US is recommended in all children with confirmed upper UTI to exclude structural abnormalities that may predispose them to the risk of recurrence. It is particularly indicated in the following cases[2,4]:
- Under 2 years old with first febrile UTI
- Any age with recurrent febrile UTIs (≥ 2 episodes of febrile UTI)

– Signs of severe infection or renal sepsis (see Section 8.1.1)
– Palpable abdominal or bladder mass
– Poor urine flow
– Raised creatinine
– Infection with non-*E coli* organisms
– Family history of renal disease
– Failure to respond to appropriate antibiotics within 48 hours

If renal abnormalities are detected, refer for further management to a renal specialist if possible.

8.1.4 Follow-up

Routine follow-up is not required for children with first febrile upper UTI and normal renal US. However, children who have had an upper UTI are at risk of recurrence; families should therefore be instructed on the signs that may indicate a repeat infection. Upper UTI is a risk factor for renal scarring, with approximately 15% of children developing renal scarring after a first upper UTI[5]. Likelihood of renal scarring is increased with recurrent upper UTI but can be minimised with prompt treatment.

8.2 Post-infectious glomerulonephritis

Glomerulonephritis is an autoimmune reaction in the kidneys that is initiated by an external trigger and is characterised by inflammation and glomerular injury. It is most often of infectious origin in children, commonly occurring after a streptococcal throat or skin infection (particularly Group A beta-haemolytic streptococcus, though other bacteria can also be the trigger, e.g. *Staphylococcus aureus*). Antibiotics do not prevent post-infectious glomerulonephritis (PIGN) in susceptible individuals, however adequate antibiotics to treat the acute infection reduce circulation of nephritogenic strains among close contacts[6]. Prompt and adequate antibiotic treatment, therefore, plays an important role in the control of PIGN. Although PIGN is seen in children worldwide, 97% of cases occur in low-resource settings. It typically affects children from 5-12 years of age and is more common in boys than girls[7].

8.2.1 Clinical features

Haematuria is the predominant finding in PIGN, varying from asymptomatic benign haematuria to acute nephritic syndrome, with the classic features of:
– Haematuria (micro or macroscopic – red or dark brown urine)
– Proteinuria (usually mild but may, rarely, be heavy[a])
– Oedema (often facial/orbital, but can be generalised)
– Hypertension (varies from mild to severe)

Patients typically also complain of lethargy, weakness and loss of appetite. Renal function is impaired to varying degrees, though is often normal. Diagnosis is made based on clinical presentation and a history of recent skin or throat infection (though this is not always evident).

8.2.2 Investigations

– Urine dipstick (blood and protein positive)
– Urine microscopy
– Blood creatinine (at least baseline measurement) and electrolytes, if available

8.2.3 Management

PIGN is usually a self-limiting illness that requires supportive treatment only. Management is focused on eradication of the nephritogenic strain and treatment of fluid overload, which causes the clinical complications of PIGN:

– Give oral antibiotics if evidence of ongoing acute streptococcal infection:
  - **phenoxymethylpenicillin** (**Penicillin V**) PO for 10 days
    - < 1 year: 125 mg 2 times daily
    - 1 to < 6 years: 250 mg 2 times daily
    - 6 to < 12 years: 500 mg 2 times daily
    - ≥ 12 years: 1 g 2 times daily

a Proteinuria in PIGN is typically less than that seen in nephrotic syndrome. If proteinuria is in nephrotic range (> 3+ on dipstick), consider nephrotic syndrome as a possible alternative diagnosis.

  - or **amoxicillin** PO: 25 mg/kg (max. 1g) 2 times daily, for 6 days.
  - or **erythromycin** PO for 10 days (in case of penicillin allergy):
    - 1 to 23 months: 125 mg 4 times daily
    - 2 to 7 years: 250 mg 4 times daily
    - > 7 years: 250-500 mg 4 times daily
- Restrict sodium and fluid intake: exclude salt from any meals if generalised oedema is present and restrict fluid intake to match urine output and insensible losses[b]. Exercise caution with fluid restriction in hot climates to avoid dehydration and renal failure.
- Give **furosemide** PO/IV 1 mg/kg 1 or 2 times daily to stimulate diuresis and reduce blood pressure and oedema. If significant fluid overload (displaced apex beat, distended neck veins, pulmonary oedema, severe hypertension), **furosemide** PO/IV 1 mg/kg can be given up to 3 times daily. Daily weights are helpful for monitoring, where possible.
- Monitor all urine output and record blood pressure at least once daily (ideally more frequently). Hypertension will usually respond to diuretics, but if refractory hypertension, begin a trial of **amlodipine** PO 0.1 mg/kg once daily and seek specialist medical advice.
- Monitor electrolytes and serum creatinine, if available, until the child is stable.

Overall prognosis is good in the majority of cases, with rapid resolution of symptoms once supportive care has been started although urine abnormalities may persist for several months. Some children with PIGN are unresponsive to supportive care and have a reduction in renal function that requires short-term dialysis. These children should be referred for ongoing management, where possible.

b Insensible fluid loss is the amount of body fluid lost through the skin and respiratory tract that is not easily measurable. Estimated daily insensible losses are calculated according to body weight as follows: 1-10 kg = 25 mL/kg; > 10-20 kg = 12.5 mL/kg; > 20 kg = 5 mL/kg.

8.3 Nephrotic syndrome

Nephrotic syndrome is a clinical condition characterised by proteinuria, oedema and low serum albumin. It results from increased permeability of the glomeruli, allowing protein to leak into the urine. The vast majority of cases are idiopathic without associated kidney dysfunction and the most common finding on renal biopsy is minimal change disease (MCD), though increasingly, focal segmental glomerulosclerosis (FSGS) is being seen, especially among black children[8]. Prognosis in children with MCD is very good. More rarely, nephrotic syndrome can be secondary to nephritic syndromes (post-infectious glomerulonephritis (PIGN), membranoproliferative glomerulonephritis, IgA nephropathy) or systemic disease (systemic lupus erythematosus, vasculitides and sickle cell disease). Estimated incidence is 1.15-2.1/100 000 children per year, typically affecting young children (average age 3-7 years old), and the condition is more common in boys than girls[9]. Although relatively rare, it is responsible for significant morbidity in children and relapse is not uncommon.

8.3.1 Clinical features

Idiopathic nephrotic syndrome typically follows a trigger such as an upper respiratory tract infection. Painless, pitting oedema is usually the presenting sign and progressively increases from mild localised oedema, e.g. periorbital oedema on waking or ankle oedema, to massive generalised oedema affecting the whole body with associated complications of pleural effusions and ascites.

Diagnosis is made based on the triad of:
– Proteinuria > 3+ on dipstick
– Oedema
– Hypoalbuminaemia < 30 g/L

Patients with MCD – the majority of those with idiopathic nephrotic syndrome – are usually between 1 and 10 years old and typically have normal renal function, no signs of hypertension and minimal, if any, haematuria. There may be oliguria if the patient is intravascularly depleted. A presumptive diagnosis can be made in children with oedema and heavy proteinuria (as above), in the absence of renal impairment, hypertension and severe haematuria. Consider alternative diagnoses in patients with a family history of kidney disease, extrarenal disease (arthritis, rash, anaemia) or chronic disease of another organ system. Additionally, patients with signs of fluid overload such as pulmonary oedema are unlikely to have MCD.

The differential diagnosis of generalised oedema includes kwashiorkor (most common, see Table 8.2), vitamin B_1 deficiency, heart failure, liver failure, protein losing enteropathy and anaphylaxis[10].

Table 8.2 - Nephrotic syndrome vs kwashiorkor

	Nephrotic syndrome	Kwashiorkor
Oedema	Oedema of the face, followed by legs Ascites and generalised oedema common	Oedema of the hands and feet followed by the face Ascites rare Generalised oedema depends on severity
Urine dipstick	Protein 3+	Protein negative or 1+
Skin/hair changes	No	Common
Mental state	Normal, attentive	Irritable, inattentive, apathetic

Complications

Complications of nephrotic syndrome are rare but significant. Immune deficiency occurs due to reduced concentrations of serum immunoglobulins and complement factors and impaired ability of the body to produce specific antibodies. This leads to increased susceptibility to serious bacterial infections such as peritonitis, pneumonia and empyema (particularly due to *Strep. pneumoniae*), which are the leading cause of death in children with nephrotic syndrome[11]. Other complications include increased coagulability leading to thromboembolism; renal insufficiency and hypovolaemia. Growth restriction may be secondary to prolonged and repeated courses of steroids in recurrent or persistent nephrotic syndrome.

8.3.2 Investigations

- Urine dipstick:
  - Perform urine dipstick test on two separately obtained urine samples.
  - Protein > 3+ is diagnostic, along with hypoalbuminaemia.
  - In case of haematuria (macro or microscopic ≥ 2+), consider glomerulonephritis and other causes such as schistosomiasis, in endemic areas.
- Blood tests, if available:
  - Creatinine and blood urea nitrogen (BUN)
  - Serum sodium (hyponatremia is possible)
  - Serum albumin concentration: less than 30 g/L is diagnostic, along with proteinuria.
  - Cholesterol (hyperlipidaemia): raised in nephrotic syndrome, can help to differentiate between nephrotic and nephritic syndrome in mixed presentations.
  - FBC: increased Hb and Hct due to haemoconcentration, thrombocytosis.

8.3.3 Management

The mainstay of treatment for idiopathic nephrotic syndrome is corticosteroid therapy, with patients being classified as having either steroid-sensitive nephrotic syndrome (SSNS) or steroid-resistant nephrotic syndrome (SRNS). 80-90% of children have SSNS and will respond to treatment within 4 weeks[12,13]. Children who do not respond to treatment (SRNS) should be referred for specialist input, as management can be challenging. Renal biopsy is not necessary

before starting steroids for idiopathic nephrotic syndrome, as response to steroids is more indicative of long-term outcome than changes on biopsy. Steroids should be started on any child who meets the diagnostic criteria for presumptive nephrotic syndrome (see above), and has the following clinical criteria:

- Between 1 and 10 years old
- No ongoing bacterial infection (also exclude HIV, Hep B and syphilis)
- Active TB excluded or treatment already initiated.

Initial therapy for first presentation of idiopathic nephrotic syndrome

- **Prednisolone** PO 60 mg/m^2 or 2 mg/kg[14,15] (max. 80 mg/day) once daily in the morning for minimum of 4 weeks, until resolution of proteinuria.
- Then reduce to **prednisolone** PO 40 mg/m^2 or 1.5 mg/kg (max. 40 mg/day) once daily in the morning on alternate days for 4 weeks then stop prednisolone.
- Steroid therapy should not be extended beyond 2-3 months for an initial presentation of SSNS[16,17].

See Appendix 16 for calculation of body surface area (BSA) in children based on weight. Alternatively, prednisolone dosing can be estimated based on body weight as a proxy for BSA using the following formula[18]:

60 mg/m^2 = (weight (kg) x 2) + 8

40 mg/m^2 = weight (kg) + 11

Treatment of relapse in SSNS[a]

- **Prednisolone** PO 60 mg/m^2 or 2 mg/kg (max. 80 mg/day) once daily in the morning until resolution of proteinuria (negative or trace on dipstick) for 3 consecutive days.
- Then reduce to **prednisolone** PO 40 mg/m^2 or 1.5 mg/kg (max. 40 mg/day) once daily in the morning on alternate days for at least 4 weeks[b].

Management of children with frequent relapses (FR)[c], steroid-dependent nephrotic syndrome (SDNS)[d], or SRNS[e] is complicated and requires the input of specialists to tailor treatment to individual needs. There is some evidence that the use of daily prednisolone during episodes of upper respiratory tract and other infections can be helpful in preventing relapse in FR and SDNS[19].

Management of oedema

- Restrict sodium and fluid intake: exclude salt from any meals if generalised oedema is present and restrict fluid intake to match urine output and insensible losses[f]. Exercise caution with fluid restriction in hot climates to avoid dehydration and renal failure.

a Relapse is defined as the reappearance of proteinuria > 3+ for more than 3 consecutive days at any time after successful steroid treatment.

b Lower steroid doses may provide similar rates of remission, however there is no consensus to date.

c FR is defined as > 2 relapses within 6 months of initial response, or > 4 relapses in any 12-month period.

d SDNS is defined as two consecutive relapses during corticosteroid treatment, or within 14 days of stopping treatment.

e SRNS is defined as failure to achieve complete remission after 8 weeks of corticosteroid treatment.

f Insensible fluid loss is the amount of body fluid lost through the skin and respiratory tract that is not easily measurable. Estimated daily insensible losses are calculated according to body weight as follows: 1-10 kg = 25 mL/kg; > 10-20 kg = 12.5 mL/kg; > 20 kg = 5 mL/kg.

– Diuretic therapy: children with nephrotic syndrome are often intravascularly deplete, despite their appearance, therefore diuretics should be used with extreme caution to prevent further intravascular depletion and shock. In cases of anasarca (massive generalised oedema with skin breakdown and ascites) without signs of intravascular volume depletion (tachycardia, cold/clammy extremities, oliguria), cautiously give **furosemide** PO/IV 1 mg/kg 1 or 2 times daily to stimulate diuresis and reduce oedema.

Management of complications

Children should be evaluated daily for the appearance of signs and symptoms of infection. For guidance on the management of specific infections refer to the following chapters: pneumonia (Chapter 4, Section 4.5), empyema (Chapter 4, Section 4.6), peritonitis (Chapter 5, Section 5.4), sepsis (Chapter 3, Section 3.2) and meningitis (Chapter 3, Section 3.3).

Immunisation

Ensure routine immunisations are up to date to minimise the risk of serious bacterial infections. In particular:
– Administer conjugate pneumococcal vaccination (see MSF Essential Drugs).
– Postpone live vaccinations (e.g. measles, polio, BCG) until prednisolone dose is below 1 mg/kg daily (or below 2 mg/kg on alternate days)[19].
– Vaccinate household members with live vaccines, if possible, ensuring child is protected from gastrointestinal, urinary and respiratory secretions of vaccinated contacts for 3-6 weeks after vaccination, through rigorous attention to hygiene.

8.3.4 Prognosis

Overall prognosis is good for children with SSNS, with steady resolution of symptoms once steroids have been started. However, relapse occurs in 70-90% of children at least once[13] with 40-50% of children showing steroid dependency and relapsing as soon as steroids are tapered[12]. Complications associated with the use of repeated, prolonged steroid therapy include obesity, short stature, decreased bone density, cataracts, hypertension, adrenal suppression and behavioural changes[20]. Children with SRNS should be referred for specialist management as their clinical course can be complex.

8.4 Acute kidney injury

Acute kidney injury (AKI), previously referred to as acute renal failure, is a sudden decrease in kidney function that compromises the normal regulation of fluid, electrolytes and the acid-base balance. This results in fluid overload, uraemia, hypertension, hyperkalaemia, hyperphosphatemia, hypocalcaemia and metabolic acidosis. It is a relatively common complication among hospitalised sick children and is associated with longer lengths of stay and higher mortality.

8.4.1 Classification and causes

AKI is classified as pre-renal, renal or post-renal, indicating the origin of the kidney injury[21].

Pre-renal

Pre-renal AKI results from decreased kidney perfusion, usually due to loss of circulating volume. The most frequent cause in children is dehydration secondary to gastroenteritis, but acute blood loss, burns and dehydration due to diabetic ketoacidosis (DKA) are also common causes. Pre-renal AKI may also be due to profound hypotension in an acutely unwell child. Decreased blood supply to the kidneys leads to reduced glomerular filtration rate (GFR) and concentrated urine.

Renal (intrinsic)

Includes any pathology affecting the kidney itself. Causes are numerous and diverse, including:
- Acute post-infectious glomerulonephritis (PIGN), with or without nephrotic syndrome (see Section 8.2 and Section 8.3 respectively).
- Acute tubular necrosis (ATN), e.g. after birth asphyxia or after prolonged acute pre-renal kidney injury. Recovery from ATN is often preceded by a polyuric phase (abnormally high urine output) and can take days to weeks.
- Nephrotoxicity due to medications (e.g. gentamicin, NSAIDs) or venom (e.g. certain herbs or snake bites)
- Sepsis, due to a combination of haemodynamic, inflammatory and immune mechanisms
- Malaria, due to haemolysis and high parasitaemia (usually reversible with prompt and adequate malaria treatment)
- Haemolytic Uraemic Syndrome (HUS)
- G6PD deficiency
- Sickle cell disease

Post-renal

Also known as obstructive uropathy, as it is caused by an obstruction to the outflow of urine from the kidneys. In children, this is most commonly caused by posterior urethral valves (in boys only) but can also be due to kidney or bladder calculi or any other obstruction including trauma.

8.4.2 Clinical features

Reduced urine output (oliguria or anuria[a]) is the most common symptom of AKI, however in certain cases there may be normal or even high urine output (polyuria[b]). Other characteristic signs and symptoms of AKI are directly related to reduced urine output:
– Oedema
– Hypertension

Additional symptoms vary according to the underlying cause of AKI, and may include:
– Haematuria (macro or microscopic)
– Fever
– Vomiting
– Abdominal pain
– Rash
– Bloody diarrhoea
– Haemorrhage
– Pallor

Certain elements of the history may help to indicate the origin of the AKI, e.g. history of recent infection or medication ingestion.

8.4.3 Investigations

Investigations confirm the diagnosis and help to differentiate between pre-renal, renal and post-renal causes (see Table 8.3).
– Urinalysis, including urinary protein
– Blood pressure monitoring
– Urinary sodium and osmolality, if available
– Blood tests, if available: Urea, creatinine[c] and electrolytes, blood urea nitrogen (BUN), FBC, coagulation, blood gases (for bicarbonate and pH) and liver function tests
– Estimated GFR (eGFR): calculated using the formula 0.41 x height (cm) / creatinine (mg/dL). Normal eGFR is 80 – 120 mL/min/m^2.
– Renal ultrasound, if available: ideally to exclude hydronephrosis, but as a minimum to see if the bladder is full.
– ECG or cardiac monitoring, if available: to monitor T waves.

Table 8.3 - Typical findings in investigation of AKI (adapted from NHSGGC Guidelines[22])

	Pre-renal	Renal (intrinsic)	Post-renal
Urine output	Oliguria	Oliguria to polyuria	Variable
Urinary osmolality (milliosmoles)	> 500	< 300	< 350
Urinary sodium (mmol/L)	< 10	> 40	> 40

a Oliguria is defined as a urine output of < 1 mL/kg/hr in infants or < 0.5 mL/kg/hr in children; anuria is defined as no urine output or urine output of < 1 mL/kg/day.
b Polyuria is defined as a urine output of > 3 mL/kg/hr.
c Normal values of serum creatinine vary by age and gender, see local lab references for normal ranges.

	Pre-renal	Renal (intrinsic)	Post-renal
Urea, creatinine and electrolytes	Increased urea Lower creatinine compared to renal and post-renal Hypernatraemia	Creatinine increasing by 45-130 mmol/L/day Hyperkalaemia Hypocalcaemia Hyperphosphataemia	Hyponatraemia Hyperkalaemia Hyperchloraemic acidosis
Urinalysis	Often normal	Granular and epithelial cell casts, red cell casts, pyuria, haematuria, proteinuria	
Renal ultrasound	Empty bladder	Possible structural abnormality e.g. horseshoe[d] or absent kidney, renal parenchymal disease.	Obstruction of urinary tract (full bladder), hydronephrosis
eGFR	Reduced	Reduced	Reduced

8.4.4 Management

Management of underlying cause

Treatment of the underlying cause of AKI usually restores kidney function to normal.

Pre-renal

- Correct any dehydration, hypovolaemia or acute blood loss (see Chapter 2, Section 2.2 and Section 2.5 and Chapter 5, Section 5.3).
- Treat shock or circulatory impairment contributing to hypotension (see Chapter 2, Section 2.2).

Renal (intrinsic)

- Manage PIGN (and nephrotic syndrome if present). See Section 8.2 and Section 8.3 respectively.
- Remove any nephrotoxic medications.
- Provide supportive care (e.g. fluid management, pain control, nutritional support) for conditions that do not have definitive treatment, to allow time for natural resolution and recovery of kidney function (e.g. ATN, nephrotoxic kidney injury, HUS).
- Treat sepsis (see Chapter 3, Section 3.2).
- Treat malaria (see Chapter 3, Section 3.4).

Post-renal

- Relieve urinary outflow obstruction, e.g. insert urinary catheter[e] in boys with suspected or confirmed posterior urethral valves. Children often become temporarily polyuric after relieving urinary outflow obstruction – measure urine output and replace fluid and electrolytes as needed (see Chapter 15, Section 15.2 and Section 15.3).
- Refer for definitive surgical management.

d Horseshoe kidney is when the kidneys are fused together at the lower end, creating the shape of a 'U' or horseshoe.

e If urinary catheter is unavailable, a small NG tube can be used to relieve urinary outflow obstruction temporarily for emergency relief.

Symptomatic management

Until the underlying cause can be identified and treated, symptomatic management is required. This can be complex and challenging.

Fluid overload

- Fluid restriction: daily fluid requirements should only be to replace losses i.e. urine, vomiting, diarrhoea and insensible losses[f]. If significant fluid overload (displaced apex beat, distended neck veins, pulmonary oedema, severe hypertension), restrict intake to replacement of insensible losses only.
- Administer **furosemide** IV 2-5 mg/kg over 1 hour. May be repeated if there is a good diuretic response (max. 1 g per day).
- Monitor and record blood pressure and fluid balance accurately at least 2 times daily.
- Weigh patient daily.
- Do not add potassium to oral or IV fluid intake.

Hypertension

- Measure blood pressure when the child is at rest and relaxed and ensure correct sized cuff is used to avoid over or underestimated readings[g] (see MSF Manual of Nursing Care Procedures, Procedure: Haemodynamic assessment).
- Start **amlodipine** PO 0.1 mg/kg once daily if blood pressure is over the 95th centile for age (see Appendix 17). Monitor blood pressure carefully for 1-2 hours after administration. Increase to 0.2 mg/kg once daily if necessary.
- Treat hypertension as an emergency if there are signs of hypertensive crisis (headache, blurred vision, seizures) or if blood pressure is 20 mmHg over the 95th centile for age. Untreated hypertensive crisis can lead to cerebral haemorrhage, blindness and death:
  - Administer **furosemide** IV 1-2 mg/kg over 3 to 5 minutes if fluid overloaded.
  - Start **labetalol** via continuous IV infusion at a rate of 0.5-1 mg/kg/hr. Monitor blood pressure every 15 minutes and increase dose gradually according to response up to a maximum of 3 mg/kg/hr. Aim for a gradual reduction in BP until BP is ≤ 95th centile for age (see Appendix 17). Labetalol may cause bronchoconstriction therefore should be avoided in children with asthma or chronic lung disease. If labetalol is unavailable, **atenolol** PO 1-2 mg/kg once daily can be given as an alternative.

Hyperkalaemia

- Repeat serum potassium urgently to verify results, ideally via venepuncture to avoid sampling haemolysis which will result in an inaccurately high potassium.
- Avoid potassium-rich foods (e.g. bananas, oranges, raisins, tomatoes, avocados, nuts).
- Use only fresh blood for transfusion (if required).
- Treat hyperkalaemia when K+ > 6 mmol/L, especially if there are signs of hyperkalaemia on ECG (peaked T waves, wide QRS complex, arrythmias):
  - Administer nebulised **salbutamol** to promote potassium uptake into cells:
    - ▷ < 5 years: 2.5 mg
    - ▷ ≥ 5 years: 5 mg
  - Administer **calcium gluconate** 10% IV 0.5 mL/kg (max. 10 mL) over 3 minutes to stabilise cardiac muscle excitability.

f Insensible fluid loss is the body fluid lost through the skin and respiratory tract that is not easily measurable. Estimated daily insensible losses are calculated according to body weight as follows: 1-10 kg = 25 mL/kg; > 10-20 kg = 12.5 mL/kg; > 20 kg = 5 mL/kg.

g Blood pressure cuff should be 2/3 of the length of the upper arm. A blood pressure cuff that is too small will give a falsely high blood pressure reading, while one that is too large will give a falsely low reading.

- If central venous access in situ, and the patient can be cared for in an ICU environment with adequate monitoring and staffing levels, administer a mixed infusion of **glucose** (**dextrose**) **50%** 2 mL/kg and **short-acting insulin** 0.05 IU/kg in the same syringe over 5 to 10 minutes using a syringe pump, to promote intracellular potassium shift. Close monitoring of blood glucose level (BGL) is required before, during and after infusion (within an hour of administration), as insulin can cause a rapid fall in BGL.

Other considerations

– Ensure medication dosages are adapted according to renal function where necessary, and stop all nephrotoxic drugs (e.g. gentamicin, and NSAIDs).
– If the patient has metabolic acidosis, and blood gas analysis and adequate monitoring are available, consider correction with **sodium bicarbonate** according to local protocol.
– Optimise caloric value in any nutritional intake as children with AKI are in a hypercatabolic state (see Chapter 15, Section 15.5). The majority of calories should be given as carbohydrates.
– Consider referral for dialysis if no improvement despite the above measures and correction of the underlying cause, or seek specialist support to assist with insertion of a peritoneal dialysis catheter if transfer is not possible.

8.4.5 Prognosis

The prognosis of AKI is directly dependent on the underlying cause and its potential for resolution, however, children who have suffered AKI from any cause are at risk of developing irreversible chronic or even end-stage renal failure which may occur years after the original insult. Annual follow-up is recommended to monitor blood pressure and check urine dipstick for proteinuria.

8.5 Acute painful scrotum

Acute painful scrotum may indicate a serious underlying problem and should be promptly evaluated to exclude conditions that may impact the viability of the testis. It is a common complaint in young and adolescent boys. Potential causes of acute painful scrotum include testicular torsion, epididymitis, trauma, orchitis, strangulated inguinal hernia and torsion of the testicular appendages, with the latter being the most common cause[23]. Other conditions can cause referred pain to the scrotum, including urinary tract infection, urethritis, renal calculi and intra-abdominal pathologies.

8.5.1 Clinical features

Diagnosis is clinical in most cases and a thorough description of the pain and associated features can help to differentiate between causes[24]. Presence or absence of fever, trauma and previous similar episodes can also be helpful. Scrotal oedema and erythema are common findings in acute painful scrotum and do not help to differentiate between causes.

Scrotal examination

Inspection

Look for any obvious swellings, lesions, trauma or discharge. Identify the presence of a 'blue dot' which indicates ischaemia in torsion of the testicular appendages.

Palpation

Gently palpate the testis to identify the following:

- Tenderness: palpation may reveal a specific point of tenderness suggestive of testicular appendage torsion or epididymitis, or more generalised testicular or scrotal tenderness seen in testicular torsion.
- Position, orientation, and size of testis.
- Texture and character of testis, e.g. firm vs normal (hard-boiled egg); fixed vs mobile.
- Swellings of testis or surrounding tissue, e.g. any associated or reactive hydrocoele.

Transillumination

Transilluminate any identified swellings to differentiate between solid and cystic or fluid-filled swellings. Fluid-filled swellings such as hydrocoeles will glow bright red (transilluminate) when a light is shone through them, while solid masses will appear dark.

Reflexes

Test for presence or absence of the cremasteric reflex on the affected side by stroking the inside of the upper thigh. Elevation of the testis on the same side indicates a positive reflex. Consider testicular torsion in the absence of cremasteric reflex.

Table 8.4 outlines the main features of the three most common causes of acute painful scrotum in children.

Table 8.4 - Differentiation of main causes of acute painful scrotum (adapted from UpToDate[25])

	Testicular torsion	Torsion of testicular appendages	Epididymitis
Onset of pain	Acute, sudden	Acute, sudden	Subacute, gradual
Location of pain	Whole testicle initially, then more widespread. May be associated with lower abdominal or inguinal pain	Localised to torsed appendage initially, then whole testis	Localised to epididymis initially, then more widespread
Character of pain	Constant, severe pain. Occasionally intermittent if testicle is torsing and detorsing	Constant, mild to severe pain	Usually mild to moderate; may be relief of pain with elevation of testis (Prehn sign)
Specific scrotal features	Testis high in scrotum and may be lying transverse due to twisting of cord; testis hard on palpation; reactive hydrocoele common; cremasteric reflex absent on side of torsion	Palpable hard tender mass at superior or inferior pole of testis in an otherwise soft testicle; 'Blue dot' sign; Reactive hydrocoele occasionally	Swelling localised to epididymis; Inflammatory nodule on epididymis may be palpable
Associated symptoms	Nausea, vomiting, loss of appetite	None	Painful urination, urethral discharge; Fever
Typical age	Around puberty, but can occur in neonates	Pre-pubertal (peak age 7-12 years)	Post-pubertal if associated STI; pre-pubertal
Clues in the history	Previous self-resolving episodes of similar pain (intermittent torsion); more common in winter	Recent increase in size of testes (pre-pubertal enlargement); more common in winter	Recent viral infection, especially in pre-pubertal boys
Urinalysis	Normal	Normal	Pyuria common

Complications

Testicular torsion that is not promptly identified and treated can lead to significant ischaemia of the affected testicle such that it is no longer viable and requires removal. Irreversible ischaemia and necrosis can occur in as little as 6 hours from onset[23], depending on the degree of torsion, therefore testicular torsion is considered a surgical emergency.

8.5.2 Investigations

- Urinalysis and culture
- Gram stain (with or without culture) of any discharge
- Doppler ultrasound of scrotum: may show a hypoechoic testis with reduced or no perfusion in testicular torsion.

8.5.3 Management

Management depends on the most likely cause, as outlined below.

Testicular torsion

If testicular torsion is suspected, urgent surgical referral is required for surgical detorsion and orchidopexy (fixation of the testicle in the scrotum). If emergency surgery is not available, or if there is likely to be a long delay in referral, manual detorsion should be attempted to try to restore blood flow and increase the chances of maintaining viability of the testis while the patient awaits surgery[26]:

- Give adequate analgesia and sedation (see Chapter 15, Section 15.4).
- Lie the patient on his back.
- Stand at the patient's feet and rotate affected testicle away from the midline, outwards towards the thigh (medial to lateral) at least one complete 360-degree rotation. More than one rotation may be necessary to fully detorse the testicle, as torsion of more than 360 degrees is possible.
- Re-evaluate the patient for signs of successful detorsion such as instant relief of pain due to rapid return of blood flow to the testis, and lower position of the testis in the scrotum.
- If there is no relief of pain or the pain worsens during the procedure, attempt to rotate the testicle in the opposite direction (lateral to medial).

Surgical exploration is necessary even after clinically successful manual detorsion, to ensure complete resolution and to prevent recurrence by performing a bilateral orchidopexy.

Torsion of the testicular appendages

Management is conservative with rest, analgesia, anti-inflammatory medications and scrotal elevation. Symptoms usually resolve within 7 days.

Epididymitis

Treatment depends on likelihood of associated sexually transmitted infection and/or urinary tract infection. If there is pyuria or positive urine culture, antibiotic treatment should be given for urinary tract infection (see Section 8.1). Epididymitis with negative urinalysis and culture is most likely a post-viral inflammatory process and is therefore treated conservatively with rest and analgesia[27,28,29].

8.6 Paraphimosis

Paraphimosis refers to a retracted foreskin that cannot be returned to its normal anatomical position over the glans of the penis. When the foreskin is left retracted for some time, it creates a circumferential restrictive band of tissue that causes congestion and subsequent oedema of the glans, further limiting the ability to reduce the foreskin[30]. It only occurs in non-circumcised or partially circumcised males.

8.6.1 Clinical features

Predisposing factors and causes for paraphimosis include[31]:
- Phimosis: a partial phimosis[a] may predispose patients to paraphimosis when the foreskin is retracted for cleaning, passing urine or manipulation/stimulation.
- Iatrogenic: failure to return foreskin to usual position after genitourinary procedures such as urinary catheterisation.
- Penile trauma and sexual activity are uncommon in pre-adolescent males.

Diagnosis is usually evident based on history and clinical findings. Patients typically complain of penile pain and swelling.

Examination

Clinical examination reveals:
- Significant pain on examination, particularly tenderness of the glans and retracted foreskin.
- Oedema of the glans and foreskin.
- Constricting ring of tissue immediately behind the head of the penis (ensure that there is no foreign body causing constriction, e.g. hair, cloth, jewellery).
- Flaccid and unaffected penile shaft.
- Decreased urinary stream in infants and young males.

In later stages:
- Firm, inelastic glans with blue or black discoloration, indicating ischaemia (rare).
- Bladder distention due to complete urinary obstruction.

Complications

If left untreated, affected tissues become increasingly oedematous and ischaemia ensues, causing local skin necrosis. In very rare cases penile necrosis, gangrene and autoamputation may occur.

8.6.2 Management

Paraphimosis should be considered a urologic emergency, requiring urgent reduction of the foreskin to its anatomical position to prevent further swelling and complications. Adequate analgesia is crucial to facilitate manipulation, and parenteral analgesia may be required.

a Partial phimosis, when the preputial opening is too small to easily fit over the glans, is usually physiologic in young boys but may also occur after infection, inflammation, or trauma. Up to 10% of uncircumcised males will have physiologic phimosis at 3 years of age.

Technique[32,33]

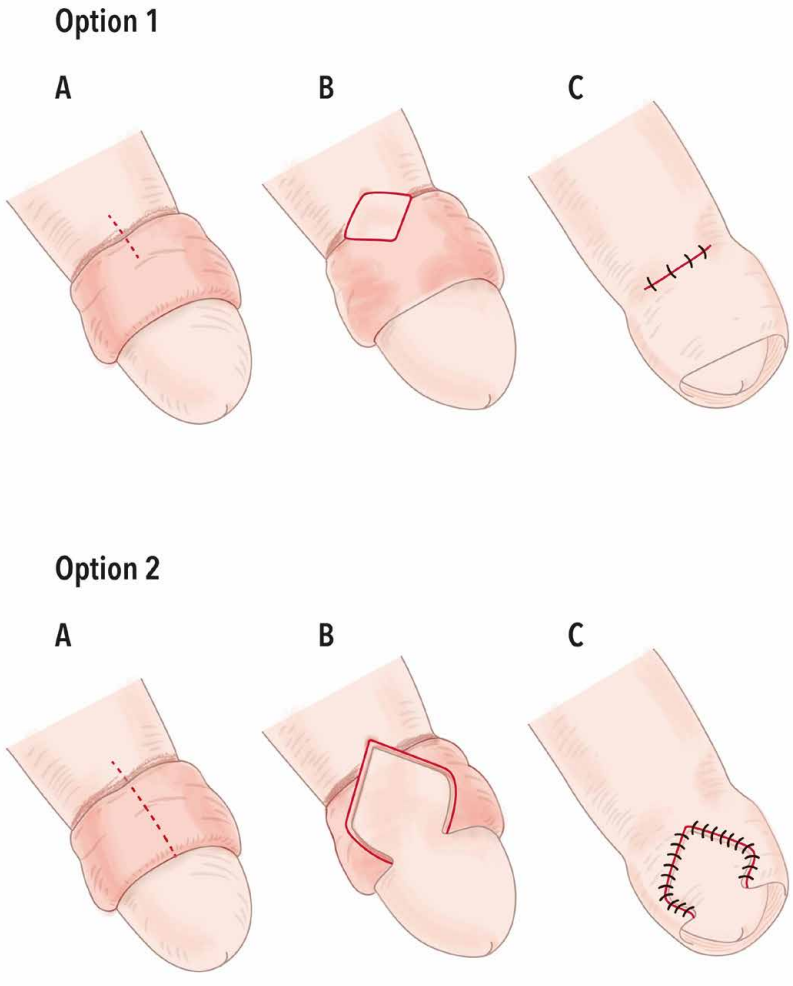
– Analgesia:
  • Apply **lidocaine 2% gel** or **EMLA cream**[b] to the glans and distal penile shaft 30-60 minutes before the procedure and cover in plastic wrap to keep the cream in place.
  • Consider parenteral analgesia or procedural sedation (see MSF Standards for Paediatric Procedural Sedation) if extreme pain limits ability to perform reduction procedures.
– Reduction of oedema:
  • Encircle the glans with a gloved hand and apply even, circumferential pressure for several minutes to reduce swelling.
  • Alternatively, wrap a self-adhesive bandage around the penis approximately 3 times, starting at the glans and continuing up the penile shaft. The first layer should be loosely wrapped with subsequent layers becoming tighter to exert a constant, steady pressure. The wrap should be left in place for 10-15 minutes before removal.
  • Application of a swab soaked with **glucose** (**dextrose**) **50%** for 1 hour may be a useful adjunct to reduce swelling by osmosis. In the absence of glucose (dextrose) 50%, granulated sugar can be poured onto the swollen glans and foreskin and kept in place with a glove or swab until swelling subsides (1-2 hours)[34].
  • The 'iced-glove' method can also be used to reduce swelling[35], though re-evaluation every 15-20 minutes is essential to prevent cold and/or ischaemic injury. Fill a glove with ice and close with a knot then invaginate the thumb of the glove by sliding it over the shaft of the penis so that the ice surrounds the penis[31,36].
– Manual reduction of foreskin:
  • Paraphimosis reduction should be attempted only after swelling has begun to subside via the chosen method (see above).
  • Place two thumbs on glans penis and position index and long fingers immediately behind swollen constricting ring of foreskin.
  • Apply gentle consistent traction on the ring of foreskin to ease foreskin back over the glans while exerting counterpressure on the glans with the thumbs.
  • The constricting ring should come over the glans along with the foreskin.

If manual reduction fails, refer for surgical reduction without delay. If surgery is unavailable or there is likely to be a long delay in referral, a dorsal slit procedure should be attempted:
– Ensure adequate analgesia (see above) including procedural sedation (see MSF Standards for Paediatric Procedural Sedation) and penile block, if possible.
– Disinfect and drape the area.
– Using a scalpel, make a 1-2 cm longitudinal incision on the dorsal aspect of the penile shaft (see Figure 8.1):
  • Start the incision just above the tight ring of constricted foreskin behind the swelling and transect the tight ring of skin (**Option 1A**).
  • Begin the incision superficially and gradually cut deeper until the ring is released, without removing any skin.
  • There should be a palpable and visible release of the paraphimotic ring if successful, and an associated reduction in swelling.
  • If done correctly, the released ring opens up to create a diamond shaped incision (**Option 1, B**) that can then be sutured horizontally (**Option 1C**).
  • If the ring is not completely released, or there is too much swelling of the foreskin, extend the incision to the edge of the foreskin to open it completely (**Option 2A and 2B**).

b EMLA cream is a mixture of **lidocaine 2.5%** and **prilocaine 2.5%**.

– Roll the foreskin over the glans to completely reduce the paraphimosis once the ring is cut. If necessary, manually decompress residual swelling before/during this step to help reduce the paraphimosis.
– Suture the edges of the incision with absorbable sutures, depending on the shape and size of the incision after reduction of the foreskin over the glans (**Option 1C** or **Option 2C**).
– Following dorsal slit procedure, consider referral for circumcision.

Figure 8.1 - Dorsal slit procedure[c]



Post-reduction care

Following successful reduction of paraphimosis, patients and parents/carers should be advised:
– Not to retract the foreskin for a few days.
– That only the child should retract his foreskin for cleaning and should avoid irritants.
– To ensure that the foreskin is immediately replaced over the glans after retraction.
– That circumcision is usually unnecessary unless paraphimosis is recurrent or surgery was required to reduce the paraphimosis.

c Original illustration by Sarah Imani.

References Chapter 8

1. Kaufman J. How to… collect urine samples from young children. *Arch Dis Child - Educ Pract Ed*. 2020;105(3):164-171. https://doi.org/10.1136/archdischild-2019-317237
2. *Recommendations | Urinary tract infection in under 16s: diagnosis and management | Guidance | NICE*. Published July 27, 2022. Accessed October 23, 2023. https://www.nice.org.uk/guidance/ng224/chapter/Recommendations
3. *Recommendations | Pyelonephritis (acute): antimicrobial prescribing | Guidance | NICE*. Published October 31, 2018. Accessed April 18, 2022. https://www.nice.org.uk/guidance/ng111/chapter/Recommendations
4. Shaikh N, Hoberman A. Urinary tract infections in infants older than one month and children less than two years: Acute management, imaging and prognosis. *UpToDate*. Published May 2021. https://www.uptodate.com/contents/urinary-tract-infections-in-infants-older-than-one-month-and-children-less-than-two-years-acute-management-imaging-and-prognosis
5. Kaufman J, Temple-Smith M, Sanci L. Urinary tract infections in children: an overview of diagnosis and management. *BMJ Paediatr Open*. 2019;3(1):e000487. https://doi.org/10.1136/bmjpo-2019-000487
6. *Post-Streptococcal Glomerulonephritis: For Clinicians | CDC*. Published July 13, 2023. Accessed October 23, 2023. https://www.cdc.gov/groupastrep/diseases-hcp/post-streptococcal.html
7. Niaudet P. Poststreptococcal glomerulonephritis. *UpToDate*. Published May 2021. https://www.uptodate.com/contents/poststreptococcal-glomerulonephritis
8. Bakhiet YM, Mudi A, Khumalo T, Moonsamy G, Levy C. Idiopathic nephrotic syndrome in South African children. *Afr Health Sci*. 2018;17(4):1130. https://doi.org/10.4314/ahs.v17i4.22
9. El Bakkali L, Rodrigues Pereira R, Kuik DJ, Ket JCF, Van Wijk JAE. Nephrotic syndrome in The Netherlands: a population-based cohort study and a review of the literature. *Pediatr Nephrol*. 2011;26(8):1241-1246. https://doi.org/10.1007/s00467-011-1851-8
10. Niaudet P. Clinical manifestations, diagnosis and evaluation of nephrotic syndrome in children. *UpToDate*. Published May 2023. https://www.uptodate.com/contents/clinical-manifestations-diagnosis-and-evaluation-of-nephrotic-syndrome-in-children
11. Niaudet P. Complications of nephrotic syndrome in children. *UpToDate*. Published July 2020. https://www.uptodate.com/contents/complications-of-nephrotic-syndrome-in-children
12. Niaudet P. Long-Term Outcome of Children with Steroid-Sensitive Idiopathic Nephrotic Syndrome. *Clin J Am Soc Nephrol*. 2009;4(10):1547-1548. https://doi.org/10.2215/CJN.05950809
13. Larkins N, Kim S, Craig J, Hodson E. Steroid-sensitive nephrotic syndrome: an evidence-based update of immunosuppressive treatment in children. *Arch Dis Child*. 2016;101(4):404-408. https://doi.org/10.1136/archdischild-2015-308924

14. Basu B, Bhattacharyya S, Barua S, Naskar A, Roy B. Efficacy of body weight vs body surface area-based prednisolone regimen in nephrotic syndrome. *Clin Exp Nephrol*. 2020;24(7): 622-629.
https://doi.org/10.1007/s10157-020-01875-y

15. Saadeh SA, Baracco R, Jain A, Kapur G, Mattoo TK, Valentini RP. Weight or body surface area dosing of steroids in nephrotic syndrome: is there an outcome difference? *Pediatr Nephrol*. 2011;26(12):2167-2171.
https://doi.org/10.1007/s00467-011-1961-3

16. Hahn D, Samuel SM, Willis NS, Craig JC, Hodson EM. Corticosteroid therapy for nephrotic syndrome in children. Cochrane Kidney and Transplant Group, ed. *Cochrane Database Syst Rev*. Published online August 31, 2020.
https://doi.org/10.1002/14651858.CD001533.pub6

17. Webb NJ, Woolley RL, Lambe T, et al. Sixteen-week versus standard eight-week prednisolone therapy for childhood nephrotic syndrome: the PREDNOS RCT. *Health Technol Assess*. 2019;23(26):1-108.
https://doi.org/10.3310/hta23260

18. Emma F, Montini G, Gargiulo A. Equations to estimate prednisone dose using body weight. *Pediatr Nephrol*. 2019;34(4):685-688.
https://doi.org/10.1007/s00467-018-4127-8

19. Radhakrishnan J, Cattran DC. The KDIGO practice guideline on glomerulonephritis: reading between the (guide)lines—application to the individual patient. *Kidney Int*. 2012;82(8): 840-856.
https://doi.org/10.1038/ki.2012.280

20. Christian MT, Maxted AP. Optimizing the corticosteroid dose in steroid-sensitive nephrotic syndrome. *Pediatr Nephrol*. 2022;37(1):37-47.
https://doi.org/10.1007/s00467-021-04985-1

21. Olowu WA, Niang A, Osafo C, et al. Outcomes of acute kidney injury in children and adults in sub-Saharan Africa: a systematic review. *Lancet Glob Health*. 2016;4(4):e242-e250.
https://doi.org/10.1016/S2214-109X(15)00322-8

22. Ramage I. Acute renal failure in paediatrics (management and investigation). Published November 2020. Accessed October 18, 2023.
https://www.clinicalguidelines.scot.nhs.uk/nhsggc-guidelines/nhsggc-guidelines/kidney-diseases/acute-renal-failure-in-paediatrics-management-and-investigation/

23. Pomajzl AJ, Leslie SW. Appendix Testis Torsion. *In: StatPearls*. StatPearls Publishing; 2023. Accessed October 18, 2023.
http://www.ncbi.nlm.nih.gov/books/NBK546994/

24. Brenner JS, Aderonke O. Evaluation of non-traumatic sctoral pain or swelling in children and adolescents. *UpToDate*. Published November 2021.
https://www.uptodate.com/contents/evaluation-of-nontraumatic-scrotal-pain-or-swelling-in-children-and-adolescents

25. Brenner JS, Aderonke O. Causes of scrotal pain in children and adolescents. *UpToDate*. Published April 2022.
https://www.uptodate.com/contents/causes-of-scrotal-pain-in-children-and-adolescents

26. Ringdahl E, Teague L. Testicular torsion. *Am Fam Physician*. 2006;74(10):1739-1743.
https://www.aafp.org/pubs/afp/issues/2006/1115/p1739.html

27. Santillanes G, Gausche-Hill M, Lewis RJ. Are Antibiotics Necessary for Pediatric Epididymitis?: *Pediatr Emerg Care*. 2011;27(3):174-178. https://doi.org/10.1097/PEC.0b013e31820d647a

28. Gkentzis A, Lee L. The aetiology and current management of prepubertal epididymitis. *Ann R Coll Surg Engl*. 2014;96(3):181-183. https://doi.org/10.1308/003588414X13814021679311

29. Cristoforo TA. Evaluating the Necessity of Antibiotics in the Treatment of Acute Epididymitis in Pediatric Patients: A Literature Review of Retrospective Studies and Data Analysis. *Pediatr Emerg Care*. 2021;37(12):e1675-e1680. https://doi.org/10.1097/PEC.0000000000001018

30. Samm BJ, Dmochowski RR. Trauma injuries and conditions affecting the penis, scrotum, and testicles. *Postgrad Med*. 1996;100(4):187-200. https://doi.org/10.3810/pgm.1996.10.101

31. Tews M. Paraphimosis: Clinical manifestations, diagnosis, and treatment. *UpToDate*. Published May 2020. https://www.uptodate.com/contents/paraphimosis-clinical-manifestations-diagnosis-and-treatment

32. Choe JM. Paraphimosis: current treatment options. *Am Fam Physician*. 2000;62(12): 2623-2626, 2628. https://www.aafp.org/pubs/afp/issues/2000/1215/p2623.html

33. Pohlman GD, Phillips JM, Wilcox DT. Simple method of paraphimosis reduction revisited: Point of technique and review of the literature. *J Pediatr Urol*. 2013;9(1):104-107. https://doi.org/10.1016/j.jpurol.2012.06.012

34. González Fernández M, Sousa Escandón MA, Parra Muntaner L, López Pacios JC. Azúcar: tratamiento de elección en la parafimosis irreductible [Sugar: treatment of choice in irreducible paraphimosis]. *Actas Urol Esp*. 2001;25(5):393-395. https://doi.org/10.1016/S0210-4806(01)72638-1

35. Mackway-Jones K, Teece S. Best evidence topic reports. Ice, pins, or sugar to reduce paraphimosis. *Emerg Med J EMJ*. 2004;21(1):77-78. https://emj.bmj.com/content/21/1/77.long

36. Houghton GR. The 'iced-glove' method of treatment of paraphimosis. *Br J Surg*. 2005; 60(11):876-877. https://doi.org/10.1002/bjs.1800601110

Chapter 9: Endocrinology

9.1 Diabetes mellitus (type 1)

Type 1 diabetes mellitus (T1DM) is caused by destruction of beta pancreatic cells that produce insulin, leading to an absolute insulin deficiency. It most commonly presents in childhood, with a first peak of onset between 4 and 6 years of age and a second peak between 10 and 14 years of age. T1DM is an autoimmune disease that is thought to be triggered by various environmental factors in people with a genetic predisposition. It is one of the most common chronic diseases in childhood, though there is wide geographical and ethnic variation in incidence[1]. Prognosis depends on availability of treatment, with significantly reduced life expectancy in children and young adults with untreated or poorly controlled diabetes.

Clinical features

Most commonly, children present with general malaise and lethargy, and careful history elicits the classic triad of:
- Polyuria (increased urination)
- Polydipsia (increased drinking)
- Weight loss

If symptoms go unrecognized, acidosis ensues, and the patient will present in diabetic ketoacidosis requiring emergency treatment (see Section 9.2).

Complications

Hypoglycaemia is a common complication for children with T1DM on treatment (see Section 9.3). Long-term complications from poorly controlled diabetes include neuropathy, retinopathy, nephropathy, and cardiovascular disease.

9.1.1 Diagnosis

The diagnosis of diabetes is based on the presence of **one** of the following diagnostic criteria, in patients presenting with classic signs and symptoms[2]:

Test	Result
Fasting blood glucose	≥ 126 mg/dL (7 mmol/L)
2-hour post-load blood glucose	≥ 200 mg/dL (11.1 mmol/L)
Random blood glucose	≥ 200 mg/dL (11.1 mmol/L)
Glycosylated haemoglobin (HbA1c)	≥ 48 mmol/mol (6.5%)

Fasting blood glucose = no calorific intake for at least 8 hours; 2-h post-load blood glucose = performed 2 hours after ingestion of 1.75 g/kg oral glucose; Random blood glucose = measurement at any time during the day; Glycosylated haemoglobin (HbA1c) = reflects average glycaemia over the previous 10-12 weeks.

In asymptomatic patients with elevated values, repeat testing is recommended as soon as possible in the following days to confirm the diagnosis, ideally using the same test.

9.1.2 Management

T1DM is a chronic illness that requires lifelong treatment with insulin (see Section 9.2.4 for more detail on insulin initiation and titration). Age-appropriate education for the child, as well as general education for the parent/carer, is an important part of the management plan and information should be repeated at every opportunity to ensure sufficient understanding of the disease and how to manage complications.

Education on the following is required:
- Basic understanding of T1DM and its cause (highlighting that it is not caused by poor diet)
- Dietary intake
- Insulin administration
- Monitoring of blood glucose level (BGL) using a blood glucose monitor
- Hypoglycaemia symptoms and management
- Hyperglycaemia and ketosis detection and management
- Sick-day management

Refer children with newly diagnosed diabetes for long-term follow-up, depending on local resources, and arrange:
- At least once-weekly follow-up for the first month.
- Home glucose monitoring. Each patient should be provided with a glucometer and enough strips for a minimum of three BGL measurements per day until the medical visit. A notebook should be provided to record the BGL measurements taken.

Refer to local or national guidelines, where available, for more detail on education material and long-term follow-up.

9.2 Diabetic ketoacidosis

Diabetic ketoacidosis (DKA) is a medical emergency defined by the combined presence of hyperglycemia, metabolic acidosis and ketosis in a child with diabetes. DKA can be fatal if not diagnosed rapidly and treated promptly. Fluid replacement is initially more important than initiating insulin as early mortality is due to dehydration and shock, but the clinical and chemical changes must be corrected gradually to prevent complications. Cerebral oedema is a potential and severe complication associated with the management of DKA.

In DKA there is an absolute deficiency of insulin resulting in hyperglycaemia and increased lipolysis, leading to increased ketones in the blood, glycosuria and osmotic diuresis (which is associated with fluid loss and potential electrolyte abnormalities). The increase in ketones leads to a metabolic acidosis with an increased anion gap.

In up to 80% of children with type 1 diabetes mellitus (T1DM), DKA is the first presentation of the condition[3]. Though much less common, children with type 2 diabetes may also present with DKA.

9.2.1 Diagnosis

Check if known T1DM. Enquire about any interruption to or inadequate insulin therapy. If not previously diagnosed with diabetes, enquire about symptoms of T1DM, including polydipsia, polyuria, fatigue, irritability, vomiting, abdominal pain, weight loss and family history[a].

DKA is diagnosed when all of the following 3 criteria are present:
- BGL ≥ 200 mg/dL (≥ 11.1 mmol/L)
- Ketonuria (++ or more)
- Plus, one or more of the following clinical features:
  - Kussmaul breathing[b] (deep, rapid, sighing)
  - Fruity breath
  - Decreased level of consciousness
  - Signs of dehydration
  - Abdominal pain and/or vomiting
  - Shock

Where possible, confirm metabolic acidosis: serum bicarbonate < 15 mmol/L or blood pH < 7.3.

Consider any precipitating factors:
- Infections (e.g. pneumonia, malaria, urinary tract infections)
- Major surgical conditions (e.g. acute abdomen)

a Family history of T1DM increases the likelihood of diabetes, however many children with T1DM have no family history of the condition.

b Kussmaul breathing is deep, laboured breathing that is usually rapid but respiratory rate may be normal. It is a form of hyperventilation which aims to remove carbon dioxide in response to metabolic acidosis.

9.2.2 Management

Treatment objectives are:
– Resuscitation and correction of shock
– Fluid replacement
– Insulin to reduce glucose gradually, aiming for an hourly glucose reduction of maximum 90 mg/dL/hr (5 mmol/L/hr)
– Maintenance of potassium concentration
– Identification and management of underlying condition or precipitating factors.

Resuscitation and correction of circulatory impairment or shock[4]

Assess and manage ABCDE:
– A: Ensure patent airways. If necessary, protect airway.
– B: Administer oxygen > 6 L/min via mask (use non-rebreathing mask if available), aiming for SpO_2 between 94-98%.
– C: IV access and take blood for BGL, FBC, electrolytes and send blood for culture.
– Measure weight and estimate the % of body weight lost in dehydration (i.e. the fluid deficit):
  • If recent weight available, compare to current weight to calculate fluid deficit.
  • If recent weight unavailable, standard fluid deficit in DKA is 7.5%, or 10% if considered to be in severe DKA.
– Treat circulatory impairment according to severity and level of consciousness (using Paediatric Glasgow Coma Scale (GCS), see Appendix 13):
  • Shock: administer a fluid bolus of 10 mL/kg **Ringer lactate** (or **sodium chloride 0.9%**) IV over 15-30 minutes then reassess after. If signs of shock persist, repeat another bolus.
  • Not in shock and GCS > 7: administer 10 mL/kg **Ringer lactate** (or **sodium chloride 0.9%**) IV over 60 minutes.
  • Not in shock but GCS ≤ 7: start IV maintenance fluids (see Chapter 15, Section 15.2).
  • Avoid excessive fluid boluses due to the risk of cerebral oedema.
– Insert a nasogastric tube (NGT, conical tip) if unconscious or has recurrent vomiting. Leave on free drainage.
– Keep nil by mouth (NBM) until alert and stable.
– Measure urine output and check for urinary ketones regularly while on insulin infusion: hourly if urinary catheter in situ, or each time the patient passes urine otherwise.

Note: Bicarbonate administration is not recommended and should not routinely be administered as it can worsen hypokalaemia.

Monitor closely and continue treatment in an intensive care area with capacity for increased nursing care due to frequency of monitoring required:
– Measure and record BGL every hour until stabilized and insulin infusion stopped.
– Evaluate and record vital signs and level of consciousness every hour.
– Where available, measure electrolytes, venous pH and serum bicarbonate every 2 to 4 hours.
– Monitor fluid input and output every hour:
  • Record all fluids administered.
  • Urinary catheterization should be avoided but may be useful in a child with impaired consciousness. Consider alternative methods for estimating urine output (e.g. weighing nappies, weighing soiled bedding, urination into a potty/urinal if possible).
  • Normal urine output is > 1 ml/kg/hour.

⚠ Check that there has been urine output following resuscitative boluses. If no urine output, reassess for shock/circulatory impairment and for urinary retention. Start fluid replacement without potassium if no urine output and add potassium to fluids only once urine output confirmed.

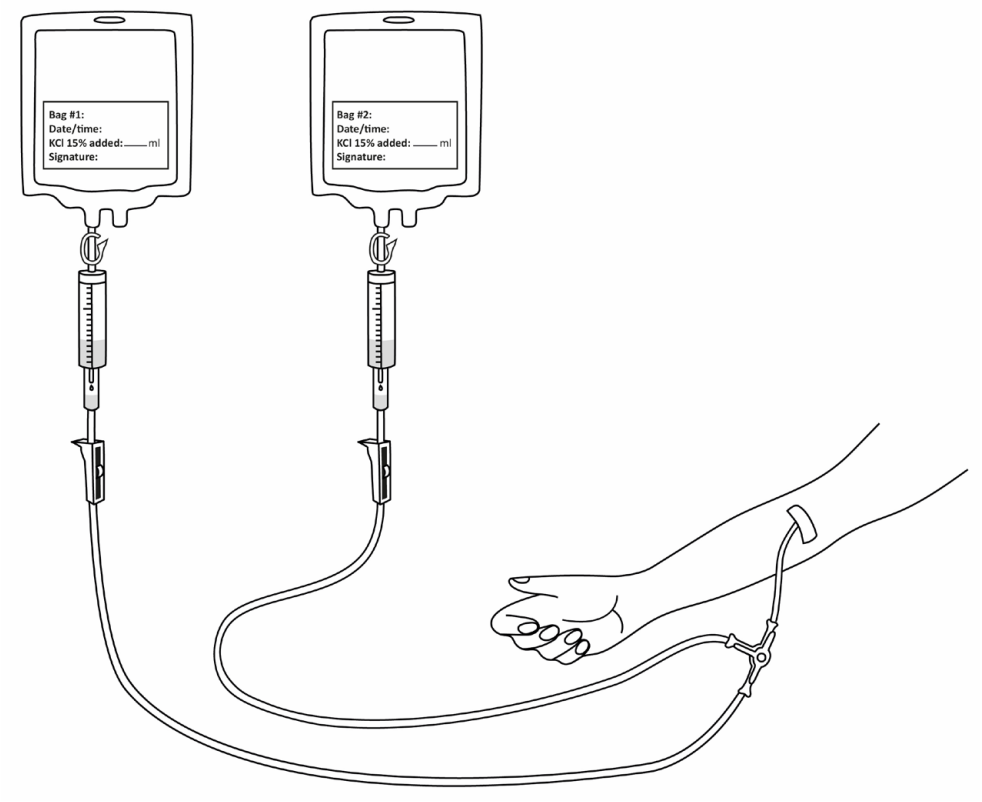
Fluid replacement

Once resuscitation is complete, start IV fluid administration. Add potassium chloride (KCl) to IV fluids only once urine output has been confirmed. Together with appropriate maintenance fluid requirements, standard fluid infusion calculations in DKA include: a 7.5% deficit to be replaced over 48 hours; or, if considered to be in severe DKA (and/or confirmed with pH < 7.1), a 10% deficit replaced over 48 hours (see Table 9.1 and Table 9.2 below)[4].

Two-bag method

- Prepare two bags of IV fluid solutions with different glucose concentrations but identical electrolyte content (see Step 1 below).
  - IV fluid bag #1 has no added glucose.
  - IV fluid bag #2 has added glucose.
- **Ringer lactate** (**RL**) is the preferred IV fluid, if not available, use **sodium chloride 0.9%** (NaCl 0.9%) as alternative.
- Ensure each bag of IV fluid is labelled with date, time, amount of KCl added (only add KCl if urine output is confirmed) and signature of the person making the fluid bag.
- Set up a two-bag system to allow each bag to be run either separately, or at the same time, without having to manipulate the IV line (see Figure 9.1 below):
  - Hang both IV fluid bags, connect each to a paediatric infusion set and prime the IV lines.
  - Connect the end of each paediatric infusion set to the same IV cannula using a 3-way stopcock.
  - Turn the 3-way stopcock as required depending on whether both bags are running simultaneously or separately.
- Adjust the rates of each bag of IV fluid to respond to changes in BGL (see Step 2 page 286).

Figure 9.1 - Two-bag method for delivery of IV fluids in DKA[c]



c Original illustration by Sarah Imani

Steps for administration of two-bag method of IV fluids:

Step 1: Preparation of IV fluids for two-bag method

Make IV fluid bag #1:
- Add 40 mmol/L KCl (use KCl 15%, 150 mg/mL = 2 mmol/mL (10 mL ampoule))

RL (or NaCl 0.9%)	**Volume of KCl 15% to add**	**Final IV fluid bag #1**
1000 mL	20 mL (2 ampoules)	RL + 40 mmol/L KCl (or NaCl 0.9% + 40 mmol/L KCl)
500 mL	10 mL (1 ampoule)	

Make IV fluid bag #2:
1. Add glucose (dextrose) 50% (G50%) to a bag of Ringer lactate (RL) to make G10%-RL (or G10%- NaCl 0.9%). Follow instructions below.
2. Add 40 mmol/L KCl.

1. Make G10%-RL (or G10%-NaCl 0.9%)

RL (or NaCl 0.9%)	**Remove**	**Add**	**Intermediary solution**
1000 mL	200 mL	G50% 200 mL	1000 mL G10%-RL (or G10%-NaCl 0.9%)
500 mL	100 mL	G50% 100 mL	500 mL G10%-RL (or G10%-NaCl 0.9%)

2. Add potassium to make final IV fluid bag #2

G10%-RL (or G10%-NaCl 0.9%)	**Volume of KCl 15% to add**	**Final IV fluid bag #2**
1000 mL	20 mL (2 ampoules)	G10%-RL + 40 mmol/L KCl (or G10%-NaCl 0.9% + 40 mmol/L KCl)
500 mL	10 mL (1 ampoule)	

Step 2: Which IV fluid bag(s) at what speed?

Refer to Table 9.1 and Table 9.2 for fluid rates corresponding to standard, half or high-speed.

- Aim for a glucose reduction of maximum 90 mg/dL/hr (5 mmol/L/hr).
- Target blood glucose is between 145-215 mg/dL (8-12 mmol/L).

Blood glucose level (mg/dL or mmol/L)	**Which bag(s) at what speed?**
> 270 mg/dL (> 15 mmol/L)	Bag #1 at standard-speed None of bag #2*
145 to 270 mg/dL (8-15 mmol/L)	Bag #1 at half-speed Bag #2 at half-speed
70 to < 145 mg/dL (4-8 mmol/L)	None of bag #1 Bag #2 at standard-speed
< 70 mg/dL (< 4 mmol/L) *Call clinician immediately*	None of bag #1 Bag #2 at high-speed**

* These patients are receiving insulin but no glucose at this stage.

** This is a large volume of fluid and should only be continued long enough to raise the glucose to > 70 mg/dL (or > 4 mmol/L), then immediately decrease the rate to standard-speed rate. If BGL decreases too rapidly despite adjusting the fluid rates, insulin dose needs to be decreased. See insulin therapy, page 288.

Table 9.1 - DKA treatment IV fluid rates (weight 3 kg to 40 kg)

Note on fluid calculations:
- Together with appropriate maintenance fluids, fluid rate calculations include replacement of deficit over 48 hours (i.e. correction of dehydration).
- Standard speed is based on the assumption of a 7.5% fluid deficit (moderate DKA).
- High speed is based on the assumption of a 10% fluid deficit (severe DKA).

Weight	Rate (mL/hr)			Weight	Rate (mL/hr)		
	Half	Standard	High		Half	Standard	High
3 kg	9	17	18	**22 kg**	48	96	108
4 kg	11	22	24	**23 kg**	50	99	111
5 kg	14	28	30	**24 kg**	51	102	114
6 kg	17	33	37	**25 kg**	52	104	117
7 kg	20	39	43	**26 kg**	54	107	120
8 kg	22	44	49	**27 kg**	55	109	123
9 kg	25	50	55	**28 kg**	56	112	126
10 kg	28	56	61	**29 kg**	57	114	129
11 kg	30	59	65	**30 kg**	59	117	133
12 kg	32	63	69	**31 kg**	60	119	136
13 kg	33	66	73	**32 kg**	61	122	139
14 kg	35	70	77	**33 kg**	63	125	142
15 kg	37	73	81	**34 kg**	64	127	145
16 kg	39	77	85	**35 kg**	65	130	148
17 kg	40	81	89	**36 kg**	66	132	151
18 kg	42	84	94	**37 kg**	68	135	154
19 kg	44	88	98	**38 kg**	69	137	157
20 kg	46	91	102	**39 kg**	70	140	160
21 kg	47	94	105	**40 kg**	71	142	163

Table 9.2 - DKA treatment IV fluid rates (weight > 40 kg)

Weight	Speed (mL/hr)		
	Half	Standard	High
41 kg	73	145	166
42 kg	74	148	170
43 kg	75	150	173
44 kg	77	153	176
45 kg	78	155	179
46 kg	79	158	182
47 kg	80	160	185
48 kg	82	163	188
49 kg	83	166	191
50 kg	84	168	194
51 kg	86	171	197
52 kg	87	173	200
53 kg	88	176	203
54 kg	89	178	207
55 kg	91	181	210

Insulin therapy

– Once shock corrected, and one hour after starting IV fluid replacement, start IV insulin[d]. Add 50 IU of soluble **insulin** to 49.5 mL **sodium chloride 0.9%** to make a total of 50 mL. Ensure insulin preparation is double checked by two qualified healthcare professionals.

By syringe pump:
- < 2 years, **insulin** IV: 0.05 IU/kg/hour (lower dose)
- ≥ 2 years, **insulin** IV: 0.1 IU/kg/hour (higher dose)

d Ensure insulin is double-checked by 2 staff to ensure medicine safety. Both the syringe and line should be changed at least once every 24 hours.

– If no syringe pump is available, administer **insulin** IM: 0.1 to 0.2 IU/kg every two hours, depending on age (as above).
– *Note*: subcutaneous route is not recommended for DKA treatment due to varied absorption from poor perfusion.
– Decrease insulin dose if BGL decreases too rapidly (> 90 mg/dL/hr or > 5 mmol/L/hr) despite adjusting the fluid rates using the two-bag method.
– Stop insulin if BGL < 70 mg/dL (< 4 mmol/L) and does not improve with adjustment of IV fluids rates and restart insulin once BGL ≥ 90 mg/dL (≥ 5 mmol/L).
– Insulin administration must be continued while ketonuria remains present, and glucose intake should be increased as necessary to allow this.
– Consider increasing insulin for children on the lower dose of insulin if BGL does not decrease over 4 hours:
  • Increase to 0.1 IU/kg/hour if using IV syringe pump.
  • Increase to 0.2 IU/kg every 2 hours if administering via IM injection.

Hypoglycaemia

Hypoglycaemia is a common and dangerous complication.
– Monitor BGL hourly while on insulin infusion and treat promptly when BGL < 60 mg/dL (< 3.3 mmol/L), see Section 9.3 for treatment of hypoglycaemia.
– Verify insulin and IV fluids are correctly prepared and administered.

Maintenance of potassium concentration

– Check serum potassium levels at 2 hours and then every 4 hours (where available).
– If K < 3 mmol/L at any point, stop insulin infusion for 1 to 2 hours then recheck. If serum potassium has dropped further, give **potassium chloride syrup** PO/NG: 1 mmol/kg as a single dose and check potassium again in 2 hours.
– Where ECG monitoring is available, check for peaked T-wave indicating hyperkalaemia.

Management of underlying condition or precipitating factor

– Consider broad spectrum antibiotic treatment if a severe infection is likely (see Chapter 3, Section 3.2.3).
– In malaria-endemic regions perform a malaria rapid test and treat for malaria if positive (see Chapter 3, Section 3.4.3).

9.2.3 Management of complications

Cerebral oedema

– Is a rare but major complication with a mortality rate of over 20%[5]. Usually it is of sudden onset, occurring between 6 to 12 hours after starting treatment.
– Clinical features include headache and vomiting, irritability, decreasing heart rate, increasing blood pressure, abnormal or slow breathing pattern (Cushing's Triad), pupillary changes, decreasing GCS, age-inappropriate incontinence and abnormal neurological signs.
– Check for the presence of criteria for cerebral oedema (see Table 9.3 page 290).
– Start treatment if: 1 diagnostic, 2 major, or 1 major and 2 minor criteria are present.

Table 9.3 - Criteria for the diagnosis of cerebral oedema[6]

Criteria for the diagnosis of cerebral oedema 1. Any one diagnostic criteria 2. Two major criteria 3. One major and two minor criteria	
Diagnostic criteria	• Abnormal motor or verbal response to pain • Decorticate or decerebrate posture • Cranial nerve palsy, especially III, IV and VI (e.g. asymmetrical pupillary light response, asymmetrical corneal light reflex, disconjugate gaze) • Abnormal neurogenic respiratory pattern (e.g. grunting, tachypnoea, Cheyne-Stokes respiration[e], gasping respiration)
Major criteria	• Altered mental status, confusion, or fluctuating level of consciousness • Sustained HR deceleration (decrease more than 20 bpm) not attributable to improved intravascular volume or sleep state • Age-inappropriate urinary incontinence
Minor criteria	• Vomiting • Headache • Lethargy or not easily rousable • Diastolic blood pressure > 90 mmHg • Age < 5 years

Treatment

– Manage A and B:
  • Support airways.
  • Administer oxygen via mask with reservoir bag (if available).
– Assess C and check BGL: exclude hypoglycaemia or shock as a cause for change in neurological condition.
– Insert NGT and leave on free drainage.
– Raise the head of the bed by 15 to 30 degrees (> 40 degrees can worsen raised intracranial pressure (ICP)).
– Consider reducing IV fluids to 70% of current fluid rate.
– Consider giving hyper-osmolar solutions (if available and staff trained in its use):

> **hypertonic saline (3%)**: 3 to 5 mL/kg over 10 to 15 minutes
>
> Alternative, **mannitol** IV: 0.5 to 1 g/kg over 10 to 15 minutes. Repeat after 30 minutes if no response.

– Electrolyte monitoring is recommended if available.

e Cheyne-Stokes respiration manifests as a cycle of fast, shallow breathing that becomes deeper and slower before leading to periodic apnoea before the cycle begins again.

9.2.4 Resolution of DKA and transition to subcutaneous (SC) insulin

- Evaluate resolution of DKA by assessing clinical improvement, particularly with correction of hydration, BGL control and clearance of urinary ketones.
- Once child is stable and fully alert, and has no clinical signs of acidosis:
  - Start oral fluids as tolerated by the child.
  - Reduce IV fluids accordingly to not exceed recommended hourly input.
- Transition to subcutaneous insulin from IV (or IM) insulin once oral fluids are well tolerated and the child remains clinically stable.
- Calculate total daily insulin requirement[f]:

> **insulin** SC: 0.3 to 0.8 IU/kg over 24 hours, in divided doses (depending on regimen chosen, see below for details)

- Administer first SC **short-acting insulin** 1 to 2 hours before stopping the insulin infusion.
- Start regular SC insulin at the next mealtime and administer it pre-meal.
- Measure BGL before each meal (pre-prandial) and at night (2 am) to monitor response and allow adjustment of insulin regime during hospital stay.
- Allow at least 48 hours to identify pattern before adjusting insulin dose unless the change is needed to avoid an obvious risk of hypoglycaemia or significant hyperglycaemia.
- Hospitalisation is recommended for at least 1 week to ensure BGL stabilisation and to provide diabetes education to patient and parents/carers. Introduce the idea of home glucose monitoring in preparation for continuation on discharge. Where feasible, all patients with diabetes should be discharged home with a blood glucose monitor and testing strips.

Recommended regimen options

If the patient has known diabetes and was already under treatment before presenting with DKA, restart same SC insulin regimen as the one followed prior to this DKA event and monitor BGL in hospital for at least 72 hours to allow any necessary modifications to be made. If this is a new presentation of diabetes, begin SC insulin either in basal bolus regimen or 2 times daily dosing regimen, depending on local availability of insulin (see details below).

Basal/long-acting regimen (basal bolus regimen)

- Preferred regimen, where available, as glycaemic control is best achieved using a daily basal dose of **long-acting insulin**[g], supplemented with boluses of **short-acting insulin** before meals.
- **Long-acting insulin** should be administered at the same time every day, preferably in the evening.
- Administer half of the calculated total daily dose as **long-acting insulin** once daily, and half as **short-acting insulin** before meals (3 to 4 times daily):

> Example for 20 kg child:
> Start with 0.3 IU/kg over 24 hours = 6 IU over 24 hours
> Administer 3 IU as **long-acting insulin** once daily and 1 IU of **short-acting insulin** before each of 3 meals.

f Start at lowest dose and increase as necessary during the hospital stay to achieve optimal glycaemic control before discharge.

g Long-acting insulins are not yet readily available in MSF projects but should be used in preference where available.

Twice-daily dosing regimen

- Administration of a mixture of **short-** and **intermediate-acting insulin** together, 2 times daily.
- Each dose should consist of approximately 30% **short-acting** and 70% **intermediate-acting insulin** (see MSF Manual of Nursing Care Procedures, SOP Mixing Insulin: Short and Intermediate-Acting).
- Premixed insulins exist[h] and can simplify administration, however they do not allow for individual adjustment of dose according to patient response and can be more difficult to manage if the child does not have stable and regular access to food[7].
- Administer 2/3 of the calculated total daily dose in the morning (AM) and 1/3 in the evening (PM), before meals:

> Example for 30 kg child:
> Start with 0.3 IU/kg over 24 hours = 9 IU over 24 hours
> Administer 6 IU as **mixed 30-70 insulin** in the morning and 3 IU of **mixed 30-70 insulin** in the evening (before meals).

	Short-acting insulin	Intermediate-acting insulin
Before breakfast	2 IU	4 IU
Before evening meal	1 IU	2 IU

- Adjust insulin dosing according to morning and evening BGL measurements to achieve BGL stabilization prior to discharge (see Table 9.4).
- Where home glucose monitoring is not possible in the twice-daily dosing regimen, consider intermediate acting insulin only.

Table 9.4 - Titration of twice-daily subcutaneous insulin regimen

For children < 35 kg:

	Pre-prandial blood glucose level (BGL)				
	< 80 mg/dL (< 4.5 mmol/L)	80 to 200 mg/dL (4.5-11 mmol/L)	> 200 to 250 mg/dL (> 11-14 mmol/L)	> 250 to 400 mg/dL (> 14-22 mmol/L)	> 400 mg/dL (> 22 mmol/L)
Morning (AM) BGL	Reduce PM insulin dose by 0.05 IU/kg*	No changes	Increase PM insulin dose by 0.05 IU/kg	Increase PM insulin dose by 0.1 IU/kg	Increase PM insulin dose by 0.15 IU/kg
Evening (PM) BGL	Reduce AM insulin dose by 0.05 IU/kg*	No changes	Increase AM insulin dose by 0.05 IU/kg	Increase AM insulin dose by 0.1 IU/kg	Increase AM insulin dose by 0.15 IU/kg

* Consider reducing even more or closely follow up if hypoglycemia is symptomatic or severe.

h Premixed combinations of intermediate and short-acting insulin: INSULIN HUMAN, BIPHASIC 30-70 IU/mL, 10 mL, vial L (Lilly), DINJINSHB1VL; INSULIN HUMAN, BIPHASIC 30-70 IU/mL, 10 mL, vial N (Novo Nordisk), DINJINSHB1VN; INSULIN HUMAN, BIPHASIC 30-70 IU/mL, 10 mL, vial S (Sanofi), DINJINSHB1VS. It is not recommended to switch the patient from insulin type or brand.

For children ≥ 35 kg:

	Pre-prandial blood glucose level (BGL)			
	< 80 mg/dL (< 4.5 mmol/L)	80-200 mg/dL (4.5-11 mmol/L)	> 200-250 mg/dL (> 11-14 mmol/L)	> 250 mg/dL (> 14 mmol/L)
Morning (AM) BGL	Reduce PM insulin dose by 4 IU	No changes	Increase PM insulin dose by 2 IU	Increase PM insulin dose by 4 IU
Evening (PM) BGL	Reduce AM insulin dose by 4 IU	No changes	Increase AM insulin dose by 2 IU	Increase AM insulin dose by 4 IU

9.2.5 Discharge criteria and follow-up

Patients can be discharged when they have been stabilised on subcutaneous insulin, with no hypoglycaemia < 60 mg/dL (3.3 mmol/L) and no hyperglycaemia > 300 mg/dL (> 16.6 mmol/L) for at least 72 hours, and the child and parent/carer have received appropriate education about diabetes and acute management of common complications.

9.3 Hypoglycaemia

Defined as a blood glucose concentration that is too low to maintain normal brain function. Hypoglycaemia cannot be identified by a specific blood glucose level (BGL)[8] as the threshold triggering a neurological response occurs across a range of values. For diagnostic purposes, the cut-off point to treat hypoglycaemia is BGL ≤ 60 mg/dL (3.3 mmol/L).

Hypoglycaemia is a medical emergency and untreated can lead to serious neurological consequences, including irreversible disability[9].

There are many conditions that can cause hypoglycaemia. Common causes include:
- Severe infection (e.g. sepsis, malaria)
- Gastroenteritis (vomiting and/or diarrhoea)
- Dehydration
- Malnutrition
- Lack of dietary intake (e.g. during acute illness)
- Iatrogenic (e.g. incorrect administration of IV fluids, quinine therapy for malaria)
- Incorrect management of a patient with known diabetes
- Intoxication (e.g. alcohol, drugs, traditional remedies)
- Congenital disorders (e.g. adrenal insufficiency, growth hormone deficiency, metabolic disorders)

9.3.1 Clinical features and assessment

Hypoglycaemia presents with nonspecific signs and symptoms and therefore it can be difficult to recognise. A detailed history should address the following information:
- Current medical history, including symptoms that could precipitate hypoglycaemia (e.g. fever, vomiting and/or diarrhoea, including their frequency and duration).
- Symptoms of hypoglycaemia (see below)
- Dietary history to check features of malnutrition
- History of toxin ingestion (see Chapter 2, Section 2.9.1 for reference to list of national poisons centres)
- Past medical history (neonatal history of hypoglycaemia, episodes suggestive of hypoglycaemia as undiagnosed seizure disorder)
- Family history (consanguinity, unexplained infant deaths)

Perform a complete clinical examination, looking for specific symptoms and signs of hypoglycaemia:
- Symptoms: hunger, sweating, palpitations, tremor, anxiety, paraesthesia, poor feeding, headache, nausea
- Signs (associated with more severe hypoglycaemia): Irritability, jitteriness, lethargy, cyanosis, pallor, tachypnoea, hypothermia, weakness, seizures, and coma. (Note that these signs are not specific for hypoglycaemia and may be early manifestations of other disorders, including sepsis, malaria, and respiratory distress syndrome.)

Signs indicative of underlying cause of hypoglycaemia:
- Short stature may indicate growth hormone deficiency. Poor weight gain may be caused by hypopituitarism and primary adrenal insufficiency.
  Check weight and length/height: plot on a growth chart.

– Midline defects (e.g. a single central incisor, cleft lip or palate, umbilical hernia) and microphallus or undescended testicles in boys may indicate hypopituitarism and/or growth hormone deficiency.
– Hepatomegaly is common feature of some metabolic disorders.
– Hyperpigmentation suggests primary adrenal insufficiency.

Check BGL on admission of all severely sick children, or at any time during admission if there is clinical deterioration, or lack of intake.
Where BGL is not available, treat for hypoglycaemia if clinically suspected to avoid adverse consequences.
In malaria-endemic regions, perform a malaria rapid test.

9.3.2 Management

Treatment of hypoglycaemia varies with the degree of hypoglycaemia and the associated symptoms.

For children with an altered level of consciousness:
– Assess and manage ABCDE (see Chapter 2, Section 2.1).
– Obtain IV or IO access.
– Administer 2 mL/kg bolus of **glucose** (**dextrose**) **10%** IV/IO over 2 to 3 minutes (do not use undiluted glucose (dextrose) 50%[a]). If there is a delay in obtaining IV/IO access, administer 10 mL/kg of **glucose** (**dextrose**) **10%** via NGT (sit the child upright).
– After the bolus, in non-malnourished children, start IV maintenance fluids with **glucose** (**dextrose**) **5%/Ringer lactate** (**G5%/RL**), unless already on maintenance **G5%/RL**, in which case increase maintenance to **glucose** (**dextrose**) **10%/Ringer lactate** (**G10%/RL**).
– Repeat BGL in 30 minutes: if still hypoglycaemic repeat IV bolus of 2 mL/kg **glucose** (**dextrose**) **10%** and, in non/malnourished children, increase maintenance to **G10%/RL**.

For children who are conscious, able to drink and swallow safely, give treatment orally:
– Give a sugar-containing drink or snack by mouth, such as: 1 to 2 teaspoons of table sugar moistened with water, or 60 mL fruit juice, milk, therapeutic milk (if SAM) or breast milk, or 5 to 10 mL honey (only if > 1 year old), or 10 mL/kg of **glucose** (**dextrose**) **10%** orally or via NGT (with child in semi-sitting position), or 1 mL/kg of **glucose** (**dextrose**) **50%** under the tongue.
– Feed the child as soon as possible.
– Repeat BGL in 15 to 30 minutes: if the child is still hypoglycaemic, administer 2 mL/kg bolus of **glucose** (**dextrose**) **10%** IV and start IV maintenance fluids with **G5%/RL**.

If recurrent hypoglycaemia AND adrenal insufficiency is suspected, check the electrolytes if available, and consider **hydrocortisone** 5 mg/kg IV (max 100 mg).

Monitoring

– Repeat BGL every 30 minutes until BGL is stable between 70 and 120 mg/dL (3.9 to 6.7 mmol/L) for two subsequent measurements.
– Thereafter, check BGL every 2 to 3 hours until it is stable for another two consecutive measurements.

a Glucose (dextrose) 50% (G50%) solution is too viscous and irritant to be used in children. Where glucose (dextrose) 10% (G10%) solution is not available, remove 100mL of glucose (dextrose) 5% (G5%) from a 500mL bottle or bag, then add 50 mL of G50% to the remaining 400 mL of G5% to obtain 450 mL of G10% solution.

References Chapter 9

1. Levitsky LL, Misra M. Epidemiology, presentation, and diagnosis of type 1 diabetes mellitus in children and adolescents. *UpToDate*. Published January 2023. https://www.uptodate.com/contents/epidemiology-presentation-and-diagnosis-of-type-1-diabetes-mellitus-in-children-and-adolescents
2. World Health Organization. *Classification of Diabetes Mellitus*. World Health Organization; 2019. Accessed October 24, 2023. https://iris.who.int/handle/10665/325182
3. Usher-Smith JA, Thompson M, Ercole A, Walter FM. Variation between countries in the frequency of diabetic ketoacidosis at first presentation of type 1 diabetes in children: a systematic review. *Diabetologia*. 2012;55(11):2878-2894. https://doi.org/10.1007/s00125-012-2690-2
4. BSPED |BSPED DKA Guidelines. Accessed October 24, 2023. https://www.bsped.org.uk/clinical-resources/bsped-dka-guidelines/
5. Lawrence SE, Cummings EA, Gaboury I, Daneman D. Population-based study of incidence and risk factors for cerebral edema in pediatric diabetic ketoacidosis. *J Pediatr*. 2005;146(5): 688-692. https://doi.org/10.1016/j.jpeds.2004.12.041
6. Wolfsdorf JI, Glaser N, Agus M, et al. ISPAD Clinical Practice Consensus Guidelines 2018: Diabetic ketoacidosis and the hyperglycemic hyperosmolar state. *Pediatr Diabetes*. 2018;19:155-177. https://doi.org/10.1111/pedi.12701
7. ISPAD, LFAC, IDF. *Pocket Book for Management of Diabetes in Childhood and Adolescence in Under-Resourced Countries*. 2nd ed. International Diabetes Federation; 2017. Accessed October 24, 2023. https://www.ispad.org/page/ISPADIDFLFaC
8. Thornton PS, Stanley CA, Leon DDD, et al. Recommendations from the Pediatric Endocrine Society for Evaluation and Management of Persistent Hypoglycemia in Neonates, Infants, and Children. *J Pediatr*. 2015;167(2):238-245. https://doi.org/10.1016/j.jpeds.2015.03.057
9. Leon-Crutchlow DDD, Lord K. Approach to hypoglycaemia in infants and children. *UpToDate*. Published May 2022. https://www.uptodate.com/contents/approach-to-hypoglycemia-in-infants-and-children

Chapter 10: Haematology

10.1 Anaemia

Anaemia is defined as a haemoglobin (Hb) level below the age-specific reference value (see Table 10.1). Severe anaemia is defined as Hb < 6 g/dL for children over 2 months of age[a].

Table 10.1 - Definition of anaemia[1]

Age	Hb level defining anaemia
< 2 months	< 13.5 g/dL
2 to < 6 months	< 9.5 g/dL
6 to 59 months	< 11 g/dL
5 to 11 years	< 11.5 g/dL
12 to 14 years	< 12 g/dL
15 years and above	< 12 g/dL (girls) < 13 g/dL (boys)

Anaemia can result from a reduction in red blood cell production, blood loss, or increased haemolysis (see Table 10.2). In tropical settings, the causes are often multiple and overlapping e.g. malnutrition and malaria.

In infants < 1 year of age, causes can be congenital, including:
- Maternal malaria and HIV: both cause IUGR, which is associated with anaemia.
- Maternal iron deficiency during pregnancy
- Preterm delivery
- Haemoglobinopathies and G6PD deficiency

Table 10.2 - Causes of anaemia

Decreased red blood cell production	Loss of red blood cells	Increased red blood cell destruction (haemolysis)
Iron deficiency Malnutrition Micronutrient deficiencies (folic acid, vitamin B_{12}, vitamin A) Depressed bone marrow function Chronic infections (e.g. HIV, visceral leishmaniasis) Renal failure	Acute haemorrhage (trauma, GI bleeding) Chronic parasitic diseases (hookworm, schistosomiasis)	Malaria Bacterial and viral infections Haemoglobinopathies Sickle cell disease (SCD) Thalassaemia Certain drugs if G6PD deficiency (primaquine, dapsone, co-trimoxazole) Injectable artesunate (delayed haemolysis)[b]

a For definition of severe anaemia in infants less than 2 months, see MSF Neonatal Care guidelines.

b Post-artemisinin delayed haemolysis (PADH) is a rare phenomenon which can occur 1-3 weeks after initiation of treatment with injectable artesunate. Clinicians should be aware of this potential complication.

10.1.1 Clinical features and history

- Symptoms include lethargy, pallor, fatigue, dizziness, shortness of breath, poor feeding or irritability in infants.
- Clinical signs include:
  - Pallor of the conjunctivae, lips, mucous membranes, nail beds, palms of hands and soles of feet
  - Dyspnoea, tachycardia, cardiac murmur
- Clinical signs of decompensation due to severe anaemia are one or more of:
  - Increased work of breathing (see Chapter 4, Section 4.1.1)
  - Altered level of consciousness (see Chapter 7, Section 7.5.1)
  - Circulatory impairment/shock (see Chapter 2, Section 2.2.1)
- Specific signs to help identify the underlying diagnosis, consider:
  - Signs of malaria, including splenomegaly
  - Evidence of active bleeding: bloody stools, haematemesis, melaena, haematuria, epistaxis
  - Indications of intravascular haemolysis: dark coloured urine, jaundice, hepatosplenomegaly
  - Suspicion of sickle cell disease: maxillary protrusion, splenomegaly, frontal and parietal bossing
  - Suspicion of thalassaemia: maxilla hyperplasia, flat nasal bridge, frontal bossing
  - Signs of malnutrition or micronutrient deficiency (cheilosis, glossitis)
  - Signs of sepsis or other acute infection
  - Suspicion of visceral leishmaniasis (kala azar): fever, splenomegaly, lymphadenopathy and wasting

With chronic or recurrent anaemia, children may have no or few symptoms or signs compared to children presenting with acute anaemia with the same Hb value, due to the body's capacity to compensate for anaemia over time.

Take a history, examine the child and perform relevant investigations to identify the underlying cause of anaemia. Consider specifically asking about:
- Medical history including previous episodes of anaemia, transfusions, sickle cell disease, thalassaemia, HIV, TB, malaria, treatment for worms, etc.
- Birth history (gestational age at birth, any neonatal jaundice/anaemia).
- Recent medication, including recent artesunate injections, traditional medicines, or any exposure to toxins.
- Diet and nutritional status.
- Menstrual history for adolescent girls.
- Family history of sickle cell disease, TB, HIV, thalassaemia, other.
- Consider asking if the child has any unusual eating habits of non-food products, e.g. dirt, paper, uncooked rice. This condition, described as pica, may be more common in children with learning or developmental disabilities and sickle cell disease, and is associated with iron-deficiency anaemia.

Investigations

- Hb
- Full blood count (FBC), if available
- In malaria-endemic regions, malaria RDT or thick and thin blood films

– If sickle cell anaemia suspected, the following tests should be done before blood transfusion[c] (see also Section 10.2):
  • Sickle scan (lateral flow RDT that can detect both sickle cell disease and trait)
  • Emmel test if sickle scan not available (ideally confirmed by electrophoresis, where available)
– Blood group and crossmatch (in case of need for transfusion), including mothers' blood group for infants less than 4 months[d].

10.1.2 Management

Anaemia itself may not always require treatment. Management of the underlying cause or condition resulting in anaemia may likely correct anaemia, and a blood transfusion is often not necessary in a clinically stable child.

Indications for blood transfusion (excluding infants < 2 months[e]):
– Profound anaemia: Hb < 4 g/dL, or
– Complicated severe anaemia: Hb ≥ 4 and < 6 g/dL with one or more signs of decompensation:
  • Increased work of breathing (see Chapter 4, Section 4.1.1)
  • Altered level of consciousness (see Chapter 7, Section 7.5.1)
  • Circulatory impairment/shock (see Chapter 2, Section 2.2.1)
– Complicated severe anaemia: Hb ≥ 4 and < 6 g/dL with evidence of ongoing blood loss:
  • Haemoglobinuria (indicating intravascular haemolysis)[2]
  • Visible bleeding (external bleeding, haematemesis, melaena, haematuria)

Note that malaria, sickle cell disease (SCD) and sepsis are not considered to be independent anaemia severity criteria in otherwise stable children, therefore are not indications for transfusion unless accompanied by one of the complications outlined above. See relevant chapters for specific transfusion criteria for children with circulatory impairment/shock (Chapter 2, Section 2.2.3) and certain complications of SCD (Section 10.2), as these may differ from the above.

Infants < 2 months of age with anaemia should be managed as for neonates, see MSF Neonatal Care Guidelines.

Initial management

– Stop any major or evident bleeding or haemorrhage (see Chapter 2, Section 2.7).
– Assess and manage ABCDE; resuscitate and stabilise (refer to Chapter 2, Section 2.1).
– Check Hb and identify any clinical signs of severity.
– Take blood for group and save, or crossmatching if transfusion required (see below).
– If history of previous transfusions or any indication of SCD, take a blood sample for testing before transfusion[c].
– Administer oxygen if clinical signs of severity, aiming for saturations ≥ 94%.
– Check axillary temperature, weight/age.

c Tests for SCD can give false results if performed within 8 weeks of a blood transfusion.

d Blood should be compatible with both the infant's and the mother's ABO and Rh group until 4 months of age (see MSF Neonatal Care guidelines for more detail).

e Young infants < 2 months of age have a significantly higher normal Hb than older infants (see Table 10.1 page 299) therefore transfusion thresholds are higher. In this age group, transfusion should be considered if Hb less than 8 g/dL in term neonates (less than 7 g/dL in preterm neonates) or if Hb less than 10 g/dL with clinical signs of intolerance to anaemia.

Profound anaemia (Hb < 4 g/dL) or complicated severe anaemia (Hb 4 - < 6 g/dL with signs of decompensation or ongoing blood loss[f])

- Urgent blood group and crossmatch (if not already done), including mothers' blood group for infants less than 4 months[g].
- Start treatment of underlying cause (e.g. malaria).
- Administer **blood transfusion**[h], calculating volume according to the presence or absence of fever[2], as follows:
  - No fever (≤ 37.5 °C) from the time of ordering blood to the time of transfusion[i]: administer 30 mL/kg **whole blood** over 4 hours or 15 mL/kg **packed red blood cells** (**PRBC**) over 3 hours.
  - Fever (> 37.5 °C) at any point from the time of ordering blood to the time of transfusion[i]: administer 20 mL/kg **whole blood** over 4 hours or 10 mL/kg **PRBC** over 3 hours.
- Depending on volume required, transfusion rate may exceed the usual recommendation of maximum 5 mL/kg/hr. Use one or more adult units of **whole blood** or **PRBC**. See MSF Manual of Nursing Care Procedures, SOP Paediatric Transfusion Set – Blood burette and SOP Using a Syringe Pump for Small Volume Blood Transfusions for more details on paediatric transfusion administration.
- Monitor children closely during transfusion for any transfusion reaction and for signs of overload, especially malnourished children who are at increased risk of fluid overload.
- Recheck Hb routinely once between 8-24 hours after the transfusion is complete[3], or at any other time if ongoing signs of decompensation or blood loss once transfusion is complete.
- Depending on the Hb level and signs of decompensation and/or ongoing blood loss (as above) repeat transfusion may be necessary. Check for signs of fluid overload before starting another transfusion - furosemide between transfusions is not indicated unless signs of fluid overload are present.

Uncomplicated severe anaemia (Hb 4 - < 6 g/dL with no signs of decompensation or ongoing blood loss)

- Admit for close monitoring:
  - Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
  - Review specifically for features of complicated severe anaemia that are indications for transfusion (see above) at 4, 8, 16, 24, 36 then 48 hours.
  - Repeat Hb at 8, 24 and 48 hours.
- Blood grouping (including mothers' blood group for infants less than 4 months[h]) and save sample in the lab for later crossmatching in case transfusion is needed.
- Start treatment of underlying cause (e.g. start malaria treatment if malaria test positive.)
- If Hb remains between 4 - < 6 g/dL, continue close monitoring, as above.
- If child develops any of the severity features or Hb decreases to < 4 g/dL, administer a **blood transfusion**, with volume dependent on presence or absence of fever as outlined above. Continue close clinical monitoring, as above.

f These criteria do not apply in haemorrhagic shock, for which transfusion volumes are different (see Chapter 2, Section 2.5).

g Blood should be compatible with both the infant's and the mother's ABO and Rh group until 4 months of age (see MSF Neonatal Care guidelines for more detail).

h Always ensure bedside verification of ABO compatibility immediately before transfusion using an ABO testing card.

i Ensure temperature is checked and recorded at the time of ordering blood and immediately prior to transfusion as a minimum.

– If Hb increases to > 6 g/dL, continue with treatment of underlying cause and observation.
– Once clinically stable, consider iron and folic acid supplementation (see below).

Although malaria is by far the principal cause of severe anaemia in most MSF contexts, outside of malaria-endemic regions the main causes of severe anaemia may be diverse. For anaemia associated with burns, trauma or surgery follow specific guidance (See Chapter 2, Section 2.7 for trauma). If the child has known sickle cell disease with complications such as acute chest crisis, acute splenic sequestration or cerebral vascular accident, see Section 10.2.

Iron supplementation

Start empiric treatment with **iron** supplementation in all children with anaemia where the underlying cause is not evident[j] and continue for 3 months:
– **Iron** combined with **folic acid** is the preferred option where available. Doses are expressed in **elemental iron**[k]:
  • 1 month to < 6 years: 1.5 to 3 mg/kg two times daily
  • 6 to < 12 years: 65 mg two times daily
  • ≥ 12 years: 65 mg two to three times daily
– In the case of moderate or severe anaemia, start iron only once the child is clinically stable as it can exacerbate infection during acute illness. **Folic acid** alone can be started in the meantime:
  • < 1 year old: 2.5 mg once daily
  • ≥ 1 year old: 5 mg once daily
– In endemic regions for hookworms, treat with **albendazole** in children over 6 months old prior to commencing iron:
  • Weight < 10 kg: 200 mg as a single dose
  • Weight ≥ 10 kg: 400 mg as a single dose
– In malaria-endemic areas, iron combined with folic acid should only be given where malaria prevention programmes and antimalarial treatments are widely available[l].
– For children with SAM, see specific dosing in Section 10.1.3.

10.1.3 Specific considerations in children with SAM

Indications for blood transfusion and transfusion volumes are the same for children with or without severe acute malnutrition (SAM), however children with SAM are more susceptible to volume overload therefore should be very carefully monitored.

For children with SAM admitted with moderate or severe anaemia and receiving ready to use therapeutic food (RUTF), give **iron/folic acid** PO at discharge from ITFC[m]:
– Weight > 8 kg: 1/2 tablet once daily
– Weight ≤ 8 kg: none needed as there is enough iron and folic acid in RUTF.

j *Note*: Iron is contraindicated in a child who has known or suspected SCD, thalassaemia, or has received multiple transfusions within a year.

k 140 mg/5ml syrup contains approximately 45 mg/5ml of elemental iron; 200 mg tablets of ferrous fumarate or ferrous sulfate (with or without folic acid) contain approximately 65 mg or elemental iron (+/- 400 micrograms of folic acid).

l Iron-folate supplementation increases the risk of clinical malaria in malaria-endemic areas where neither prevention nor antimalarial treatments are available.

m Treatment is different to children without SAM to adjust for micronutrients contained in RUTF.

10.2 Sickle cell disease

Sickle cell disease (SCD) is a genetic disorder producing an abnormal variant of the adult haemoglobin (Hb). The abnormal haemoglobin (HbS) results in distortion of the red blood cells into a classic 'sickle' shape, in response to a variety of triggers including dehydration, hypoxia, infection and increased temperature[4]. This leads to increased destruction of red blood cells (haemolysis), an increase in blood viscosity and obstruction of capillaries (causing vaso-occlusive events)[5]. In SCD, the child inherits an HbS gene from at least one parent, and another abnormal haemoglobin variant from the other parent (such as HbC or Hb beta thalassemia). Sickle cell anaemia (HbSS), the most common and most severe form of SCD, occurs when a child inherits an HbS gene from each parent.

Global data is lacking, but SCD is estimated to affect around 300,000 children born per year[6]. It is most prevalent in sub-Saharan Africa (affecting up to 3% of births), though also present amongst children born of Mediterranean (including Middle East region) and Indian origin[7]. The highest prevalence of sickle cell anaemia is in the malaria-endemic zones of sub-Saharan Africa, where it contributes significantly to under-5 deaths[8].

Sickle cell trait occurs when a child inherits a sickle gene from one parent and a normal gene from the other parent; carriers are usually asymptomatic.

10.2.1 Clinical features

- Symptoms usually begin around 4 to 6 months of age. Early manifestation: dactylitis (painful swelling of digits of hands and feet).
- Major signs: recurrent painful crises (See Section 10.2.2), chronic anaemia, splenomegaly and frequently, growth retardation and malnutrition.
- Life-threatening complications: stroke, severe bacterial infections, acute chest syndrome.
- Take a detailed history including a family history of similar clinical signs and perform a comprehensive clinical examination. Assess for history of, or presence of, any acute or chronic complications (refer to Table 10.3).

Table 10.3 - Acute and chronic complications of SCD

Acute complications	Chronic complications
Acute painful crisis Acute bacterial infections, particularly acute severe pneumonia and sepsis Acute chest syndrome Acute splenic sequestration Aplastic crisis Priapism Acute central nervous system events e.g. cerebral vascular accident Acute hepatic ischemia and/or sequestration	Cardiomyopathies, myocardial infarction, arrhythmia Chronic compensated haemolytic anaemia Haematuria, proteinuria leading to renal failure Chronic cholelithiasis and liver disease Retinopathy Leg ulcers Bone infarction and necrosis Sickle cell chronic lung disease Neurocognitive deficit Growth failure and delayed puberty

Investigations

- Hb
- FBC and reticulocyte count, if available
- Consider blood group and crossmatch
- In malaria-endemic regions, malaria RDT
- Diagnosis of SCD:
  - All testing must be done either on blood taken prior to transfusion or at least 8 weeks after the last transfusion.
  - Sickle Scan (lateral flow RDT that can detect both sickle cell disease and trait) is recommended as first line point-of-care test. A positive Sickle Scan result is enough to make the diagnosis, electrophoresis is not necessary to confirm the diagnosis unless required by national guidelines.
  - Emmel test can be performed as a screening test if Sickle Scan is not available. A positive Emmel test does not confirm the diagnosis of SCD due to low sensitivity and specificity and inability to differentiate between sickle cell trait and disease. Confirmation using Hb electrophoresis is recommended, where available.
  - Hb electrophoresis is the gold standard diagnostic tool, but is often unavailable.

10.2.2 Acute painful or vaso-occlusive crisis (VOC)

- Painful crises are the most common type of vaso-occlusive events.
- Common triggers include infection, emotional stress, exposure to cold or high altitude, dehydration.
- Severity and duration of pain can vary from minor, lasting minutes, to severe, lasting days.
- Pain is usually of rapid onset, deep, gnawing or throbbing, and can be accompanied by localised tenderness, erythema, warmth and swelling.
- Commonly affects: lumbosacral spine, knee, shoulder, elbow and femur.
- Dactylitis is a variant of VOC; very common in children up to 4 years of age. It can occur as early as 6 months of age[9] and as many as 45% of infants and toddlers will have dactylitis by 2 years of age.
- Many painful crises can be managed at home, with adequate analgesia[4].

Management

- Assess and stabilise ABCDE.
- Assess pain severity and start analgesia without delay, ideally within 30 minutes of arrival[4,9] (see Chapter 15, Section 15.4).
- Admit if pain is uncontrolled, or moderate to severe and requiring opioid analgesia.
- Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
- Administer oxygen if oxygen saturation in air is ≤ 95%[4,9].
- Evaluate for dehydration and ensure adequate hydration:
  - Encourage drinking fluids. If the patient is not able to drink, start IV **maintenance fluids** until oral intake has improved (see Chapter 15, Section 15.2). Consider NGT if IV access is difficult or refused.
  - Correct any dehydration (see Chapter 5, Section 5.3).
- If fever present (> 37.5 °C), manage as for febrile illness below.
- Blood transfusion is not routinely indicated unless there are other clinical indications for transfusion (see Section 10.1.2).

– Encourage deep breathing exercises (see Section 10.2.4).
– Consider osteomyelitis as an alternative diagnosis if there are local signs of pain and inflammation persisting for > 48 to 72 hours despite treatment for VOC. Refer to Chapter 11, Section 11.4 for management of osteomyelitis.

10.2.3 Febrile illness

While sickle cell trait is known to confer partial protection against malaria, children with SCD are more susceptible to severe malaria and invasive bacterial infections (pneumonia, cellulitis, meningitis, osteomyelitis, and sepsis) due to a poorly functioning spleen and weakened immune response[9]. Unvaccinated or partially vaccinated children are particularly at risk for invasive infections due to *H. influenzae*, *S. pneumoniae*, and meningococcus, and SCD increases susceptibility to infection by *Salmonella* spp[10]. All children with SCD presenting with fever should be carefully assessed for these complications and should be systematically treated with antibiotics.

Management

– In addition to admission based on clinical condition, admit to hospital all children with known SCD or suspected SCD and any of the following criteria:
  • Age < 2 years
  • Fever of ≥ 38.5 °C
  • Presence of acute anaemia (fall of 2 g/dL below patient's baseline Hb value, or Hb < 6 g/dL where baseline unknown[9]).
  • Signs of acute haemolysis, splenic sequestration or other co-existing complications.
– Assess and stabilise ABCDE.
– Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
– Treat presumed bacterial infection according to likely cause (all patients with SCD who present with fever should be started on antibiotics):
  • Pneumonia: refer to Chapter 4, Section 4.5.
  • Meningitis: refer to Chapter 3, Section 3.3.
  • Acute osteomyelitis: refer to Chapter 11, Section 11.4.
  • Unknown source of infection or sepsis: refer to Chapter 3, Section 3.2.
– Evaluate for dehydration and ensure adequate hydration:
  • Encourage drinking fluids. If the patient is not able to drink, start IV maintenance fluids until oral intake has improved (see Chapter 15, Section 15.2). Consider NGT if IV access is difficult or refused.
  • Correct any dehydration (see Chapter 5, Section 5.3).
– If malaria RDT positive, treat malaria in addition to bacterial infection.
– Treat pain if present.
– Monitor for the appearance of acute anaemia.
– Change to oral antibiotics once the patient shows signs of improvement (afebrile, can eat and drink) and discharge home to complete oral treatment.
– Complete oral antibiotic treatment in hospital if:
  • Less than 2 years old
  • Presence of acute anaemia (fall of 2 g/dL below patient's baseline Hb value, or Hb < 6 g/dL where baseline unknown[9].

10.2.4 Acute chest syndrome (ACS)

Acute chest syndrome (ACS) is caused by vaso-occlusion in the pulmonary vasculature, often triggered by infection, which causes sickling of red blood cells and ischaemia. It is a common reason for presentation to hospital in children with SCD and is often preceded by a peripheral VOC. ACS can vary in severity from mild to life-threatening, and patients can deteriorate rapidly therefore require close monitoring[11].

- Leading cause of death in adolescents.
- More frequent in children with asthma or previous ACS.
- Symptoms and signs include chest pain, cough, fever, wheeze, tachypnoea, respiratory distress, hypoxia (SpO_2 < 95%). Children are less likely to complain of chest pain and breathlessness than adults[11].
- Can develop suddenly or insidiously.

Management

- Assess and stabilise ABCDE.
- Admit to hospital.
- Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
- Assess regularly for severe anaemia and bronchospasm.
- Administer **oxygen** via face mask, aiming for SpO_2 between 94 - 98%.
- Ensure adequate hydration as for VOC. If oral intake is insufficient, start IV **maintenance fluids** (see Chapter 15, Section 15.2) while monitoring for fluid overload. If signs of fluid overload, administer one dose of furosemide IV.
- Give adequate pain relief (see Chapter 15, Section 15.4).
- Ensure deep breathing exercises focusing on the inspiration phase (alveolar distension, e.g. with an incentive spirometer) every 1 to 2 hours while awake.
- Administer antibiotic treatment even if no fever present:

> **ceftriaxone** IV for 7 to 10 days:
> 50 to 80 mg/kg (max. 4g if < 50 kg; max. 2g if ≥ 50 kg) every 24 hours
>
> + **azithromycin** PO 10 mg/kg once daily for 5 days.
> Alternative to azithromycin: **erythromycin** PO 10 mg/kg 4 times daily for 10 days.

- If clinical signs of wheezing and bronchoconstriction, treat as per asthma management guidance (Chapter 4, Section 4.10).
- Administer **blood transfusion** (see Section 10.1.2) if acute anaemia present (see Section 10.2.5).
- Consider referral for exchange transfusion[a] in symptomatic severe ACS (defined as oxygen saturation < 90% despite supplemental oxygen)[9,12].

10.2.5 Acute anaemia in SCD

Nearly all people with SCD have chronic anaemia, with typical baseline Hb values of 6-8 g/dL for HbSS, 10-15 g/dL for HbSC and 9-12 g/dL for HbS-beta thalassemia[9]. Chronic anaemia is well tolerated and does not routinely require transfusion in an otherwise stable child. Repeated unnecessary blood transfusions should be avoided as they increase the risk of transfusion reactions, iron overload and alloimmunisation.

a The goal of exchange transfusion is to reduce circulating levels of HbS to relieve symptoms, rather than to treat anaemia.

Chronic anaemia is often complicated by acute anaemia, defined in SCD as a drop in Hb of 2 g/dL below baseline, or Hb < 6 g/dL if baseline is unknown. Acute anaemia may require transfusion depending on the cause and severity.

– Causes: acute severe intravascular haemolysis (often secondary to malaria with fever, haemoglobinuria (dark urine) and yellow conjunctivae), splenic sequestration, or aplastic crisis.
– Clinical features: increasing fatigue, pallor of conjunctivae and palms, shortness of breath, tachycardia or heart failure.

Management

– Assess and stabilise ABCDE.
– Admit to hospital.
– Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
– Treat malaria if present.
– Assess for complications of SCD.
– In addition to standard transfusion criteria (see Section 10.1.2), administer **blood transfusion**[b] for the following complications of SCD presenting with acute anaemia (a drop in Hb of 2 g/dL below baseline, or Hb < 6 g/dL if baseline is unknown)[9]:
  • Acute splenic sequestration (see Section 10.2.6)
  • Symptomatic ACS (see Section 10.2.4)
  • Cerebral vascular accident (stroke) (see Section 10.2.8)
– If blood transfusion required, transfuse according to guidance in Section 10.1.2.
– Monitor Hb at 24 and 48 hours. Further transfusions may be necessary if haemolysis is ongoing.
– If blood transfusion not required but Hb 4 - < 6 g/dL, monitor closely according to advice in Section 10.1.2.

10.2.6 Splenic sequestration

– Sudden, rapid and massive enlargement of the spleen, with trapping of a considerable portion of the red-cell mass. Mostly in children 1 to 4 years.
– Examination: sudden enlargement of spleen, severe left upper quadrant pain. Child becomes suddenly weak, pale, short of breath with a rapidly distending abdomen, and shock.
– Investigations, if available, show a sharp decline in Hb level (drop of at least 2 g/dL), reticulocytosis (distinguishing it from aplastic crisis) and thrombocytopenia.

Management

– Assess and stabilise ABCDE.
– If signs of circulatory impairment or shock, see Chapter 2, Section 2.2.
– Admit to hospital.
– Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
– Blood group and crossmatch; order blood.
– Administer **blood transfusion** (see Section 10.1.2 and Section 10.2.5).

b Consider referral for exchange transfusion in symptomatic severe ACS (defined as oxygen saturation < 90% despite supplemental oxygen) and cerebral vascular accident (stroke) to reduce circulating HbS[9,12].

– Monitor the size of the spleen.
– Administer IV antibiotics if fever (see Section 10.2.3).
– After clinical improvement, monitor for relapse (Hb, size of spleen) and repeat transfusion as necessary according to standard transfusion criteria (see Section 10.1.2).

10.2.7 Aplastic crisis

– Transient suspension of red blood cell production by the bone marrow: impalpable spleen and absence of reticulocytes.
– Gradual onset of fatigue, shortness of breath and sometimes syncope (sudden and brief loss of consciousness associated with loss of postural tone and spontaneous recovery). Fever is quite common.
– Often occurs in several people in the same family at the same time, indicating a possible infectious cause.
– Examination may reveal signs of decompensation.
– Hb is usually far below the patient's baseline level, and the reticulocyte count is reduced or even zero.
– Erythropoiesis usually begins 7-10 days after aplasia, with gradual recovery of Hb.

Management

– Assess and stabilise ABCDE.
– Admit to hospital.
– Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
– Treat malaria or associated bacterial infection if present.
– Administer **blood transfusion** only if standard transfusion criteria present (see Section 10.1.2)
– Repeat Hb every other day. An increasing reticulocyte count and a gradual increase of the Hb indicates improvement. Monitor patient until their baseline Hb has been reached.

10.2.8 Stroke

Sudden onset of weakness, impairment of language and sometimes seizures or coma and results in adverse motor and cognitive sequelae. It is secondary to stenosis or occlusion of the internal carotid or middle cerebral artery, but acute chest syndrome, acute aplastic crisis or other acute anaemic events may precipitate events.

Management

– Assess and stabilise ABCDE.
– Admit to hospital.
– Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
– Administer **blood transfusion** (see Section 10.1.2) if acute anaemia present (see Section 10.2.5).
– Consider referral for exchange transfusion[c], which is the treatment of choice for ischaemic stroke in SCD[9,12].

c The goal of exchange transfusion is to reduce circulating levels of HbS to relieve symptoms, rather than to treat anaemia.

– Transfer the patient to a specialized facility for further management (including prophylactic therapy to prevent recurrences with transfusion programme, hydroxyurea).
– If the patient is awaiting transfer or if transfer is not possible:
  • Oxygen continuously, to maintain the SpO_2 > 94%.
  • Treat seizures if present.
  • After transfusion administer IV **maintenance fluids** for hydration (see Chapter 15, Section 15.2).

10.2.9 Priapism

– Sustained, unwanted, painful erection lasting several hours.
– Usually affects teenagers and adults but may affect younger boys.
– Prompt recognition and initiation of conservative medical management may resolve the swelling and limit the need for more aggressive and invasive intervention. Delayed diagnosis and treatment can result in necrosis and irreversible erectile dysfunction.

Ambulatory management

Ensure children know how to manage priapism early at home to prevent severe acute priapism.
– Home measures include:
  • Drinking fluids
  • Application of warm compresses
  • Gentle exercise, e.g. walking
  • Regular urination
  • Attempting ejaculation
  • Pain control
– Seek hospital care if erection lasts for longer than 2 hours.
– Consult clinician if episodes of intermittent priapism occur more than two times per month.

Hospital management of severe acute priapism

– Give adequate pain relief (see Chapter 15, Section 15.4).
– Encourage oral hydration as for a VOC; IV **maintenance fluids** if necessary and treat dehydration if present.
– Encourage all above ambulatory measures, if pain allows.
– For priapism lasting > 4 hours: refer for surgical management.

10.2.10 Prevention of complications

Provide information and education to child and parents/carers regarding regular follow-up, preventive treatments, the importance of adequate nutrition, and prompt pain management when needed. Ensure regular psychosocial assessment and the provision of support when necessary.

Education of children and their families:

Basic knowledge	
• Disease • Treatment • Monitoring	Chronic, necessarily transmitted by both parents, non-contagious. Routine (see below) and symptomatic (pain). Size of the spleen, temperature, baseline Hb.

Major precipitating factors of a painful crisis and how to prevent them	
• Cold	Wear warm clothing, avoid bathing in cold water.
• Excessive heat	For example, avoid going out at midday.
• Tight clothing	Wear wide comfortable clothing without elastics.
• Dehydration	Drink plenty of fluids.
• Excessive effort	Moderate physical activity is beneficial.
• Infections	Follow routine treatments (including vaccination).

Principal complications requiring the patient to seek urgent medical advice

- Pain unresponsive to analgesia after 24 hours or severe from the start.
- Any fever (do not treat at home).
- Respiratory problems (cough, difficulty breathing, chest pain).
- Diarrhoea/vomiting and inability to drink.
- Dehydration (dark, infrequent urine).
- Anaemia (pale or yellow conjunctivae, pale palms, enlarged spleen).

Routine follow-up

– Between crises, regular OPD consultations every 1 to 3 months (until 4 years of age), then every 3 to 6 months for 5 years of age and above:
  - Assess for chronic complications (see Table 10.3).
  - Ensure adherence to regular medications and that immunisations are up to date.
  - Check nutritional status and psychosocial situation.
  - Ensure reproductive counselling for girls of reproductive age (increased risk of VOC during pregnancy/childbirth, higher incidence of intrauterine growth restriction, foetal and perinatal loss and pre-eclampsia).
– After a crisis: as often as necessary, according to the clinical course.
– Paracetamol for home use in case of pain.

Routine preventative care

– Ensure routine immunisations are up-to-date or missed doses are completed:

Children < 5 years	• DTP, hepatitis B, polio, measles, *H. influenzae* type B vaccines • Pneumococcal conjugate vaccine (PCV13 or, if not available, PCV10) • Meningococcal conjugate vaccine in endemic areas • At 2 years: pneumococcal 23-valent polysaccharide vaccine, at least 8 weeks after the last PCV13 or PCV10.
Children ≥ 5 years	• DTP or Td, hepatitis B, polio, measles, *H. influenzae* type B vaccines • Pneumococcal conjugate vaccine (PCV13 or, if not available, PCV10) • Meningococcal conjugate vaccine in endemic areas

– Prevention of pneumococcal infections:

phenoxymethylpenicillin (**penicillin V**) PO until age 15 (as a minimum until age 5)
- 1 month to < 1 year: 62.5 mg 2 times daily
- 1 to < 5 years: 125 mg 2 times daily
- ≥ 5 years: 250 mg 2 times daily

Alternatively:
amoxicillin PO
- 1 month to < 5 years: 125 mg 2 times daily
- 5 to < 12 years: 250 mg 2 times daily
- ≥ 12 years: 500 mg 2 times daily

– Support of red blood cell production:

folic acid PO (life-long treatment)
- < 1 year: 2.5 mg once daily
- ≥ 1 year: 5 mg once daily

Note: iron is contraindicated in patients who have received multiple transfusions. Avoid combined preparations of iron and folic acid in children with SCD.

– Malaria prevention (for areas with moderate to high transmission):
  - Malaria infection in children with SCD is one of the most common causes of VOC.
  - Children with SCD have increased susceptibility to severe malaria[d].
  - Malaria in children with SCD further increases the risk of invasive bacterial infection.
  - All patients should be given a long-lasting insecticidal net (LLIN) at diagnosis.
  - As first choice in areas with malaria that occurs throughout the year, **mefloquine** is recommended for children under 5 years old. Prophylaxis may also be considered in children over 5 years, though evidence of benefit in this age group is lacking:

    mefloquine PO
    > 6 months and > 5 kg: 5 mg base/kg (max. 250 mg) once weekly
    Do not use to treat malaria.

  - In areas with variations in malaria transmission, seasonal malaria chemoprophylaxis (SMC) may be used instead. Mefloquine should not be given concomitantly with SMC.

– Consider hydroxyurea according to local protocol, if recommended in national guidelines.

d Note that conversely, sickle cell trait confers a partial protection from malaria (though children with sickle cell trait should still be tested for malaria if they present with clinical symptoms consistent with malaria).

References Chapter 10

1. WHO. *Haemoglobin Concentrations for the Diagnosis of Anaemia and Assessment of Severity*. World Health Organization; 2011. Accessed November 15, 2023. https://www.who.int/publications-detail-redirect/WHO-NMH-NHD-MNM-11.1
2. Maitland K, Olupot-Olupot P, Kiguli S, et al. Transfusion Volume for Children with Severe Anemia in Africa. *N Engl J Med*. 2019;381(5):420-431. https://doi.org/10.1056/NEJMoa1900100
3. Maitland K, Kiguli S, Olupot-Olupot P, et al. Transfusion management of severe anaemia in African children: a consensus algorithm. *Br J Haematol*. 2021;193(6):1247-1259. https://doi.org/10.1111/bjh.17429
4. Overview | Sickle cell disease: managing acute painful episodes in hospital | Guidance | NICE. Published June 27, 2012. Accessed November 15, 2023. https://www.nice.org.uk/guidance/cg143
5. Chakravorty S, Williams TN. Sickle cell disease: a neglected chronic disease of increasing global health importance. *Arch Dis Child*. 2015;100(1):48-53. https://doi.org/10.1136/archdischild-2013-303773
6. Sickle Cell Disease. WHO | Regional Office for Africa. Published November 13, 2023. Accessed November 15, 2023. https://www.afro.who.int/health-topics/sickle-cell-disease
7. Grosse SD, Odame I, Atrash HK, Amendah DD, Piel FB, Williams TN. Sickle Cell Disease in Africa. *Am J Prev Med*. 2011;41(6):S398-S405. https://doi.org/10.1016/j.amepre.2011.09.013
8. Wastnedge E, Waters D, Patel S, et al. The global burden of sickle cell disease in children under five years of age: a systematic review and meta-analysis. *J Glob Health*. 2018;8(2):021103. https://doi.org/10.7189/jogh.08.021103
9. *Evidence-Based Management of Sickle Cell Disease: Expert Panel Report, 2014 | NHLBI, NIH*. NHLBI Publications and Resources; 2014. Accessed November 15, 2023. https://www.nhlbi.nih.gov/resources/evidence-based-management-sickle-cell-disease-expert-panel-report-2014
10. Vichinsky E. Overview of the clinical manifestations of sickle cell disease. *UpToDate*. Published May 2022. https://www.uptodate.com/contents/overview-of-the-clinical-manifestations-of-sickle-cell-disease
11. Howard J, Hart N, Roberts-Harewood M, Cummins M, Awogbade M, Davis B. Guideline on the management of acute chest syndrome in sickle cell disease. *Br J Haematol*. 2015;169(4):492-505. https://doi.org/10.1111/bjh.13348
12. Davis BA, Allard S, Qureshi A, et al. Guidelines on red cell transfusion in sickle cell disease Part II : indications for transfusion. *Br J Haematol*. 2017;176(2):192-209. https://doi.org/10.1111/bjh.14383

Chapter 11:
Bone and joint problems

11.1 Introduction

This chapter explores common bone and joint problems in children that typically have an underlying pathology or cause. It does not cover immobile or painful limbs due to trauma (e.g. fractures) which is outside the scope of these guidelines, with the exception of toddler's fracture, non-accidental injury (NAI) and pulled elbow which require specific management in children.

11.2 Approach to a child presenting with a limp

Limp is a common presentation in children and has a wide range of potential causes. Limp can be due to pain, weakness or deformity. Transient synovitis and minor trauma are the most common non-infectious causes of limp in children, however certain conditions are more likely in specific age-groups (see Table 11.1). Infectious causes (osteomyelitis (see Section 11.4), septic arthritis (see Section 11.5), tuberculosis (see Chapter 4, Section 4.12), brucellosis, Lyme disease), bone malignancies and haematological disease should be considered in all children. The hip and knee are the most commonly affected joints, though pain in either of these joints may be due to pathology in the other. Limp may be also be caused by referred pain from another origin (testicular torsion, appendicitis, psoas abscess etc.) or may be neurological (hemiplegia, spinal injury/compression).

Table 11.1 - Age-specific non-infectious causes of limp

0-3 years	4-10 years	11-16 years
• Toddler's fracture • Developmental dysplasia of the hip (DDH) • Neuroblastoma	• Transient synovitis • Perthes' disease • Acute lymphocytic leukaemia (ALL)	• Slipped upper femoral epiphysis (SUFE) • Primary bone tumours e.g. osteosarcoma, Ewing's sarcoma • Osgood-Schlatter disease

11.2.1 Identifying underlying cause

A careful history can help to elicit salient diagnostic clues. Important points in the history include:
- Onset of symptoms (acute or chronic)
- Ability to weight-bear and/or walk
- Description of joint pain
- Possible trauma [accidental or non-accidental injury (NAI)]
- Preceding viral infection
- Associated symptoms: fever, general malaise, weight loss, bleeding, swelling of the joint, rash, night sweats.

Perform a complete clinical examination, focusing on the affected joint towards the end of the examination. Observe the position that the leg is held in at rest, and whether the child is able to bear weight or not. Watch the child walking, looking specifically at the gait pattern.
- Antalgic gait: short time spent with weight on affected leg when walking, suggests pain.
- Trendelenburg gait: pelvic tilt to opposite side when bearing weight on affected side, suggests unilateral hip pathology.
- Steppage gait: exaggerated lifting of the leg at the hip and knee to prevent dragging of the toes on the ground due to foot drop, suggests neurological disease.
- Waddling gait: alternating pelvic tilt when walking with wide-based gait and swinging of legs outwards (like a duck), suggests bilateral hip pathology or proximal muscle weakness.

Examine the joints above and below the affected joint to exclude pathology in these joints causing referred pain. Also ensure that an abdominal +/- genital examination are performed in case of referred pain.

Investigations

- Full blood count (FBC)
- X-ray of affected limb/joint: useful in the diagnosis of fractures, DDH, primary bone tumours, SUFE and Perthes', though advanced imaging, such as CT scan or MRI, may be required to confirm diagnosis.
- Ultrasound: used to detect joint effusions, but cannot differentiate between infection, blood and reactive fluid. Fluid can be aspirated under ultrasound guidance. May show periosteal reaction suggestive of osteomyelitis.

11.2.2 Specific common causes of limp

Transient synovitis (usually of the hip)

An acute synovial inflammation, usually of the hip (sometimes the knee), typically preceded by a viral upper respiratory tract or gastrointestinal infection. It is more common in boys than girls, and there may be a history of mild trauma. The child is systemically well with sudden reluctance to weight-bear. Passive movement of the hip can be limited due to pain. Spontaneous resolution within days to weeks, supported by analgesia and anti-inflammatories.

Toddler's fracture

Spiral fracture of the tibia caused by a twisting injury with rotational force when a child trips, stumbles or falls, common in ambulatory infants and young children. Toddler's fractures may occur after relatively minor trauma therefore parents/carers may not be aware of when/how the injury took place. Localised tenderness at the tibial fracture site is often present but may be difficult to elicit. Treatment is conservative with immobilisation to reduce discomfort.

Developmental dysplasia of the hip (DDH)

Often diagnosed soon after birth on initial newborn examination, but if not, it may present with a painless limp when the child starts walking. In unilateral dysplasia, children present with a Trendelenburg gait (see above for description), leg shortening, asymmetrical skin creases in the thigh and limited hip abduction on the affected side. Bilateral DDH, presents with a waddling gait and symmetrical limited hip abduction.

Perthes' disease

Avascular necrosis of part or all of the femoral head. Typically seen in children aged 4 to 9 years, and three times more common in boys than in girls. Usually mild symptoms with insidious onset of a painless limp or activity-related leg pain (may be referred to thigh or knee). Internal rotation and abduction of the hip on examination are mild to moderately limited. The younger the child and the less femoral head involved, the better the prognosis. Treatment in the majority of cases is reduced mobilisation and activity, however more severe cases may require bedrest with traction. If unrecognised and untreated, severe osteoarthritis may occur later in life.

Slipped upper femoral epiphysis (SUFE)

This is a misnomer as it actually is the metaphysis of the femur that slips anteriorly off the epiphysis (head of the femur) at the site of growth plate. It is common in rapidly growing prepubertal, and typically overweight children, and is more common in boys than in girls. It may present acutely after a fall or minor injury, but chronic slip with insidious pain is more common. Can present with groin, hip or knee pain, difficulty weight-bearing and restriction of internal rotation (or abduction) of the hip. Bilateral involvement occurs in 25%-40%. Children require immediate non-weight bearing and urgent referral to an orthopaedic surgeon for operative stabilisation.

Osgood Schlatter's apophysitis

A common cause of knee pain in growing adolescents caused by inflammation of the tibial tuberosity apophysis where the patellar tendon attaches to the tibia. Rapid growth in adolescence combined with repetitive movements cause irritation and/or stress injury at this site. It is typically unilateral but may be bilateral, with intermittent pain after activities like running and jumping. Apophysitis is self-limiting and most children will improve with activity modification and analgesia. Symptoms should disappear completely when the growth plates fuse.

Malignancy (e.g. leukaemia, neuroblastoma, bone tumours)

The child may be systemically well and present only with a limp, but usually 'red flags' (fever, localised bone pain/tenderness, pain at night, pallor, easy bruising, lymphadenopathy, hepatosplenomegaly, lethargy, weight loss, night sweats) are present, suggesting a more sinister diagnosis. Depending on available imaging and expertise, an attempt should be made to estimate the extent of the disease, to help to decide on potential management options locally or nationally, and to give the child and their parent/carer an indication of prognosis.

Non-accidental injury

Usually suspected by the pattern of injury (e.g. bruising in unusual places or in an infant who is not yet mobile), delay in seeking medical attention, changeable or implausible history, or a mechanism of injury inconsistent with examination findings. There may be prior history of injuries or neglect. Cases should be handled with care, and with early involvement of the psychosocial team, if available. Follow local child protection pathways if concerns are raised and consider safeguarding procedures for other children at home, who may still be in a vulnerable environment.

Tuberculous arthritis

Tuberculosis (TB) can cause arthritis in the spine, hips and knees through hematogenous spread of bacilli from other TB foci. Tuberculous arthritis is usually 'cold', i.e. the skin over the painful, swollen joint is the same temperature as the rest of the skin, and not warm as in other infective conditions. The history is usually less acute than septic arthritis and there may be systemic symptoms of TB such as fever, night sweats and weight loss. Diagnosis is made clinically or by analysis of exudate removed during joint aspiration, if possible (acid and alcohol fast bacilli (AAFB) and GeneXpert). Treatment for TB should be started as soon as possible (see Chapter 4, Section 4.11).

11.3 Pulled elbow

A pulled elbow is a common minor injury in young children. It occurs when a child's arm is pulled, twisted or stretched abruptly, causing the radius to partially slip out of the annular ligament at the elbow (subluxation). It commonly occurs in young children being pulled back from a potentially dangerous situation by a parent/carer or older sibling. Subluxation of the radial head causes restricted movement and pain on elbow flexion, pronation and supination. The child typically keeps the arm immobile, in a slightly flexed and pronated position. Pain is only elicited on movement.

There are two main techniques to reduce a pulled elbow. The first is hyper-pronation, in which pressure is applied over the radial head, whilst hyperpronating the arm. The second technique is supination-flexion, in which again pressure is applied over the radial head, whilst the arm is supinating and then flexed at the elbow. There is low quality evidence that the hyperpronation technique has a better success rate at first attempt reduction that the supination technique[1].

If history is not typical of a pulled elbow, but there is potential for another diagnosis such as a fracture, the manoeuvre should not be attempted. Ultrasound can help to detect signs of an effusion/raised fatpad, suggesting a fracture rather than a pulled elbow.

11.4 Osteomyelitis

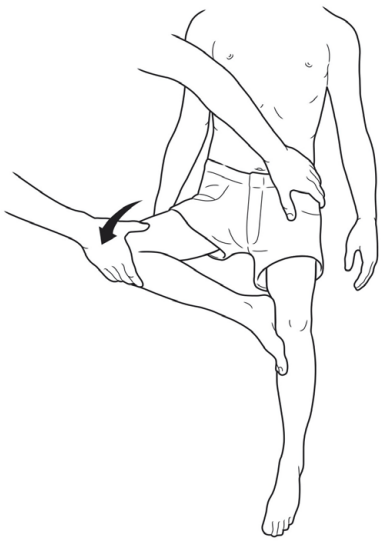
Osteomyelitis is an infection of the bone that is usually bacterial in origin. In children, acute infection most commonly occurs by haematogenous spread (bacteraemia), but can also be due to direct trauma to the bone (e.g. open fractures, war wounds), or from an infected site near the bone (e.g. mouth, skin ulcer). Typically, infection affects the metaphysis of the long bones, especially the femur and tibia, but any bone may be affected and pelvic osteomyelitis, though rare, is seen in children. Though multiple sites can be affected, infection tends to be limited to one site. Incidence is higher in children under 5 and is twice as common in boys[2]. In haematogenous spread, *Staphylococcus aureus* is the most likely cause, but other common pathogens include *Kingella kingae*, Group A and B *streptococci*, *Streptococcus pneumonia*, *E. coli* and *Haemophilus influenza* B (if not immunised). Methicillin-resistant *Staphylococcus aureus* (MRSA) is not infrequent. In children with sickle cell disease (SCD), infection by *Salmonella* spp is most common followed by other gram-negative organisms.

The following factors increase the risk of developing osteomyelitis:
- Medical: malnutrition, sickle cell disease, HIV, tuberculosis, Buruli ulcer, cellulitis, dental infections, post-malaria infection.
- Surgical/trauma: open fractures, penetrating or puncture wounds (including bites), surgical procedures with insertion of pins or screws.

11.4.1 Clinical features

Initial symptoms of acute osteomyelitis may be non-specific and subtle and only become more localised once infection is established in the bone:
- Localised bone pain (point tenderness) and pain on movement.
- Reluctance to move affected limb or weight-bear, limping.
- Fever, irritability, decreased appetite, malaise may also be present.
- Swelling, warmth and soft tissue redness around the site of pain (late sign).
- If the child complains of abdominal, hip, groin or thigh pain, consider osteomyelitis of the pelvis. During examination, pain is elicited on passive movement of the hip (simultaneously flex, abduct and externally rotate the hip) (see Figure 11.1)

Figure 11.1 - Examination for pelvic osteomyelitis



Investigations

- FBC
- Inflammatory markers: Erythrocyte Sedimentation Rate (ESR), C-reactive protein (CRP)[a], if available
- Blood culture, if available, or any other material for culture (e.g. deep tissue, bone collected during debridement).
- X-ray (AP and lateral view): localised, deep, soft tissue swelling appears on day 2 to 3, though initially may be normal. Late signs include osteopenia, lytic lesions and periosteal reaction which are evident from 10 to 21 days[3]. Osseous sequestrum (intraosseous abscess): sign of chronic osteomyelitis.
- Ultrasound: may help identify joint effusion and differentiate from septic arthritis.
- Screen for SCD and consider potential TB contacts.

11.4.2 Management

Immobilisation of the affected extremity may relieve pain and prevent fractures, but prolonged antibiotic treatment is the mainstay of management for acute osteomyelitis from haematogenous spread:

- If the patient is stable, obtain blood cultures and any other culture material before starting antibiotics, but avoid any delay in giving antibiotics.
- Administer empiric antibiotic treatment to cover the most likely pathogens (as outlined in Section 11.4)[4]. Second choice antibiotics are used **instead of**, rather than **in addition to**, first choice antibiotics if first choice is unavailable, if there is a high clinical suspicion of infection with a gram-negative organism (e.g. in sickle cell disease), or if there is non-response to first-line treatment:
  - First choice: **cloxacillin** IV: 25 mg/kg every 6 hours (for *S. aureus*)
  - Second choice:
    - **amoxicillin/clavulanic acid** (**co-amoxiclav**) IV: 30 mg/kg of the amoxicillin component, every 8 hours (or 50 mg/kg of the amoxicillin component, every 12 hours) OR
    - **cefazolin** IV: 25 mg/kg every 12 hours OR
    - **ceftriaxone** IV: 80 mg/kg (max. 4 g if < 50 kg; max. 2 g if ≥ 50 kg) every 24 hours (for *Salmonella* spp. or Enterobacterales) OR
    - **cefotaxime** IV: 50 mg/kg every 8 hours (for *Salmonella* spp. or Enterobacterales) OR
    - **clindamycin** IV: 10 mg/kg every 8 hours (for community-acquired methicillin resistant *S. aureus* (CA-MRSA)[b].
- Doses of antibiotics for acute osteomyelitis are generally higher than for other conditions.
- Antibiotic treatment should be tailored as culture results become available, due to the large number of potential pathogens, including antibiotic resistant ones e.g. MRSA.
  The duration of parenteral antibiotic treatment is variable and depends largely on clinical evolution[5]. There is growing evidence that shorter courses of parenteral antibiotics (< 7 days) have similar outcomes to prolonged courses if acute osteomyelitis is detected and treated early, avoiding the need for long-term IV access and hospitalisation[6,7,8]. Antibiotics should be administered parenterally until symptoms and signs decrease (usually around 3-5 days), before switching to oral antibiotics to complete 3 weeks of total treatment in uncomplicated osteomyelitis. Ongoing fever and raised CRP (where available) are indications to continue parenteral treatment for longer[9].

a The combination of raised CRP and ESR is the most sensitive indication of osteomyelitis.

b In contexts where prevalence of clindamycin resistance to CA-MRSA is known to be high, consider vancomycin as an alternative.

– Patients with sickle cell disease: ensure antibiotics cover *Salmonella* spp (**ceftriaxone** or **cefotaxime** are the preferred options), which is the most likely pathogen.
– Immunocompromised patients: prolong oral treatment to give a minimum of 6 weeks of total treatment.
– Patients presenting with, or suspected of having, subperiosteal abscess or other purulent collection: in addition to antibiotics, surgical debridement is required to remove the infected tissue.
– All patients with osteomyelitis resulting from an inadequately treated open fracture should be referred for surgical debridement.

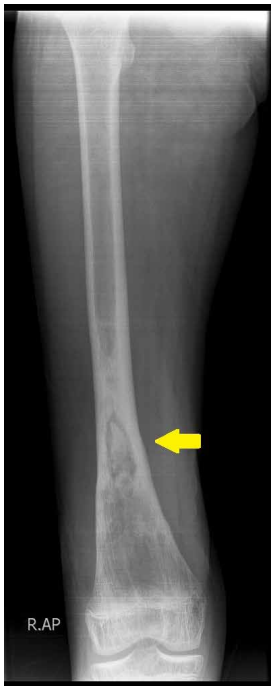
Switch to oral antibiotic treatment when all of the following are met:
– At least 3 days of parenteral treatment completed
– Clinical improvement
– Afebrile for at least 72 hours
– Able to take oral medication without a problem in the hospital
– Parent/carer able to reliably give medication to the child.

If response to treatment is not as expected, re-evaluate the child and adjust antibiotic treatment. Always consider and exclude tuberculosis (see Chapter 4, Section 4.11).

11.4.3 Chronic osteomyelitis

Chronic infection of the bone, usually defined as lasting longer than 4 weeks. It is characterised by the presence of bone necrosis, also called sequestrum formation (see Figure 11.2). It may occur secondary to untreated acute osteomyelitis or as a relapse many weeks or months after osteomyelitis that was thought to have been successfully treated[10]. Chronic drainage and fistula formation can also occur, as can abscess formation. While chronic osteomyelitis is becoming rarer due to advances in antibiotic regimens, it is still seen quite commonly in resource-limited settings and is a significant cause of disability.

Figure 11.2 - Sequestrum formation, frontal right thigh, child[c]



Sequestrum seen in the distal femoral diaphysis (arrow)

c Case courtesy of Hidayatullah Hamidi, Radiopaedia.org, rID: 63366. https://radiopaedia.org/cases/63366

Investigations

- FBC
- Inflammatory markers: ESR and CRP, if available
- Blood culture, if available
- X-ray (AP and lateral view): sequestrum formation (intraosseous abscess, seen as representing fragments of devitalized bone).

Management

- Mainstay of treatment is surgical removal (debridement) of the sequestrum and the dead tissue around it, as the necrotic tissue serves as a source of infection, as well as any associated abscess.
- Surgery may be relatively straightforward if the sequestrum is localized and not affecting the growth plates or joints, however it can be very complex when associated with pathological fracture, bone loss, growth disruption, joint involvement and severe soft tissue damage[11]. Therefore, the patient should be referred to an experienced surgical team.
- Antibiotics should be administered (as for acute osteomyelitis, above) in addition to surgical debridement as it is difficult to ensure that there is no residual infection unless deep tissue samples can be taken and sent for microbiology, which is rarely possible in resource-limited settings. Complex cases may require prolonged antibiotic treatment for several months as well as extensive wound management.
- Recurrent or TB osteomyelitis also requires surgery; these cases should be discussed with experienced clinicians.

Follow-up

- Monitor symptoms: fever and pain with movement should improve within 7 days (usually as soon as 3 to 4 days).
- Start physical therapy, if available.
- If possible, follow-up at 2 weeks and 3 months after discharge.

11.5 Septic arthritis

Septic arthritis is a serious joint infection that can lead to devastating complications, with potential joint destruction in a period of days if left untreated. It has a higher incidence in children less than 4 years old. The knee and hip are the most commonly affected joints, especially in younger children, but septic arthritis can affect any synovial joint[12].

Like osteomyelitis, microorganisms (bacteria, fungi, viruses) can enter the joint space by haematogenous spread, direct inoculation or extension of a contiguous focus of infection. Most cases of septic arthritis are caused by bacteria and usually result from haematogenous spread of *Staphylococcus aureus* from an open wound or mucosal lesion. The bacterial pathogens responsible are the same as for osteomyelitis (see Section 11.4).

11.5.1 Clinical features

Young children typically present with irritability, anorexia, cellulitis, or fever. The manifestations of joint involvement include reduced movement of the limb concerned, limp and aversion to passive movement. Children frequently adopt specific positions to reduce pain (antalgic positions), typically with the joint flexed to give laxity to the joint capsule.

Older children usually present with joint swelling, sensitivity and reduced movement of the affected joint, though the joint signs can be subtle, and they may also present with systemic symptoms such as fever and decreased appetite.

Differential diagnosis includes transient synovitis, osteomyelitis, trauma and tumours.

Examination

Examine all joints including the overlying skin, not only those visibly affected. Carry out passive movements slowly and carefully as septic arthritis causes extreme pain in the affected joint during passive movement. Identify any joint swelling or warmth, reduced joint movement or antalgic position.

Investigations

- FBC
- Inflammatory markers: ESR and CRP, if available
- Blood culture, if available
- X-ray: look for joint space widening, joint effusion, soft tissue swelling or subluxation or dislocation of joint.
- Ultrasound, if available: useful to determine if fluid is present in the joint and in guiding needle aspiration of the joint.
- Arthrocentesis: aspiration of synovial fluid under anaesthesia and strict asepsis (in the operating room if possible). WBC > 50,000/mm^3 in synovial fluid confirms septic arthritis and synovial fluid should be sent for culture. If pus is aspirated and trained personnel are present, a formal drainage can be done.

11.5.2 Management

Septic arthritis is an orthopaedic emergency and requires prompt treatment:
- Administer empiric antibiotics IV as for osteomyelitis (see Section 11.4.2).
- Refer for surgical intervention to irrigate and drain the joint. If surgical referral is not an option, it may be possible to successfully treat septic arthritis with antibiotics alone[13], with or without serial aspiration. This should be discussed with a senior clinician.
- Immobilise the joint for 24-48 hours to provide pain relief and decrease local irritation.
- Carefully mobilise the joint after 48 hours and start physical therapy, if available, to prevent the development of fibrous adhesions.
- Antibiotic treatment should be tailored as culture results become available.
- Continue parenteral antibiotics until there are signs of clinical improvement (usually more than 7 days, unless uncomplicated), before switching to oral antibiotics to complete 3 weeks of total treatment. CRP, where available, is a useful indicator of response to treatment.
- Ensure adequate pain management, including regular pain assessment and administration of analgesia, as required (see Chapter 15, Section 15.4).

Switch to oral antibiotic treatment when all of the following are met:
- At least 5-7 days of parenteral treatment completed
- Clinical improvement
- Afebrile for at least 72 hours
- Able to take oral medication without a problem in the hospital
- Parent/carer able to reliably give medication to the child.

If response to treatment is not as expected, re-evaluate the child and adjust antibiotic treatment. Always consider and exclude tuberculous arthritis (see Section 11.2.2).

References Chapter 11

1. Krul M, Van Der Wouden JC, Kruithof EJ, Van Suijlekom-Smit LW, Koes BW. Manipulative interventions for reducing pulled elbow in young children. Cochrane Bone, Joint and Muscle Trauma Group, ed. *Cochrane Database Syst Rev*. 2017;2017(7). https://doi.org/10.1002/14651858.CD007759.pub4
2. Peltola H, Pääkkönen M. Acute Osteomyelitis in Children. *N Engl J Med*. 2014;370(4): 352-360. https://doi.org/10.1056/NEJMra1213956
3. Krogstad PA. Haematogenous osteomyelitis in children: Evaluation and diagnosis. *UpToDate*. Published July 2020. https://www.uptodate.com/contents/hematogenous-osteomyelitis-in-children-evaluation-and-diagnosis
4. Castellazzi L, Mantero M, Esposito S. Update on the Management of Pediatric Acute Osteomyelitis and Septic Arthritis. *Int J Mol Sci*. 2016;17(6):855. https://doi.org/10.3390/ijms17060855
5. Grimbly C, Odenbach J, Vandermeer B, Forgie S, Curtis S. Parenteral and oral antibiotic duration for treatment of pediatric osteomyelitis: a systematic review protocol. *Syst Rev*. 2013;2(1):92. https://doi.org/10.1186/2046-4053-2-92
6. Bachur R, Pagon Z. Success of Short-Course Parenteral AntibioticTherapy for Acute Osteomyelitis of Childhood. *Clin Pediatr (Phila)*. 2007;46(1):30-35. https://doi.org/10.1177/0009922806289081
7. Zaoutis T, Localio AR, Leckerman K, Saddlemire S, Bertoch D, Keren R. Prolonged Intravenous Therapy Versus Early Transition to Oral Antimicrobial Therapy for Acute Osteomyelitis in Children. *Pediatrics*. 2009;123(2):636-642. https://doi.org/10.1542/peds.2008-0596
8. Le Saux N, Howard A, Barrowman NJ, Gaboury I, Sampson M, Moher D. Shorter courses of parenteral antibiotic therapy do not appear to influence response rates for children with acute hematogenous osteomyelitis: a systematic review. *BMC Infect Dis*. 2002;2(1):16. https://doi.org/10.1186/1471-2334-2-16
9. Dartnell J, Ramachandran M, Katchburian M. Haematogenous acute and subacute paediatric osteomyelitis: A systematic review of the literature. *J Bone Joint Surg Br.* 2012;94-B(5): 584-595. https://doi.org/10.1302/0301-620X.94B5.28523
10. Woods CR, Bradley JS, Chatterjee A, et al. Clinical Practice Guideline by the Pediatric Infectious Diseases Society and the Infectious Diseases Society of America: 2021 Guideline on Diagnosis and Management of Acute Hematogenous Osteomyelitis in Pediatrics. *J Pediatr Infect Dis Soc*. 2021;10(8):801-844. https://doi.org/10.1093/jpids/piab027
11. Jones HW, Beckles VLL, Akinola B, Stevenson AJ, Harrison WJ. Chronic haematogenous osteomyelitis in children: AN UNSOLVED PROBLEM. *J Bone Joint Surg Br*. 2011;93-B(8): 1005-1010. https://doi.org/10.1302/0301-620X.93B8.25951

12. Wall C, Donnan L. Septic arthritis in children. *Aust Fam Physician*. 2015;44(4):213-215.

13. Gigante A, Coppa V, Marinelli M, Giampaolini N, Falcioni D, Specchia N. Acute osteomyelitis and septic arthritis in children: a systematic review of systematic reviews. *Eur Rev Med Pharmacol Sci*. 2019;23(2 Suppl):145-158. https://doi.org/10.26355/eurrev_201904_17484

Chapter 12:
Medical complications specific to children with severe acute malnutrition (SAM)

12.1 Introduction

This chapter covers the management of medical conditions specific to children with severe acute malnutrition (SAM). These include re-nutrition (osmotic) diarrhoea, refeeding syndrome[a], paralytic ileus, persistent oedema, and kwashiorkor skin lesions. More details on each of these conditions can be found in this chapter. Details of routine and nutritional management of children 1-59 months of age with SAM can be found in the MSF ITFC Nutritional Care Protocol 2021, Children 1-59 months: Inpatient. In older malnourished children, refer to local protocols for routine nutritional management.

Children with acute malnutrition are also more prone to certain clinical conditions that occur in all children, whether malnourished or not. In many cases, management will be the same for both malnourished and non-malnourished children. For specific considerations on their management, refer to the appropriate chapter in these guidelines or other relevant guidelines: circulatory impairment and shock (see Chapter 2, Section 2.2), sepsis (see Chapter 3, Section 3.2), hypoglycaemia (see Chapter 9, Section 9.3), hypothermia (see Chapter 2, Section 2.6), dehydration (see Chapter 5, Section 5.3), fluid overload (see Chapter 5, Section 5.3.2), diarrhoea (see Chapter 5, Section 5.2), severe anaemia (see Chapter 10, Section 10.1), pain management (see Chapter 15, Section 15.4), candidiasis (see MSF Clinical Guidelines, Chapter 3), thiamine deficiency (see Chapter 6, Section 6.4), and ophthalmic complications (conjunctivitis, xeropthalmia) (see MSF Clinical Guidelines, Chapter 5).

a Rarely, refeeding syndrome can occur in children who do not meet the anthropometric criteria for malnutrition but have endured a period of prolonged starvation.

12.2 Re-nutrition (osmotic) diarrhoea

Diarrhoea is a frequent presentation in acutely malnourished children, and causes are many (see also Chapter 5, Section 5.2). Re-nutrition or osmotic diarrhoea is specific to children with malnutrition and is common in children with SAM receiving therapeutic foods. It may be caused by premature transition to higher osmolarity milk or to food (i.e. when starting initial treatment with F-75, or when transitioning from F-75 to F-100 or RUTF[a]), or by a temporary lactose intolerance secondary to malnutrition or infective pathogens.

12.2.1 Clinical features and assessment

Re-nutrition diarrhoea presents as loose white stools which occur soon after feeding with therapeutic milk, often within 15-30 minutes of a feed. It usually disappears within 72 hours of starting nutritional treatment.

12.2.2 Management

Management is based on modification of the therapeutic feeding regime to slowly allow the child's body to adapt to the solute load and composition of therapeutic milk. Treatment differs depending on whether diarrhoea starts in Phase 1 or Transition phase of nutritional treatment.

Phase 1

- Carefully monitor feeding and ensure that milk is given slowly and not rushed.
- In order of preference from least to most complex, the following solutions can be tried:
  - Fraction feeds: divide the volume of feed into two or four equal parts and give in small portions every 15 to 30 minutes to finish the feed over one hour. Carefully monitor feeding and ensure that the feed is not rushed or forced.
  - Increase feed frequency: if no improvement with fractioning feeds, divide the 24-hour feed volume to give feeds every 1-2 hours rather than the usual 3-hourly feeds, allowing smaller volumes to be given each time.
  - Continuous feeding: if no improvement with increasing feed frequency, consider giving feeds continuously via orogastric or nasogastric tube (OGT/NGT) using gravity or a pump (see MSF Manual of Nursing Care Procedures, SOP – Enteral Nutrition Administration Methods).
  - Dilute feeds: if no improvement with fractioning feeds, increasing feed frequency or giving continuous feeding, dilute F-75 by adding 30 mL of extra water to 100 mL of F-75 milk to reduce osmolarity. Continue for a few feeds only (until improvement of diarrhoea) before changing back to F-75, as nutritional content of diluted F-75 is inadequate for extended use.
- If re-nutrition diarrhoea persists despite all of the above measures, screen the child for TB and HIV (even if already done). Consider the possibility of lactose intolerance, though this is very rare.

a RUTF = Ready to Use Therapeutic Food

Transition phase

– If diarrhoea occurs after receiving RUTF or F-100, immediately after starting transition, transition phase has probably been started too early. Return to phase 1 with F-75 for 24 to 48 hours.
– If there are irregular and/or inconsistent bouts of loose stool after being in transition phase for a day or so, increase the length of stay in transition phase until resolution of the problem (likely to improve spontaneously). If no resolution, return to phase 1 with F-75 for 24 to 48 hours.

If diarrhoea persists for more than 72 hours, in the absence of another obvious explanation for diarrhoea (e.g. otitis media, pneumonia, UTI), consider other infective causes of diarrhoea and treat accordingly (see Chapter 5, Section 5.2.1).

12.3 Refeeding syndrome

Refeeding syndrome is a complex syndrome occurring upon re-introduction of feeding after a prolonged period of starvation. It involves potentially fatal shifts in fluids and electrolytes due to hormonal and metabolic changes and usually occurs within the first week of nutritional treatment. The hallmark of refeeding syndrome is hypophosphataemia, though many other electrolyte imbalances can also occur, including abnormalities in sodium, potassium and magnesium[1]. Thiamine deficiency and changes in glucose, fat and protein metabolism complicate the condition further[2]. Management of refeeding syndrome is challenging, especially in resource-limited settings where electrolyte monitoring is often not possible.

Refeeding syndrome should not be confused with re-nutrition or osmotic diarrhoea which is common in severely malnourished children starting therapeutic feeds and is not a major cause for concern (see Section 12.2).

12.3.1 Clinical features and assessment

Children with refeeding syndrome appear unwell with a deterioration in their general condition. Presentation is variable and non-specific, including:

- Signs of circulatory impairment or shock:
  - Lower limb temperature gradient
  - Weak radial pulse or severe tachycardia
  - Capillary refill time of 3 seconds or more
- Signs of fluid overload:
  - Increased respiratory rate and/or heart rate
  - Hypoxia
  - Fine crackles in lung fields (pulmonary oedema)
  - Galloping heart rhythm
  - Enlarged liver
  - Peripheral oedema and/or puffy eyes (may overlap with kwashiorkor signs)
- Hyper- or hypoglycaemia
- Paralytic ileus with abdominal distention
- Hypo- or hyperthermia
- Altered consciousness

Always consider differential diagnoses including sepsis, decompensated anaemia, severe dehydration or fluid overload from other causes (e.g. IV fluid administration). Where diagnostic tests are available and treatment for electrolyte imbalance is possible, check for hypophosphatemia, hypokalaemia, hypomagnesemia, sodium and water retention, and thiamine deficiency.

12.3.2 Management

- Transfer to ICU where available (or in-patient area with increased monitoring and nursing care, depending on project capacity).
- Return to (or continue with) phase 1 treatment for SAM with **F-75 therapeutic milk**.
- Under the guidance of an experienced clinician, consider (see also Section 12.2.2):
  - Reducing feed volumes and/or
  - Fractioning feeds and/or
  - Reducing the speed of feed administration.
- Where feasible and able to monitor electrolytes, correct electrolyte imbalances (see Chapter 15, Section 15.3).
- If critically unwell, start empiric broad-spectrum IV antibiotic treatment: **ceftriaxone** IV/IM 80 mg/kg (max. 4 g if < 50 kg; max 2 g if ≥ 50 kg) every 24 hours.
- In cases of severe paralytic ileus, see Section 12.4.
- Assess fluid status closely.
- Administer **thiamine** as follows:

Loading dose:
- < 15 years: 100 mg slow IV infusion over 30 minutes once daily for 48 hours

If IV not possible: give PO/via NGT at the same dose.

Maintenance dose: to be started after 48 hours of IV treatment
- ≤ 12 years: 25 mg PO once daily for 1 month
- > 12 years: 25 mg PO 2 times daily for 1 month

12.3.3 Prognosis

Refeeding syndrome is associated with high mortality, ranging from 30-71% even in high-resource settings[3,4]. Prevention, through strict adherence to feeding protocols, and early detection of refeeding syndrome are critical to reducing morbidity and mortality from the condition.

12.4 Paralytic ileus (acute abdominal distension)

Paralytic ileus (sometimes called pseudo-obstruction) is a condition in which peristalsis is temporarily impaired, leading to intolerance of oral intake. Signs and symptoms mimic obstruction, though in this case the obstruction is functional rather than mechanical. It is relatively common in children with SAM and diarrhoea and is associated with complications such as infection and shock, with increased mortality[5]. Causes include electrolyte imbalance (e.g. hypomagnesaemia, hypokalaemia), infection, refeeding syndrome, reduced blood supply to the bowel (mesenteric ischaemia), and certain medications (e.g. opioids, anti-diarrhoeal agents, anticholinergics).

Surgical conditions such as volvulus and intussusception present with similar clinical signs and should be included in the differential diagnosis. These conditions should be excluded with a surgical review before a diagnosis of paralytic ileus is made.

12.4.1 Clinical features and assessment

Children usually present with abdominal distension and appear unwell with:
- Absent or much diminished bowel sounds
- Vomiting (but can be absent) or bilious vomiting (sign of severity)
- Traces of blood in stools (sometimes), or few or no stools
- Reduced flatus (passing gas per rectum)
- Reluctance/refusal to feed

While the predominant sign of paralytic ileus is abdominal distension, it should be noted that malnourished children commonly have a certain degree of abdominal distension, either secondary to gastroenteritis or due to the same mechanisms that cause refeeding syndrome. These cases often resolve gradually with nutritional treatment and do not require treatment for paralytic ileus.

12.4.2 Management

- Assess and manage ABCDE.
- Make the child nil-by-mouth (NBM), insert NGT and leave on free drainage (attach to catheter bag or other waterproof bag).
- Take a full history and carry out thorough clinical examination of abdomen.
- Get surgical review, where possible.
- Measure abdominal circumference at start of treatment and every 4 hours until resolution of condition.
- Start **glucose** (**dextrose**) **5%-Ringer lactate** (**G5%-RL**) IV at maintenance rate (see Chapter 15, Section 15.2):
  - Add 5 mL of **potassium chloride 15%** (2 mmol/mL) to a 500 mL bag (see also Chapter 15, Section 15.2).
  - Continue for 6 hours with careful monitoring (see below).

– If paralytic ileus associated with refeeding syndrome, administer **thiamine** as follows:

Loading dose:
- < 15 years: 100 mg slow IV infusion over 30 minutes once daily for 48 hours

If IV not possible: give PO/via NGT at the same dose.

Maintenance dose: to be started after 48 hours of IV treatment
- ≤ 12 years: 25 mg PO once daily for 1 month
- > 12 years: 25 mg PO 2 times daily for 1 month

– Administer antibiotic treatment: **ceftriaxone** IV (IM): 80mg/kg (max. 4 g if < 50 kg; max 2 g if ≥ 50 kg) every 24 hours and **metronidazole** IV 10 mg/kg every 8 hours.

– In regions with a high helminth burden, consider giving antihelminth treatment:

albendazole PO
- 12 – 23 months: 200 mg once daily for 3 days[a]
- ≥ 24 months: 400 mg once daily for 3 days

mebendazole PO
- ≥ 12 months and > 10kg: 100 mg 2 times daily for 3 days

12.4.3 Monitoring

– Monitor and record vital signs at least every hour using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
– Look for signs of improvement in intestinal function:
  - Decreasing abdominal circumference (measurement)
  - Visible peristalsis
  - Stool/flatus output
  - Return of bowel sounds on auscultation
– Monitor blood glucose level (BGL) every 4 hours and correct hypoglycaemia if needed.

Review after 6 hours of management:

– **Improvement** (signs of intestinal motility present after 6 hours):
  - Give 5 mL/kg of **F-75** therapeutic milk as a trial.
  - After one hour, gently aspirate the gastric residual, measure the volume and discard:
    ▷ If the volume aspirated is the same as, or more than the volume introduced, stop F-75 trial and wait another 6 hours before attempting to re-feed.
    ▷ If the volume aspirated is less than the volume introduced, re-administer 5 mL/kg of F-75, and gradually increase the amount of F-75 at each 3-hourly feed until the child reaches their full feed volume (for F-75 feed volume calculations, see MSF ITFC Nutritional Care Protocol 2021, Children 1-59 months: Inpatient, and Appendix 18.
    ▷ Discontinue IV maintenance fluids when the child reaches 50% of their full feed volume.
– **No improvement** (no sign of intestinal motility after 6 hours):
  - Continue IV fluids at same rate and measure BGL every 4 hours.
  - If no improvement after another 6 to 8 hours, refer for surgical input where available.

a Albendazole is not systematically recommended to children less than 12 months but can be given on a case-by-case basis according to clinician assessment.

12.5 Persistent oedema

Oedema associated with malnutrition (including refeeding syndrome) usually reduces and improves within approximately 4 days of starting therapeutic nutritional treatment. If oedema persists beyond 4 days, investigation is required to rule out other underlying medical causes.

12.5.1 Clinical features and assessment

Before considering other underlying medical causes, it is important to ensure that therapeutic feeds have been correctly given:

- Check that the parent/carer is not giving food other than the therapeutic feeds that have been prescribed for the child.
- Assess if the therapeutic feeds are being prepared, given and taken correctly.
- Check if hydration fluids such as ReSoMal are properly prescribed and given and not just freely available on the ward.

After verification that therapeutic feeds have been prescribed and given correctly, consider other possible contributory medical conditions, including:

- Severe anaemia (see Chapter 10, Section 10.1)
- Congestive heart failure (consider beri-beri) (see Chapter 6, Section 6.2 and Section 6.4)
- Renal dysfunction (nephrotic syndrome, glomerulonephritis) (see Chapter 8, Section 8.2 and Section 8.3)
- Cirrhosis
- Obstruction of lymphatic or venous drainage of the lower limbs
- Hypothyroidism (oedema (myxoedema) can occur at pretibial level and may be associated with peri-orbital swelling)
- Oedema of iatrogenic origin (e.g. traditional treatments or counterfeit drugs)
- Cushing's syndrome

Investigations

- Hb to check for anaemia
- HIV and TB screening, if not already done
- Urine dipstick, to exclude renal causes of oedema

12.5.2 Management

- If non-adherent to prescribed therapeutic feeding regime, reinforce the importance of giving the prescribed volume of milk at the designated times.
- Treat any identified underlying causes.
- Reassess dehydration status and management. Check for any new signs of fluid overload and manage accordingly (see Chapter 5, Section 5.3.2).
- Make sure only therapeutic food is given to the child and that no traditional treatments are used.

If potential underlying medical causes have been ruled out or treated, consider the following modifications to the nutritional management:

– Continue Phase 1 with F-75 therapeutic milk for at least one more week.
– For children newly diagnosed with HIV and/or TB where treatment has just been started, switch to Transition phase, as improvement in oedema may not be seen until after 2 weeks. Monitor closely in Transition phase for signs of intolerance or worsening of the clinical condition, including oedema.

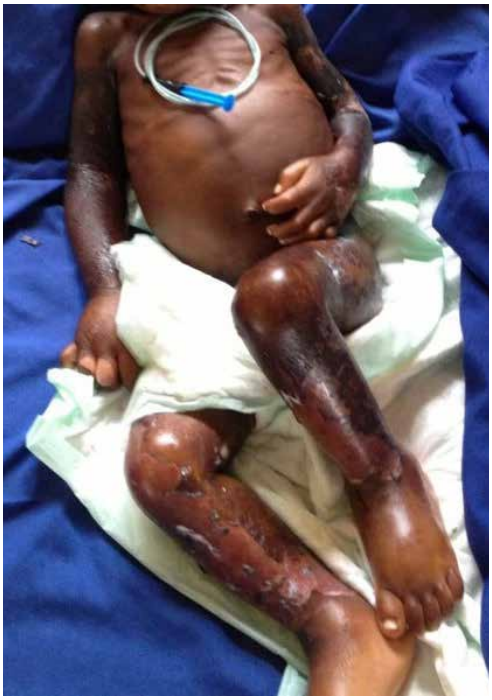
12.6 Kwashiorkor skin lesions

Skin lesions are a common feature of kwashiorkor and the underlying cause is not fully understood. Different types of lesions can develop and may at times be present simultaneously. The lesions are characterized by hypo- or hyper-pigmentation, desquamation that flakes or peels, and in extreme cases ulceration that may spread to any area of the body.

Epidermal ulceration gives way to exudative open skin lesions, resembling burns. This can lead to loss of fluid and heat, with an associated risk of hypothermia.

Lesions can easily become infected. As acutely malnourished patients do not exhibit a standard inflammatory reaction, typical signs of infection such as pus formation and fever are often absent. Superinfection is thus more difficult to detect, and specific measures must be taken to prevent and to treat it.

Figure 12.1 - Kwashiorkor skin lesions[a]



12.6.1 Management

Management should follow a systematic and holistic approach to wound care. This means the whole patient should be assessed and not just the lesion(s). Assessment should be methodological and with special attention to pain management – this is especially relevant for children with kwashiorkor. The following is a summary of important steps in management of kwashiorkor skin lesions. For full details on management, including detailed advice on dressings, see MSF OCB Wound Care Protocol and Kwashiorkor Wounds protocols.

a Images reprinted with permission from Kirrily de Polnay, 2016.

General measures and prevention of complications

Organization and hygiene

- Ensure good general hygiene and infection prevention and control measures (hand hygiene, gowns, cleaning and disinfection of reusable medical equipment).
- If possible, group kwashiorkor patients in one area to facilitate better care and improve nursing supervision.
- Keep flies and insects away from wounds (care for patients on their beds, use mosquito nets).
- Change bedsheets regularly (if possible, daily) and any time they are soiled/moistened.
- Ensure good toileting habits and the use of nappies/diapers or potties to keep wounds free from urine and faeces.
- Carry out personal hygiene and wound care at the warmest time of the day to prevent hypothermia. Personal hygiene for the patient should be performed carefully using damp cloths to wash around the lesions. Avoid baths.
- Ensure dressing changes and wound care take place away from the patient's bedside.

Patient care

- Cut patient's nails to prevent scratching and minimize nails as a source of infection.
- In children with extensive perineal lesions, keep the area clean and dry and ensure that all stool is removed after each bowel movement. If the area does not improve with these measures, consider temporary urinary catheter placement.
- Moisturise the whole body[b]:
  - Use vaseline or equivalent (not zinc oxide).
  - Apply on all healthy skin, three times daily.

Pressure ulcers

Severely malnourished children, especially those who are critically unwell, may have difficulty moving. This, together with fragile skin and a lack of underlying tissue protection, leads to an increased risk of developing pressure ulcers (bedsores). Ulcers often affect the heels, sacrum (lower back), ischium (hips) and occiput (back of head), however, all boney projections should be considered at risk, including the trochanters (top of thigh bone). In addition to general hygiene and patient care measures:

- Always use side positioning (ventral or dorsal) with a maximum 30° angle (not 90°).
- Use adapted items for appropriate patient positioning such as special foam mattresses, gel cushions and positioning cushions[c].
- Reposition patients regularly and use an appropriate mobilization chart, such as MSF Manual of Nursing Care Procedures, Repositioning and Turning Chart to plan and monitor changes of position.
- Check skin each time the patient is repositioned.
- Take care when removing dressings and use bandages instead of adhesives for fixation.
- Be aware of the risk of pressure ulcers related to therapeutic and diagnostic devices (such as OGT/NGTs, oxygen nasal prongs). If indicated, use protective padding under devices to avoid friction (hydrocolloid dressing or adhesive tape elastic foam[d]).
- Secure medical devices (e.g. pulse oximetry probe, oxygen nasal prongs, IV cannulae) with steristrips or similar rather than adhesive tape and change position of devices regularly where appropriate.

b All kwashiorkor patients, including those without skin lesions or wounds, should have daily skin hydration. This can be done by a parent/carer after appropriate instruction.

c See following items in MSF catalogue: EHOEMATTF1-, EHOECUSG001, EPHYCUSGLU+

d See following items in MSF catalogue: SDREEAHC3S-, SDRETAPA1F25

Pain management

Kwashiorkor skin lesions are extremely painful and distressing for the child and their family. Regular analgesia may be required for children with extensive, open skin lesions and a pain assessment should be done routinely every day, as well as prior to wound care procedures (see Chapter 15, Section 15.4). Consider dressing changes in theatre under anaesthesia for extensive lesions.

12.6.2 Antibiotics for infected lesions

Superimposed infection is common in kwashiorkor skin lesions and requires treatment with antibiotics:

– First line:
  amoxicillin/clavulanic acid (ratio 7:1 or 8:1) PO for 7 days
  Dosage expressed in amoxicillin:
  - < 40 kg: 50 mg/kg 2 times daily
  - ≥ 40 kg:
    Ratio 8:1: 3000 mg daily (2 tablets of 500/62.5 mg 3 times daily)
    Ratio 7:1: 2625 mg daily (1 tablet of 875/125 mg 3 times daily)
– Second line (if no clinical improvement after 48-72 hours[e]):
  clindamycin PO 10 mg/kg, 3 times daily for 10 days

Malnourished children often heal more slowly than non-malnourished children, therefore it is important to monitor lesions carefully and frequently to look for evidence of improvement after starting antibiotics. Lack of immediate improvement does not always indicate treatment failure.

e Clinical improvement includes decreased wound pain, redness and heat and reduction/absence of pus.

References Chapter 12

1. Mehanna HM, Moledina J, Travis J. Refeeding syndrome: what it is, and how to prevent and treat it. *BMJ*. 2008;336(7659):1495-1498. https://doi.org/10.1136/bmj.a301
2. Persaud-Sharma D, Saha S, Trippensee AW. Refeeding Syndrome. In: *StatPearls*. StatPearls Publishing; 2023. Accessed October 30, 2023. http://www.ncbi.nlm.nih.gov/books/NBK564513/
3. Friedli N, Baumann J, Hummel R, et al. Refeeding syndrome is associated with increased mortality in malnourished medical inpatients: Secondary analysis of a randomized trial. *Medicine (Baltimore)*. 2020;99(1):e18506. https://doi.org/10.1097/MD.0000000000018506
4. Vignaud M, Constantin JM, Ruivard M, et al. Refeeding syndrome influences outcome of anorexia nervosa patients in intensive care unit: an observational study. *Crit Care*. 2010;14(5):R172. https://doi.org/10.1186/cc9274
5. Chisti MJ, Shahid AS, Shahunja KM, et al. Ileus in children presenting with diarrhea and severe acute malnutrition: A chart review. Vinetz JM, ed. *PLoS Negl Trop Dis*. 2017;11(5):e0005603. https://doi.org/10.1371/journal.pntd.0005603

Chapter 13:
HIV Infection

13.1 Introduction

In 2021, 1.68 million children under 15 years of age were living with HIV worldwide (of whom 88% in sub-Saharan Africa), but only 52% were receiving anti-retroviral treatment (ART)[1]. Without any intervention, it is estimated that up to 52% of children who are vertically infected with HIV will die before the age of 2 years old[2]. Thus, early infant diagnosis (EID) and ART are crucial to improving the survival of HIV-infected children. Access to EID has improved significantly in recent years, but still only around 30% of infants with vertically acquired HIV infection are diagnosed and treated within the recommended timeframe[3].

Natural history

The vast majority of children with HIV are infected during pregnancy, childbirth or breastfeeding. The very young age at which they are infected and an inability to mount a sufficient immune response, results in a persistently high viral load with devastating clinical consequences. Vertically acquired HIV infection advances rapidly in young children, with direct damage to the immune system from the virus itself, as well as the secondary effects of recurrent and severe acute infections, underlying chronic infection, susceptibility to malnutrition, and poor growth and development.

This chapter covers the basic management of a sick HIV-exposed or infected child requiring inpatient care. For comprehensive guidance on the management of children living with HIV refer to national guidelines (where available), other MSF guides (e.g. MSF HIV/TB Clinical Guide for Primary Care, Paediatric HIV handbook) and/or WHO resources[3].

13.2 Key recommendations

The 2021 WHO "Consolidated guidelines on HIV prevention, testing, treatment, service delivery and monitoring: recommendations for a public health approach" includes the following[3]:

- In high HIV burden settings[a], all children admitted for inpatient care should routinely be tested for HIV unless HIV status is already known.
- In low HIV burden settings, all children admitted for inpatient care should routinely be tested for HIV if:
  - Biological parent known to have (or suspected to have died of) HIV infection or an undiagnosed long-term illness
  - Presence of malnutrition
  - Recurrent infection, fever of unknown origin, poor response to treatment
  - Diagnosis of tuberculosis
- All HIV-infected children and adolescents should be commenced on ART (regardless of WHO clinical stage and CD4 cell count) on the day of diagnosis or within 7 days thereof, except in the case of cryptococcal meningitis, when ART should be delayed for 4 weeks after the induction phase of treatment.
- In children diagnosed with tuberculosis, ART should be started as soon as possible within 2 weeks of starting TB treatment, except in the case of TB meningitis (delay ART for 4 weeks).

a High-burden HIV settings are those where HIV prevalence in the adult population ≥ 1%.

13.3 Diagnosis

Consider an underlying HIV infection in any sick child who presents with malnutrition, recurrent or severe infections, tuberculosis, persistent fever or who does not improve despite appropriate treatment for their presumed diagnosis.

Diagnosis of HIV infection can be confirmed in all children 18 months of age and over (or 3 months after cessation of breastfeeding, whichever comes later) with a simple rapid diagnostic test (RDT) for HIV antibodies. Refer to WHO or national diagnostic algorithms where available. For infants and children younger than 18 months of age, or those who are breastfed beyond 18 months, DNA PCR, ideally as point-of-care nucleic acid testing (NAT), is required to make a diagnosis of HIV. Refer to Table 13.1 below and national guidelines for more detail on testing and diagnosis of HIV in children under 18 months of age.

Pre-test information should be provided to the parents/carers and/or child (depending on age) prior to testing.

Table 13.1 - Diagnosis of HIV in infants and children 18 months and younger

<table>
<tr><th colspan="2">Assess exposure
(if HIV status of mother unknown)</th><th>Timing of DNA PCR/NAT</th></tr>
<tr><td rowspan="2">Ideally, test mother</td><td>If maternal HIV RDT positive
➔ DNA PCR/NAT required

If maternal HIV RDT negative
➔ no further testing required</td><td rowspan="2">4-6 weeks of life
or at the earliest opportunity thereafter

If DNA PCR/NAT positive
➔ consider child to be infected and start treatment. Repeat DNA PCR/NAT to confirm diagnosis[a].

If DNA PCR/NAT negative
➔ ensure regular clinical monitoring and repeat DNA PCR/NAT systematically at 9 months of age.

If DNA PCR/NAT negative at 9 months
➔ ensure regular clinical monitoring and perform HIV RDT systematically at 18 months of age or 3 months after the cessation of breastfeeding, whichever is later.</td></tr>
<tr><td colspan="2">If mother not available, perform DNA PCR/NAT[b] on child</td></tr>
</table>

a If repeat NAT negative, perform a third NAT to determine final diagnosis. Continue treatment until results of third NAT are available – if negative, treatment can be stopped.

b If DNA PCR/NAT is unavailable or it is not possible to test all babies with unknown exposure using DNA PCR/NAT, HIV RDT can be used instead as a screening tool for exposure to HIV. However, HIV RDT only reliably identifies exposure in infants < 4 months; in infants and children 4-18 months, a positive HIV RDT establishes exposure but a negative HIV RDT does not fully rule out exposure, therefore DNA PCR/NAT testing may still be required.

13.4 Management

The following section outlines the management of infants and children with confirmed HIV infection.

13.4.1 Initial management

– Assess and manage ABCDE; stabilize as needed (Chapter 2, Section 2.1).
– Assess nutritional status if not already done.
– Breastfed infants should continue breastfeeding[a].
– Assess, screen for and manage other concomitant infections or conditions:
  • Common childhood illnesses present more frequently and more severely.
  • Treatment is the same as for non-HIV infected children (refer to respective sections in these guidelines or MSF Clinical Guidelines) for the following conditions:

Paediatric Guidelines	Clinical Guidelines
• Pneumonia (see Chapter 4, Section 4.5) • Sepsis (see Chapter 3, Section 3.2) • Malaria (see Chapter 3, Section 3.4) • Meningitis and meningoencephalitis (see Chapter 3, Section 3.3) • Diarrhoea (see Chapter 5, Section 5.2), including persistent diarrhoea • Mastoiditis (see Chapter 4, Section 4.12) • Tuberculosis (see Section 13.4.3 and Chapter 4, Section 4.11)	• Varicella zoster • Herpes zoster • Oral/oesophageal herpes • Oral/oesophageal candidiasis • Skin infections (fungal, bacterial, scabies, pruritic papular eruptions) • Molluscum contagiosum; warts (HPV)

  • HIV-infected children are at risk of developing opportunistic infections, such as pneumocystis pneumonia (PCP) and cryptococcal meningitis, as well as other conditions specific to HIV infection, e.g. lymphoid interstitial pneumonitis (LIP). These are briefly covered in Table 13.2. Children over 10 with advanced HIV disease should be routinely screened for cryptococcal meningitis.
  • Cancers associated with HIV-infection are not in the scope of this guide; refer to other sources.

a Breastfeeding is not contraindicated in babies born to HIV positive mothers. To mitigate the risk of transmission of HIV through breastmilk, maternal viral load should be suppressed through ART. If it is not possible to suppress maternal viral load, consideration should be given to continuation of infant prophylaxis beyond the 6- or 12- week period, in accordance with national guidance.

Table 13.2 - Opportunistic infections and conditions in children living with HIV

Condition	Causes	Clinical features	Management
Pneumocystis pneumonia (PCP)	*Pneumocystis jirovecii*	Common in children under 1 year Respiratory distress and hypoxaemia Acute or sub-acute onset Fever can be high, but often afebrile Non-productive cough Feeding difficulties in infants Chest usually clear on auscultation CXR: Diffuse interstitial infiltration, hyperinflation, pneumothorax or normal (20%). Effusion very uncommon with PCP.	Administer **oxygen** via facemask, aiming for SpO_2 between 94 - 98%. Supportive care with fluids and feeds if needed (see Chapter 15, Section 15.2 and Section 15.5 respectively). High-dose **co-trimoxazole** PO (or IV) for 21 days: 50 mg/kg SMX + 10 mg/kg TMP, 2 times daily or 25 mg/kg SMX + 5 mg/kg TMP, 4 times daily + For severe cases: **prednisolone** PO: 1 mg/kg 2 times daily for 5 days, then 1 mg/kg once daily for 5 days, then 0.5 mg/kg once daily for 5 days. Continue **co-trimoxazole** prophylaxis (see Table 13.4) after treatment completion
Lymphoid Interstitial Pneumonitis (LIP) Children > 3 years	Lympho-proliferative infiltrate	Slow onset: cough, dyspnoea, hypoxaemia (SpO_2 < 92%). Often enlarged lymph nodes, spleen and chronic parotitis. May find wheeze, clubbing, signs of right heart failure. CXR: Bilateral reticulonodular infiltrate. Similar appearance to miliary TB, but more irregular distribution and clinically distinct: child with LIP may look well, child with TB is usually more ill with fever and weight loss.	Improvement with ART. Symptomatic management if needed: • Inhaled bronchodilators for wheeze (see Chapter 4, Section 4.10.1). • Steroids may be useful. If no response observed after 1 month, discontinue by weaning gradually over 2 months.

Condition	Causes	Clinical features	Management
Mycobacterium avium complex (MAC)	*Mycobacterium avium complex*	Weight loss, fatigue, unremitting fever, chronic diarrhoea, wasting, abdominal pain Enlarged lymph nodes, hepatomegaly, anaemia, unresolving pulmonary infiltrate Investigations: Hb, FBC (anaemia, neutropaenia, thrombocytopaenia) Where available, raised ALP, LDH, transaminases. AFB and culture from sterile site (blood, bone marrow, lymph node) if possible Consider in suspected TB (especially EPTB) not responding to TB treatment with supportive lab findings.	Combined treatment of at least 2 drugs: **azithromycin** 10 mg/kg once daily (**clarithromycin** may be used as an alternative) + **ethambutol** 15 to 25 mg/kg once daily Treatment should be continued for at least 12 months after sputum culture conversion to negative. Delay starting ART for 2 weeks if not yet on ART.
Cryptococcal meningitis	*Cryptococcus neoformans*, especially with low CD4	Older children (> 12 years old) Fever, headache, lethargy, irritability, abnormal cry, poor feeding, vomiting, neck stiffness, convulsions, bulging fontanelle Serum CrAg positive CSF findings: Opening pressure – very elevated CSF aspect – clear Specific tests - Indian ink +; crypto Ag + WBC - < 800, mainly lymphocytes Protein (mg/dL) – 20-500, Pandy neg Glucose (mg/dL) – low < 45	Delay initiation of ART for 4-6 weeks after starting antifungal treatment. Single high dose **amphotericin B** IV: 10 mg/kg + 14 days of treatment with: **flucytosine** PO: 25 mg/kg four times daily + **fluconazole** PO: 12 mg/kg once daily (max. 800 mg/day) then consolidation regimen: **fluconazole** PO alone 6 – 12 mg/kg once daily (max. 800 mg/day) for 8 weeks Maintenance regimen: **fluconazole** PO: 6 mg/kg once daily until CD4 > 200 cells/mm^3 and viral load (VL) suppression on ART. Repeated therapeutic lumbar puncture should be done if raised intracranial pressure (headache, vomiting, visual disturbance) to keep pressure < 20 mm H_2O. Remove 1 mL/kg, max. 25 mL per puncture.

Condition	Causes	Clinical features	Management
HIV encephalopathy Develops during first 2 years of life		This is a diagnosis of exclusion. At least one of the following, progressing over two months in the absence of another illness: • Loss or failure to attain developmental milestones, loss of intellectual capacity • Microcephaly: head circumference < 5th percentile for age, or stagnation and failure of head circumference to grow • Motor deficits: symmetrical spastic paresis, increased reflexes (pyramidal tract motor deficit), gait disturbance or ataxia. Facial motor signs such as abnormal eye movements	Early initiation of ART reduces viral damage to the brain. ART may improve some established clinical features.
Focal neurological deficits	**Stroke** due to HIV associated vasculitis or coagulopathy **CNS tumour** **Cerebral toxoplasmosis** **Tuberculosis** (tuberculoma, vasculitis)	**Stroke**: sudden onset, no signs of raised intracranial pressure (ICP) **CNS tumour**: sudden or progressive onset with signs of raised ICP (severe headache, vomiting) and no improvement after at least 10 days of treatment for toxoplasmosis. **Toxoplasmosis**: rare in children; may occur in severely immune suppressed children not on CTX. May or may not have signs of raised ICP.	**Stroke**: supportive treatment (see Chapter 15) **CNS tumour**: supportive treatment (see Chapter 15) and management of raised ICP (see Chapter 2, Section 2.8.3). **Toxoplasmosis** **pyrimethamine** + **sulfadiazine** + **folic acid** for 6 weeks or high dose **co-trimoxazole** for 6 weeks (see above dosing for PCP) Treatment response is expected within 10 days. Secondary prophylaxis is needed after treatment (see Table 13.4). In settings where neuroimaging is not available, consider empiric treatment trial of high dose **co-trimoxazole** for all HIV-infected children who present with a focal deficit, with or without raised ICP.

Condition	Causes	Clinical features	Management
Persistent diarrhoea (> 14 days) or **Chronic diarrhoea** (> 28 days)	**Pathogens specific to advanced HIV**: **Bacteria** MAC (see above) **Protozoa** *Cryptosporidium, Isospora*	More than 3 stools per day – bloody or watery Dehydration – assess severity: recent weight loss, reduced conscious level, sunken eyes, reduced skin tone, thirst. Malnutrition and wasting Stool analysis on three separate samples If available: WBC and CD4	Rehydration as required depending on assessment (see Chapter 5, Section 5.3). Chronic diarrhoea has a high associated mortality in HIV patients. Urgent ART is needed. If no pathogen identified, antibiotic trial for 7 days: High dose **co-trimoxazole** PO (see above dosing for PCP) + **metronidazole** PO: 15 mg/kg 3 times daily MAC (see above) **If *Isospora belli* confirmed by stool analysis**: **co-trimoxazole** PO: 50 mg/kg SMX + 10 mg/kg TMP, 2 times daily for 10 days, followed by 25 mg/kg SMX + 5 mg/kg TMP, 2 times daily for 3 weeks.

13.4.2 Start antiretroviral treatment

For children with confirmed HIV infection, initiate combination **ART** as soon as possible based on national guidelines or according to the following WHO recommendations[3]:

Age/weight	Preferred 1st line ART[b]	Alternative
Children > 3 kg – 29.9 kg	ABC + 3TC + DTG	ABC + 3TC + LPV/r
Adolescents ≥ 30 kg	TDF + 3TC + DTG	TDF + 3TC + EFV 400 mg

- Wherever possible, use pre-qualified paediatric fixed dose combinations (FDCs).
- If ABC/3TC fixed dose combination (FDC) is not available as the preferred backbone, AZT/3TC FDC is an alternative.
- Dosing of paediatric ART is outlined in Table 13.3 below.
- In adolescents weighing 30 kg or more, give TDF 300mg/3TC 300 mg/DTG 50 mg FDC, once daily.
- For more detailed information, refer to MSF HIV/TB clinical guide for primary care and the WHO Paediatric ARV dosing dashboard[c].

Table 13.3 - Simplified dosing of child-friendly FDCs in children 4 weeks and older (excluding adolescents ≥ 30 kg)[3]

Weight	ABC/3TC (2 times daily)			Dolutegravir (once daily)	
	60/30 mg dispersible tab	120/60 mg dispersible tab	600/300 mg tab	10 mg dispersible tab	50 mg tab
3 to < 6 kg	1 tab, morning and evening	½ tab, morning and evening	–	½ tab	–
6 to < 10 kg	1½ tabs, morning and evening	½ tab morning, 1 tab evening	–	1½ tabs	–
10 to < 14 kg	2 tabs, morning and evening	1 tab, morning and evening	–	2 tabs	–
14 to < 20 kg	2½ tabs, morning and evening	1 tab morning, 1½ tabs evening	–	2½ tabs	–
20 to < 25 kg	3 tabs, morning and evening	1½ tabs, morning and evening	–	3 tabs	1 tab
25 to < 35 kg	–	–	½ tab, morning and evening	–	1 tab

In children < 18 months of age with known HIV exposure who are admitted critically unwell or with a presumptive infection (particularly an opportunistic infection), start ART while waiting for the DNA PCR/NAT results. Ensure follow-up of DNA PCR/NAT results and final confirmation of diagnosis of HIV in all children starting presumptive treatment (see Section 13.3).

b Abacavir (ABC), lamivudine (3TC), dolutegravir (DTG), tenofovir (TDF), lopinavir/ritonavir (LPV/r), efavirenz (EFV), zidovudine (AZT)

c https://paedsarvdosing.org/?sfvrsn=c32f09d7_10

Side effects

ART medications have a number of side effects which should be monitored at each follow-up. Almost all ARVs can cause mild constitutional symptoms such as headache, nausea and fatigue. In addition, specific potential side effects include renal impairment (TDF), anaemia (AZT), neutropenia (AZT), hepatic impairment (NVP; LPV/r; EFV; DTG; TB-HIV co-treatment), hypersensitivity reactions (ABC; NVP; EFV), CNS disturbance (EFV), and mitochondrial toxicity (3TC; AZT; ABC; TDF).

13.4.3 HIV and tuberculosis co-infection

HIV-tuberculosis (TB) co-infection is common in newly presenting sick children with HIV. Both HIV-exposed and infected children are at high risk of active TB and should be screened for TB:
- Take a full history including family history of TB and any potential household contacts with TB.
- Conduct a comprehensive examination. Note that extrapulmonary TB is more common in children therefore full clinical examination of all systems is necessary.
- Ensure relevant investigations are performed e.g. GeneXpert, TB LAM (see Chapter 4, Section 4.11). Note that tuberculin skin test (TST) may be negative in HIV co-infection.

If TB disease is suspected: start TB treatment as soon as possible while waiting for TB investigation and results. Refer to Chapter 4, Section 4.11. In the case of suspected TB meningitis in an HIV-infected child, consider adding corticosteroid therapy.

Immune Reconstitution Inflammatory Syndrome (IRIS)

IRIS is a paradoxical reaction that can occur in patients with an underlying opportunistic infection and whose immunity is rapidly improving on ART. To avoid IRIS in children with suspected TB who are not yet on ART, delay ART initiation and start TB treatment immediately. Initiate ART as soon as TB drugs are tolerated within 2 weeks of starting TB treatment, unless TB meningitis is suspected. In this case, delay ART by at least 4 weeks (and initiate within 8 weeks) after starting TB treatment[3].

If active TB excluded, start TB preventive treatment. Refer to Chapter 4, Section 4.11 and MSF Tuberculosis Guidelines for details.

13.4.4 Co-trimoxazole prophylaxis

Give **co-trimoxazole** PO once daily to all children from 4 to 6 weeks of age who are confirmed as HIV-exposed or infected[d]:
- 50 mg/kg SMX (max. 800 mg) + 10 mg/kg TMP (max. 160 mg) once daily (see Table 13.4).

d Prophylaxis against pneumonia (especially PCP), cerebral toxoplasmosis, certain types of diarrhoea, malaria, severe bacterial infections (strep pneumoniae, haemophilus influenzae, salmonella, legionella, nocardia, methicillin sensitive staphylococcus aureus and many gram-negative bacilli).

Table 13.4 - Simplified dosing of once daily co-trimoxazole prophylaxis in children

Weight	200/40 mg per 5 mL oral suspension	100/20 mg dispersible tab	400/80 mg scored tab	800/160 mg scored tab
3 to < 6 kg	2.5 mL	1 tab	–	–
6 to < 10 kg	5 mL	2 tabs	½ tab	–
10 to < 14 kg	5 mL	2 tabs	½ tab	–
14 to < 20 kg	10 mL	4 tabs	1 tab	½ tab
20 to < 25 kg	–	4 tabs	1 tab	½ tab
25 to < 35 kg	–	–	2 tabs	1 tab

13.5 Prevention of Mother to Child Transmission (PMTCT)

Refer to MSF Prevention of mother-to-child transmission of HIV Guidelines for full details on PMTCT.

– All HIV-exposed infants should receive ART:
  - Infants who are at high risk[a] of acquiring HIV should receive **AZT** and **NVP** prophylaxis once daily until 6 weeks of age, regardless of whether they are breastfed or formula fed.
  - In high-risk breastfed infants, AZT and NVP prophylaxis (or NVP alone) should be continued for an additional 6 weeks (total of 12 weeks of infant prophylaxis).
  - For low-risk breastfed infants (i.e. whose mothers are receiving ART and have a suppressed VL at least 4 weeks prior to delivery), give only NVP once daily for 6 weeks.
  - For infants receiving replacement feeding whose mothers are receiving ART, give NVP once daily (or AZT 2 times daily) for 4-6 weeks.

See also Appendix 19 for more detail, including dosing of ARV prophylaxis in PMTCT.

a A high-risk infant is defined as an infant whose mother was first identified as HIV-infected at delivery or in the postpartum period, infected during pregnancy or breastfeeding, received less than 4 weeks of ART prior to delivery, or did not achieve viral suppression by the time of delivery.

13.6 Prior to discharge

– Ensure referral to HIV and/or maternal-child health services has been established.
– Continuity of ART and close follow-up and monitoring is vital for children growing up with HIV.

References Chapter 13

1. Paediatric care and treatment. UNICEF DATA. Accessed October 30, 2023. https://data.unicef.org/topic/hivaids/paediatric-treatment-and-care/
2. Newell ML, Coovadia H, Cortina-Borja M, Rollins N, Gaillard P, Dabis F. Mortality of infected and uninfected infants born to HIV-infected mothers in Africa: a pooled analysis. *The Lancet*. 2004;364(9441):1236-1243. https://doi.org/10.1016/S0140-6736(04)17140-7
3. *Consolidated Guidelines on HIV Prevention, Testing, Treatment, Service Delivery and Monitoring: Recommendations for a Public Health Approach*. World Health Organization; 2021. https://www.who.int/publications/i/item/9789240031593

Chapter 14:
Fever of unknown origin (FUO) and neglected tropical diseases (NTDs)

14.1 Fever of unknown origin (FUO)

There is no widely agreed definition of fever of unknown origin (FUO), also known as persistent fever, in children[1]. FUO is a diagnosis of exclusion, therefore the clinical definition of FUO in children for the purposes of these guidelines is: fever at least once per day for more than 7 days, with no confirmed diagnosis after initial comprehensive assessment that includes a detailed history, thorough clinical examination, and appropriate laboratory investigations.

Given the lack of a consensus definition, the incidence of FUO in children is uncertain.

14.1.1 Causes

Causes of FUO in children are numerous. Infectious diseases (viral, bacterial, parasitic or fungal) are the most commonly identifiable causes, followed by rheumatologic diseases (most commonly juvenile idiopathic arthritis (JIA) and systemic lupus erythematosus) and neoplastic disorders[2]. The remainder are caused by various conditions including Kawasaki disease, inflammatory bowel disease, immunodeficiencies, factitious fever, and drugs (see Appendix 20 for a comprehensive list of causes). For infectious causes, consider the epidemiology of the area as well as clinical features to guide the differential diagnosis. As potential causes of FUO are many, a systematic approach to the patient is required. Exclude the most common causes of FUO (TB, HIV, undiagnosed malaria, enteric fever, pneumonia) before investigating for other conditions.

14.1.2 Clinical features

Before starting a detailed diagnostic workup, it is essential to demonstrate the presence of fever in a controlled setting. Therefore, patients with suspected FUO should be admitted for regular monitoring and recording of fever and other vital signs. The medical team should repeat the history and clinical examination on multiple occasions to identify clues that may have been omitted or overlooked previously.

Specific points to be reviewed in the history include:
- Symptoms: potential undiagnosed underlying medical condition
- Growth: particularly decreased growth velocity
- Immunisations: up-to-date or missing immunisations
- Living conditions: urban/rural/nomadic
- Occupation/school
- Epidemiology of the area: malaria, TB, HIV, leishmaniasis
- Season: rainy or dry season
- Recent travel or displacement
- Diet: goat's milk, unpasteurized products, raw meat, pica
- Exposure/Contact: animals, lakes/rivers, sand/soil, mosquitoes/ticks/bites/cats, tuberculosis, sexual, blood products, piercing/tattoos.

Full head-to-toe clinical examination should be performed, including vital signs (especially HR and temperature association) and anthropometric assessment (to rule out malnutrition or short stature). If not done on admission, the patient with FUO should be evaluated while febrile. This is necessary to assess how unwell the patient appears and to record any accompanying symptoms (e.g. the rash of JIA is characteristically evanescent and may be present only during fever).

14.1.3 Investigations

Initial baseline investigations for all children with FUO:
- Full blood count (FBC), including Hb
- Blood glucose level (BGL)
- Malaria RDT and blood film
- Urine dipstick and culture, if available
- Blood culture, if available
- HIV testing
- Mantoux testing, if available
- Liver and renal function tests, if available
- Radiology:
  - CXR (to check the lungs but also the hila and mediastinum)
  - If CXR is not available, ultrasound of chest can be performed, although ultrasound is limited in evaluation for TB in children. Paediatric TB is commonly characterized by hilar and/or mediastinal lymph nodes, which are difficult to visualize on ultrasound.
  - Abdominal ultrasound

Further investigations to be considered depending on clinical suspicion, evolution and availability (see Figure 14.1):
- Recombinant kinesin antigen (rK39) test[a] (for visceral leishmaniasis)
- Leishmania DAT (direct agglutination test)
- TB screening: microscopy and culture, or GeneXpert where available (see Chapter 4, Section 4.11 for further investigations if TB suspected).
- Urinary microscopy for schistosomiasis
- Stool microscopy and culture
- LP for CSF examination: biochemistry, Gram stain and culture, GeneXpert
- RDT for HIV, HBV, HCV
- Card Agglutination Test for Trypanosomiasis (CATT)
- Rose Bengal test for brucellosis
- Rickettsia IgM
- Cardiac ultrasound

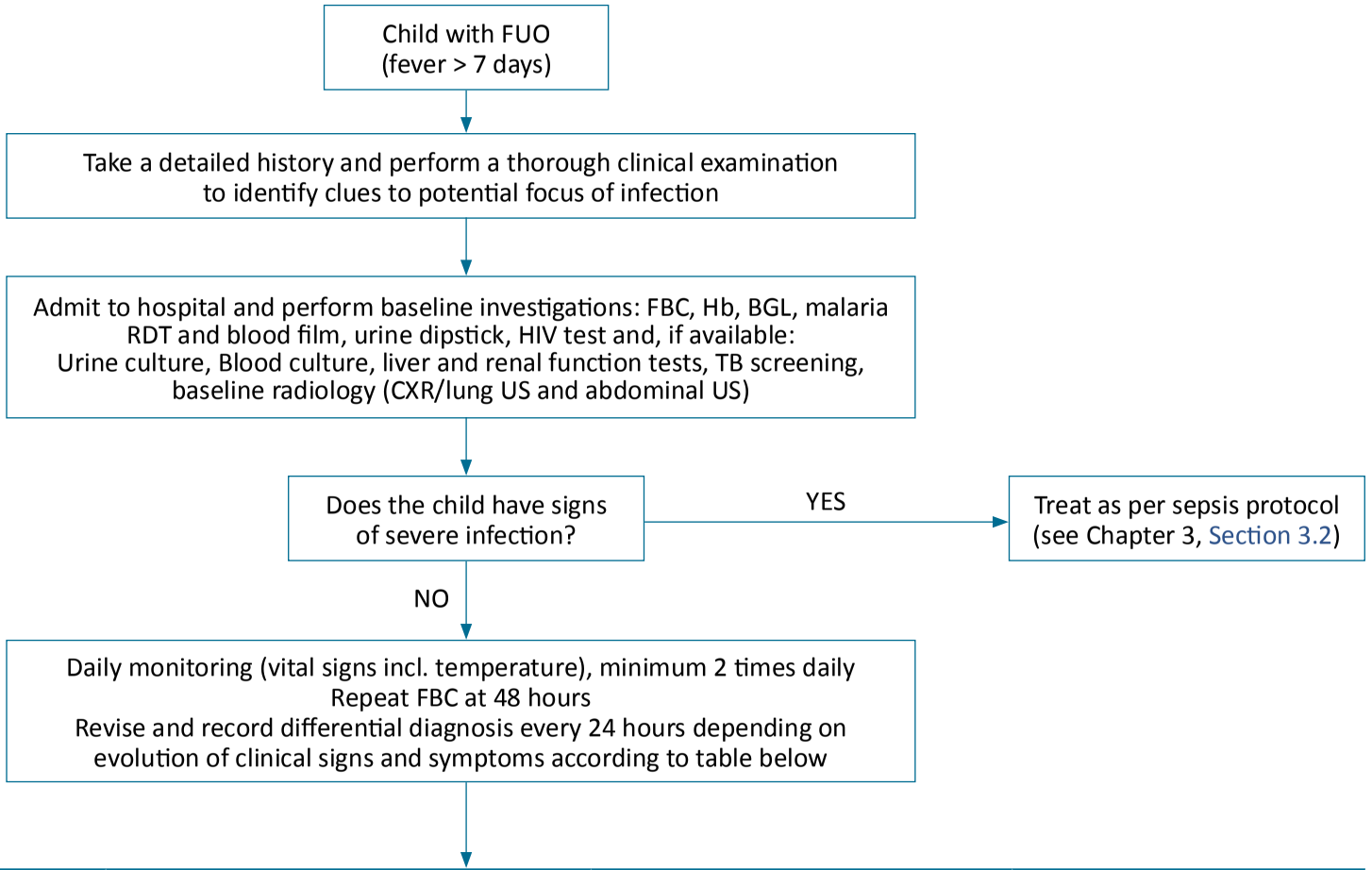
14.1.4 Management

After exclusion of the most common causes of FUO, management is guided by the principal symptoms and signs, and the organ systems affected (see Figure 14.1). Ensure close clinical monitoring and revise diagnosis daily based on new or evolving clinical signs and symptoms.

If, after careful and detailed assessment (thorough history of symptoms, exposure, family and past medical history; head to toe clinical examination; baseline and targeted investigations), no source or obvious cause is identified, use empiric treatment to cover several common pathogens while continuing to investigate:
- If hospitalised due to severity of symptoms:
  - **ceftriaxone** IV: 50 - 80 mg/kg (max. 4 g if < 50 kg; max. 2 g if ≥ 50 kg) every 24 hours
    +
  - **doxycycline** PO: 2 - 2.2 mg/kg (max. 100 mg) 2 times daily (or **azithromycin** PO: 10 mg once daily in children < 8 years)
- If treated as outpatient: **doxycycline** PO (or **azithromycin** PO in children < 8 years)

a Useful antigen in ELISA assays with high sensitivity and specificity in immunocompetent patients in the Indian subcontinent. The sensitivity is lower and more variable in East Africa and Brazil, although specificity remains high. This antigen rapid test requires minimal equipment and is easy to use.

Figure 14.1 - Algorithm for the management of a child with FUO



Main sign/ symptom	Potential cause	Clues in history or examination	Investigations (if available)	Management
Hepatomegaly and/or Splenomegaly	Visceral Leishmaniasis	Known endemic area; sandfly bite;	Leishmaniasis rapid test (rK39) or serology (DAT); pancytopenia on FBC; raised CRP	See Section 14.2

Main sign/ symptom	Potential cause	Clues in history or examination	Investigations (if available)	Management
Hepatomegaly and/or Splenomegaly	Viral hepatitis	Previous blood transfusion (B/C/D); sexual contact (B/C/D); poor hygiene practices (A/E); jaundice	HBV and HCV RDTs	See MSF Clinical Guidelines, Chapter 8
	Schistosomiasis	Swimming/bathing in infected water (rivers/lakes); fever and rash with bronchospasm (Katayama fever)	Urine dipstick, urine and stool microscopy	See MSF Clinical Guidelines, Chapter 6
	Amoebic or bacterial liver abscess	Poor hygiene practices; lack of access to clean water	Abdominal US; leucocytosis on FBC; raised CRP	See MSF Clinical Guidelines, Chapter 3
	Human African Trypanosomiasis	Sub-Saharan Africa only; known endemic area; tsetse fly bite; sleeping pattern	Card Agglutination Test for Trypanosomiasis (CATT)	See MSF Clinical Guidelines, Chapter 6
	Leptospirosis	Exposure to domestic animals/rodents; recent heavy rain/flooding; tropical/ subtropical; biphasic fever; 'red eyes'	CXR; Blood smear; raised CRP	See MSF Clinical Guidelines, Chapter 7
	Brucellosis	Exposure to livestock; drinking unpasteurised milk; rural areas	Rose Bengal test, blood culture	See MSF Clinical Guidelines, Chapter 7
	Borreliosis (Tick-Borne or Louse-Borne Relapsing Fever)	Known endemic area; tick bite – temperate regions of Africa, rural; body lice – Horn of Africa, epidemic in cold season, overcrowding and poor sanitation; biphasic fever	Blood smear	See MSF Clinical Guidelines, Chapter 7
Respiratory	Pneumonia (atypical/ fungal[b])	Poorly maintained water pipes; exposure to bird/bat droppings	CXR and/or lung US	See Chapter 4, Section 4.5
	TB	Known endemic area; close contact with suspected/known case	TB screening; HIV screening	See Chapter 4, Section 4.11 and MSF TB Guidelines
	Tumour	Chronic symptoms	CXR, lung US, FBC	Consider referral

b Atypical/fungal lung infections include legionella and histoplasmosis. See also Appendix 20.

Main sign/ symptom	Potential cause	Clues in history or examination	Investigations (if available)	Management
Cardiac	Endocarditis	Poor dentition; recent procedure	Blood culture and cardiac US	Follow local guidance
	Myocarditis/Pericarditis (bacterial/viral/TB)	Recent URTI	Cardiac US, TB screening	Follow local guidance
	American Trypanosomiasis (Chagas disease)	American continent; known endemic area (rural); triatomine bug faeces; severe constipation	Blood microscopy, ECG, CXR	See MSF Clinical Guidelines, Chapter 6
	Kawasaki disease	Desquamation of hands and feet	Clinical diagnosis, cardiac US	Follow local guidance
Abdominal pain/diarrhoea	Enteric fever (typhoid and paratyphoid)	Poor hygiene practices; lack of access to clean water; known endemic area; relative bradycardia; salmon rash	Blood culture; abdominal US; leucopenia; raised CRP	See Chapter 3, Section 3.6
	Amoebic or bacterial liver abscess	Poor hygiene practices; lack of access to clean water	Abdominal US; leucocytosis on FBC; raised CRP	See MSF Clinical Guidelines, Chapter 3
	Appendiceal abscess	Recent appendicitis	Abdominal US	Consider referral
	HIV	Previous blood transfusion; mother sick or known HIV positive	HIV testing	See Chapter 13 and HIV guidelines
	TB	Known endemic area; close contact with suspected/known case	TB screening	See Chapter 4, Section 4.11 and MSF TB Guidelines
Genitourinary	Pyelonephritis	Recent UTI; congenital renal problem	Urine dipstick	See Chapter 8, Section 8.1
	Schistosomiasis	Recent swimming/bathing in infected water (rivers/lakes)	Urine dipstick, urine and stool microscopy	See MSF Clinical Guidelines, Chapter 6
	Genital infections	Recent sexual activity/assault	Genital swabs, urine dipstick	See MSF Clinical Guidelines, Chapter 9

Main sign/ symptom	Potential cause	Clues in history or examination	Investigations (if available)	Management
Neurological	Malaria	Known endemic area; no bed net; rainy season	Malaria RDT +/- blood film	See Chapter 3, Section 3.4
	Meningitis (incl. TB)	Missed immunisations; known epidemic-prone area	Lumbar puncture	See Chapter 3, Section 3.3, Chapter 4, Section 4.11 and MSF TB Guidelines
	Mastoiditis/intracranial abscess	Recent otitis media	Clinical diagnosis, CT head	See Chapter 4, Section 4.12
	Tetanus	Missed immunisations; dirty wound (soil)	Clinical diagnosis	See Chapter 3, Section 3.5
	Leptospirosis	Exposure to domestic animals/rodents	CXR, Blood smear	See MSF Clinical Guidelines, Chapter 7
	Human African Trypanosomiasis	Sub-Saharan Africa only, known endemic area; tsetse fly bite	Card Agglutination Test for Trypanosomiasis (CATT)	See MSF Clinical Guidelines, Chapter 6
	HIV	Previous blood transfusion; mother sick or known HIV positive	HIV testing	See Chapter 13 and HIV guidelines
Dermatological/ skin rash	Rickettsiosis	Insect bite (ticks, rat fleas, mites); 'inoculation eschar': painless, black, crusted lesion with erythemartous halo at bite	Rickettsia IgM	See MSF Clinical Guidelines, Chapter 7
	Erysipelas/cellulitis	Infected wound site	Clinical diagnosis	See MSF Clinical Guidelines, Chapter 4
	Kawasaki disease	Desquamation of hands and feet	Clinical diagnosis, cardiac US	Follow local guidance

Main sign/ symptom	Potential cause	Clues in history or examination	Investigations (if available)	Management
Musculoskeletal	Osteomyelitis	Missed immunisations; known SCD; recent IO access; puncture wound	FBC, blood culture, limb x-ray	See Chapter 11, Section 11.4
	Septic arthritis	Missed immunisations; open wound	FBC, blood culture, joint US	See Chapter 11, Section 11.5
	Brucellosis	Exposure to livestock; drinking unpasteurised milk; rural areas	Rose Bengal test, blood culture	See MSF Clinical Guidelines, Chapter 7
	TB	Known endemic area; close contact with suspected/known case	TB screening	See Chapter 4, Section 4.11 and MSF TB Guidelines
	Rheumatic/neoplasm	Chronic symptoms	Blood smear	Consider referral
Multiorgan (including weight loss, skin rash)	Sepsis		FBC, blood culture	See Chapter 3, Section 3.2
	TB	Known endemic area; close contact with suspected/known case	TB screening	See Chapter 4, Section 4.11 and MSF TB Guidelines
	HIV	Previous blood transfusion; mother sick or known HIV positive	HIV testing	See Chapter 13 and HIV guidelines
	Rickettsiosis	Insect bite (ticks, rat fleas, mites); 'inoculation eschar': painless, black, crusted lesion with erythemartous halo at bite	Rickettsia IgM	See MSF Clinical Guidelines, Chapter 7
	Borreliosis	Known endemic area; tick bite – temperate regions of Africa, rural; body lice – Horn of Africa, epidemic in cold season, overcrowding and poor sanitation	Blood smear	See MSF Clinical Guidelines, Chapter 7
	Leptospirosis	Exposure to domestic animals/rodents	CXR, Blood smear	See MSF Clinical Guidelines, Chapter 7
	Rheumatic/neoplasm	Chronic symptoms	Blood smear	Consider referral

14.2 Leishmaniasis

A neglected tropical disease caused by protozoa of the genus *Leishmania* and transmitted by the bite of an infected sandfly. There are different types of leishmaniasis:
– Visceral leishmaniasis (or kala-azar) (VL): most severe form
– Cutaneous leishmaniasis (CL)
– Muco-cutaneous leishmaniasis (MCL)
– Disseminated cutaneous leishmaniasis (DCL)

14.2.1 Visceral leishmaniasis (kala-azar)

Visceral leishmaniasis (VL) is a severe systemic infection primarily caused by *Leishmania donovani* and *L. infantum* (synonym *L. chagasi*) and is potentially fatal if left untreated[3]. It occurs predominantly in South and Central Asia, East and North Africa, Mediterranean area of South Europe, and South and Central America. In endemic areas, children are at greater risk than adults[4]. Presentation of the disease depends on several factors, including host immune response, nutritional status, parasite burden and its virulence. The incubation period is generally from 2 to 6 months (but can range from few weeks to several years)[5].

Clinical features

Onset of signs and symptoms are usually insidious:
– Intermittent fever (generally lasting > 2 weeks) associated with (over a period of weeks to months):
  • Malaise
  • Poor appetite
  • Weight loss
  • Abdominal tension, minimally tender or painless splenomegaly (with or without hepatomegaly)
  • Pallor or severe anaemia due to bone marrow suppression, splenic sequestration, and haemolysis
– Thrombocytopenia: spontaneous bleeding from the nasal mucosa (epistaxis), gingiva, or other sites.

Less commonly, fever may be associated with rapidly progressive signs.

Suspect VL in any child presenting with a history of prolonged fever (more than 2 weeks) with splenomegaly and/or lymphadenopathy and/or wasting.

Complications include: hepatic dysfunction, jaundice, marked cachexia, diffuse oedema, chronic diarrhoea and malabsorption, or rarely, disseminated intravascular coagulation[6,7]. Secondary bacterial infections can develop due to immunosuppression, pneumonia being among the most common and a frequent cause of death.

Differential diagnosis includes other causes of fever of unknown origin (see Section 14.1).

Investigations[8,9]

- FBC (anaemia, neutropenia, thrombocytopenia)
- BGL
- Recombinant kinesin antigen (rK39) test[a] (first choice diagnostic test)
- Leishmania DAT (direct agglutination test)
- Malaria RDT (where endemic)
- Renal and liver function tests, if available.

Note: where VL is endemic, serum antibodies may be positive among children with subclinical infection or those who have recovered after successful treatment. In addition, very young infants may be serologically positive due to maternal antibodies if the mother had VL in pregnancy. Serological tests should only be used, therefore, in symptomatic patients without a history of VL treatment. VL relapse can only be diagnosed by tissue aspirate microscopy from the spleen, bone marrow or lymph node.
Serum antibodies may be low or undetectable in severely immunocompromised children (e.g. those with HIV). In these cases, diagnosis should be made on the basis of clinical suspicion if parasitological confirmation through microscopy of tissue aspirates is not possible.

Management

- Admit to hospital and manage any complications (anaemia, thrombocytopenia, intercurrent infections, e.g. malaria, pneumonia, TB, HIV, diarrhoea).
- Assess nutritional status. If malnourished, refer appropriately.
- Start VL treatment according to national guidelines where implemented/available or follow treatment by region below.
- Ensure information and education provided from admission to parents/carers and child that the treatment is long and must be followed regularly.
- Any cases of suspected VL should be notified.

East Africa

- For children < 2 years old OR with other severe disease (liver, renal, or cardiac diseases, HIV co-infection, severe malnutrition, very poor general condition), administer:

> **liposomal amphotericin B** (AmBisome™) IV infusion
> 3 to 5 mg/kg once daily for 6 to 10 days, up to a total dose of 30 mg/kg

- For children ≥ 2 years old without other severe disease, administer:

> First-line:
> - **pentavalent antimonia**l IM or slow IV
> 20 mg/kg once daily for 17 days
> - + **paromomycin** IM
> 15 mg (equivalent to 11 mg base)/kg once daily for 17 days
>
> Second-line in case of relapse:
> - **liposomal amphotericin B** (AmBisome™) IV infusion
> 3 to 5 mg/kg once daily for 6 to 10 days, up to a total dose of 30 mg/kg

a Useful antigen in ELISA assays with high sensitivity and specificity in immunocompetent patients in the Indian subcontinent. The sensitivity is lower and more variable in East Africa and Brazil, although specificity remains high. This antigen rapid test requires minimal equipment and is easy to use.

– For HIV co-infected children:
  - **liposomal amphotericin B** (AmBisome™) IV infusion
    3 to 5 mg/kg once daily for 6 to 10 days up to a total dose of 30 mg/kg
  - + **miltefosine** PO for 28 days[b]
    - ▷ Children 2 to 11 years: 2.5 mg/kg once daily
    - ▷ Children ≥ 12 years and < 25 kg: 50 mg once daily
    - ▷ Children ≥ 12 years and adults 25 to 50 kg: 50 mg 2 times daily

South Asia

– First-line treatment:
  - **liposomal amphotericin B** (AmBisome™) IV infusion
    10 mg/kg single dose

– Second-line treatment for relapse:
  - **paromomycin** IM
    15 mg (equivalent to 11 mg base)/kg once daily
  - + **miltefosine** PO (as above), both for 10 days

Middle East, Central Asia, Mediterranean, Latin America

– First-line treatment:
  - **liposomal amphotericin B** (AmBisome™) IV infusion
    3 to 5 mg/kg once daily for 4 to 7 days, up to a total dose of 20 to 21 mg/kg

⚠ Liposomal amphotericin B requires strict cold chain during transportation, storage under 25 °C and protection from light. It must not be diluted with saline solutions or mixed with other electrolytes or medicines.

14.2.2 Cutaneous leishmaniasis

Causes ulcerated skin lesion(s), usually on exposed areas which can leave life-long disfiguring scars[10]. Around 75% of the global estimate of 0.6 to 1 million cases per year occur in Afghanistan, Algeria, Brazil, Iran, Iraq, Pakistan, and Syria, and children represent between 10 to 55% of cases[11,12]. Young age (lack of immunity), infants (immature immune system), underlying malnutrition increases risk of CL, with higher first-line treatment failure in children < 12 years[3,13].

Leishmania major and *tropica* are the most common in Asia, Africa and Europe (mainly southern, Mediterranean countries, especially Greece):
– *Leishmania major*: zoonotic transmission, more typical in rural and suburban contexts, frequently appears as severely inflamed and ulcerated skin lesions (“wet ulcers”), which heal spontaneously within 2-8 months, leaving an atrophic scar.
– *Leishmania tropica*: anthroponotic transmission, typically in urban contexts, appears as painless, frequently multiple, dry ulcers or plaques. Normally develops and self-heals slower (one year or longer), may develop into a chronic persistent and remitting lesion (Leishmania recidivans). Untreated lesions can become secondary infected and can leave destructive and disfiguring scars.
– Less common include *Leishmania infantum* (Mediterranean region) and *aethiopica* (Ethiopia and Kenya).

b Allometric dosing based on weight, height and gender is recommended for more accurate dosing in children under 30 kg to prevent underdosing. For advice on individual dosing, refer to specialist clinician.

In the Americas, species include *Leishmania mexicana* and *amazonesis*, and with increased risk of mucosal CL, *braziliensis* and *guyanensis*. Around 15.5% (with a range of < 5% to 47% between countries) of cases were reported to be in children ≤ 10 years of age[5].

Clinical features

- Erythematous papule appears at site of the sandfly bite, which enlarges to a nodule, extending and deepening to form a scabbed ulcer (painless, unless there is secondary bacterial or fungal infection).
- Single lesions are more frequent (40 to 75%) in children[14] and in around 35 to 48% cases are located on the head and neck.
- Lesions usually heal spontaneously, leaving a scar and life-long protection.

Diagnosis is usually clinical in endemic areas, and based on having at least 2 of the following criteria for suspected CL:

- ✔ History of more than 1 month
- ✔ Not painful
- ✔ Not itchy
- ✔ On exposed body parts
- ✔ Started as a small papule or nodule when it was first noticed which did not itch.

Differential diagnoses include: cutaneous tuberculosis, leprosy, psoriasis, impetigo, verruca, yaws, fungal infection, cutaneous mycoses, basal cell carcinoma.

Investigations

Microscopy:
- Identification of parasites in Giemsa-stained smears or culture.
- Take sample for the smear using fine needle aspiration (FNA) or skin scraping from the nodule or active margin/raised edge of the ulcer or lesion. FNA is more sensitive and less painful.

Management[15]

Treatment options are limited for children with most guidance based on extrapolation from adult treatments (and data)[10]. Antimonial treatment can be toxic in children. Ensure all effort is made to obtain parasitological confirmation and assess risk-benefit on a case-by-case basis.

Safe and effective intra-lesional injection is sometimes not possible with a resisting child. In those situations, it may be safer to treat the child with IM injections, or to leave the child untreated.

Indications for treatment include if lesions are:
- Severe enough to justify systemic treatment
- Located on the face, active (with raised edges), and large
- Early (usually nodular), where treatment may prevent lesion enlarging.
- On a joint (e.g. wrist, elbow, knee, ankles)
- Causing a loss of function (e.g. on fingers, elbow, knee or toes).
- Lupoid (usually chronic)
- Persistent active (> 6 months)

Pentavalent antimonial

meglumine antimoniate or **sodium stibogluconate** (**SSG**)

	Local treatment	Systemic treatment
Injection	Intralesional (intradermal)	Intramuscular
Indications	1 to 3 lesions[c] Lesions < 5 cm diameter Cooperative child and parent/carer	Four or more lesions Lesions of ≥ 5 cm in diameter Lesions near eyes, on lips, or in oedematous extremities (hand, feet) Painful injection site (fingers, toes) Difficult to inject intralesionally due to location (on ears or nose) Uncooperative child < 5 years of age.
Dose	0.5 to 4 mL, depending on the size of the lesion(s), infiltrated into the raised edges around and /or into the base of the lesion/ulcer	20 mg/kg Administer under close medical supervision.
Frequency	2 times/week (fixed days)	Once daily
Duration	5 to 8 treatment sessions (up to 12 sessions for *L. tropica*) Refer to specialist for follow-up.	20 days (up to 28 days for *L. tropica*)

In the case of treatment failure or contraindication to antimonials, oral **miltefosine** is an alternative (effective for *L. major* and possibly *L. tropica*). Refer to specialist clinician for dosing.

For wound care, refer to MSF OCB Wound Care Protocol and refer to specialist.

Secondary infection

Most common pathogens are streptococci and staphylococci.
Examine all lesions carefully for secondary infection as it may not be evident. Palpate whole lesion thoroughly as often infection is under the thick crust.

– Consider if one or more of the following signs and symptoms:
  - Ulcerating, weeping or purulent discharge (may be hidden under the crust).
  - Lesion is painful.
  - Swelling or oedema around the lesion.
  - Red from inflammation.
– Often good cleaning and light debridement is sufficient, but if necessary, start oral antibiotics.

Concomitant treatment with antimonials:

– Intralesional antimonial treatment: treat secondary bacterial infection before starting antimonial treatment. If intralesional treatment already started, postpone further intralesional treatment until antibiotic treatment completed.
– IM antimonial treatment: antibiotic treatment can start/continue simultaneously, combined with daily wound care.

c If the patient has more than 3 lesions, but all lesions are less than 2 cm, intralesional treatment could still be considered.

Mucocutaneous leishmaniasis

Occurs in Latin America and, more rarely, in Africa (Ethiopia, Sudan).

14.2.3 Post-kala-azar dermal leishmaniasis (PKDL)

Post-kala-azar dermal leishmaniasis (PKDL) is a skin rash that appears in a proportion of patients after a cured episode of VL, caused by an incomplete immune response to Leishmania that allows for parasites to persist in the skin. Very few patients however relapse with VL after PKDL, so it is generally seen as a sign of developing immunity. Only patients with severe or disfiguring disease or with lesions remaining for > 6 months, and young children with mucosal lesions that interfere with feeding, are treated.

Refer to MSF Clinical Guidelines, Chapter 6 for more details.

14.3 Noma (cancrum oris)

Noma, also known as cancrum oris, is a necrotising gingivitis that causes rapid destruction of the tissues of the mouth and face. It most frequently occurs in young children, with peak age of onset between 2 to 6 years[16]. It affects all tissues of the face from soft tissue to bone and is fatal in 90% of cases in the acute phase without treatment. Sequelae for survivors include significant disfigurement and functional problems with eating and speaking due to trismus and loss of facial tissue. Data are lacking on the exact incidence and prevalence of the disease due to high mortality in the acute phase of the illness and the social stigma of the visible sequelae which mean that many cases remain hidden and unaccounted for. Estimates from 1998 indicate that there are approximately 140 000 new cases of noma per year[16], though this is likely to be an underestimation. The majority of cases occur in sub-Saharan Africa.

The exact pathophysiology of noma remains unclear, but an altered oral microbiota is strongly linked with the disease[17]. It thought to be due to a polymicrobial infection of anaerobic commensal oral pathogens which become pathogenic when the immune system is weakened. Both *Fusobacterium necrophorum* and *Prevotella intermedia* have been implicated in noma pathogenesis, however the exact role they play has been inconsistently described[17]. Risk factors for noma include malnutrition, poverty, recent measles or other immuno-suppressive infection, proximity to livestock, weaning from breastmilk, and poor oral hygiene. It is not a contagious disease.

14.3.1 Clinical features

Diagnosis is based on clinical features and history. Children typically present with a simple gingivitis (bleeding, swollen and sensitive gums), that progresses rapidly over a few weeks according to the following WHO stages[16]:

Stage of infection	Signs and symptoms	Duration	Reversible
Warning stage: Simple gingivitis	• Bleeding gums when brushing • Swollen and sensitive gums • Occasional bad breath	Indefinite	Yes
Stage 1: Acute necrotising gingivitis	• Spontaneously bleeding gums • Painful ulceration of the gums • Fetid breath • Excessive salivation	Indefinite	Yes
Stage 2: Oedema	• Rapid extension of gingival ulceration • Facial swelling/oedema • Painful cheek and mouth • High fever • Difficulty eating, anorexia • Lymphadenopathy (head and neck)	1 to 2 weeks	Yes

Stage of infection	Signs and symptoms	Duration	Reversible
Stage 3: Gangrenous stage	• Extensive destruction of intraoral soft and hard tissue • Blackened necrotic lesion with well demarcated perimeter • Separation of the slough, leaving hole in the face often around cheeks or lips • Rapid perforation of the cheek, exposing teeth and bone • Progressive drying of the facial gangrene • Anorexia • Apathy	1 to 2 weeks	No
Stage 4: Scarring stage	• Trismus may occur depending on location of lesions • Sequestration of teeth and exposure of bones • Beginning of scarring	1 to 2 weeks	No
Stage 5: Sequelae stage	• Disfigurement of the face • Trismus • Tooth loss or displacement • Feeding and speech difficulties • Salivary leak and nasal regurgitation	Permanent	No

Stages 1 and 2 are reversible, while stages 3-5 are irreversible and lead to permanent damage to facial tissues.

14.3.2 Management

Management depends on the stage of the disease when it is detected. Early stages can be managed in the community but from stage 2 onwards, inpatient treatment is necessary.

Warning stage: Simple gingivitis

– Rinse mouth regularly with clean salted water[a] and help child to maintain good oral hygiene daily.
– Give mouthwash with chlorhexidine 0.2%, 10 mL 3 times daily.
– Assess for malnutrition and start nutritional treatment if necessary (see MSF ATFC Nutritional Care Protocol). If not malnourished, give health and nutrition education including high protein diet (beans, meat, fish, eggs, milk, peas).

a Add half a teaspoon of table salt to a cup/glass of warm water and dissolve. Use the salted water to rinse the mouth and then spit, it should not be swallowed.

– Give **Vitamin A** supplementation :
  • Infants < 6 months: 50 000 IU once daily for 2 days
  • Infants 6 to 11 months: 100 000 IU once daily for 2 days
  • Children 12 to 59 months: 200 000 IU once daily for 2 days

  A third dose should be given to children with signs of vitamin A deficiency (xeropthalmia, corneal ulceration), 4 to 6 weeks later[b].
– Ensure regular mouth inspection.
– Consider deworming (see Chapter 5, Section 5.2).
– Counsel and test for HIV.

Stage 1: Acute necrotising gingivitis

– Follow all management steps outlined above for Warning stage: Simple gingivitis.
– Give oral antibiotics for 14 days:

First choice:
amoxicillin PO: 100 mg/kg, 2 times daily
+ **metronidazole** PO: 15 mg/kg, 2 times daily

Alternative:
amoxicillin/clavulanic acid (ratio 7:1 or 8:1) PO
Dosage expressed in amoxicillin:
• < 40 kg: 50 mg/kg 2 times daily
• ≥ 40 kg:
  Ratio 8:1: 3000 mg daily (2 tablets of 500/62.5 mg 3 times daily)
  Ratio 7:1: 2625 mg daily (1 tablet of 875/125 mg 3 times daily)

– Give analgesia for pain (see Chapter 15, Section 15.4).
– Screen for and treat any co-morbidities such as malaria (see Chapter 3, Section 3.4), measles (see Chapter 3, Section 3.7), diarrhoea (see Chapter 5, Section 5.2), tuberculosis (see Chapter 4, Section 4.11), HIV (See Chapter 13).
– Treat anaemia, if present (see Chapter 10, Section 10.1).
– Arrange regular follow-up at health centre for monitoring until resolution.

Stage 2: Oedema

– Admit the child to hospital.
– Correct any dehydration (see Chapter 5, Section 5.3).
– Administer IV antibiotics without delay:

First choice:
amoxicillin-clavulanic acid (**co-amoxiclav**) IV: 50 mg/kg every 6 hours for 14 days
+ **gentamicin** slow IV: 5 mg/kg every 24 hours for 5-7 days
+ **metronidazole** IV: 15 mg/kg every 12 hours for 14 days

Alternative:
ampicillin IV: 100 mg/kg every 6 hours for 14 days
+ **gentamicin** + **metronidazole** as above

– Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).

b If, for practical reasons, the patient is unlikely to receive their 3rd dose 4-6 weeks later, it is possible to give the 3rd dose from day 8 onwards.

- Give mouthwash with chlorhexidine 0.2%, 10 mL 3 times daily.
- Give analgesia for pain (see Chapter 15, Section 15.4).
- Start IV maintenance fluids if unable to eat and drink (see Chapter 15, Section 15.2).
- Give Vitamin A supplementation as outlined above.
- Assess for malnutrition and start nutritional treatment if necessary (see MSF ITFC Nutritional Care Protocol). If not malnourished, provide high-calorie, high-protein diet (see also Chapter 15, Section 15.5).
- Screen for and treat any co-morbidities such as malaria (see Chapter 3, Section 3.4), measles (see Chapter 3, Section 3.7), diarrhoea (see Chapter 5, Section 5.2), tuberculosis (see Chapter 4, Section 4.11), HIV (See Chapter 13).
- Treat anaemia, if present (see Chapter 10, Section 10.1).
- Consider deworming (see Chapter 5, Section 5.2).

Stage 3: Gangrenous stage

- Stabilise the patient using an ABCDE approach (see Chapter 2, Section 2.1).
- Admit the child to hospital and start treatment without delay.
- Follow all management steps outlined above for Stage 2: Oedema.
- Carry out wound care and debridement of all gangrenous tissue, ensuring appropriate analgesia given for all debridements and dressing changes (see MSF OCB Wound Care Protocol).
- See additional steps in Stages 4 and 5 for management of scarring and sequelae.

Stage 4: Scarring stage

Patients presenting at this stage have survived the acute phase of the disease but still require antibiotics in case of any residual infection. Focus at this stage is minimising sequelae:

- Administer IV antibiotics as in Stage 2: Oedema.
- Give other relevant treatment measures outlined in Stage 2: Oedema.
- Carry out wound care and debridement of all gangrenous tissue, ensuring appropriate analgesia given for all debridements and dressing changes (see MSF OCB Wound Care Protocol).
- Remove any loose teeth.
- Start physiotherapy/facial exercises to minimise restriction of movement due to scarring and trismus.

Stage 5: Sequelae stage

At this stage, there is no longer any acute risk but irreversible damage to the face requiring physical, psychological and social rehabilitation. Children may still die at this stage if they are unable to eat and drink due to trismus, or if they are socially isolated and neglected. Treatment at this stage:

- Give relevant treatment measures outlined in Stage 2: Oedema, excluding antibiotics.
- Start or continue physiotherapy/facial exercises, as above.
- Refer for reconstructive surgery, if available, to restore function and improve aesthetics (referral to specialist surgical centres required).
- Assess for malnutrition and start nutritional treatment if necessary (see MSF ITFC Nutritional Care Protocol). If not malnourished, provide high-calorie, high-protein diet (see also Chapter 15, Section 15.5).
- Provide psychological support and social rehabilitation (see MSF Mental Health and Psychosocial Support Guidelines).

14.3.3 Prognosis

If patients survive the acute stages of the disease, they are left with life-changing sequelae that can ostracise them from their communities. Trismus and loss of facial tissue, especially the lips, cause difficulties with eating, drinking and speech. Survivors often have salivary leak and open holes in their faces, leaving them socially outcast or obliged to cover their faces in public. If surgery is available, survivors usually require multiple reconstructive surgeries and both functional and cosmetic outcomes are variable. Trismus may recur despite surgery.

14.3.4 Prevention

Noma is a multifactorial disease that continues to exist in places with extreme poverty and malnutrition. However, there are some prevention measures that can reduce the likelihood of the disease, including:

- Increasing awareness of the disease in communities.
- Promotion of exclusive breastfeeding for the first 6 months of life and continuation until 2 years or older.
- Practising good oral hygiene.
- Using clean water for drinking and oral hygiene.
- Early recognition and treatment of simple gingivitis and acute necrotising gingivitis.
- Regular vitamin A supplementation in communities.
- Measles vaccination.
- Zinc supplementation for diarrhoeal disease.
- Systematic deworming in communities.
- Nutritional screening and treatment of children at risk.
- Routine oral examination of children at each medical visit.

References Chapter 14

1. Haidar G, Singh N. Fever of Unknown Origin. Longo DL, ed. *N Engl J Med*. 2022;386(5): 463-477.
https://doi.org/10.1056/NEJMra2111003
2. Chow A, Robinson JL. Fever of unknown origin in children: a systematic review. *World J Pediatr*. 2011;7(1):5-10.
https://doi.org/10.1007/s12519-011-0240-5
3. Aronson N, Herwaldt BL, Libman M, et al. Diagnosis and Treatment of Leishmaniasis: Clinical Practice Guidelines by the Infectious Diseases Society of America (IDSA) and the American Society of Tropical Medicine and Hygiene (ASTMH). *Clin Infect Dis*. 2016;63(12):1539-1557.
https://doi.org/10.1093/cid/ciw742
4. Kafetzis D. An overview of paediatric leishmaniasis. *J Postgrad Med*. 2003;49(1):31.
https://doi.org/10.4103/0022-3859.930
5. Bern C. Visceral leishmaniasis: Clinical manifestations and diagnosis. *UpToDate*. Published February 2022.
https://www.uptodate.com/contents/visceral-leishmaniasis-clinical-manifestations-and-diagnosis
6. De Santana Ferreira E, De Souza Júnior VR, De Oliveira JFS, Costa MFH, Da Conceição De Barros Correia M, De Sá AF. Rare association of consumptive coagulopathy in visceral leishmaniasis: A case report. *Trop Doct*. 2021;51(1):120-122.
https://doi.org/10.1177/0049475520967239
7. Scalzone M, Ruggiero A, Mastrangelo S, et al. Hemophagocytic lymphohistiocytosis and visceral leishmaniasis in children: case report and systematic review of literature. *J Infect Dev Ctries*. 2016;10(01):103-108.
https://doi.org/10.3855/jidc.6385
8. World Health Organization. *Control of the leishmaniases: report of a meeting of the WHO Expert Commitee on the Control of Leishmaniases, Geneva, 22-26 March 2010*. World Health Organization; 2010. Accessed November 13, 2023.
https://iris.who.int/handle/10665/44412
9. Chappuis F, Rijal S, Soto A, Menten J, Boelaert M. A meta-analysis of the diagnostic performance of the direct agglutination test and rK39 dipstick for visceral leishmaniasis. *BMJ*. 2006;333(7571):723.
https://doi.org/10.1136/bmj.38917.503056.7C
10. Uribe-Restrepo A, Cossio A, Desai MM, Dávalos D, Castro MDM. Interventions to treat cutaneous leishmaniasis in children: A systematic review. Laouini D, ed. *PLoS Negl Trop Dis*. 2018;12(12):e0006986.
https://doi.org/10.1371/journal.pntd.0006986
11. Pan American Health Organization. Leishmaniasis: Epidemiological Report of the Americas 2018.
https://iris.paho.org/handle/10665.2/34856
12. Norouzinezhad F, Ghaffari F, Norouzinejad A, Kaveh F, Gouya MM. Cutaneous leishmaniasis in Iran: Results from an epidemiological study in urban and rural provinces. *Asian Pac J Trop Biomed*. 2016;6(7):614-619.
https://doi.org/10.1016/j.apjtb.2016.05.005

13. Aksoy M, Doni N, Ozkul HU, et al. Pediatric Cutaneous Leishmaniasis in an Endemic Region in Turkey: A Retrospective Analysis of 8786 Cases during 1998-2014. Pimenta PF, ed. *PLoS Negl Trop Dis*. 2016;10(7):e0004835. https://doi.org/10.1371/journal.pntd.0004835

14. Blanco VM, Saravia NG, Cossio A, Martinez JD. Clinical and Epidemiologic Profile of Cutaneous Leishmaniasis in Colombian Children: Considerations for Local Treatment. *Am J Trop Med Hyg*. 2013;89(2):359-364. https://doi.org/10.4269/ajtmh.12-0784

15. *Manual for Case Management of Cutaneous Leishmaniasis in the WHO Eastern Mediterranean Region*. WHO Regional Publications, Eastern Mediterranean Series; 2014. Accessed November 13, 2023. https://www.who.int/publications/i/item/9789290219453

16. *Information Brochure for Early Detection and Management of Noma*. WHO, Regional Office for Africa; 2017. Accessed November 13, 2023. https://iris.who.int/handle/10665/254579

17. Baratti-Mayer D, Gayet-Ageron A, Hugonnet S, et al. Risk factors for noma disease: a 6-year, prospective, matched case-control study in Niger. *Lancet Glob Health*. 2013;1(2):e87-e96. https://doi.org/10.1016/S2214-109X(13)70015-9

Chapter 15:
Supportive care in hospital

15.1 Oxygen therapy

Oxygen is an essential treatment for hypoxia and is indicated when oxygen saturation is < 92% in stable patients, aiming to maintain SpO_2 ≥ 92%. A higher threshold is used in emergency management of critically unwell children and for specific conditions where there is impaired delivery of oxygen to body tissues[1].

Administer oxygen in the following situations:
- During resuscitation: all children regardless of SpO_2, aiming for SpO_2 ≥ 94%
- Critically unwell children: if SpO_2 < 94%, aiming for SpO_2 94 - 98%
- Children with impaired delivery of oxygen to body tissues, e.g. severe anaemia, severe sepsis, sickle cell disease, severe heart failure: if SpO_2 < 94%, aiming for SpO_2 94 - 98%
- Stable children: if SpO_2 < 92%, aiming for SpO_2 ≥ 92%

15.1.1 Modes of delivery

Oxygen can be delivered via nasal cannula, a simple oxygen mask or a non-rebreathing mask. Choose most appropriate oxygen delivery system according to the child's clinical condition, age and flow of oxygen required. See also MSF Manual of Nursing Care Procedures, SOP - When to use which mask? for more information on when to use each oxygen delivery method.

Note:
- Young children may become very distressed when an oxygen mask or nasal cannula are placed on the face, such that the delivery of oxygen is inefficient, or the child's condition worsens. Keeping the child on the lap of the parent/carer to provide reassurance may help. If the child is still distressed, ask the parent/carer to hold a simple mask as close to the child's face as possible, without attaching it with elastic.
- For resuscitation or during anaesthesia, oxygen should be delivered via bag-mask ventilation (see Chapter 2, Section 2.1).

Always use the minimum flow of oxygen possible to achieve desired oxygen saturations according to the device used. For patients who require maximum 2 litres/min of oxygen a flow splitter can be used, to provide up to 5 patients with oxygen from a 10 L oxygen concentrator. Use of a flow splitter also allows a more accurate regulation of flow rate. See MSF Manual of Nursing Care Procedures, SOP Annex: How to set up an oxygen flow splitter. Monitor adequacy of oxygen therapy using pulse oximetry, either intermittently or continuously, as required (see Section 15.1.2 below).

Nasal cannula (NC)

Delivers oxygen via the nasal passageway that mixes with air breathed in by the mouth; therefore the amount of oxygen received is diluted. With standard flow rates of 1 to 4-6 L/min, between 24-35% oxygen is delivered. NC can be used in all age groups and may be better tolerated than oxygen masks, especially in younger children (see Figure 15.1).

At standard flow rates (see Table 15.1), there is no need for humidification. High flow rates administered for more than 2 hours can cause dryness and irritation of the nares which can cause bleeding. Therefore, effective humidification is necessary if NC oxygen is delivered above standard flow rates for more than 2 hours[2].

Table 15.1 - Standard, high and maximum flow rates via NC by age

Age of child	Standard flow rate	High flow rate	Maximum flow rate that can be safely delivered via NC using a standard oxygen concentrator[a]
1 month to < 2 years	1 to 2 L/min	> 2 L/min	4 L/min
2 to 12 years	2 to 4 L/min	> 4 L/min	6 L/min
> 12 years (≥ 30 kg)	4 to 6 L/min	> 6 L/min	10 L/min

To apply, attach NC tubing to the child's face with tape[b] and/or secure behind the ears (see Figure 15.2).

Figure 15.1 - Nasal cannula tubing

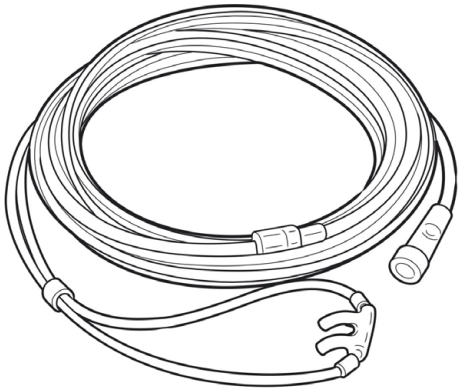
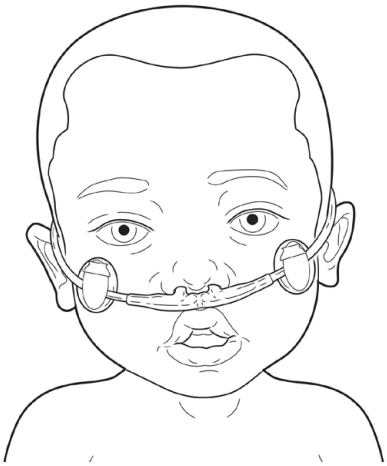


Figure 15.2 - Attachment of NC to the face



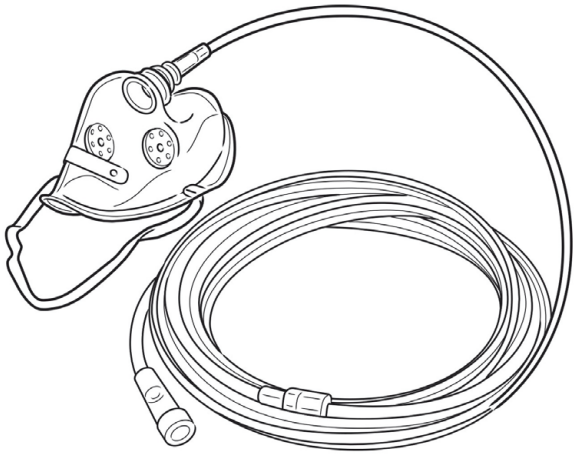
Simple mask

Delivers oxygen via a mask covering the mouth and nose, secured with an elastic band around the head (see Figure 15.3). Recommended for initial oxygen delivery in acute presentation and/or when oxygen delivery via NC is insufficient. Standard flow rates of 5 to 10 L/min will deliver between 35-60% of oxygen. There are two holes in the mask (see diagram) that allow air to mix with oxygen delivered via the tubing and for exhaled air to escape the space in the mask. A minimum flow rate of 5 L/min must be ensured to avoid rebreathing exhaled carbon dioxide.

a High-flow nasal cannula (HFNC) systems allow greater flow rates to be delivered via specially designed circuits, however these are not yet widely available in MSF fields. It should be noted that standard oxygen concentrators alone with NC cannot be used to administer safe and effective HFNC respiratory support. See Chapter 3, Section 3.1.3 for more detail.

b Use of a foam tape or hydrocolloid dressing can be used to protect the skin, particularly for malnourished children or those at risk of skin breakdown.

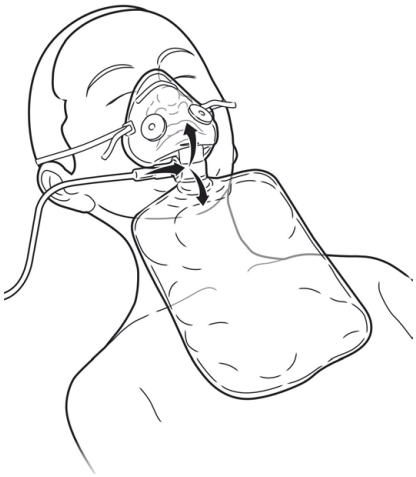
Figure 15.3 - Simple oxygen mask



Non-rebreathing mask with reservoir

Should be used in children who are breathing spontaneously but in severe respiratory distress, respiratory failure or in shock (see Figure 15.4). With optimal oxygen flow rate of 10-12 L/min and a good seal between the mask and face, actual oxygen delivered can reach 60-95%. Where such high flow rates are not feasible, provide sufficient flow rate to ensure the reservoir bag remains 2/3 full during inspiration (or as a minimum > 5 L/min in younger children and > 8 L/min in adolescents).

Figure 15.4 - Non-rebreathing mask with reservoir



15.1.2 Monitoring

Children receiving oxygen therapy should be monitored closely. Where possible, apply continuous saturation monitoring, ensuring that appropriate alarm parameters have been set on the monitoring device. Otherwise monitor and record saturations along with vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).

15.1.3 Weaning

Weaning off oxygen should be considered in children who are stable or clinically improving when:

– If continuously monitored: SpO_2 is consistently ≥ 92% for at least 3 hours.
– If intermittently monitored: SpO_2 ≥ 92% on at least two separate consecutive readings taken several hours apart.

Oxygen should be prescribed, with target SpO_2 indicated to allow for nurse-led weaning and adjustment of flow rates to meet the desired target.

See also MSF Manual of Nursing Care Procedures, Procedure: Oxygen therapy.

15.2 Parenteral fluids

Maintenance fluids should be administered to all children for whom oral intake is medically contraindicated, including children with an altered level of consciousness who cannot eat or drink (most often Glasgow Coma Score < 8 or PU on AVPU scale), intractable vomiting despite nasogastric feeding, or severe respiratory distress from malaria, asthma, pneumonia or bronchiolitis. Maintenance fluids preserve body water homeostasis by covering physiologic daily fluid losses (sweating, urination, breathing) but are not sufficient for replacement of excessive additional losses (e.g. profuse diarrhoea), or to rehydrate a clinically dehydrated child (see Chapter 5, Section 5.3).

15.2.1 Maintenance fluid composition

Children are more prone to hypoglycaemia that adults and therefore require stable delivery of a solution containing both salts and sugar. It is not appropriate to give glucose-free solutions to children as maintenance fluids or to give alternating bags of **Ringer lactate** (**RL**) with bags of glucose. The preferred choice of IV fluids to use as maintenance for all children (with or without malnutrition) is a combined solution containing **glucose** (**dextrose**) **5%**[a] (**G5%**) and undiluted RL to create a **G5%-RL** solution. If RL is unavailable, **sodium chloride 0.9%** (**NaCl 0.9%**) can be used as an alternative. See Table 15.2, for instructions on how to obtain **G5%-RL**, (or **G5%-NaCl 0.9%**) using **glucose** (**dextrose**) **50%** (**G50%**) if pre-mixed bags are unavailable.

Some children receiving maintenance fluids may require an increased glucose concentration in maintenance fluids due to repeated hypoglycaemia (see Chapter 9, Section 9.3) and require a **glucose** (**dextrose**) **10%** (**G10%**)-**RL** (or **G10%-NaCl 0.9%**) solution (see Table 15.2).

Table 15.2 - Making maintenance fluids from available IV fluids

RL or NaCl 0.9%	G50% to add	Resulting solution
500 mL bag –> remove 50 ml = 450 mL	50 mL	500 mL of G5%-RL or G5%-NaCl 0.9%
1000 mL bag –> remove 100 ml = 900 mL	100 mL	1000 mL of G5%-RL or G5%-NaCl 0.9%
500 mL bag –> remove 100 mL = 400 mL	100 mL	500 mL of G10%-RL or G10%-NaCl 0.9%
1000mL bag –> remove 200 mL = 800 mL	200 mL	1000 mL of G10%-RL or G10%-NaCl 0.9%

15.2.2 Calculating maintenance fluid rate

Maintenance fluid requirement is calculated using the Holliday-Segar formula, either over 24 hours or as an hourly rate as follows (see also Table 15.3).

a Note: dextrose 5% is the same as glucose 5%.

Daily maintenance fluid requirement:
- For the first 10 kg of bodyweight (0 to 10 kg), give 100 mL/kg/day;
- For the next 10 kg of bodyweight (11 to 20 kg) give an additional 50 mL/kg/day;
- For each kg above 20 kg, give an additional 20 mL/kg/day.

Hourly maintenance fluid rate ('4:2:1' rule):
- For the first 10 kg of bodyweight (0 to 10 kg), give 4 mL/kg/hour;
- For the next 10 kg of bodyweight (11 to 20 kg) give an additional 2 mL/kg/hour;
- For each kg above 20 kg, give an additional 1 mL/kg/hour.

e.g. An 8 kg child = 4 mL x 8 kg = 32 mL/hr
A 12 kg child = (4 mL x 10 kg) + (2 mL x 2 kg) = 44 mL/hr
A 25 kg child = (4 mL x 10 kg) + (2 mL x 10 kg) + (1 mL x 5 kg) = 65 mL/hr

Table 15.3 - Infusion rates by weight for maintenance fluids

Administer G5%-RL (or G5%-NaCl 0.9%) (Rates rounded for ease of administration)			
Weight (kg)	**Rate of infusion in mL/hour[b]**	**Weight (kg)**	**Rate of infusion in mL/hour**
3	15	22	65
4	20	23	65
5	25	24	65
6	30	25	65
7	30	26	65
8	35	27	70
9	40	28	70
10	40	29	70
11	45	30	70
12	45	31	70
13	45	32	75
14	50	33	75
15	50	34	75
16	55	35	75
17	55	36	75
18	55	37	80
19	60	38	80
20	60	39	80
21	60	40	80

b A paediatric infusion set should be used to administer maintenance fluids at rates less than 60 mL/hr. In paediatric infusion sets, 1 mL = 60 drops therefore the rate in mL/hr is the same as the rate in drops/min. For volumes over this rate, an adult infusion set may be used.

Maintenance fluid rates may need to be reduced in critically unwell children with specific pathologies that require fluid restriction, such as when there is suspicion of raised intracranial pressure, e.g. meningitis (see Chapter 3, Section 3.3), cerebral malaria (see Chapter 3, Section 3.4), head injury (see Chapter 2, Section 2.8); or increased ADH secretion, e.g. severe pneumonia (see Chapter 4, Section 4.5), severe bronchiolitis (see Chapter 4, Section 4.7). In these cases, a restriction of 70% of total calculated maintenance fluid is often advised (see Table 15.4).

Table 15.4 - Infusion rates by weight for restricted maintenance fluids (70%)

Administer G5%-RL (or G5%-NaCl 0.9%) (Amounts rounded for ease of administration)			
Weight (kg)	**Rate of infusion in mL/hour[c]**	**Weight (kg)**	**Rate of infusion in mL/hour**
3	10	22	45
4	15	23	45
5	15	24	45
6	20	25	45
7	20	26	45
8	25	27	45
9	25	28	50
10	30	29	50
11	30	30	50
12	30	31	50
13	35	32	50
14	35	33	50
15	35	34	50
16	35	35	55
17	40	36	55
18	40	37	55
19	40	38	55
20	40	39	55
21	40	40	55

15.2.3 Potassium in maintenance fluids

Hypokalaemia can cause respiratory depression and cardiac rhythm abnormalities, therefore potassium is usually added to maintenance fluids in children who are not taking anything orally if maintenance fluids will continue beyond 24 hours, as well as systematically for children in diabetic ketoacidosis (DKA). However, the decision to add potassium chloride (KCl) to

c A paediatric infusion set should be used to administer maintenance fluids at rates less than 60 mL/hr. In paediatric infusion sets, 1 mL = 60 drops therefore the rate in mL/hr is the same as the rate in drops/min. For volumes over this rate, an adult infusion set may be used.

intravenous fluids in MSF settings should not be taken lightly. Potassium is a potentially lethal medication and can cause cardiac arrest in children if administered in excess of requirements. Great care is required when adding potassium to IV fluids, as miscalculation of the required amount can lead to massive differences in potassium dose. Even at therapeutic doses, potassium is irritant to veins (causing burns and thrombophlebitis) if administered too quickly or through small veins. KCl should never be injected directly into the vein.

Where feasible, KCl should be added to maintenance fluids according to instructions in Table 15.5 and the MSF Paediatric Injectables Handbook. Make sure the child is urinating to ensure that there is no renal failure before adding KCl to fluids and always ensure that the potassium additions are checked by two senior members of nursing/medical staff. Carefully label IV fluids bags containing potassium with the date, time and the amount of KCl added, as well as the signatures of those preparing the medication (see Figure 15.5).

The potassium requirement for children is 2–3 mmol/kg/day. The addition of 2–3 mmol KCl to 100 mL of IV fluids (20–30 mmol KCl per litre) allows an appropriate amount of potassium to be delivered when giving standard rate maintenance fluids. In diabetic ketoacidosis, potassium requirements are higher, and should be 40 mmol KCl per litre (see Chapter 9, Section 9.2).

⚠ One 10-mL ampoule of KCl 15% contains 20 mmol = 2 mmol/mL. Always double check that the ampoules contain 10 mL of KCl 15%, as content and manufacturer may vary.

Table 15.5 - Addition of KCl to maintenance fluids

G5%-RL or G10%-RL	Volume of KCl 15% to add	Resulting solution
1000 mL (1 litre)	10 mL (1 ampoule)	**G5%-RL + 20 mmol/L KCl** or **G10%-RL + 20 mmol/L KCl**
500 mL	5 mL (½ ampoule)	
In diabetic ketoacidosis only, increased KCl administered (40 mmol/L):		
1000 mL (1 litre)	20 mL (2 ampoules)	**G5%-RL + 40 mmol/L KCl** or **G10%-RL + 40 mmol/L KCl**
500 mL	10 mL (1 ampoule)	

Figure 15.5 - Example of bag label for maintenance fluids with added KCl

Child's name:_____

Volume of original bag: _____ mL
Volume removed: _____ mL
G50% volume added: _____ mL
KCl 15% volume added: _____ mL

Date/time bag prepared: _____
Prepared by (signature):_____
Checked by (signature): _____

Rate of infusion: _____mL/hr
Start date/time: _____

15.2.4 Monitoring

Regardless of the maintenance fluid administered, a child on intravenous fluids must be carefully monitored and have a record of fluid balance kept, aiming for a neutral fluid balance (see MSF Nursing Care Manual of Procedures, Fluid balance chart: User Guide). Ensure that the volume of any additional fluids administered with medication or as IV flushes is included in the fluid balance calculation, as this may be quite significant.

In addition, children on IV fluids should be monitored for fluid overload. Signs of fluid overload are:
– Increased RR by ≥ 10 breaths/minute from initial RR, or
– Increased HR pulse rate by ≥ 20 beats/min from initial HR
PLUS any one of the following:
– New or worsening hypoxia = decrease in SpO_2 by > 5%
– New onset of rales and/or pulmonary oedema (fine crackles in lung fields)
– New galloping heart rhythm
– Increased liver size (liver must have been marked with pen prior to fluid administration)
– New peripheral oedema and/or puffy eyelids.

Management if signs of fluid overload present:
– Stop all fluids.
– Administer **furosemide** IV: 0.5 mg/kg (repeat once if necessary).
– Place child into semi-sitting position and ensure high-flow oxygen via non-rebreathing mask.
– Monitor every 15 minutes until child has been stable for at least one hour.

IV maintenance fluids should be administered for as short a time as possible to minimise the risk of electrolyte abnormalities (see Section 15.3). In addition, early feeding improves outcomes in critically unwell children, therefore aim to start enteral feeding and wean down IV fluids as soon as possible (see Section 15.5).

15.3 Electrolyte abnormalities

Hospitalised children, especially those who are critically unwell and/or receiving IV fluids are at risk of electrolyte abnormalities. Children with malnutrition have an even higher likelihood of developing electrolyte abnormalities during inpatient treatment, particularly associated with refeeding syndrome (see Chapter 12, Section 12.3). Electrolyte abnormalities are most commonly seen in children with gastrointestinal symptoms, especially persistent vomiting and/or diarrhoea; renal disease, such as acute kidney injury (AKI); and endocrine disturbance, such as diabetic ketoacidosis (DKA).

Abnormalities of sodium, potassium and calcium are the most common treatable electrolyte imbalances and manifest with specific symptoms, though these may go undetected until life-threatening signs and symptoms develop.

15.3.1 Normal electrolyte ranges

Table 15.6 - Normal biochemistry values for children according to age

Component	Normal range	
Sodium (Na)	135-145 mmol/L	
Potassium (K)	3.5-4.9 mmol/L	
Calcium, ionised (iCa) 1-12 months > 12 months	 1.24-1.49 mmol/L 1.20-1.30 mmol/L	 5.0-6.0 mg/dL 4.65-5.25 mg/dL
Calcium, total serum (Ca) 1-12 months > 12 months	 2.00-2.67 mmol/L 2.12-2.62 mmol/L	 8.0-10.7 mg/L 8.5-10.5 mg/L
Chloride (Cl)	95-105 mmol/L	
Creatinine[a]	27-62 µmol/L	0.3-0.7 mg/dL
Glucose	3.3-7.0 mmol/L	60-126 mg/dL
Bicarbonate (HCO_3^-)	19-28 mmol/L	

Notes
- For Na, K, Cl, HCO_3, and glucose, mmol/L equal to mEq/L.
- iCa = ionized calcium is physiologically active (or free) calcium and makes up 40 to 45% of total serum calcium.

a Normal values of serum creatinine vary by age and gender, see local lab references for more specific ranges.

15.3.2 Sodium disorders

Hyponatraemia

Hyponatraemia is one of the most common electrolyte abnormalities in children and is typically defined as a serum sodium below 135 mmol/L. In children, it often occurs secondary to gastroenteritis with prolonged vomiting and/or diarrhoea and rehydration with free water; inappropriate ADH release; nephrotic syndrome; heart failure; or renal failure. It may also occur as a side effect of diuretic use, and as a complication of certain medical conditions such as adrenal insufficiency, cystic fibrosis (CF), hyperglycaemia and primary renal disorders. Management depends on the fluid status of the child therefore it is important to try to determine the most likely cause of hyponatraemia (see Table 15.7 for more detail).

Table 15.7 - Causes of hyponatremia based on fluid status

Hypovolaemia (fluid loss/dehydration)	Euvolaemia (stable fluid balance)	Hypervolaemia (fluid overload)
• Gastrointestinal losses (vomiting, diarrhoea) and rehydration with free water • Skin losses (CF, burns) • Hyperglycaemia (diabetes) • Renal losses (diuretics, primary tubular disorders) • Adrenal insufficiency (hypoaldosteronism)	• Increased ADH secretion (secondary to medical conditions such as severe pneumonia, bronchiolitis, head injury, CNS infection) • Administration of hypotonic fluids by mouth (diluted formula milk, excessive water) • Psychogenic polydipsia • Medications (antiepileptics)	• Iatrogenic (excess IV fluid administration) • Nephrotic syndrome • Heart failure • Renal failure

Clinical features

Children are usually asymptomatic if serum sodium is > 125 mmol/L. Below this level, symptoms include the following:

– Nausea
– Malaise
– Headache
– Lethargy
– Seizures may occur below 120 mmol/L (severe hyponatraemia) and lead to irreversible neurological damage
– In extreme cases, brain herniation may occur leading to respiratory and cardiac arrest and, ultimately, death.

Investigations

– Blood urea and electrolytes (UE) to confirm sodium level
– Blood glucose level (BGL)
– Blood gas, if available
– Serum and urine osmolality, if available

Management

Treatment of hyponatraemia depends on severity of symptoms and fluid status, with emergency treatment required if the child has reduced conscious level or seizures. Correction should be done slowly to prevent osmotic demyelination syndrome[b].

– Mild to moderate hyponatraemia:
  - Serum sodium 120 - 134 mmol/L and asymptomatic
  - Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
  - Treatment depends on fluid status (adapted from RCH Melbourne Clinical Practice guidelines[3]):

Fluid status	Sodium level	Treatment	Monitoring
Hypovolaemia/ dehydration	130 - 134 mmol/L	Treatment for dehydration with oral rehydration solution (see Chapter 5, Section 5.3)	Measure serum sodium levels 12 hourly (or 4-6 hourly if Na < 125 mmol/L) Ensure correction rate no more than 8 mmol/L in 24 hours Monitor for CNS symptoms (new or ongoing)
	< 130 mmol/L	Administer maintenance fluids with G5%-NaCl 0.9% at full rate (see Section 15.2)	
Hypervolaemia or euvolaemia[c]	120 - 134 mmol/L	Restrict total fluid intake to 50-70% maintenance volume, ideally in enteral intake rather than IV fluids. If IV fluids required, ensure G5%-NaCl 0.9% is administered.	

– Severe hyponatraemia - asymptomatic or mildly symptomatic but without seizures or altered conscious level:
  - Serum sodium < 120 mmol/L; or < 125 mmol/L and symptomatic.
  - Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
  - If completely asymptomatic, give oral hypertonic saline:

NaCl 3% PO:
3 - 5 mmol/kg/day (or 6 – 10 mL/kg/day) in 4 to 6 divided doses

NB. NaCl 3% contains 30 g/L of sodium which is equivalent to 0.5 mmol/mL

b Osmotic demyelination syndrome is diffuse demyelination of the brain that can be irreversible, leading to profound permanent neurological symptoms such as dysarthria, confusion and coma.

c Euvolaemia = a normal circulatory or blood fluid volume in the body.

- If mildly symptomatic but without seizures or altered conscious level, calculate volume of **NaCl 0.9%** required to correct sodium deficit and replace over 48 hours, ensuring correction rate of no more than 8 mmol/L in 24 hours:

  > Volume of **NaCl 0.9%** (mL) required = 3.9 x weight (kg) x (Target Na – Real Na)
  >
  > NB. If (Target Na – Real Na) is greater than 16 mmol, correction should be done over a longer period to ensure that correction rate does not exceed 8 mmol/24 hours

- Repeat serum sodium levels every 4-6 hours until ≥ 125 mmol/L, then monitor 12 hourly until normal.
- Treat likely underlying cause in addition to correction with hypertonic saline (e.g. correct any dehydration (see Chapter 5, Section 5.3), restrict fluids if hypervolaemic).

– Severe hyponatraemia with seizures or altered conscious level:
- Medical emergency requiring urgent treatment.
- Treat any seizures (see Chapter 7, Section 7.2).
- Administer **NaCl 3%** IV: 3-5 mL/kg over 15-30 minutes using a syringe pump and, ideally, via a central line (see MSF Paediatric Injectables Handbook for more detailed administration guidance). Can be repeated if ongoing seizures or Na < 125 mmol/L.
- Repeat serum sodium level, aiming to correct serum sodium by no more than 2 mmol/L per hour in the first 3-4 hours.
- Once seizures stop, calculate volume of **NaCl 0.9%** required to correct sodium deficit and replace over 48 hours, ensuring correction rate of no more than 12 mmol/L in 24 hours including the hypertonic saline bolus(es). Consider giving oral **NaCl 3%** as an alternative (as above) if asymptomatic following **NaCl 3%** IV bolus(es).
- Repeat serum sodium levels every 4-6 hours until ≥ 125 mmol/L, then monitor 12 hourly until normal.
- Treat the underlying cause, e.g. dehydration (see Chapter 5, Section 5.3), hypervolaemia.

Hypernatraemia

Raised serum sodium is due either to a water deficit or sodium excess. It is seen commonly in children who are dehydrated due to gastroenteritis and burns. See Table 15.8 for a full list of potential causes. It is typically classified as mild, moderate or severe and treatment depends on severity.

Table 15.8 - Causes of hypernatraemia

Water deficit (fluid loss/dehydration)	Sodium excess
• Gastrointestinal losses (vomiting, diarrhoea) • Skin losses (CF, burns) • Hyperglycaemia (diabetes) • Renal losses (diuretics, primary tubular disorders) • Diabetes insipidus (due to ADH insufficiency or insensitivity)	• Ingestion of excessive sodium (inappropriately concentrated formula milk, salt poisoning, high osmolality rehydration solutions) • Iatrogenic (hypertonic saline, sodium bicarbonate) • Hyperaldosteronism (nephrotic syndrome, steroids)

Clinical features

– Lethargy
– Weakness
– Altered level of consciousness
– Irritability
– Seizures
– Muscle cramps
– Depressed deep tendon reflexes
– Respiratory failure

Investigations

– Blood UE to confirm sodium level
– BGL

Management

Treat dehydration or hypovolaemic shock, if present, before correcting hypernatraemia (see Chapter 2, Section 2.2). Ensure that sodium levels are repeated after any IV fluids have been administered to accurately guide specific treatment. Aim to reduce sodium levels no faster than 10 mmol/L in 24 hours to reduce the risk of cerebral oedema.

– Mild hypernatraemia:
  • Serum sodium 146 - 149 mmol/L
  • Manage the underlying cause and repeat serum sodium in 4-6 hours
– Moderate hypernatraemia:
  • Serum sodium 150 - 169 mmol/L
  • Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
  • Calculate free water deficit (FWD) based on an estimated requirement of 4 mL/kg of fluid to reduce serum sodium by 1 mmol/L:

    FWD = 4 mL x weight (kg) x (Real Na – Desired Na)

  • Add calculated FWD to the volume of fluids to be replaced according to dehydration status (see Chapter 5, Section 5.3). Replace half of the total volume over 24 hours with **G5%-NaCl 0.9%** and half over the next 24 hours.
  • Repeat serum sodium levels every 12 hours until within normal range.
  • Monitor for fluid overload and keep a strict fluid balance.
– Severe hypernatraemia:
  • Serum sodium ≥ 170 mmol/L
  • Manage as for moderate hypernatremia, calculating free water deficit (FWD) based on an estimated requirement of 3 mL/kg of fluid to reduce serum sodium by 1 mmol/L as follows:

    FWD = 3 mL x weight (kg) x (Real Na – Desired Na)

15.3.3 Potassium disorders

Hypokalaemia

Low serum potassium is the most common electrolyte abnormality in children and may be due to gastrointestinal losses through vomiting and diarrhoea, renal losses, decreased intake (anorexia), diabetic ketoacidosis, certain medications (e.g. diuretics, insulin, salbutamol) or may be iatrogenic in children receiving prolonged IV fluids that are not supplemented with potassium. It is defined as potassium < 4.1 mmol/L in infants (1 month to 1 year) or < 3.4 mmol/L in children over 1 year old.

Clinical features

- Ascending muscle weakness or paralysis
- Abdominal distension
- Anorexia
- Nausea and vomiting
- Constipation (secondary to paralytic ileus)
- Cardiac arrhythmias

Investigations

- Blood UE to confirm potassium level
- BGL
- Blood gas, if available
- Electrocardiogram (ECG)

Management

Treatment of hypokalaemia depends on the severity.

- Mild, asymptomatic hypokalaemia:
  - Potassium 3 - 3.4 mmol/L
  - Usually doesn't require specific treatment
  - Correct underlying cause and recheck potassium level in 2-3 hours.
- Moderate hypokalaemia:
  - Potassium 2.5 - 2.9 mmol/L
  - Treat with **potassium** orally for 2 days:

    7.5% potassium chloride syrup (1 mmol of K+/mL) PO:
    - < 45 kg: 2 mmol/kg (2 mL/kg) once daily
    - ≥ 45 kg: 30 mmol (30 mL) 3 times daily
  - Repeat potassium level 2 hours after oral administration and at the end of treatment.
- Severe hypokalaemia:
  - Potassium < 2.5 mmol/L or patients with symptomatic hypokalaemia
  - Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).

- Treat urgently with either oral or IV **potassium**:

  First choice - for stable patients who are able to take oral medication
  7.5% potassium chloride syrup (1 mmol K+/mL) PO for 2 days:
  - < 45 kg: 2 mmol/kg (2 mL/kg) once daily
  - ≥ 45 kg: 30 mmol (30 mL) 3 times daily

  Second choice - for patients unable to take oral medication
  15% potassium chloride solution (2 mmol K+/mL) IV:
  0.2 mmol/kg/hr (max. 10 mmol/hr) for 3 hours
  Each mmol of potassium is diluted in 25 mL of NaCl 0.9%

  Infusion may be repeated if severe symptoms persist or if serum potassium remains < 3 mmol/L.

- Repeat potassium level 1 hour after the end of the infusion or two hours after oral administration.

Hyperkalaemia

Hyperkalaemia is relatively common in hospitalised children and is defined as a serum potassium above 5.5 mmol/L. It occurs in children with renal failure, in diabetic ketoacidosis in extensive trauma and may be iatrogenic in children receiving IV fluids supplemented with potassium.

Clinical features and complications

– Neurological signs: paraesthesia, muscle weakness
– Hypotension
– Cardiac arrhythmias (ventricular tachycardia and fibrillation)
– If severe:
  - Respiratory failure
  - Cardiac arrest
  - Death

Investigations

– Blood UE to confirm potassium level
– BGL
– Blood gas, if available
– Electrocardiogram (ECG)

Management

Treatment of hyperkalaemia depends on the severity:
– Repeat serum potassium urgently to verify results, ideally via venepuncture to avoid sampling haemolysis which will result in an inaccurately high potassium.
– Stop all IV infusions containing potassium immediately.
– Avoid potassium-rich foods (e.g. bananas, oranges, raisins, tomatoes, avocados, dried fruits and nuts).
– Use only fresh blood for transfusion (if required).

– Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
– If hyperkalaemia with K+ ≤ 6 mmol/L, continue with above measures only and monitor serum potassium again after 2 hours.
– If hyperkalaemia with K+ > 6 mmol/L, especially if there are signs of hyperkalaemia on ECG (peaked T waves, wide QRS complex, arrythmias), actively treat as follows:
  • Administer nebulised **salbutamol** to promote potassium uptake into cells:
    < 5 years: 2.5 mg nebuliser, repeated after 1 to 2 hours if necessary
    ≥ 5 years: 5 mg nebuliser, repeated after 1 to 2 hours if necessary
  • Administer **calcium gluconate 10%** IV 0.5 mL/kg (max. 10 mL) over 3 minutes to stabilise cardiac muscle excitability.
  • If central venous access in situ, and the patient can be cared for in an ICU environment with adequate monitoring and staffing levels, administer a mixed infusion of **glucose** (**dextrose**) **50%** 2 mL/kg and **short-acting insulin** 0.05 IU/kg in the same syringe over 5-10 minutes, using a syringe pump, to promote intracellular potassium shift. Close monitoring of BGL is required before, during and after infusion (within an hour of administration), as insulin can cause a rapid fall in BGL.
  • Repeat serum potassium hourly until stable and within therapeutic range.

15.3.4 Calcium disorders

Hypocalcaemia

Low serum calcium can be due to hypoparathyroidism or vitamin D deficiency and may occur secondary to sepsis, hyperphosphatasemia, hypomagnesemia and ingestion of toxins or poisons.

Clinical features

– Tetany
– Neuromuscular irritability with weakness
– Paraesthesia, cramps, fatigue
– Altered level of consciousness
– Seizures
– Cardiac arrhythmias
– Trousseau's sign: carpopedal spasm after arterial occlusion of an extremity for 3 minutes
– Chvostek's sign: muscle twitching on percussion of the facial nerve

Investigations

– Blood UE
– Blood gas, if available
– Electrocardiogram (ECG), if severe hypocalcaemia

Management

Specific treatment of hypocalcaemia depends on severity and is required if iCa[d] < 4 mg/dL (< 1 mmol/L).

d iCa = ionized calcium is physiologically active (or free) calcium and makes up 40 to 45% of total serum calcium.

– If mild or asymptomatic, treat with oral calcium and vitamin D supplementation:

calcium carbonate PO: 10 - 25 mg/kg 3 times daily with meals
+
colecalciferol (**vitamin D3**) PO:
- < 3 months: 2000 IU once daily for 3 months
- 3 to < 12 months: 2000 IU once daily for 3 months or 50 000 IU single dose
- 12 months to < 12 years: 3000 to 6000 IU once daily for 3 months or 150 000 IU single dose
- ≥ 12 years: 6000 IU once daily for 3 months or 300 000 IU single dose

– If severe or symptomatic with signs of tetany:
  - Monitor and record vital signs as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts).
  - Administer **calcium gluconate** IV (see MSF Paediatric Injectables Handbook for more detailed administration guidance):

calcium gluconate 10% solution by slow IV injection over 5-10 minutes:

- < 20 kg:
  0.5 mL/kg (max. 10 mL) by slow IV injection over 5-10 minutes, then 2 to 4 mL/kg (max. 40 mL) by continuous IV infusion over 24 hours
  (dilute in 100 mL of glucose (dextrose) 5%, NaCl 0.9% or Ringer lactate)
- ≥ 20 kg:
  10 mL by slow IV injection over 5-10 minutes, then 40 mL by continuous IV infusion over 24 hours
  (dilute in 250 mL or 500 mL of glucose (dextrose) 5%, NaCl 0.9% or Ringer lactate)

  - Repeat calcium 3-4 hours after loading dose administered.
  - Begin supplementation with **colecalciferol** (**vitamin D3**) PO as above.

15.4 Pain management

Pain is an unpleasant sensory and emotional experience associated with actual or possible tissue damage. Assessing the presence and severity of pain in children can be challenging, especially in infants and younger children. Being unable to communicate verbally about pain does not exclude that the child is experiencing pain and needs appropriate analgesia. Pain assessment should be routine in all paediatric hospital care and treatment adequately tailored and adapted.

15.4.1 Assessment

- Take a history and examine the child.
- Try to assess where the pain is (adjust to child's age and understanding).
- In older children, ask to describe the pain:
  - Character: sharp, dull, stabbing, burning, cramping, spasmodic, radiating, etc.
  - Pattern: sudden, intermittent, chronic; at rest, at night, on movement, etc.
  - Aggravating or relieving factors
  - Associated symptoms.
- Assess intensity with a validated pain assessment tool to rate the 'pain score', recording the score and the tool used. Use a self-reporting tool as preference, but where necessary a behavioural assessment tool can be used, both in accordance to age, cognitive ability, and level of consciousness or sedation. Choose the pain tool that is most adapted and accepted according to context.
- Assess adequacy of treatment: use same pain assessment tool for consistency and re-evaluate and record pain intensity after every treatment to monitor and adjust analgesia adequately.
- If not already known, identify the underlying cause of the pain and treat if possible.

Self-reporting pain assessment tools

- Use in children who can quantify the level of pain and rate or score it.
- Note that as pain is always subjective, that how the child rates or scores their pain should be accepted and respected.
- Numerical rating scale: 6 years and above.
- FACES® rating scale can be tried in 3 years and above.
- Ask the child to select the number (Figure 15.6) or facial expression (Figure 15.7) that best corresponds to the intensity of their pain. Note the corresponding score.

Figure 15.6 - Numerical pain rating scale (6 years and above)

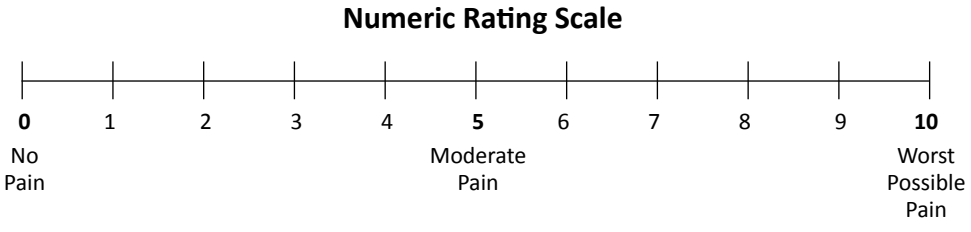
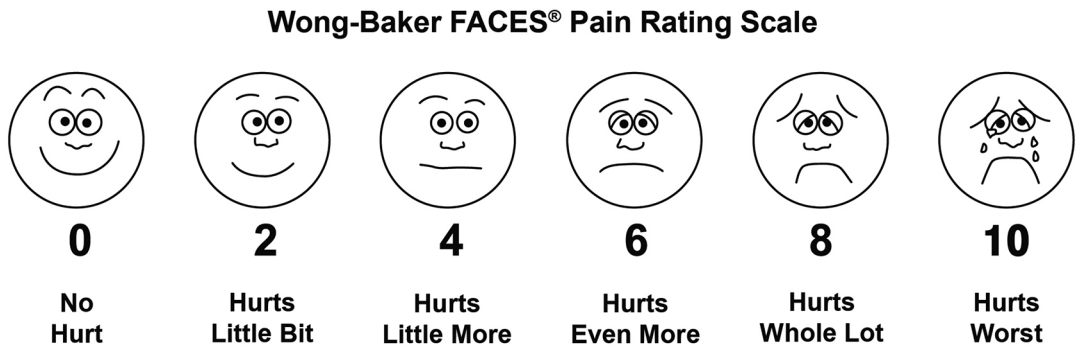


Figure 15.7 - Wong-Baker FACES® Pain Rating Scale[a] (3 years and above)



Behavioural assessment tools[4]

For children unable to self-report (too young, cognitive impairment, unconscious or severely sick), assess child's behaviour to score intensity of pain. Various tools exist for different ages:
- Neonatal Facial Coding System (NFCS) recommended for infants ≤ 3 months.
- Face Limb Activity Cry Consolability (FLACC) scales recommended for children > 3 months.
- EVENDOL (Evaluation Enfant Douleur) scale recommended for young children from birth to 7 years.

Neonatal Facial Coding System (NFCS)

Recommended for infants ≤ 3 months.
- Assess for all 4 facial signs and add total score (see Table 15.9 and Figure 15.8)
- Total score: > 2 is moderate to severe pain, 0 is no pain.

Table 15.9 - NFCS Scoring system

Items	Scoring	
	0	1
Brow bulge	no	yes
Eye squeezed shut	no	yes
Accentuated nasolabial fold	no	yes
Open mouth	no	yes

Figure 15.8 - NFCS facial signs

FLACC (Face Limb Activity Cry Consolability) scale

Recommended for > 3 months, acute pain and for post-operative care (see Table 15.10).
- Each category is scored from 0 to 2, giving a final score between 0 and 10.
- Corresponding pain intensity:
  - 0 to 3: mild pain
  - 4 to 6: moderate pain
  - 7 to 10: severe pain

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Table 15.10 - FLACC scoring scale

FLACC Scale	Scoring		
	0	1	2
Face	No particular expression or smile	Occasional grimace or frown, withdrawn, disinterested	Frequent to constant frown, clenched jaw, quivering chin
Legs	Normal position or relaxed	Uneasy, restless, tense	Kicking, or legs drawn up
Activity	Lying quietly, normal position, moves easily	Squirming, shifting back and forth, tense	Arched, rigid or jerking
Cry	No cry (awake or asleep)	Moans or whimpers, occasional complaint	Crying steadily, screams or sobs, frequent complaints
Consolability	Content, relaxed	Reassured by occasional touching, hugging or being talked to, distractible	Difficult to console or comfort

EVENDOL (Evaluation Enfant Douleur)

The EVENDOL behavioural score was developed by a multi-professional group of experts in child pain, to better identify and assess the intensity of pain in young children, from birth to 7 years of age; studies have validated this scale in emergencies (medical or traumatic), in pre-hospital medical transport, in post-operative and neonatal care and for newborns in maternity wards[5,6].

– Five features are assessed:
  - Vocal or verbal expression
  - Facial expression
  - Movements
  - Postures
  - Interaction with the environment
– Refer to EVENDOL chart in Appendix 21. Give a score for each feature and calculate total out of maximum 15. Can be used at rest (R) or with movement (M).
– Score rating:
  - Score 1/15 to 3/15: mild pain
  - Score 4/15 to 7/15: moderate pain
  - Score 8/15 to 15/15: severe pain

15.4.2 Management

– Relieve pain according to type (acute or chronic) and intensity.
– Where possible and appropriate, treat underlying cause.
– Non-pharmacologic measures (e.g. cognitive, behavioural, physical and supportive therapies) help control pain by providing comfort or an element of distraction from the physical pain (see Table 15.11). Two interventions are more effective than one. Use in combination with pharmacologic treatment. See also MSF Manual of Nursing Care Procedures, Procedure: Pain management.

Table 15.11 - Examples of non-pharmacologic pain management measures

Infants and young children	Older children
• Breastfeeding • Non-nutritive sucking e.g. use of dummy to promote sucking for comfort • Physical comfort: Kangaroo Care, swaddling, facilitated tucking • Oral sucrose/expressed breastmilk (usually reserved for pre-procedure analgesia)	• Listening to music or singing • Distraction: recalling of favourite place; counting backwards by serial sevens • Blowing soap bubbles • Breathing exercises: quiet, calm environment; slow inhalation and long exhalation
Drawing and playing Physical measures: massage, applying ice locally, occasionally heat	

– Give appropriate pharmacologic treatment (see below).
– Reassess pain and response to treatment regularly, at least every time vital sign measurements are taken.

Analgesics

– Use oral analgesics whenever possible (better tolerated, fewer side effects, safer).
– Identify step on the three-step ladder that corresponds to pain score (see Table 15.12).

Table 15.12 -Three-step ladder

Ladder step	Analgesia
Step 1: mild pain Pain score 1-3	Paracetamol +/- ibuprofen
Step 2: moderate pain Pain score 4-6 (4-7 EVENDOL)	Paracetamol +/- ibuprofen + low-dose oral morphine or tramadol[b]
Step 3: severe pain Pain score 7-10 (8-15 EVENDOL)	Paracetamol +/- ibuprofen + morphine IV, IM, SC

– Select analgesia corresponding to step on the three-step ladder (see Table 15.13 for analgesic drug dosing). For moderate and severe pain, give regular analgesia over 24 hours, including sufficient analgesia to allow the child to sleep through the night and to avoid breakthrough pain:

Step 1: mild pain

– Give paracetamol and consider adding ibuprofen if necessary.

Step 2: moderate pain

– Add a low-dose oral strong opioid to step 1 analgesia.
– First line is morphine. Use tramadol as an alternative only if oral morphine is not available or feasible, exercising particular caution in children < 12 years[b].

b Tramadol is not approved for use in children < 12 years in some countries due to the risk of increased opioid toxicity including life-threatening respiratory depression. If oral morphine is not available, tramadol may be considered in hospitalised children < 12 years under close medical supervision at a dose of 1 to 2 mg/kg every 6 to 8 hours (max. 400 mg/day).

– Adjust choice of opioid according to age and by monitoring efficacy of the analgesia given.
– For acute pain, start with immediate-release oral morphine.
– For chronic pain, low doses of sustained-release oral morphine are preferred.

Step 3: severe pain

– Add IV, IM or SC morphine to step 1 analgesia.
– For acute severe pain and in emergencies, administer morphine by IV titration (Table 15.14).
– IV morphine use requires:
  • Adequate monitoring of pain, sedation, and vital signs (HR, RR, BP).
  • Staff to recognise and treat respiratory depression as a result of an overdose of morphine.
  • Immediate availability of naloxone and a basic airway kit (see Chapter 2, Section 2.9.5 for management of morphine toxicity).

Table 15.13 - Analgesic drug dosing

Drug	Route	Dose
Paracetamol	PO	15 mg/kg every 4 to 6 hours (max. 60 mg/kg/day)
	IV (over 15 mins)	• < 10 kg: 10 mg/kg every 6 hours (max. 30 mg/kg/day) • 10 kg to 49 kg: 15 mg/kg every 6 hours (max. 60 mg/kg/day) • ≥ 50 kg: 1 g every 6 hours (max. 4 g/day, or 3 g/day if risk of hepatotoxicity).
Ibuprofen	PO	• 3 months to 11 years: 5 to 10 mg/kg every 6 to 8 hours (max. 30 mg/kg/day) • ≥ 12 years: 200 to 400 mg every 6 to 8 hours (max. 1200 mg/day)
Tramadol[c]	PO, IM, IV	• ≥ 12 years: 50 to 100 mg every 4 to 6 hours (max. 400 mg/day)
Morphine	PO immediate release (MIR)	• 1 to 5 months: 0.1 mg/kg every 4 hours • 6 months to 1 year: 0.2 mg/kg every 4 hours • 2 to 11 years: 0.2 to 0.3 mg/kg every 4 hours • ≥ 12 years: 5 to 10 mg every 4 hours To be adjusted in relation to pain intensity.
	PO sustained release (MSR)	• ≥ 6 months: 0.5 mg/kg every 12 hours To be adjusted in relation to pain intensity.
	SC or IM	• 1 to 5 months: 0.1 to 0.2 mg/kg every 6 hours • 6 months to 11 years: 0.1 to 0.2 mg/kg every 4 hours • ≥ 12 years: 2.5 to 10 mg every 4 hours To be adjusted in relation to pain intensity.

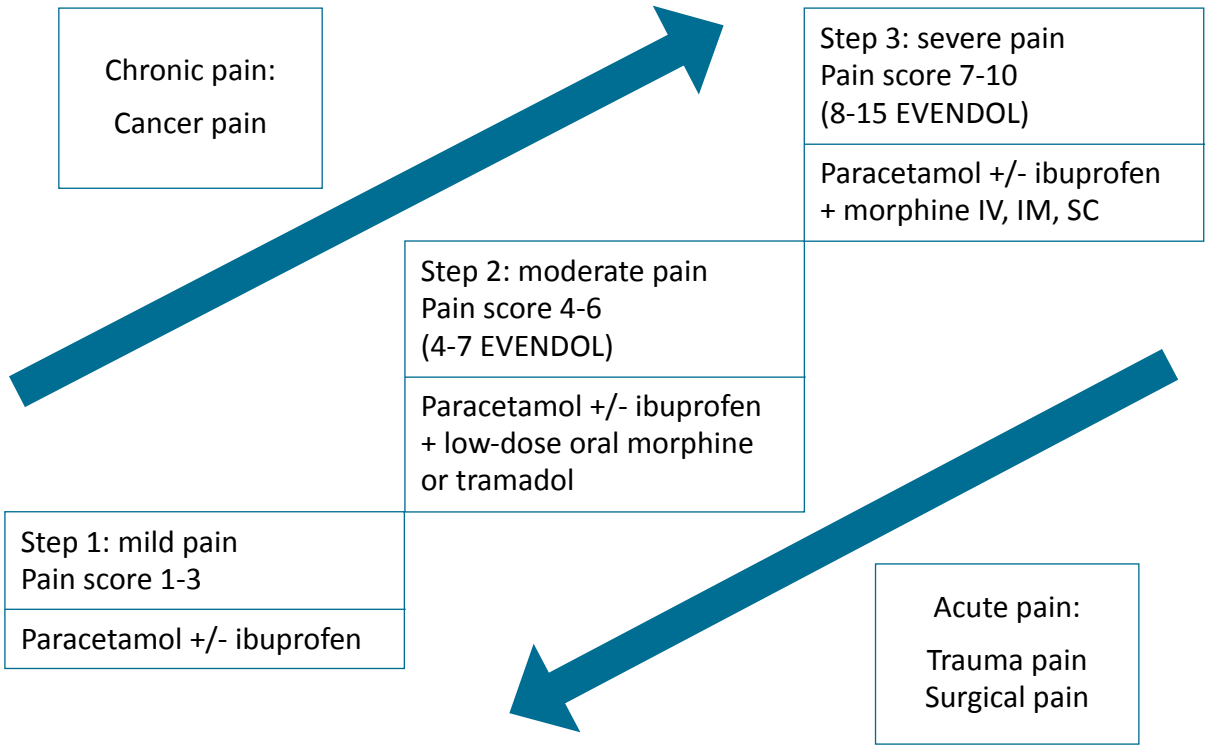
c Tramadol is not approved for use in children < 12 years in some countries due to the risk of increased opioid toxicity including life-threatening respiratory depression. If oral morphine is not available, tramadol may be considered in hospitalised children < 12 years under close medical supervision at a dose of 1 to 2 mg/kg every 6 to 8 hours (max. 400 mg/day).

Table 15.14 - IV morphine titration

Age/weight	1st dose	Following doses	Interval
< 6 months	0.05 mg/kg	0.05 mg/kg	5 to 10 mins until pain controlled
≥ 6 months < 50 kg	0.1 mg/kg	0.05 mg/kg	5 to 10 mins until pain controlled
≥ 50 kg	2 to 3 mg	2 to 3 mg	5 to 10 mins until pain controlled
Dilution: see MSF Paediatric Injectables Handbook for details on dilution and administration.			

– Move up or down the pain ladder depending on pain intensity and type of pain (Figure 15.9):
  - Acute pain, surgical or trauma-related pain: intensity of pain higher initially but will then decrease. Strategy is to move down the ladder.
  - Chronic pain, cancer-associated pain: background pain with increase in intensity. Strategy is to move up the ladder.

Figure 15.9 - Strategy for use of pain ladder



– Anticipate and treat adverse effects of analgesia. Constipation is especially common when opioids are used, give laxatives routinely to prevent constipation when opioids are used for > 3 days.
– Be aware of contraindications to analgesic medications.

Contraindications

Ibuprofen	Bleeding or coagulation defects, history of severe asthma or severe hepatic or renal impairment.
Tramadol	Severe respiratory distress and the risk of or known seizures (epilepsy, head injury, meningitis) Do not give tramadol with or shortly before or after morphine.
Morphine	Severe respiratory distress, severe liver failure, non-stabilised epilepsy and raised intracranial pressure. It should not be given in combination with other opioid analgesics (tramadol) or with other drugs that actively affect the CNS (benzodiazepines, neuroleptics, antihistamines, phenobarbital, phenytoin) because of the increased risk of sedation.

15.4.3 Chronic pain

Defined as pain that lasts or recurs for longer than 3 months and is associated with significant emotional distress and/or functional disability[7]. Most chronic pain in children is secondary to an underlying condition and requires long-term management in an outpatient setting.

Management requires a combination of non-pharmacologic measures, cognitive behavioural therapy and analgesics, with goals set with the child and family (regarding learning to live with a level of background pain, managing crises or breakthrough pain, mental health support, etc.).

15.4.4 Considerations for children with severe acute malnutrition (SAM)

Despite limited pharmacological evidence, as renal and hepatic function may be significantly altered in a child with severe acute malnutrition, it is currently recommended to reduce dosing by 50% or to increase the interval between doses.

Recommended analgesic dosing for children with SAM:

Drug	Route	Dose
Paracetamol	PO, IV	10 mg/kg every 8 hours (max. 30 mg/kg/day)
Ibuprofen	PO	5 mg/kg every 8 hours (max. 15 mg/kg/day)
Tramadol[d]	PO, IV, IM	≥ 12 years: 1 mg/kg every 6 to 8 hours maximum
Morphine	PO	0.2 mg/kg every 8 hours maximum
	IM/SC	0.1 mg/kg every 4 to 8 hours

d Tramadol is not approved for use in children < 12 years in some countries due to the risk of increased opioid toxicity including life-threatening respiratory depression. If oral morphine is not available, tramadol may be considered in hospitalised children < 12 years with malnutrition under close medical supervision.

15.4.5 Neuropathic pain

Pain due to a lesion, disease or injury of the somatosensory nervous system. This primary lesion can be peripheral or central and has a protective function as well. Neuropathic pain can occur acutely but can become a chronic pain that has a substantial burden on the patient with psychological distress, physical disability and reduced overall quality of life. It is often the most severe and most difficult persistent pain to manage. Rehabilitation and psychological therapies such as cognitive-behavioural therapy (CBT) should be provided alongside pharmacological treatment.

Causes in children include trauma, phantom limb pain following amputation, spinal cord injury, tumours, abscesses, post-surgical, viral nerve damage (e.g HIV, HSV), autoimmune or metabolic diseases, or drugs (e.g. ARVs, ethambutol, isoniazid)[8].

Diagnosis is clinical and based on features described of an unusual pain, such as burning, shooting, electric shocks or other sensations that may be difficult to describe, and the area of the skin near the pain may be numb or very sensitive that even light touch or clothes may be painful.

Management

gabapentin PO

- 6 to 11 years: 5 mg/kg/day once daily. Titrate dose over 3 days, increasing 5 mg/kg/day. Maximum dose: 15 mg/kg/day given in three divided doses.
- ≥ 12 years: D1: 300 mg once daily; D2: 300 mg 2 times daily; D3: 300 mg 3 times daily. After D3: titrate dose as required, increasing by 300 mg/day at 2-day intervals until D10 and subsequently at 3 day intervals up to a maximum of 3600 mg in three divided doses.

amitriptyline PO

- 6 to 11 years: start at 0.5 mg/kg at bedtime. Gradually titrate up once a week up to maximum of 1 mg/kg. Maximum dose: 75 mg daily.
- ≥ 12 years: week 1: 25 mg once daily at bedtime; week 2: 50 mg once daily at bedtime; week 3: 75 mg once daily at bedtime. Maximum dose: 75 mg daily. Avoid in patients at risk of self-harm.

Dual treatment is recommended[9,10]. In cases of mild neuropathic pain, clinicians may consider starting gabapentin or amitriptyline in isolation depending on patient risk factors. Monitor closely for the development of suicidal thoughts and evaluate response to treatment after 2 to 4 weeks. Neither medication should be stopped abruptly.

15.4.6 Sedation or analgesia before a painful procedure

Consider prophylactic analgesia before painful procedures.

- For minor procedures such as IV catheter insertion, non-pharmacological measures are usually sufficient.
- Start with step 1 analgesics: paracetamol +/- ibuprofen, given at least 30 minutes before the procedure.

– Local topical anaesthetics can be used in inpatient and emergency care settings:
  - Dermal cream[e]: use with planned procedures e.g. lumbar puncture.
    - ▷ Apply half of a 4 g tube of **EMLA cream** (lidocaine/prilocaine) to the skin. Cover the cream with an occlusive dressing and wait for 45 to 60 minutes. Analgesic effects last for up to 4 hours after removal of the cream.
    - ▷ Adverse reactions: transient skin irritation
  - Subcutaneous injection of **lidocaine 1%** may be used for minor surgical procedures by staff trained in the procedure.
    - ▷ Infiltrate **lidocaine 1%** SC: 3 mg/kg/injection (max. 5 mg/kg/injection) in the area involved with a small-bore needle (e.g. 25 Gauge needle). Do not use as IV.
– For procedures that require a stronger analgesia/sedation, such as ketamine, trained staff and protocols need to be available (refer to MSF Standards for Paediatric Procedural Sedation).

e Transitory Z code **DEXTZFR0063**; mixture of lidocaine 2.5% and prilocaine 2.5% in a cream base

15.5 Nutritional support for the critically unwell child

Nutritional support is an essential element of paediatric critical care for all children, both non-malnourished and malnourished, following initial resuscitation. Ideally, nutritional support in hospital should be provided orally (i.e. eating and drinking), but this is not feasible in critically unwell children. Enteral nutrition via oro/nasogastric tube (O/NGT)[a] is therefore used to allow timely introduction of nutritional support. O/NGTs should be used for as short a time as possible, as the goal is to get the child back on a nutritionally appropriate oral diet as soon as safely possible (see MSF Hospital Food Service Management Protocol).

Early introduction of enteral nutrition has been shown to be beneficial in critically unwell children, leading to reduced infections (particularly pneumonia), and a likely reduction in mortality[11,12,13]. Enteral nutrition should therefore be started as soon as the child is haemodynamically stable i.e. has received appropriate fluid resuscitation for circulatory impairment.

Intravenous fluids have limited nutritional value and maintain adequate hydration, blood sugar levels and electrolyte balance in the short term only. Children recovering from critical illness have a considerable risk of developing nutritional deficiencies, therefore the use of exclusive IV fluids should be limited to the first 24-48 hours of critical illness.

While the principles of nutritional support for critically unwell children are the same for both malnourished and non-malnourished children, the enteral nutrition products and volume of feeds are not. Ensure that nutritional assessment is carried out before starting enteral feeding in critically unwell children, if not already done at admission. This chapter will focus on nutritional support for the non-malnourished critically unwell child. For advice on enteral feeding in critically unwell malnourished children from 1-59 months, refer to the MSF ITFC Nutrition Care Protocol 2021[b]. For older critically unwell malnourished children, refer to local protocols.

15.5.1 Indications for enteral nutrition

Enteral feeds should be started in the first 24 to 48 hours of admission[13] if the following conditions are met:
- Haemodynamically stable
- No signs of acute abdomen (see Chapter 5, Section 5.4)
- No imminent surgery
- Unable to tolerate oral intake

Although not contraindicated, a cautious approach should be taken when introducing enteral feeds in children with severe respiratory distress, as increasing stomach volume may cause deterioration. These children should be closely monitored for signs of worsening distress and have an OGT inserted in preference to an NGT to minimise respiratory obstruction.

a In some contexts, naso-duodenal, jejunostomy and gastrostomy tubes may be used, though much less common.

b Specific advice on the management of children with moderate acute malnutrition in Note 5.6 of this protocol.

Children with a reduced level of consciousness have reduced protective airway reflexes (e.g. gagging/coughing) therefore are at greater risk of regurgitation of gastric contents. This is not a contraindication to the introduction of enteral feeds but necessitates close monitoring and a more cautious approach to avoid aspiration of stomach contents into the airway and lungs, causing an aspiration pneumonia. The position of the O/NGT should be verified after insertion and before each use (see MSF Manual of Nursing Care Procedures, SOP – Gastric Tubes: Maintenance).

15.5.2 Enteral nutrition products

The choice of enteral nutrition product depends on the child's age, their calorie and fluid requirements, and availability of the product. For all critically unwell children, expressed breastmilk should be encouraged if the child is still breastfeeding. Remaining energy and fluid requirements can be provided with the chosen appropriate enteral nutrition product. Isocaloric enteral nutrition products are usually used to meet energy needs, but hypercaloric enteral nutrition products may be preferred in specific cases e.g. if the child is fluid restricted or for conditions with extreme increases in energy needs such as burns. See Table 15.15 for calorie and water content of various enteral products.

Table 15.15 - Calorie and water content of enteral nutrition products

Type of enteral nutrition	Calorie content (kcal/100 mL)	Free water content (mL water/100 mL milk)
Breastmilk	70	90
Standard infant formula	70	90
F-100 diluted (F-100d)	70	–
F-100	100	86[14]
Enteral nutrition product, isocaloric, child[c]: 1 kcal/mL	100	83
Enteral nutrition product, hypercaloric, child[d]: 1.5 kcal/mL	150	73

Enteral nutrition products in order of preference for non-malnourished critically unwell children:

– 1 to 6 months:
  - Expressed breastmilk
  - Standard infant formula
  - F-100 diluted (F-100d)[e]

c Isocaloric, normoprotein, ready to use enteral nutrition available in MSF catalogue with code **NFOSENICNPW05**. This is adequate for most children requiring enteral feeds. Semi-elemental drink/enteral powder also available as NST with code **NFOSDEICSEWV4** but is reserved for exceptional cases and is not available in all projects.

d Hypercaloric, normoprotein, ready to use enteral nutrition available in MSF catalogue with code **NFOSERHCNPF05**. This is typically reserved for patients with extremely increased energy requirements such as in children with severe burns.

e Only to be used if neither of the first two products are available. See MSF ITFC Nutrition Care Protocol 2021 for preparation guidance.

– > 6 months to 1 year:
  - Expressed breastmilk
  - Standard infant formula
  - F-100[f]
– > 1 year:
  - Expressed breastmilk (if still breastfeeding)
  - Appropriate enteral nutrition product
  - F-100[f]

15.5.3 Daily fluid requirements

Total daily fluid requirement

The total daily fluid requirement is the amount of fluid that the body needs to maintain hydration each day. This fluid requirement can be met either intravenously (IV) or enterally, or as a combination of the two. All fluids given to the child should be accounted for in the total daily fluids, including IV flushes, medication infusions and enteral feeds. Total daily fluid requirement is typically calculated using the Holliday-Segar formula which calculates maintenance fluid requirements (see Section 15.2). Critically unwell patients are often fluid restricted, which should be considered when calculating total daily fluid requirement (see Section 15.2.2). If fluid restriction is considered necessary, the restriction is applicable to both IV and enteral fluid volumes.

Enteral fluid volumes

In children, enteral fluid volume is equivalent to total daily fluid requirement[15,16,17]. This volume meets hydration and nutritional requirements, as enteral nutrition products in this age group are isocaloric. In infants, however, while total daily fluid requirements calculated using Holliday-Segar will meet hydration needs, they are likely to be nutritionally inadequate, since infant feeds are hypocaloric. Standard enteral fluid volumes for nutritional purposes in infants are outlined in Table 15.16.

Table 15.16 - Standard enteral fluid volumes for the provision of nutrition in infants[11]

Age	Fluids (mL/kg/day)
1-3 months	150 (140-160)
4-6 months	140 (130-155)
7-12 months	130 (120-145)

15.5.4 Energy requirements in critical illness

The volume of enteral nutrition to be administered during critical illness is based on calorie (energy) requirements per kg of body weight, which vary depending on the phase of critical illness. In the acute phase (lasting hours to days), there may be a significant reduction in energy expenditure due to decreased activity and reduced insensible losses e.g. in comatose patients

f Only to be used if neither of the first two products are available. See MSF ITFC Nutrition Care Protocol 2021 for preparation guidance.

while in other patients stress factors during the acute phase can lead to hypermetabolism and significantly increased energy expenditure, especially with fever or burns. It is therefore difficult to accurately estimate energy requirements without risking either over- or underfeeding, both of which can have adverse effects on recovery[13]. Overfeeding in particular during the acute phase can exacerbate the catabolic stress response and impair recovery. Resting energy expenditure is therefore used as a proxy for energy requirement during the acute phase of critical illness. In the stable and recovery phases of critical illness, energy provision should be gradually increased to ensure minimal loss of lean body mass.

Calculation of energy requirements in the acute phase of critical illness

In the absence of known resting energy expenditure, it is recommended that the Schofield equation, which measures basal metabolic rate (BMR), is used to estimate energy requirements in the acute phase of illness[11,12] (see Table 15.17). Weight at admission should be used for calculations to ensure that the nutritional support is appropriate.

Table 15.17 - Schofield energy equations (modified from AUSPEN[11])

Age	Gender	kcal
0 to < 3 years	Male	BMR = 59.5 x W* – 30
	Female	BMR = 58.3 x W – 31
3 to < 10 years	Male	BMR = 22.7 x W + 504
	Female	BMR = 20.3 x W + 486
10 to 15 years	Male	BMR = 17.7 x W + 658
	Female	BMR = 13.4 x W + 692

*W = weight (kg)

These calculations are only valid for the acute phase of critical illness (up to maximum 7 days).

15.5.5 Calculating target daily enteral feed volumes in the acute phase of critical illness

Use the following steps to calculate the target volume of enteral feed required daily to meet energy needs during the acute phase of critical illness (up to maximum 7 days).

Step 1: Calculate the estimated daily energy requirements according to weight (see Schofield energy equation, Table 15.17).

Step 2: Choose the most appropriate/available enteral nutrition product (see Table 15.15). If the patient is fluid restricted, consider hypercaloric feeds (children) or fortification of breastmilk (infants) to meet energy needs without exceeding target enteral fluid volumes.

Step 3: Calculate and prescribe the target daily acute phase enteral feed volume according to the calorie content of the chosen enteral nutrition product.

Target daily acute phase enteral feed volume =
estimated daily energy requirement ÷ calorie content of chosen enteral nutrition product

Example: 3.5-year-old female weighing 12 kg
- **Step 1**: Estimated daily energy requirement (kcal/day) = 20.3 x 12 + 486 = 730 kcal/day
- **Step 2**: Chosen enteral nutrition product = F-100 = 1 kcal/mL
- **Step 3**: Target daily acute phase enteral feed volume (mL/day) = energy requirement (kcal/day) ÷ calorie content of chosen enteral nutrition product (kcal/mL) = 730 ÷ 1 = **730 mL/day**

See Appendix 22 for pre-calculated tables of target daily enteral feed volumes according to age and weight in the acute phase of illness (up to maximum 7 days).

15.5.6 Administration of enteral feeds

Enteral feeds should be started slowly and increased as quickly as tolerated (see below for signs of feed intolerance), aiming for delivery of two-thirds of total calculated target daily acute phase requirements within 7 days at the latest[13]. If the child improves rapidly, full feeds can be established within a few days. Ensure 4-hourly blood glucose monitoring for the first 24-48 hours after introduction of enteral feeds[18]. Until enteral feeds are established, critically unwell children should receive IV maintenance fluids (see Section 15.2), which should be gradually reduced as enteral feeds are increased to maintain the same total daily fluid intake.

Enteral feeds should be administered according to prescription either by gravity or using an enteral feeding pump, if available (see MSF Manual of Nursing Care Procedures, SOP – Enteral Nutrition Administration Methods). The preference for feed delivery is intermittent feeds every three hours. If intermittent feeds are not tolerated, increase feed frequency to every two hours or hourly, reducing volumes accordingly. If there is still intolerance on hourly bolus feeds, start continuous feeding.

Signs of enteral feed intolerance

Signs of feed intolerance can be non-specific and include:
- Clinical signs of shock or haemodynamic instability
- Increasing respiratory distress
- Vomiting
- Diarrhoea
- Blood in stool
- Abdominal distension (abdominal girth increased for two consecutive measurements)
- Temperature instability
- Hyperglycaemia
- Large gastric residuals (seen on checking for correct placement of O/NGT)
- Reduced bowel sounds

Consider refeeding syndrome (See Chapter 12, Section 12.3) in children who deteriorate after the introduction of enteral feeds after a prolonged period of starvation, even if they do not meet the anthropometric criteria for acute malnutrition.

Stepwise approach to introducing and increasing enteral feeds

Step 1: Start at 30% of target daily acute phase enteral feed volume (as calculated above). If tolerated, reduce IV fluids accordingly and continue for 6-12 hours.

Step 2: Increase to 50% of target daily acute phase enteral feed volume and reduce IV fluids accordingly. If tolerated, continue for 6-12 hours.

Step 3: Increase to 70% of target daily acute phase enteral feed volume and reduce IV fluids accordingly. If tolerated, continue for 6-12 hours.

Step 4: Increase to target daily acute phase enteral feed volume. If tolerated, stop IV fluids and provide remaining daily enteral fluid intake in the form of water via O/NGT in 30-60 mL aliquots[g].

Total enteral fluid requirement = enteral feed volume + IV fluids + water

Example: 3.5-year-old non-malnourished child weighing 12 kg, no fluid restriction in place.

Current IV maintenance fluids: 45 mL/hr
Chosen enteral nutrition product: F-100
Target daily acute phase enteral feed volume = 730 mL
Target 3-hourly acute phase enteral feed volume = 730 ÷ 8 = 90 mL

- **Step 1**: Start at 30% of target acute phase enteral feed volume = 90 x 0.3 = 30 mL every 3 hours. Reduce IV fluids to 35 mL/hr and continue for 6-12 hours.
- **Step 2**: Increase to 50% of target acute phase enteral feed volume = 90 x 0.5 = 45 mL every 3 hours. Reduce IV fluids to 30 mL/hr and continue for 6-12 hours.
- **Step 3**: Increase to 70% of target acute phase enteral feed volume = 90 x 0.7 = 60 mL every 3 hours, reduce IV fluids to 25 mL/hr for 6-12 hours.
- **Step 4**: Increase to 100% of target acute phase enteral feed volume = 90 mL every 3 hours and give 45 mL water via O/NGT every 3 hours.

15.5.7 Advancing enteral feeds

Target enteral feed volumes calculated for the acute phase of critical illness should be used up to a maximum of 7 days. If the child is improving and target acute phase enteral feed volumes are tolerated, feed volume can be cautiously increased to full enteral fluid volume.

The child should be advanced to full oral intake as soon as they are well enough, i.e. when fully conscious and able to safely tolerate oral feeds. In infants, re-establish breastfeeding as soon as possible, or give expressed breastmilk or infant formula via mouth. In children, introduce food according to usual eating habits. In the first few days after re-establishing oral feeds, record food and fluid intake to ensure that it is adequate. For further advice on nutrition requirements for hospitalised children, please refer to MSF Hospital Food Service Management Protocol.

If the child remains critically unwell after 7 days, an individualised enteral nutrition plan should be devised with the input of a nutrition specialist[h], as the target enteral feed volumes calculated for the acute phase will be inadequate to meet their increasing daily energy needs (see Section 15.5.3 and Section 15.5.4 above).

g Do not give water to infants under 6 months old. In infants under 6 months old, continue to gradually increase enteral feeds as tolerated until full enteral feed volume has been reached (see Table 15.16 for standard enteral feed calculations in infants) and continue to reduce IV fluids accordingly until they can be stopped.

h Consider consulting the MSF telemedicine platform for specific case by case advice.

15.6 Palliative care

Paediatric palliative care aims to relieve suffering and improve the quality of life for children with life-threatening illnesses, as well as to provide support to their families. Although palliative care is often started when curative options have been exhausted, it can also be provided alongside potentially curative treatments. It is not synonymous with end-of-life care and should be a component of any care plan for children with significant life-limiting illnesses. The aim of palliative care is to promote comfort and dignity to children with serious health problems, regardless of whether their illness can be cured or not, and palliative care may take place in hospital or at home. It encompasses physical, psychosocial, and spiritual support and requires the input of a multidisciplinary team. End-of-life care is a component of palliative care that occurs in the last hours or days of life.

In humanitarian and low-resource settings, palliative care may be required more frequently for conditions that may be curable in other contexts with more advanced healthcare. Common conditions in children that require palliative care include congenital cardiac anomalies and other congenital anomalies, malignancies, critical illness or injury where recovery is unlikely, chronic or degenerative conditions for which there is no definitive treatment (e.g. HIV, muscular dystrophies), and severe neurological conditions. Palliative care should be integrated into care early in paediatric critical illness, as it is often difficult to predict prognosis and eventual outcome in children. A child's developmental stage will heavily influence all aspects of palliative care.

This chapter will briefly outline the main components of paediatric palliative care – symptom management; communication; and psychosocial support. For a comprehensive guide to paediatric palliative care, refer to MSF OCBA Palliative Care Programmatic and Clinical Guidelines. For more guidance on psychosocial support in palliative care, refer to MSF Mental Health and Psychosocial Support Guideline, Chapter 13.

15.6.1 Symptom management

Children may not be able to express what is distressing them. It is important to look for non-verbal cues and listen to family members when assessing for symptoms, especially pain.

Common symptoms that may affect children requiring palliative care include:
- Pain (see Section 15.4 for the assessment and management of pain in children)
- Breathlessness
- Secretions
- Nausea, with or without vomiting
- Constipation
- Anxiety
- Spasticity and muscle spasm
- Seizures

Examination

Carry out a complete physical examination, paying particular attention to inside the mouth and ears, presence of lymph nodes and skin problems (especially nappy area and scalp).

Management

Symptom management should be holistic, including both pharmacological and non-pharmacological options. Ensure thorough assessment of symptoms, treat any treatable causes, give medications to control symptoms at age-appropriate dosing (preferably via oral route), and consider social, psychological or spiritual factors which may impact symptom management. If palliative care will take place at home, adequate planning is required to ensure that good-quality care is provided.

Specific symptom management includes:

- Respiratory care:
  - Ensure regular mouth hygiene (nursing care using mouth swabs, treating mouth sores etc).
  - Gentle suctioning can relieve distress from secretions in the mouth and airway.
  - Modify positioning to minimise breathlessness.
  - Oxygen for comfort[a], as required.
- Pain relief (see also Section 15.4):
  - Assess pain regularly and ensure that pain relief is adequate.
  - Use adjuvant therapy if indicated, e.g. for neuropathic pain.
  - Ensure non-pharmacological measures are used in combination with medications, e.g. allow presence of parents/carers and encourage physical comforting such as cuddling, breastfeeding; bring familiar objects from home; encourage play, music and drawing; provide access to physical measures such as massage, heat/cold therapy; teach breathing exercises to calm.
- Nausea, with or without vomiting:
  - Treatment with antiemetic should be short-term.
  - In children over 1 year old, consider **metoclopramide**[b] PO or slow IV, 100 to 150 micrograms/kg (max. 10 mg) repeated as required up to 3 times daily.
- Constipation:
  - Common side effect of opioid analgesia.
  - Treat with **lactulose** PO:
    - 1-11 months, 2.5 mL 2 times daily
    - 1-4 years, 2.5-10 mL 2 times daily
    - 5-17 years, 5-20 mL 2 times daily
- Anxiety:
  - Try non-pharmacologic methods to calm anxiety in the first instance, e.g. breathing exercises, distraction, music, psychosocial support.
  - Consider **diazepam** PO in children over 1 year old, 2 mg 2 or 3 times daily.
- Spasticity and muscle spasm:
  - Use pillows or other supports to maintain normal joint position.
  - Prevent contractures through gentle physiotherapy and passive movement of limbs.
  - Consider the use of **diazepam** PO as a muscle relaxant:
    - 1 month - 2 years: 0.1 to 0.3 mg/kg once or 2 times daily
    - > 2-4 years: 2.5 mg once or 2 times daily
    - 5-12 years: 5 mg once or 2 times daily
    - ≥ 12 years: 5 to 10 mg once or 2 times daily

a The provision of oxygen in palliative care is for comfort only, i.e. to minimise symptoms of respiratory distress. It is not necessary to target a certain saturation level or to administer high flows which may cause discomfort.

b Metoclopramide can induce severe extra-pyramidal side-effects in children therefore should be used with caution and for maximum of 5 days. It is contraindicated in children less than 1 year old.

  - **Baclofen** PO may be used as an alternative, if available:
    75 micrograms/kg 4 times daily, increased gradually at weekly intervals until satisfactory response up to a maintenance dose of maximum 0.75 to 2 mg/kg daily (max. 40 mg/day < 8 years; max. 60 mg ≥ 8 years).
- Seizures:
  - Seizures cause stress and discomfort to the child, therefore it is important that they are adequately controlled in children receiving palliative care.
  - Manage according to advice in Chapter 7, Section 7.2.

15.6.2 Communication

Communication with the child

Good communication is essential when providing palliative care. Language and methods of communication should be adapted to the child's level of development and understanding. Important discussions and sharing of sensitive information should only take place after consultation and agreement with parents/carers/families. Honesty is a key component of communication with children, and it is important not to lie, even when faced with difficult questions. Children are often aware that they are dying, even if no-one tells them directly, and they will pick up on the worried faces of their parents/carers and healthcare team. We may inadvertently cause more worry and anxiety by failing to talk about this, as children may imagine a situation that is worse than reality when faced with uncertainty.

Some important points to remember when communicating with children:
- Engage with children non-verbally before starting to speak to them to build trust, e.g. smile, offer a toy, engage in play/drawing with them.
- Get down to their level to make them feel more comfortable, e.g. sit on the bed or floor.
- Maintain a distance that allows the child to feel safe, leaving them to come closer when they are ready.
- Use language that is appropriate for their developmental age.
- Talk to the child with their parents/carers unless otherwise requested and allow them to sit on their parent's/carer's lap or stay near them if they want to.
- Ensure that you speak directly to the child as well as the parents/carers.
- Be honest and don't make promises that are unrealistic.
- Listen to the child when they speak and don't rush them or interrupt if they are unable to express themselves easily.
- Don't give information to the child without their parent's/carer's permission.

Communication with families

It can be difficult to discuss palliative care for a seriously unwell child with their families, and any such conversation requires great sensitivity. Ensure that you allocate the time required to speak to family members, and that discussions take place in a quiet location that allows privacy. Involve other members of the multidisciplinary team who are closely involved in the care of the child, such as the nurse or the mental health team, to provide additional support to families. It is important to be honest with families so that they can prepare for what lies ahead, and in turn prepare other family members, especially siblings. It will usually be the family who will talk to their child to explain what is happening, so they need to have all the information required to do this in the best way possible and to allow them to make decisions regarding

care. Reassure families that palliative care does not mean that there that is nothing more that can be done, but that it aims to make the child more comfortable by treating pain and other symptoms. Explain to families if options are available for providing palliative care at home, so that they can decide if this would be best for their child and their family. Provision of palliative care at home may not be possible, but families should still be offered the option of taking their child home to provide whatever care they can in their home environment, if this is what they feel is best for them and their child.

If it seems likely that the child will not survive, there are key steps that should be followed to inform a family that death is expected:

1) Open the conversation by introducing yourself and asking permission to talk about their child's current condition.
2) Assess their understanding of the illness and their child's condition.
3) Ask about how much information they would like to know about their child's condition and likely prognosis, both short- and long-term.
4) Share the prognosis sensitively but clearly and allow the family time to process this information.
5) Assess goals by asking the family what they would like to do for their child, considering the information they have just received.
6) Establish a plan, recommending a focus on symptom control, comfort and allowing the child to be close to their loved ones.
7) Close the conversation by reassuring the family that you are available for support or further information and ensure that they have a way to contact a member of the team whenever they need to.
8) Record all conversations with families and patients in the patient's medical file and communicate to the rest of the team during handover processes so that all medical staff are aware of the plan.

Communication within the multidisciplinary team

Good communication amongst members of the multidisciplinary team is essential to ensure that all staff are aware of conversations and decisions regarding palliative care. Where feasible, all members of the multidisciplinary team should be involved in discussions about the palliative care plan. Ensure good record of discussions and decisions in the patient's medical file, and handover of key information during shift changes.

15.6.3 Psychosocial support

Support for the child

Children with life-limiting illnesses need emotional and psychosocial support to understand their illness and what it may mean for them. It is important that they are able to talk to people they trust to be able to share their worries. Common worries for children include pain and other symptoms, changes to their daily life, school and other activities, concern for their parents/carers, guilt and changes in relationships with siblings and friends. Activities such as art and music may help children to express how they feel and find strategies to cope with their worries and all children should continue to play and learn even when they are ill. As children are still growing and developing, their understanding of their illness may change over time, and they may have new questions or require new strategies to cope with their illness. Involve the mental health team in the child's care to evaluate and provide support where required.

Support for family members

Caring for sick children is very challenging, especially when the child may not get better. Parents/carers have many worries related to this including how they will cope; their new role as a medical carer for a sick child; how they will explain things to siblings and other family members and support them; the financial implications of being unable to work; and feelings of guilt. Support families by listening to their fears and challenges and involving them in their child's care and any decisions that must be made. They should be treated as part of the team caring for their child and given positive encouragement that they are making the right choices for their child. Encourage the family to draw on support from wider family, the community, and religious leaders, where relevant.

Siblings will need additional support as they may feel neglected due to the attention that is given to the sick child and may experience conflicting emotions. They also need consistent and honest information about their sick brother or sister and to be able to ask questions or talk about any fears that they may have. They usually want to be close to their parents/carers and their sick sibling, and older children may want to help care for them which should be encouraged. All siblings should be able to play and spend time with their sick brother or sister if desired. Encourage parents/carers to maintain normal routines for siblings as much as possible, and to ensure that appropriate care is available for siblings if their parents/carers are away from home caring for the sick child.

References Chapter 15

1 World Health Organization. *Oxygen Therapy for Children: A Manual for Health Workers*. World Health Organization; 2016. Accessed November 20, 2023. https://iris.who.int/handle/10665/204584

2. *WHO Recommendations on Child Health: Guidelines Approved by the WHO Guidelines Review Committee*. World Health Organization; 2017. Accessed November 29, 2023. https://www.who.int/publications-detail-redirect/WHO-MCA-17.08

3. The Royal Children's Hospital Melbourne : Clinical Practice Guidelines - Hyponatraemia. The Royal Children's Hospital Melbourne. Accessed November 29, 2023. https://www.rch.org.au/clinicalguide/guideline_index/Hyponatraemia/

4. Beltramini A, Milojevic K, Pateron D. Pain Assessment in Newborns, Infants, and Children. *Pediatr Ann*. 2017;46(10). https://doi.org/10.3928/19382359-20170921-03

5. Fournier-Charrière E, Tourniaire B, Carbajal R, et al. EVENDOL, a new behavioral pain scale for children ages 0 to 7 years in the emergency department: Design and validation. *Pain*. 2012;153(8):1573-1582. https://doi.org/10.1016/j.pain.2012.02.024

6. Beltramini A, Galinski M, Chabernaud JL, et al. Pain Assessment in Children Younger Than 8 Years in Out-of-Hospital Emergency Medicine: Reliability and Validity of EVENDOL Score. *Pediatr Emerg Care*. 2019;35(2):125-131. https://doi.org/10.1097/PEC.0000000000000953

7. Nicholas M, Vlaeyen JWS, Rief W, et al. The IASP classification of chronic pain for ICD-11: chronic primary pain. *Pain*. 2019;160(1):28-37. https://doi.org/10.1097/j.pain.0000000000001390

8. Howard RF, Wiener S, Walker SM. Neuropathic pain in children. *Arch Dis Child*. 2014; 99(1):84-89. https://doi.org/10.1136/archdischild-2013-304208

9. Freynhagen R, Bennett MI. Diagnosis and management of neuropathic pain. *BMJ*. 2009; 339(aug12 1):b3002-b3002. https://doi.org/10.1136/bmj.b3002

10. Baron R, Binder A, Wasner G. Neuropathic pain: diagnosis, pathophysiological mechanisms, and treatment. *Lancet Neurol*. 2010;9(8):807-819. https://doi.org/10.1016/S1474-4422(10)70143-5

11. Australasian Society of Parenteral and Enteral Nutrition. *Australian and New Zealand Paediatric Critical Care - Nutrition Support Guideline*. 2023. https://custom.cvent.com/FE8ADE3646EB4896BCEA8239F12DC577/files/863fd86399ba4c3ab82da757faffa5c1.pdf

12. Tume LN, Valla FV, Joosten K, et al. Nutritional support for children during critical illness: European Society of Pediatric and Neonatal Intensive Care (ESPNIC) metabolism, endocrine and nutrition section position statement and clinical recommendations. *Intensive Care Med*. 2020;46(3):411-425. https://doi.org/10.1007/s00134-019-05922-5

13. Mehta NM, Skillman HE, Irving SY, et al. Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Pediatric Critically Ill Patient: Society of Critical Care Medicine and American Society for Parenteral and Enteral Nutrition. *J Parenter Enter Nutr*. 2017;41(5):706-742. https://doi.org/10.1177/0148607117711387

14. Therapeutic milk technical bulletin | UNICEF Supply Division. Accessed November 29, 2023. https://www.unicef.org/supply/documents/therapeutic-milk-technical-bulletin

15. Nager AL, Wang VJ. Comparison of Nasogastric and Intravenous Methods of Rehydration in Pediatric Patients With Acute Dehydratio. *Pediatrics*. 2002;109(4):566-572. https://doi.org/10.1542/peds.109.4.566

16. Oakley E, Borland M, Neutze J, et al. Nasogastric hydration versus intravenous hydration for infants with bronchiolitis: a randomised trial. *Lancet Respir Med*. 2013;1(2):113-120. https://doi.org/10.1016/S2213-2600(12)70053-X

17. Mackenzie A, Barnes G. Randomised controlled trial comparing oral and intravenous rehydration therapy in children with diarrhoea. *BMJ*. 1991;303(6799):393-396. https://doi.org/10.1136/bmj.303.6799.393

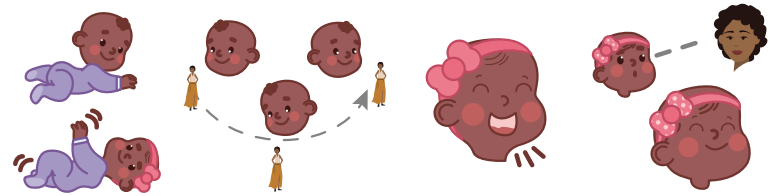
18. Singer P, Blaser AR, Berger MM, et al. ESPEN guideline on clinical nutrition in the intensive care unit. *Clin Nutr*. 2019;38(1):48-79. https://doi.org/10.1016/j.clnu.2018.08.037

Appendices

Appendix 1. Developmental milestones

2 Months

Physical & Movement | Cognitive | Communication/Language | Social & Emotional



- Holds head up when on tummy
- Moves both arms and legs
- Opens hands briefly

- Follows past midline
- Watches caregiver as they move

- Laughs and vocalises (sounds other than crying)
- Reacts to loud sounds

- Smiles responsively and spontaneously
- Looks at caregiver's face

4 Months

Physical & Movement | Cognitive | Communication/Language | Social & Emotional

- Holds head steady without support when held.
- Brings hands to mouth.
- Pushes up on elbows/forearms when on tummy

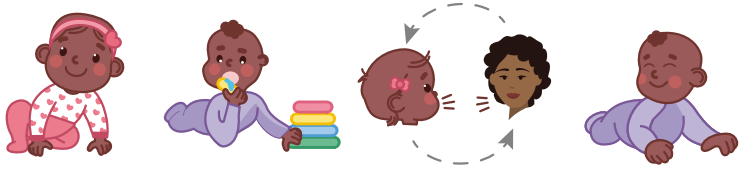
- Looks at their hands with interest.

- Makes sounds back when caregiver talks to them.
- Turns head towards the sound of caregiver's voice.

- Smiles on his own to get caregiver's attention.
- Looks at caregiver, moves, or makes sounds to get or keep their attention.

6 Months

Physical & Movement | Cognitive | Communication/Language | Social & Emotional



- Leans on hands to support themselves when sitting.
- Pushes up with straight arms when on tummy.
- Rolls from tummy to back.

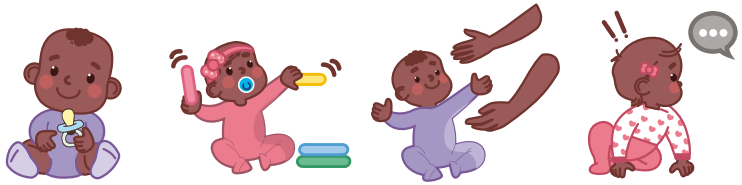
- Puts things in their mouth to explore them.
- Reaches to grab a toy they want.
- Closes lips to show they don't want more food.

- Takes turns making sounds with caregiver .

- Knows familiar people.
- Laughs.

9 Months

Physical & Movement | Cognitive | Communication/Language | Social & Emotional



- Gets to a sitting position by themselves.
- Moves things from one hand to their other hand.
- Sits without support

- Bangs two things together.
- Looks for objects when dropped out of sight (like toy).

- Lifts arms to be picked up.

- Looks when you call their name.
- Reacts when caregiver leaves (looks, reaches for caregiver, cries).

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12 Months

Physical & Movement | Cognitive | Communication/Language | Social & Emotional

- Pulls up to stand.
- Pincer grasp: picks up things between thumb and pointer finger like small bits of food.
- Puts blocks in and out of cup.
- Looks for things they see you hide, like a toy under a blanket.
- Understands "NO" (pauses briefly or stops, when you say it).
- Calls a parent "mama" or "dada" or another special name.
- Plays games with you, like pat-a-cake.

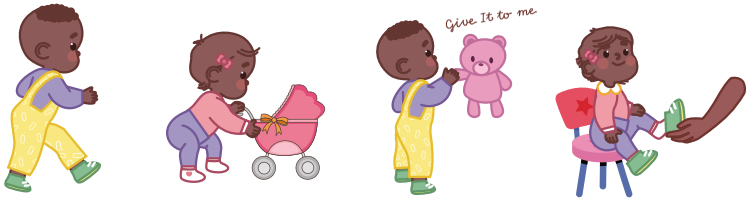
15 Months

Physical & Movement | Cognitive | Communication/Language | Social & Emotional

- Takes a few steps on their own.
- Uses fingers to feed themselves some food.
- Tries to use things the right way, like a phone cup or book.
- Tries to say one or 2 words besides "mama" or "dada", like "ba" for ball or "da" for dog.
- Looks at a familiar object, when you name it.
- Follows directions given with both a gesture and words e.g. They give you a toy when you hold out your hand and say, "Give me the toy!".
- Copies other children while playing, like taking toys out of a container when another child does.
- Shows you an object they like.
- Claps when excited.
- Hugs stuffed doll or other toy.
- Shows affection (hugs, cuddles or kisses caregiver).

18 Months

Physical & Movement | Cognitive | Communication/Language | Social & Emotional



- Walks without holding on to anyone or anything.
- Feeds themselves with their fingers.
- Climbs on and off a couch or chair without help
- Copies you doing chores, like sweeping with a broom.
- Plays with toys in a simple way, like pushing a toy car.
- Tries to say three or more words besides "mama" or "dada".
- Follows one-step directions without any gestures, like giving you the toy, when you say, "Give it to me!"
- Moves away from you but looks to make sure caregiver is close.
- Points to show something interesting.
- Helps caregiver to dress themselves by pushing arm through sleeve or lifting up foot.

24 Months

Physical & Movement | Cognitive | Communication/Language | Social & Emotional

- Walks up steps
- Kicks a ball
- Plays with more than one toy at the same time, like putting toy food on a toy plate.
- Says at least two words together, like "More milk".
- Points to at least two body parts when you ask them to show you.
- Uses more gestures than just waving and pointing, like blowing a kiss or nodding "YES".
- Notices when others are hurt or upset, like pausing or looking sad when someone is crying.
- Looks at caregivers face to see how to react in a new situation.

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30 Months

Physical & Movement	Cognitive	Communication/Language	Social & Emotional

- Takes some clothes off by themselves, like loose pants or an open jacket.
- Jumps off the ground with both feet.

- Uses things to pretend, like feeding a block to a doll as if it were food.
- Follows two-step instructions like "Put the toy down and close the door!".

- Says two or more words, with one action word, like "Doggie run!".
- Names things in a book when you point and ask, "What is this?".

- Plays next to other children and sometimes plays with them.

36 Months

Physical & Movement	Cognitive	Communication/Language	Social & Emotional

- Puts on some clothes by themselves, like loose pants or a jacket.

- Draws a circle when you show them how.

- Speech all understandable

- Interactive play

48 Months

Physical & Movement	Cognitive	Communication/Language	Social & Emotional

- Holds pencil or crayon between fingers and thumb, not a fist.
- Catches a large ball most of the time.

- Draws a person with three parts
- Tells what comes next in a well-known story.
- Names four colours

- Talks about at least one thing that happened during their day, like "I played soccer!".
- Answers simple questions like, "What is a coat for?" or "What is a coat for?".

- Pretends to be something else during play (teacher, superhero, dog).
- Asks to go play with children, if none are around, like "Can I play with Alex?".
- Avoids danger, like not jump from tall heights.

60 Months

Physical & Movement	Cognitive	Communication/Language	Social & Emotional

- Hops on one foot.

- Counts to 10.
- Uses words about time, like "yesterday", "tomorrow" or "morning" and "night".
- Pays attention for 5 to 10 minutes during activities (e.g., during story telling time or making arts and crafts)

- Tells a story they heard or made up with at least two events
  e.g., a cat was stuck in a tree and a man saved it.

- Follows rules or takes turns when playing games with other children.
- Sings, dances or acts for you.

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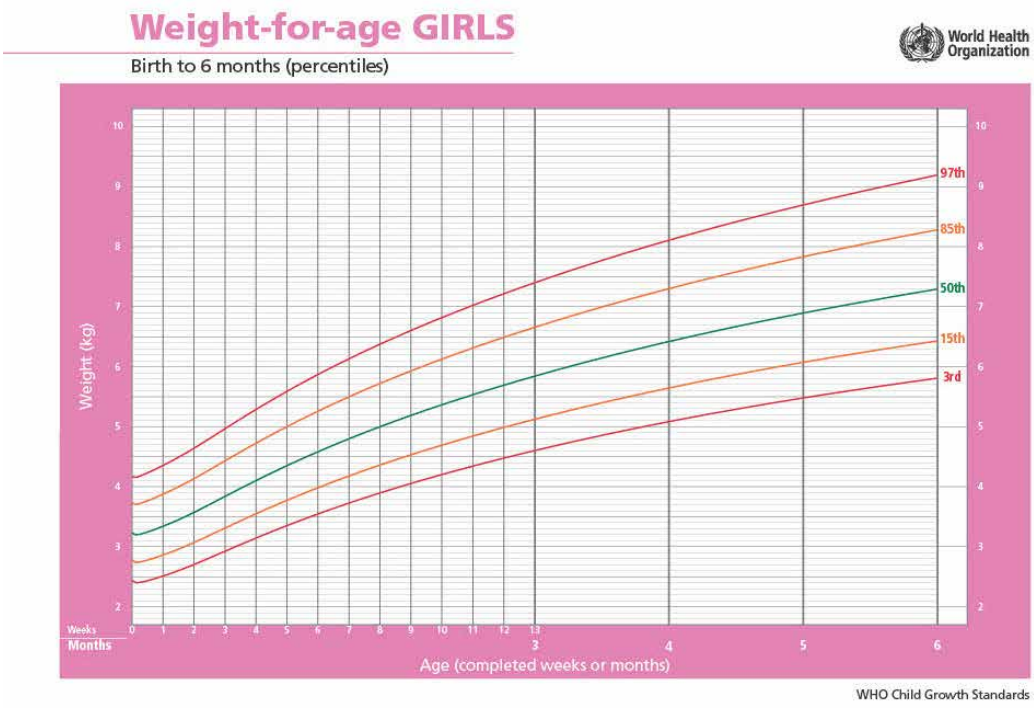
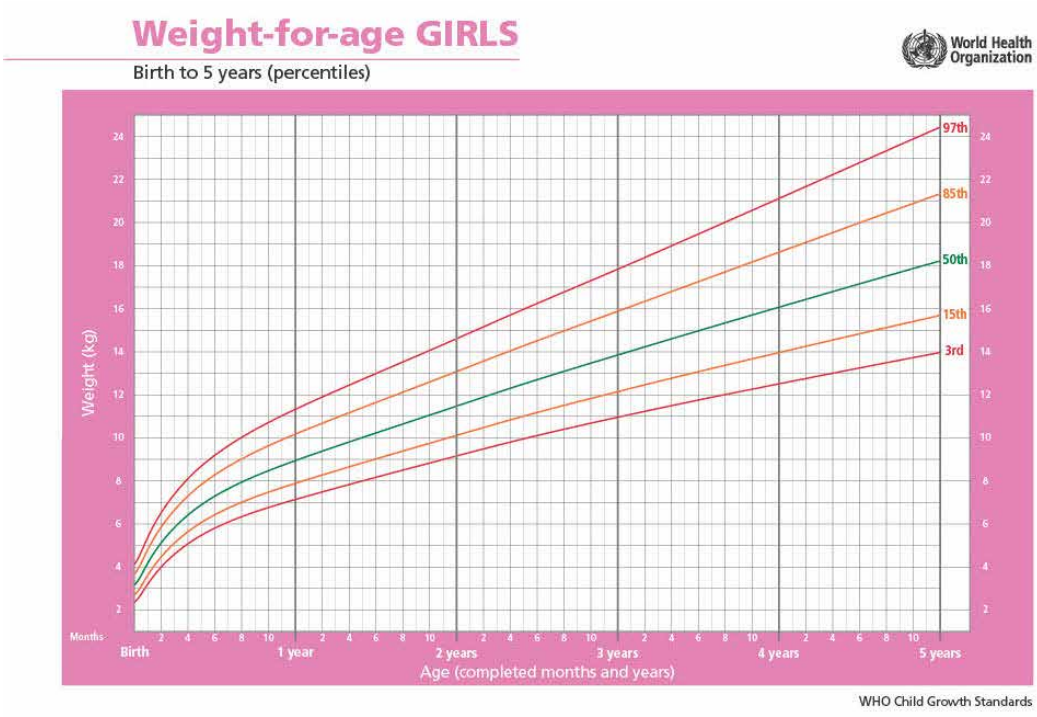
Appendix 2. WHO growth charts for children

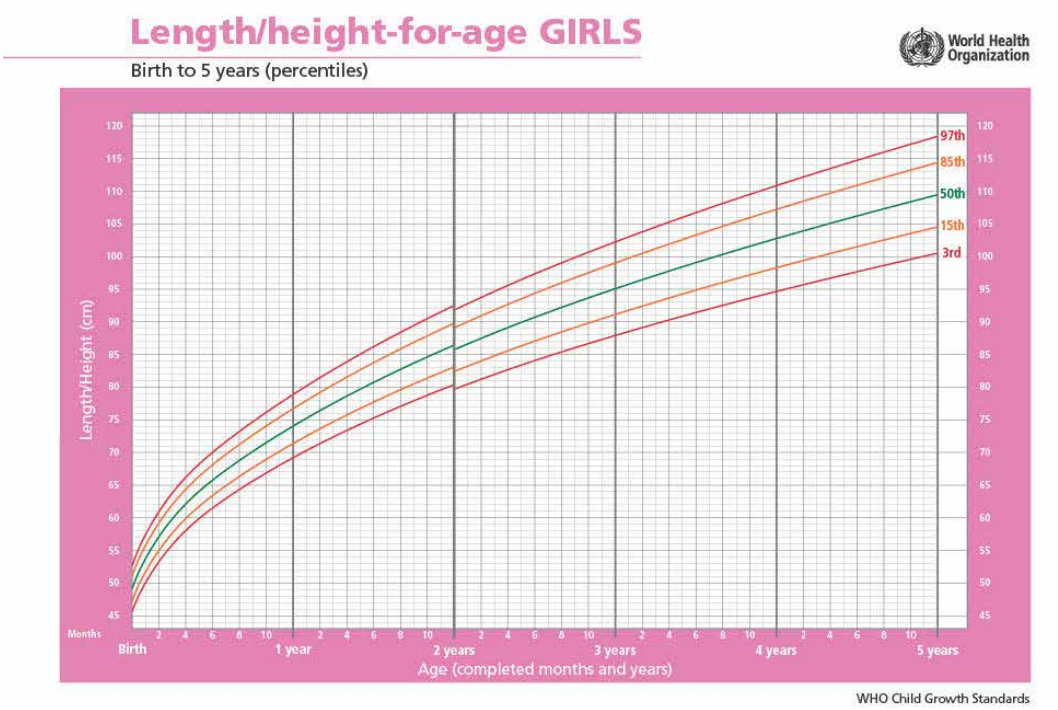
Full list of growth standards available to download at https://www.who.int/tools/child-growth-standards/standards.

2.1 Weight for age – girls (birth to 6 months and birth to 5 years)

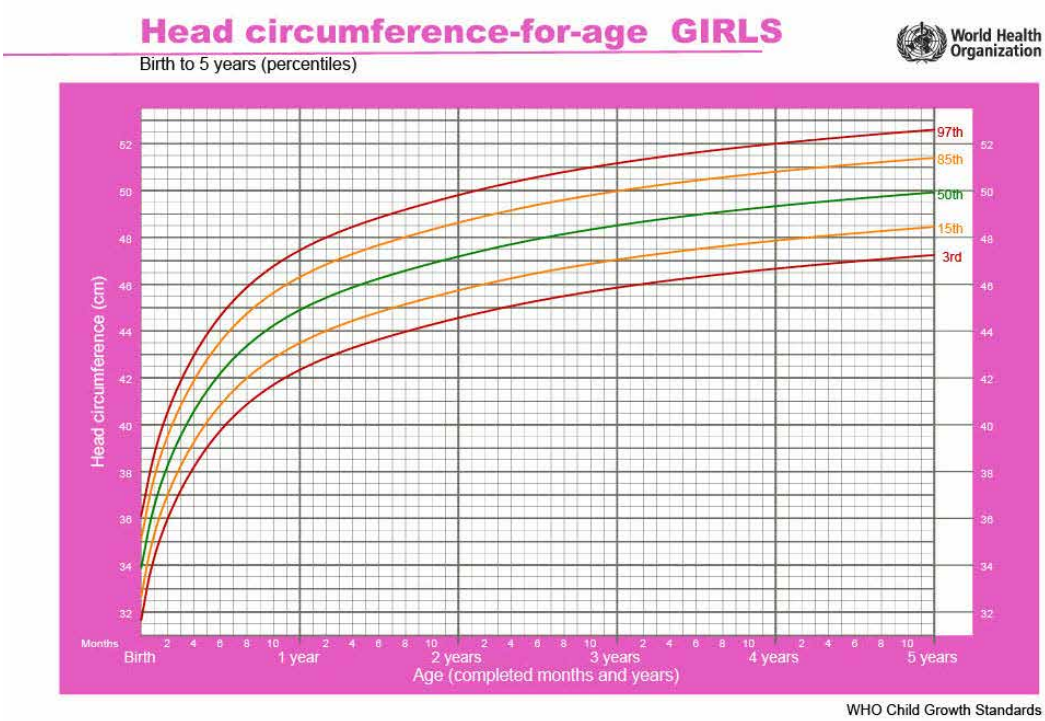




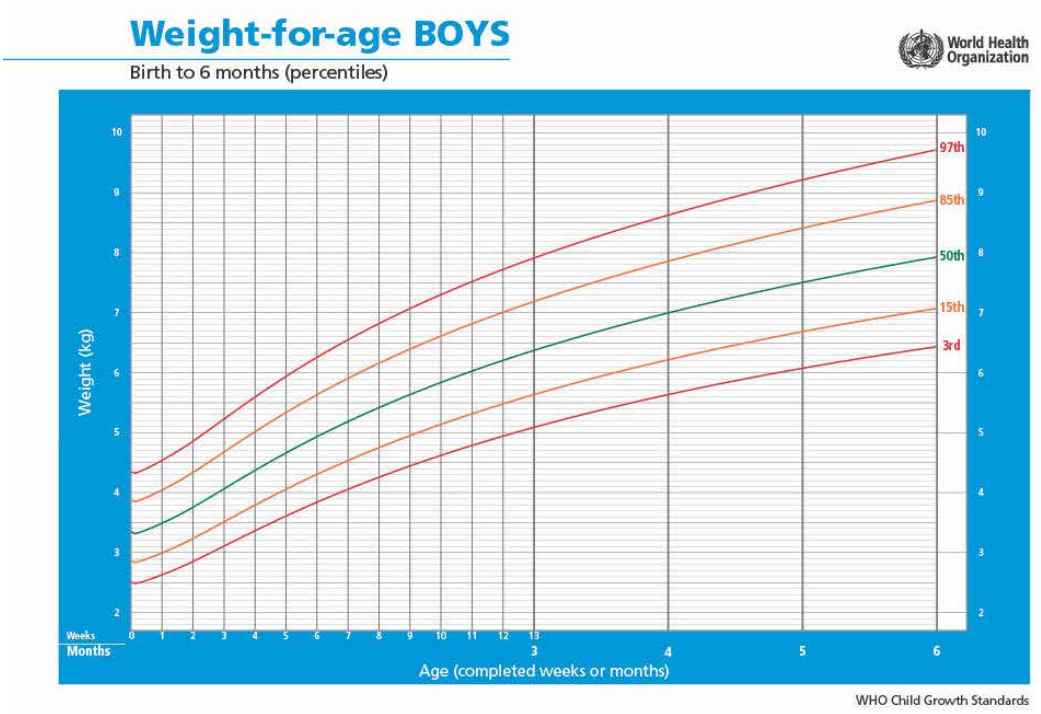
2.2 Length/height for age – girls (birth to 5 years)

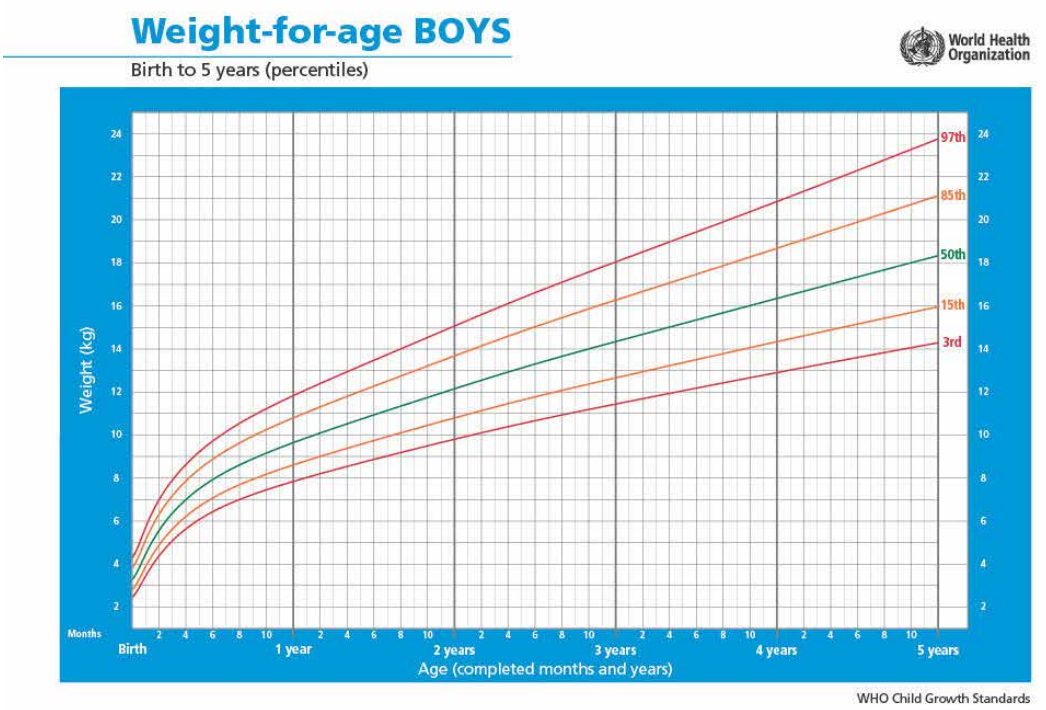


2.3 Head circumference for age – girls (birth to 5 years)

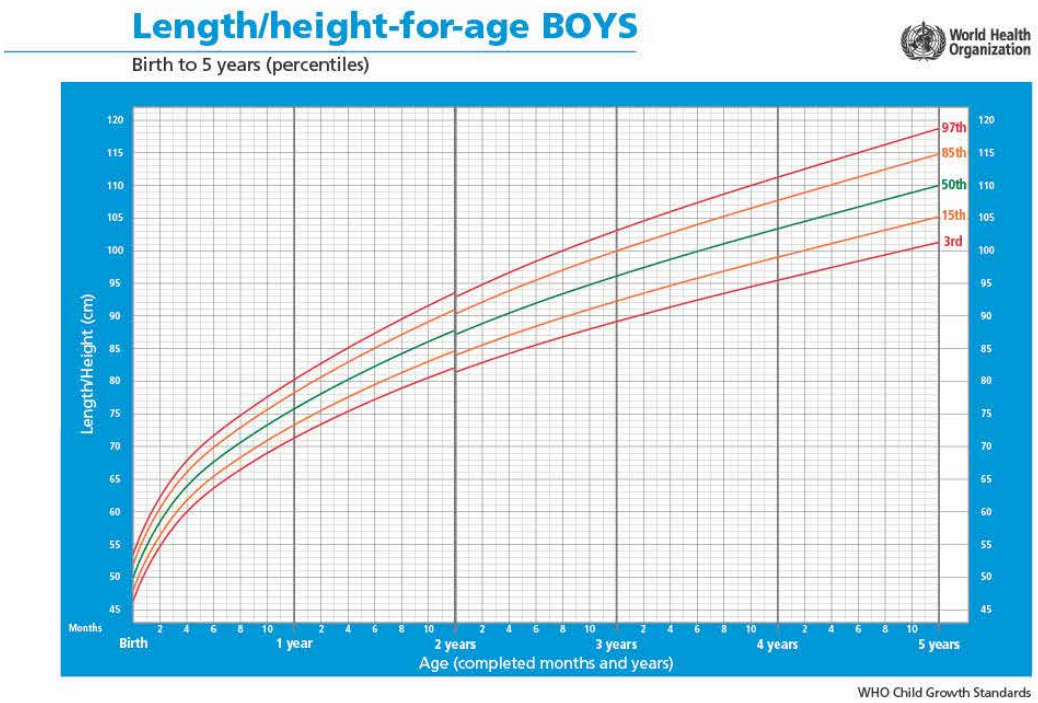


2.4 Weight for age – boys (birth to 6 months and birth to 5 years)

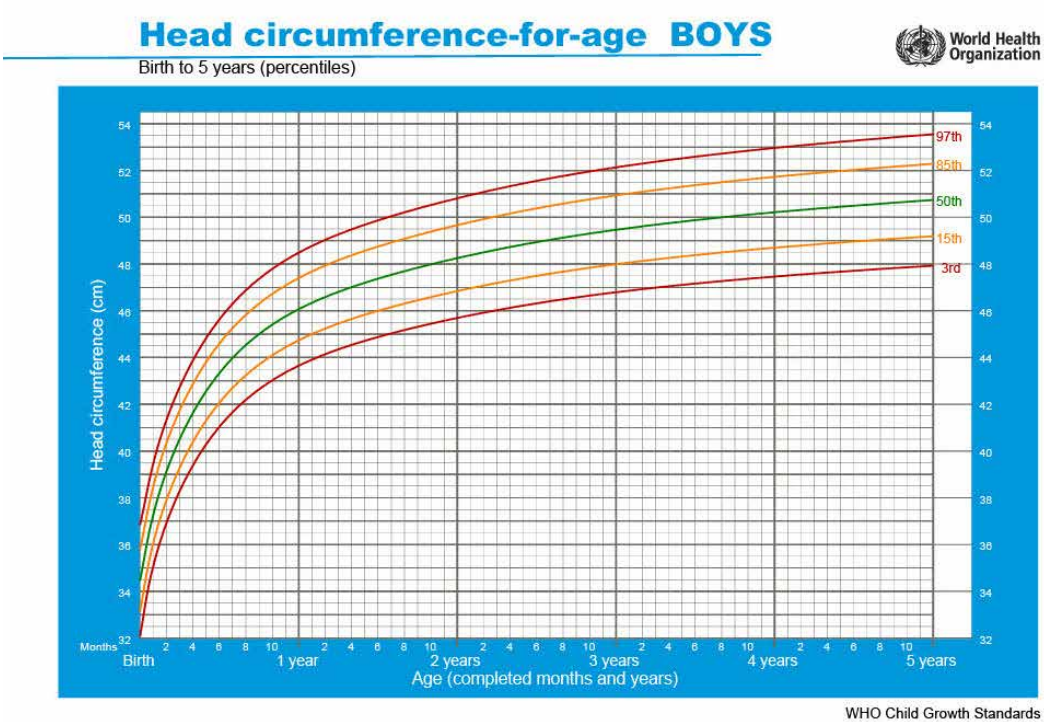




2.5 Length/height for age – boys (birth to 5 years)



2.6 Head circumference for age – boys (birth to 5 years)



Appendix 3. Paediatric vital signs

Respiratory and heart rate

Normal respiratory rate and heart rate for children according to age

Age	Respiratory rate Normal range (breaths/min)	Heart rate Normal range (beats/min)
< 2 months	30-60	100-160
2 to 11 months	30-50	90-160
1 to 5 years	25-40	80-140
6 to 12 years	20-30	70-120
> 12 years	14-20	60-100

Temperature and oxygen saturations

Thresholds for temperature and oxygen saturations for children

Temperature (°C)			Oxygen saturation Normal range %
Location	Fever	Hypothermia	
Axillary	> 37.5	< 35	$SpO_2 \geq 92\%$
Core	> 38	< 35.5	

AVPU

AVPU to assess level of consciousness in children[a]

A	Alert
V	Voice: responds to vocal stimuli
P	Pain: responds to painful stimuli[b]
U	Unresponsive

a Blantyre and Glasgow Coma Scales can also be used to assess conscious level in children but are more complex and less useful in emergency situations (see Appendix 13).

b A painful stimulus can be given by applying supra-orbital pressure at the supraorbital notch or by applying pressure to the nailbed.

AVPU is used for emergency assessment of neurological status as it is a quick and simple tool. It is used to screen for any deviation from normal level of consciousness. Any score below 'A' is abnormal and should prompt a more detailed neurological assessment and evaluation of conscious level e.g. Glasgow Coma Scale (see Appendix 13). Scores of 'P' or 'U' indicate coma.

Blood pressure

Normal blood pressure for children according to age[c]

Blood pressure (mmHg)			
Age	**Systolic (50^{th} to 90^{th} percentile for age)**	**Diastolic (50^{th} to 90^{th} percentile for age)**	**Systolic hypotension**
1 to 11 months	72-104	37-56	< 70
1 to 2 years	86-104	40-61	< 70 + (age in years x 2)
3 to 5 years	89-108	46-68	
6 to 8 years	93-111	55-72	
9 years	97-112	59-74	
10 to 11 years	98-116	59-75	< 90
12 to 15 years	103-129	61-80	

c BP ranges correspond to an average of male and female data for children with height between 25^{th} and 75^{th} centile for age. Data adapted from Tables 4 and 5 of reference:

Flynn JT, Kaelber DC, Baker-Smith CM, et al. Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents. Pediatrics. 2017;140(3):e20171904. https://doi.org/10.1542/peds.2017-1904

Appendix 4. Oropharyngeal airway insertion

An oropharyngeal airway can be used in an unconscious child to lift the tongue and pharyngeal soft tissues off the posterior pharynx to maintain a patent airway.

To choose the correctly sized oral airway, hold it along the side of the child's face with the flange at the corner of the mouth (Figure 4.1). The tip of the airway should reach the angle of the mandible. It should be inserted in the same direction as its final position, using a tongue depressor to push the tongue to the floor of the mouth to avoid pushing the device into the base of the tongue. Once in place, it allows air to flow into the airway unobstructed (Figure 4.2).

Figure 4.1 - Sizing of oropharyngeal airway

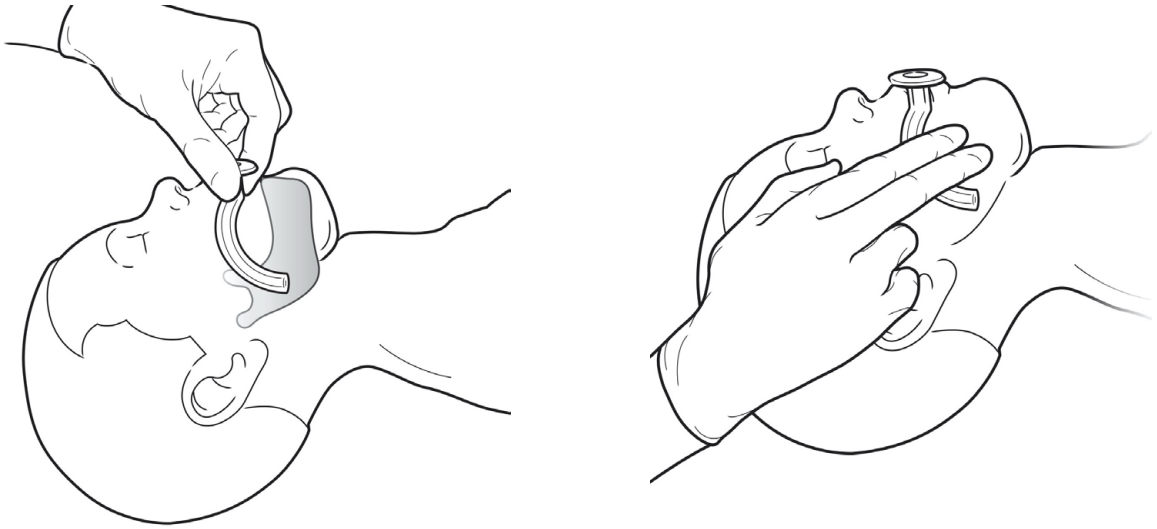
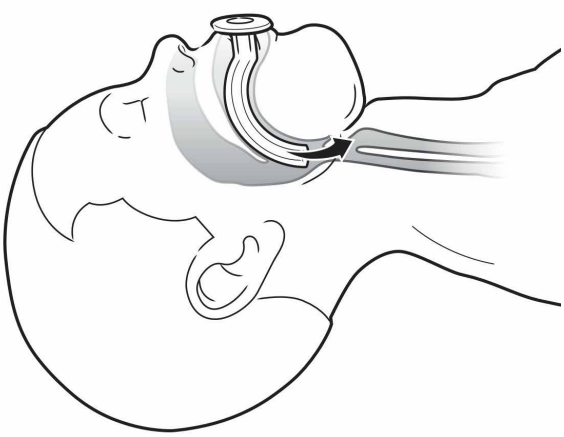


Figure 4.2 - Position and airflow of oropharyngeal airway



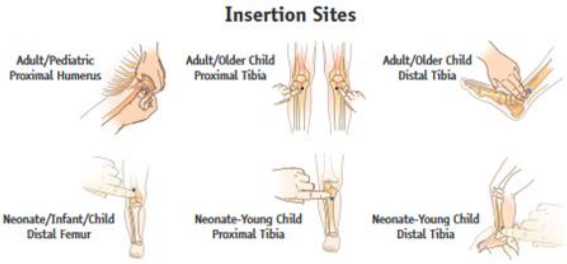
Appendix 5. Intraosseous needle insertion

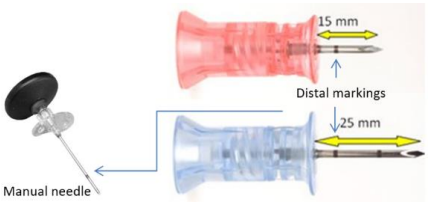
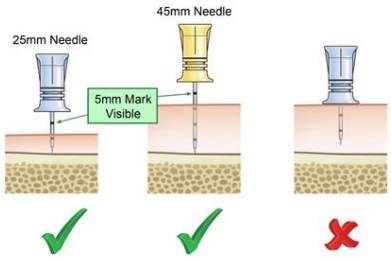
Copied with permission from MSF Manual of Nursing Care Procedures, SOP – Intraosseous Needle: Insertion.

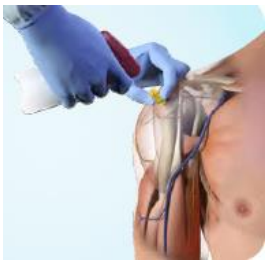
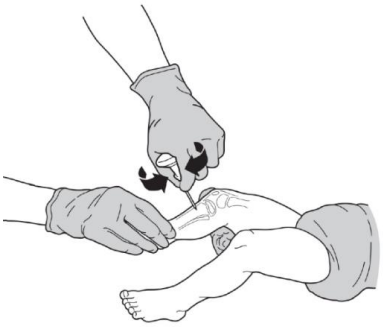
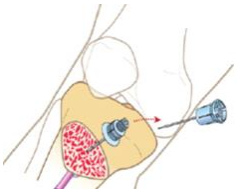
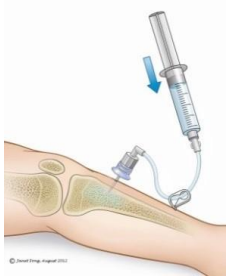
MSF Library of Nursing Resources

SOP - Intraosseous Needle: Insertion

Refer to the full *procedure Intraosseous Needle- Insertion, fixation and maintenance, removal* for rational and additional information on each step

	Pre-procedure
	1. Perform hand hygiene
	2. Confirm the patient's identity
	3. Explain procedure to patient or caregiver in their preferred language and why they require the procedure and the benefits and risks of receiving it. Allow the patient/caregiver to ask questions and obtain verbal consent
	4. Ensure the patient does not have any known allergies to medications
	5. Provide privacy
	6. Perform hand hygiene
	7. Assess the patient and the patient's limbs to determine: a. what location to use b. what size of intraosseous needle to use In adults there are three appropriate insertion sites: the proximal humerus, proximal tibia and distal tibia. In neonatal/paediatric patients, there are three appropriate insertion sites; the proximal tibia (preferred), the distal tibia and the distal femur. In newborns, an umbilical line should be first attempted. 
	8. Perform hand hygiene
	9. Clean/disinfect tray/trolley and intraosseous drill and allow to dry
	10. Gather remaining equipment on dry tray/trolley: a. For **drill** insertion: i. Intraosseous drill ii. EZ-IO intraosseous needle The EZ-IO drill has 2 needle sizes: paediatric : 15 mm long, pink (3 kg to 39 kg) paediatric and adult : 25 mm long, blue (more than 39kg) iii. L-shaped EZ-CONNECT extension tubing for motorized insertion iv. EZ-IO stabilizing dressing for motorized insertion v. Non-sterile gloves b. OR for **manual** insertion: i. Intraosseous needle with trocar for manual insertion ii. Extension tubing for manual insertion iii. Sterile gauze and clear adhesive iv. Sterile gloves c. Flush(s): i. 0.9% sodium chloride ii. 19G needle(s)

	iii. 10ml syringe(s) d. 5ml syringe to attempt aspiration e. 5ml syringe if drawing blood f. Antiseptic skin solution g. Alcohol-based hand rub h. Detergent/disinfectant for surfaces i. Sharps container j. Waste bin(s)
	11. Obtain assistance if needed
	Procedure
	12. Perform hand hygiene
	13. Using a non-touch technique, draw up 10ml of 0.9% sodium chloride into the syringe Prime the appropriate extension tubing with 0.9% sodium chloride. Leave the syringe attached to the extension tubing and place on general aseptic field
	14. **If using a drill,** using a non-touch technique, connect the needle set to the driver on the powered drill, leaving the needle cap on until ready to insert
	15. Relocate the insertion site of the needle by palpating the anatomical landmarks
	16. Perform hand hygiene a. **For drill insertion**: apply non-sterile gloves b. **For manual insertion**: apply sterile gloves
	17. Disinfect the skin in a back and forth, up and down movement for 30 seconds with appropriate antiseptic. ALLOW TO AIR DRY Do NOT re-palpate the area for insertion
	18. Stabilize the limb of the insertion site
	19. Remove the needle cap and identify the black needle markings The needle needs to be long enough so that the distal mark on the needle is visible once the needle is inserted into the skin. 
	20. Place the needle at a 90° angle from the bone and insert the intraosseous needle with a rotating mechanism through the skin/subcutaneous tissue until bone is reached. Then **STOP** 

	21. **If using a drill:** Press the driver trigger whilst applying minimal pressure, driving through the bone until a 'give' is heard or felt Release the driver trigger when the proximal mark on the needle is level with the skin Remove the power driver from the needle set while stabilizing the needle hub 
	22. **If using a manual intraosseous needle:** Elevate elbow so that it is in line with the needle and grasp the needle in the palm of the dominant hand, index and middle fingers approximately 2 cm from the tip. Ensure the bevel is facing towards the foot. Use a screwing motion applying steady downward Pressure perpendicular to bone but slightly away from the physeal (or growth) plate and advance the needle into the bone until a 'give' is heard or felt 
	23. Remove the stylet by holding the plastic base of the needle hub with one hand whilst turning the upper part of the needle counter clockwise. The catheter should feel secure in the bone. 
	24. Safely discard of stylet in a sharps container
	25. Using a non-touch technique, connect the 5ml syringe and aspirate 0.5-1ml of bone marrow. If needed, withdraw blood for blood sampling. Disconnect the 5ml syringe and attach 10ml syringe primed with 0.9% sodium chloride.
	26. Flush with 1-2 mL of 0.9% of sodium chloride. If no tissue swelling observed flush with 0.9% of sodium chloride: • 3ml in neonates • 5-10ml in paediatrics • 10 ml in adults
	27. Disconnect the 10ml syringe access as needed using a non-touch technique
	28. Clean and dry surrounding skin, if bloody or wet from insertion, then apply a stabilizing dressing with a transparent adhesive using a non-touch technique **CAUTION**: The stabilizer dressing must be applied before the extension set. The stabilizer dressing will not fit over the extension line. 

	Post-procedure
	29. Ensure all sharps are disposed of in a safety box and other waste disposed of correctly according to local procedures
	30. Remove gloves and clean/disinfect tray/trolley and motorized drill, if used
	31. Perform hand hygiene
	32. Document in the patient's file: a. date and time of insertion, The intraosseous vascular access can only remain in site for a **maximum of 24 hours or for 8 hours in neonates**. It is recommended to write the date and time of insertion on the dressing for appropriate monitoring of the site. b. size and length of the needle, c. number of attempts, d. location of the device, e. whether it was a manual or drill insertion f. the name of the healthcare worker who inserted the needle

Intraosseous Needle: Insertion_SOP_v1.0-2021

Appendix 6. Performing a lumbar puncture

A lumbar puncture (LP) is a relatively simple and safe procedure, but it is frightening for most children and their parents/carers. Be sure to explain the procedure and urgent indications to the parent/carer and provide reassurance to both the child and parents/carers.

LP is indicated to confirm a diagnosis of meningitis or encephalitis and should only be performed if a laboratory is available and capable of analysing any cerebrospinal fluid (CSF) collected for microscopy and biochemistry as a minimum. If available, culture and GeneXpert should also be performed. LP should only be carried out by a clinician trained to do so.

Treatment with antibiotics should not be delayed in order to perform an LP. Ideally an LP should be performed before antibiotic administration but if there are any contraindications or if performing the procedure is likely to delay antibiotic administration by more than 30 minutes, administer antibiotics first. Results of an LP performed up to 2-3 days after antibiotic administration can still be useful.

Contraindications

Ensure that there are no contraindications to LP and that consent has been obtained from the patient or parent/carer.

Contraindications to LP are:
- Severe cardiopulmonary instability that potentially requires prompt resuscitation measures (e.g. shock)
- Obvious signs of increased intracranial pressure (ICP), other than bulging fontanelle: decerebrate or decorticate posturing, absent doll's eye reflex, abnormal respiratory pattern, unequal pupil size or dilatation of pupils
- Focal neurological signs
- Focal seizures or seizures within the last 30 minutes
- Bradycardia, hypertension
- Obvious bleeding disorder and/or low platelet count (< 80 000 platelets/microlitre)
- Skin infection over the site for LP

Equipment

You will need two people to perform this procedure – one trained clinician to carry out the LP, and one assistant to hold the child in the correct position.

Equipment includes:
- Spinal needle for LP, 22 G (0.7 x 40 mm)
- Antiseptic solution for skin
- Sterile gloves
- Surgical mask
- 4 x 4 sterile compresses
- Lidocaine 1% (without epinephrine)
- Tubes for collection of CSF (non-sterile red-top blood tubes can be used if you are not obtaining a CSF culture).

Analgesia and anaesthesia

Give prophylactic analgesia before carrying out a lumbar puncture, which can be a painful and uncomfortable procedure. Non-pharmacological measures should be used for all children, regardless of age, in addition to analgesia. Local anaesthesia should be used in children older than 3 months to numb the area e.g., lidocaine. If the LP is planned and non-emergent, local anaesthetic cream e.g. EMLA can be used, if available. See Chapter 15, Section 15.4.6 for details of pre-procedure analgesia.

Positioning

The most important determinant of a successful lumbar puncture is how well the child is held. Ensure that the child is held firmly enough to keep them still but comfortable. The spine should be curled as much as possible to open the vertebral spaces, with attention to avoid over-flexion of the neck which can cause respiratory compromise. Watch the patient carefully to ensure that their breathing remains regular and calm. Monitor oxygen saturations throughout the procedure.

Young children should be held lying down (Figure 6.1), while an older child can be held either lying down or sitting up (Figure 6.2). Feel for the posterior-superior iliac crests on each side and visualise an imaginary line running between the iliac crests – this line intersects the spine at approximately the fourth lumbar vertebrae (L4). Feel for the intervertebral spaces of L3-4 and L4-5 and mark the chosen space by pressing the fingernail lightly into the skin overlying the space to leave a small indentation.

Figure 6.1 - Positioning and holding a child on their side for LP

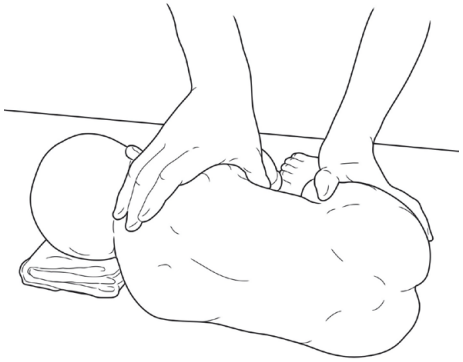
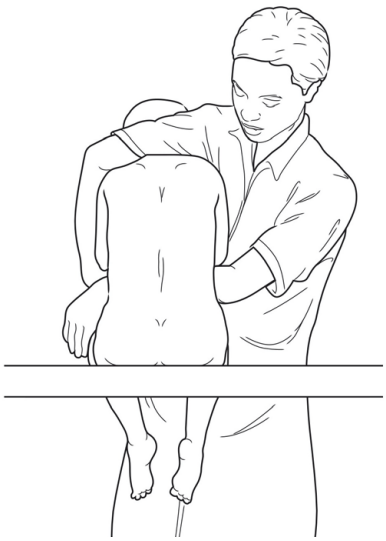


Figure 6.2 - Positioning and holding an older child sitting up for an LP



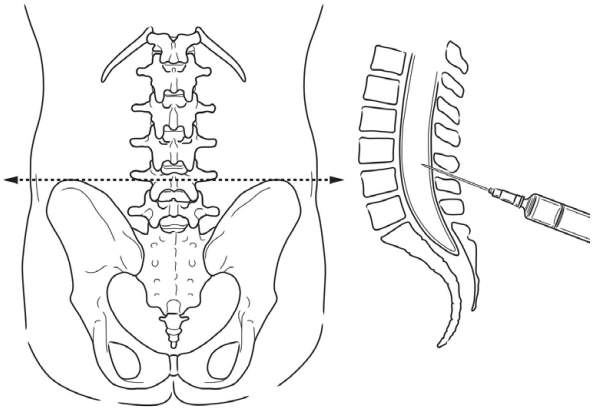
Procedure

Wash and disinfect your hands with an alcohol-based solution. Put on sterile gloves and take standard precautions. Disinfect the insertion site in a large circular motion from centre to periphery using antiseptic solution. Carefully palpate again the chosen intravertebral space (either L3-4 or L4-5) without touching any non-sterilised skin. Administer local anaesthetic (see Chapter 15, Section 15.4.6).

Needle insertion and CSF collection

- Hold the needle in your dominant hand.
- Advance the needle slowly through the spinous ligaments, aiming slightly towards the umbilicus (see Figure 6.3).
- Once a slight "pop" is felt, remove the stylet slowly.
- Place the stylet on a sterile surface for later reinsertion.
- Let CSF drip out slowly and collect 1–2 mL, according to laboratory capabilities.
- If no CSF comes out, rotate the needle slowly; if there still is no CSF, reinsert the stylet and advance very slowly (1 mm) and repeat the procedure.
- Note the pressure, colour, and clarity of the CSF flow.
- Once CSF has been collected, replace the stylet prior to removing the needle.
- Apply compression to the area and apply a small protective dressing.

Figure 6.3 - Needle insertion for LP



Monitoring

Monitor the child for 1–3 hours post-procedure. Vital signs, including AVPU, should be taken immediately post-procedure and then as often as required using an early warning system (see MSF Manual of Nursing Care Procedures, Assessment and vital signs, Charts: Vital sign charts). Ensure the sterile dressing is in place, clean and intact. The dressing should stay on at least for 48 hours. The child should lie down for few hours after the procedure, then can remain in a position of comfort. They should not be too active (no running, jumping, dancing, excitement), but movement is not limited. Advise the parent/carer to call for help if any of the following occur: fever, altered level of consciousness or abnormal behaviour, headache, nausea/vomiting.

Complications of lumbar puncture

- Headache: most common, minimised by having the child lie down after the procedure.
- Cerebral herniation: most serious complication, it can occur when LP is performed in a patient with raised ICP. Most cases occur within the first 12 hours after LP.
- Infection: meningitis can be induced if the LP is performed through a soft tissue infection at the site of puncture or if unsterile equipment/procedure is used.

Appendix 7. Clinical Respiratory Score (CRS)

The Clinical Respiratory Score (CRS) is a simple scoring system that can be used to guide the assessment of respiratory distress and response to treatment. Based on the total score obtained, the child can be classified as having mild, moderate or severe respiratory distress.

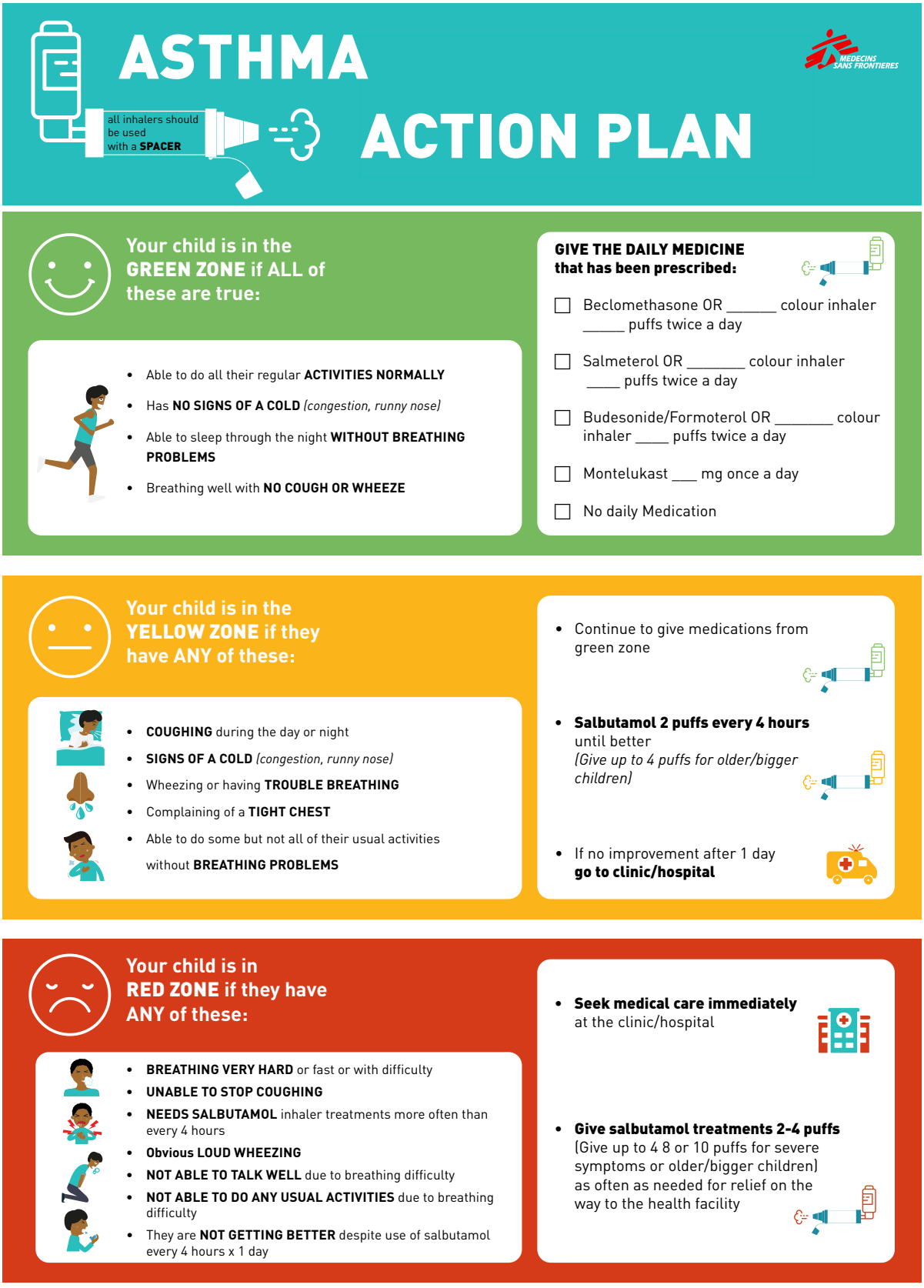
Clinical Respiratory Score (CRS)[1,2]

Assess	Score 0	Score 1	Score 2
Respiratory rate (breaths/minute)	Age < 2 months: < 50 Age 2-11 months: < 40 Age 1-5 years: < 30 Age > 5 years: < 20	Age < 2 months: 50-60 Age 2-11 months: 40-50 Age 1-5 years: 30-40 Age > 5 years: 20-30	Age < 2 months: > 60 Age 2-11 months: > 50 Age 1-5 years: > 40 Age > 5 years: > 30
Auscultation	Good air movement, expiratory scattered wheezing or loose rales/ crackles	Depressed air movement inspiratory and expiratory wheezes or rales/crackles	Diminished or absent breath sounds, severe wheezing or rales/ crackles or marked prolonged expiration
Use of accessory muscles	Mild to no use of accessory muscles, mild to no retractions or nasal flaring on inspiration	Moderate intercostal retractions, mild to moderate use of accessory muscles, nasal flaring	Severe intercostal and subcostal retractions, nasal flaring
Mental status	Normal to mildly irritable	Irritable, agitated, restless	Lethargic
Room air SpO_2	> 95%	90-95%	< 90%
Colour	Normal	Pale to normal	Cyanotic, dusky

Based on the total score obtained, 3 categories of respiratory distress are possible:
Mild (≤ 3), **Moderate (4-7)**, **Severe (8-12)**

1. Nayani K, Naeem R, Munir O, et al. The clinical respiratory score predicts paediatric critical care disposition in children with respiratory distress presenting to the emergency department. *BMC Pediatr.* 2018;18(1):339. https://doi.org/10.1186/s12887-018-1317-2
2. Asthma/Recurrent Wheezing Clinical Guideline | Clinical Standards | Texas Children's Hospital. Texas Children's Hospital. Published January 2019. Accessed November 20, 2023. https://www.texaschildrens.org/sites/default/files/uploads/documents/outcomes/standards/AcuteAsthma.pdf

Appendix 8. Asthma action plan



Appendix 9. How to make a spacer with a plastic bottle

Copied with permission from MSF Manual of Nursing Care Procedures, Annex – How to make a spacer with a plastic bottle.

MSF Manual of Nursing Care Procedures

How to make a spacer with a plastic bottle

Annex n 1 – Medication by inhalation using a spacer

If no commercially produced spacer available within the project, a plastic one can be made from a 500ml plastic bottle.

- Cut the bottom of the bottle.
- Wash the bottle in a solution of one drop of dishwashing soap in 1 L of potable water to reduce the electrostatic charge within the plastic spacer. Do NOT rinse and let air dry. Not rinsing improves medication delivery of the spacer.
- Once air dried, tape the end to make the edges smooth before applying to the patient's face.
- Adapt the MDI to the nozzle of the bottle with tape.
- Prior to use, prime the spacer with two puffs of the medication to be delivered.

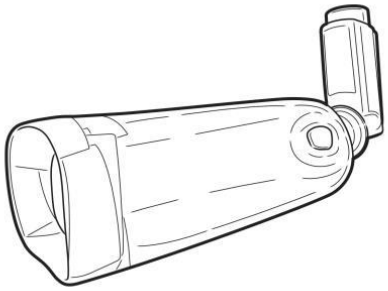


Figure 1: *Homemade spacer from 500ml plastic bottle*

Note that plastic spacers have electrostatic charges within the chamber that attract particles and significantly reduce medication delivery to the lungs.

A very similar process can be followed for producing a plastic spacer with mouthpiece.

- Wash the bottle in a solution of one drop of dishwashing soap in 1 L of potable water to reduce the electrostatic charge within the plastic spacer. Do NOT rinse and let air dry. Not rinsing improves medication delivery of the spacer.
- Once air dried, prepare an opening with the same shape and size of the MDI connection at the end of the bottle
- Adapt the MDI to the opening with tape.
- Prior to use, prime the spacer with two puffs of the medication to be delivered.

Figure 2: *Homemade spacer from 500ml plastic bottle*

Note that plastic spacers have electrostatic charges within the chamber that attract particles and significantly reduce medication delivery to the lungs

Annex 1 – Medication by inhalation using a spacer_v1.0-2020

Appendix 10. Inhaler technique using a spacer

Copied with permission from MSF Manual of Nursing Care Procedures, SOP – Medication administration by inhalation using a spacer.

MSF Manual of Nursing Care Procedures

Medication administration by inhalation using a spacer

***SOP** – Please refer to the full procedure for rational and additional information on each step*

	Pre-procedure
	1. Perform hand hygiene
	2. Confirm the patient's identity
	3. Explain procedure to patient or caregiver, ensuring the patient/caregiver understands why he/she is receiving the treatment, the risks and benefits of receiving the medication and what the possible side effects are. Allow patient/caregiver to ask questions and obtain verbal consent
	4. Ensure the patient does not have any known allergies to medications
	5. Perform any necessary assessment before administration of medication
	6. Perform hand hygiene
	7. Clean/disinfect tray/trolley and allow to dry
	8. Verify the prescription and ensure: a. The right patient b. The right medication c. The right dose and dilution d. The right route e. The right date and time f. The prescription is valid (legible and signed) g. The medication has not already been administered h. The medication is appropriate for the patient's condition
	9. Gather equipment on dry tray/trolley: a. Medication to be administered in an inhaler form b. Spacer with face mask OR with mouthpiece c. Alcohol-based hand rub d. Nurses watch or a clock with a second hand e. Waste bin (s)
	Procedure
	10. Perform hand hygiene
	11. Confirm the patient's identity and check that it matches the medical prescription
	12. Position patient upright in a sitting position
	13. If necessary, clear the upper airways by asking the patient to blow his/her nose or clearing the patient's nose
	14. Remove mouthpiece cover from inhaler and shake the inhaler well for 2-5 seconds
	15. Insert the inhaler upright into the spacer
	16. Ask the patient to create a seal with their mouth over the mouthpiece or ensure that the mask covers the nose and mouth and apply gently to the face to create a seal
	17. Ask the patient to slightly tilt their head backwards while inhaling slowly and deeply. Press down on the canister to deliver the medication
	18. If possible, the patient should hold his/her breath for 10 seconds and then breathe out. If this is not possible, follow the next step
	19. If patient unable to hold breath, instruct the patient to breathe normally for 4-6 breaths
	20. If more than one dose/puff is needed, wait 30 seconds while the patient breathes normally, shake the inhaler and repeat steps 16-19

	21. If mask used, wipe patient's face after administration
	22. If the medication administered was a corticosteroid, ensure the patient rinses his/her mouth with water 2 minutes after administration
	Post-procedure
	23. Perform hand hygiene
	24. Take apart the spacer, clean the mouthpiece or facemask and spacer and allow to air dry
	25. Document administration and assessment findings in the patient's file
	26. Follow-up patient
	27. If the patient is going to be followed as an outpatient, ensure sufficient time for patient education, (offer appropriate tools and allow the patient/caregiver to ask questions)

Medication administration by inhalation using a spacer_v1.0-2020

Appendix 11. Sputum specimen collection in children

Selected relevant parts copied from Appendix 3, MSF Tuberculosis Guidelines.

Appendix 3. Collection, storage, and shipment of respiratory specimens

3.1 Respiratory specimen collection

Staff members (and attendants if necessary) present during sputum collection or collection of any other respiratory specimen should wear a respirator to prevent bacilli inhalation.

When a patient cannot expectorate spontaneously, respiratory specimens can be obtained by sputum induction (in children and adults) or by nasopharyngeal or gastric aspiration (in children only). These procedures must be performed under close medical supervision and only if the specimen is collected for molecular tests, culture, or genome sequencing.

They should be well explained to the patient and the person accompanying them beforehand.

3.1.4 Sputum induction

Patients should be observed for respiratory distress (including SpO_2 monitoring) during the procedure and for 15 minutes after the procedure. Oxygen must be ready at hand (risk of bronchospasm).

Equipment

- Gloves
- Labelled sputum container
- Mask and tubing for nebulizer
- Holding chamber (spacer) with masks of different sizes (to be sterilised between each patient)
- Sterile hypertonic solution of 3 to 6% sodium chloride
- Sterile solution of 0.9% sodium chloride (for the specimen)
- Salbutamol metered dose inhaler
- Pulse oximeter and oxygen

Procedure

Patients should fast for at least 2 hours before the procedure to reduce the risk of vomiting and aspiration.

- Seat the patient comfortably. For young children, sit upright in an adult's arms.
- Give the patient the sputum container.
- Administer 200 micrograms (2 puffs) of salbutamol via a holding chamber, 10 minutes before nebulization.
- Fill the nebulizer with 5 ml of 3 to 6% hypertonic saline solution (sputum inducer).
- Place the nebulizer mask over the patient's mouth.
- Leave the patient to inhale until the reservoir is empty.
- Encourage the patient to cough and spit at any time if they feel to urge to do so.
- Collect at least 2 ml of sputum and close the container tightly.
- Terminate the procedure if unsuccessful after 15 minutes.

3.1.5 Nasopharyngeal aspiration

Equipment

- Gloves
- Suction catheter (CH6 for children 1-11 months; CH8 for children 1-10 years)
- 50 ml syringe or equipment for electric suction
- Sterile solution of 0.9% sodium chloride
- Labelled collection container

Procedure

Children should fast for at least 2 hours before the procedure to reduce the risk of vomiting and aspiration.

- Do 1 to 2 minutes of clapping.
- Clean out the nasal cavity with 0.9% sodium chloride.
- Lie the child on their back or side.
- Lubricate the end of the suction catheter.
- Put 2 drops of 0.9% sodium chloride into each nostril.
- Measure the distance from the tip of the nose to the angle of the jaw, which represents the depth to which the catheter should be inserted. Gently insert the suction catheter to this depth without applying suction.
- Once the catheter is in the posterior nasopharynx, suction with the 50 ml syringe or the electric suction device[a] and slowly pull out the catheter whilst suctioning.
- Collect 2 to 3 ml of respiratory secretions. If insufficient (< 2 ml), put 2 drops of 0.9% sodium chloride into each nostril, then suction on the other nostril.
- Close the container tightly.

3.1.6 Gastric aspiration

Equipment

- Gloves
- Nasogastric tube (CH6 for children 1-11 months; CH8 for children 1-10 years)
- 50 ml syringe
- Sterile water
- Labelled collection container

Procedure

Children should fast for 4 to 8 hours before the procedure. The specimen should be collected early in the morning in order to collect the sputum swallowed during the night.

- Place the child in a half-sitting or sitting position in the adult's arms.
- Insert a nasogastric tube and check that it is correctly placed.
- Suction with a 50 ml syringe.
- Collect 5 to 10 ml of gastric fluid. If insufficient (< 5 ml), rinse the stomach with 10 ml of sterile water and suction again.
- Close the container tightly.
- Start culture within 4 hours of collecting the specimen. If there will be more than 4 hours delay, neutralize with an equal volume of sodium bicarbonate.

a If an electric suction device is used, the suction pressure should be 80-100 mmHg for children 1-11 months; 100-120 mmHg for children 1-10 years.

Appendix 12. WHO rehydration plans A, B and C

WHO Plan A for no dehydration

Give **ORS** PO, 10 ml/kg after each loose stool to prevent dehydration:

Weight (kg)	< 5	5 to < 10	10 to 20	> 20
ORS (mL) to be given after each loose stool	50	100	200	300

WHO Plan B for some dehydration

Give **ORS** PO, 75 mL/kg over 4 hours:

Weight (kg)	< 6	6 to < 10	10 to < 12	12 to < 19	19 to < 30
Total ORS (mL) over 4 hours	200-400	400-700	700-900	900-1400	1400-2200
Volume of ORS per hour (mL/hr)	50-100	100-175	175-225	225-350	350-550

– In addition, give extra ORS to replace fluids lost with each loose stool according to plan A (above).
– Reassess degree of dehydration after 4 hours and continue with appropriate treatment plan. If dehydration has resolved, management with plan A can continue at home.

WHO Plan C for severe dehydration

Administer **Ringer lactate** IV (alternatively **sodium chloride 0.9%**), 100 mL/kg over 3 hours (or over 6 hours if < 12 months) as follows:

Age	First administer 30 mL/kg* over:	Then administer 70 mL/kg over:
< 12 months	1 hour	5 hours
≥ 12 months	30 minutes	2½ hours

* Repeat this volume if radial pulse remains weak or absent.

– As soon as the child is awake, alert, and can tolerate a nasogastric tube or take oral fluids, start **ORS** at 5 mL/kg/hour in addition to the ongoing IV fluid resuscitation and encourage breastfeeding (if relevant).
– In addition, if tolerated, give extra ORS to replace fluids lost with each loose stool according to plan A (above).
– Assess the degree of dehydration at the end of the fluid resuscitation (3 hours for children, 6 hours for infants). Continue further rehydration according to degree of dehydration following the appropriate treatment plan (A, B or C).

Appendix 13. Glasgow and Blantyre Coma Scales

13.1 Glasgow Coma Scale

The Glasgow Coma Scale (GCS) is widely used to assess brain injury and neurological status in children and adults. Young children should be assessed using an adapted version of the GCS which takes into account their relatively immature verbal and motor developmental level. There is no universally accepted Paediatric Glasgow Coma Scale and variations exist in practice. It is generally recommended that children 2 years and younger should use an adapted GCS, and children 5 years and older should use the conventional adult GCS. For children between the ages of 2 and 5 years (i.e. 3- and 4-year-olds), either scale can be used depending on their level of development and verbal abilities.

Both the GCS and Paediatric GCS have a minimum score of 3 and a maximum score of 15. It is useful to give a score for each criterion as well as the total score e.g. E4 + V3 + M5 = 12/15.

Table 13.1 - Paediatric Glasgow Coma Scale (infants and children ≤ 2 years old)

CRITERIA	BEST RESPONSE	SCORE
Eye opening response	Opens eyes spontaneously	4
	Opens eyes in response to speech/noise	3
	Opens eyes in response to painful stimulus*	2
	Does not open eyes	1
	TOTAL EYE OPENING SCORE	**_/4**
Verbal response	Coos, babbles, alert	5
	Irritable cries, but consolable	4
	Cries/wails in response to painful stimulus*, persistently irritable	3
	Moans in response to painful stimulus*, inconsolable	2
	No verbal response	1
	TOTAL VERBAL SCORE	**_/5**
Motor response	Moves spontaneously and purposefully	6
	Withdraws from touch	5
	Withdraws from painful stimulus*	4
	Abnormal flexion to painful stimulus* (decorticate response)	3
	Extension to painful stimulus* (decerebrate response)	2
	No motor response	1
	TOTAL MOTOR SCORE	**_/6**
	GCS TOTAL SCORE = E__+ V__+ M__	**__/15**

* A painful stimulus can be given by applying supra-orbital pressure at the supraorbital notch or by applying pressure to the nailbed.

Table 13.2 - Glasgow Coma Scale

CRITERIA	BEST RESPONSE	SCORE
Eye opening response	Opens eyes spontaneously	4
	Opens eyes in response to speech	3
	Opens eyes in response to painful stimuli*	2
	Does not open eyes	1
	TOTAL EYE OPENING SCORE	**_/4**
Verbal response	Orientated, words or sentences to usual ability	5
	Confused, disorientated, words or sentences less than usual ability	4
	Inappropriate words	3
	Incomprehensible sounds, moaning	2
	No verbal response	1
	TOTAL VERBAL SCORE	**_/5**
Motor response	Obeys commands	6
	Localises painful stimuli	5
	Flexion withdrawal to painful stimuli*	4
	Abnormal flexion to painful stimuli* (decorticate response)	3
	Extension to painful stimuli* (decerebrate response)	2
	No motor response	1
	TOTAL MOTOR SCORE	**_/6**
	GCS TOTAL SCORE = E__+ V__+ M__	**__/15**

* A painful stimulus can be given by applying supra-orbital pressure at the supraorbital notch or by applying pressure to the nailbed.

Interpretation of GCS and Paediatric GCS score

Score 13-15 Mild brain injury/insult

Score 9-12 Moderate brain injury/insult

Score 3-8 Severe brain injury/insult.

All patients with a score of ≤ 8 are in a comatose state while those with a score of 3 are in a deep coma and completely unresponsive.

13.2 Blantyre Coma Scale

The Blantyre Coma Scale is a modification of the original GCS, originally designed to measure coma in cerebral malaria. It is suitable for use in pre-verbal children and has a minimum score of 0 and a maximum score of 5.

Table 13.3 - Blantyre Coma Scale

CRITERIA	BEST RESPONSE	SCORE
Eye opening response	Watches or follows	1
	Fails to watch or follow	0
Verbal response	Cries appropriately with painful stimulus*, or, if verbal, speaks	2
	Moan or abnormal cry with painful stimulus*	1
	No vocal response to painful stimulus*	0
Motor response	Localises painful stimulus*	2
	Withdraws limb from painful stimulus*	1
	No response or inappropriate response	0
	TOTAL SCORE	**__/5**

* A painful stimulus can be given by applying supra-orbital pressure at the supraorbital notch or by applying pressure to the nailbed.

Interpretation of Blantyre Coma Scale score

5 Normal conscious level

3-4 Abnormal conscious level

< 3 Coma

0 Deep coma

Appendix 14. Urinary collection procedures

14.1 Midstream urine specimen collection

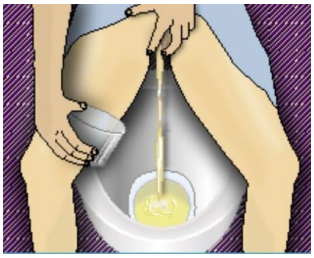
Copied with permission from MSF Manual of Nursing Care Procedures, SOP – Specimen Collection: Midstream Urine.

MSF Library of Nursing Resources

SOP - Specimen Collection: Midstream Urine

Refer to the full procedure *Specimen Collection – Urine* for rational and additional information on each step

	Pre-procedure
	1. Perform hand hygiene
	2. Confirm the patient's identity and check that it matches the medical request
	3. Explain procedure to patient or caregiver in their preferred language and why they require the procedure and the benefits and risks of receiving it. Allow the patient/caregiver to ask questions and obtain verbal consent
	4. Obtain a history of the illness
	5. Ask whether the patient/caregiver is able to collect the sample on their own
	6. Perform hand hygiene
	7. Clean/disinfect tray/trolley and bedpan or urinal and allow to dry
	8. Gather remaining equipment on dry tray/trolley: a. Urine collection pot b. Bedpan or urinal (if no latrine/toilet available) c. Soap and water or 0.9% sodium chloride d. Transport bag e. Non-sterile gloves (if patient requires assistance) f. PPE (according to risk assessment) g. Alcohol-based hand rub h. Detergent/disinfectant for surfaces i. Waste bin (s)
	9. Using a permanent marker, label the sample pot (on the container and not the lid) with: a. the patient's name (first and last name) b. date of birth c. patient identification number d. Date and time of collection
	Procedure
	10. Perform hand hygiene. If patient requires assistance, put on non-sterile gloves and other PPE
	11. Ask the patient/caregiver to wash their own hands before urine collection
	12. **If the patient can do the collection independently**, explain the procedure and collection process
	13. Allow the patient to use the latrine/toilet. If none are available, provide privacy and give the patient a bedpan or urinal
	14. Retract the foreskin (if patient male) or separate the labia (if patient female) and clean the skin surrounding the urethral meatus with soap and water or 0.9% sodium chloride
	15. Ask the patient to begin voiding first stream of urine into the toilet or bedpan/urinal

	16. Without interrupting the urine flow, place the urine container into the urine stream  
	17. Once the urine container is sufficiently full, allow the patient to continue voiding in the latrine/toilet or bedpan/urinal. Close the urine pot, touching only the outside
	18. Allow the patient to perform personal and hand hygiene
	19. If needed, transfer the urine from the urine pot into a labelled analysis tube
	Post-procedure
	20. If excess urine was collected in a bedpan/urinal/pot, dispose of urine correctly in the dirty utility (sluice room)/toilet or as per local procedure
	21. Clean/disinfect tray/trolley, urine pot and bedpan/urinal, if needed
	22. Remove non-sterile gloves/PPE and discard. Perform hand hygiene
	23. Put sample in a transport bag and ensure the laboratory request is filled by the treating clinician and completed by healthcare worker collecting the sample
	24. Follow local procedure for transportation of specimens to the laboratory
	25. Document in the patient's file: a. procedure date and time b. any urine observations c. volume of urine voided (if collected in bedpan/urinal) and if strict fluid balance is required

Specimen Collection: Midstream Urine_SOP_v1.0-2021

14.2 Urine collection bag

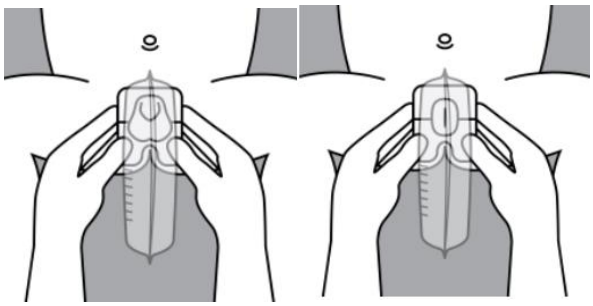
Copied with permission from MSF Manual of Nursing Care Procedures, SOP – Specimen Collection: Paediatric Urine Collection Bag.

MSF Library of Nursing Resources

SOP - Specimen Collection: Pediatric Urine Collection Bag

Refer to the full procedure *Specimen Collection - Urine* for rational and additional information on each step

	Pre-procedure
	1. Perform hand hygiene
	2. Confirm the patient's identity and check that it matches the medical request
	3. Explain procedure to patient or caregiver in their preferred language and why they require the procedure and the benefits and risks of receiving it. Allow the patient/caregiver to ask questions and obtain verbal consent.
	4. Obtain a history of the illness
	5. Provide privacy
	6. Perform hand hygiene
	7. Clean/disinfect tray/trolley and allow to dry
	8. Gather remaining equipment on dry tray/trolley: a. Non-sterile urine collection pot b. Urine collection bag (boy, girl or premature) c. Soap and water or 0.9% sodium chloride d. Transport bag e. Non-sterile gloves f. PPE (according to risk assessment) g. Alcohol-based hand rub h. Detergent/disinfectant for surfaces i. Waste bin (s)  Urine collection bags available in MSF male (left) female (right)
	9. Using a permanent marker, label the sample pot (on the container and not the lid) with: a. the patient's name (first and last name) b. date of birth c. patient identification number d. date and time of collection
	Procedure
	10. Perform hand hygiene. Apply non-sterile gloves and PPE
	11. Retract the foreskin (male) or separate the labia (female). Clean the skin surrounding the urethral meatus with soap and water or 0.9% sodium chloride and allow to dry.
	12. With the help of an assistant, keep the genitals exposed. Unwrap the bag and expose the adhesive on the bottom half of the urine bag.

	13. Apply the adhesive starting between the anus and the genitals and then over the genitals, ensuring there are no wrinkles.  Reapply nappy to help secure the bag in place.
	Post-procedure
	14. Ensure waste disposed of correctly according to local procedures
	15. Clean/disinfect tray/trolley
	16. Remove non-sterile gloves/PPE and discard. Perform hand hygiene.
	17. Check every 20-30 minutes if the patient has urinated to obtain fresh sample and avoid overfilling.
	18. Once 10-15 ml of urine in the bag, perform hand hygiene and apply non-sterile gloves/PPE
	19. Using a non-touch technique, carefully remove the bag from the skin and transfer sample into the urine pot and close the lid
	20. Remove non-sterile gloves/PPE and discard. Perform hand hygiene.
	21. Place sample in a transport bag and ensure the laboratory request is filled by the treating clinician and completed by healthcare worker collecting the sample
	22. Follow local procedure for transportation of specimens to the laboratory
	23. Document in the patient's file: a. procedure date and time b. any urine observations c. volume of urine collected, especially if strict fluid balance is required

Specimen Collection: Pediatric Urine Bag_SOP_v1.0-2021

14.3 In-out catheter specimen collection

Copied with permission from MSF Manual of Nursing Care Procedures, SOP - Intermittent Urinary Catheterisation.

MSF Library of Nursing Resources

SOP – Intermittent Urinary Catheterization

Refer to the full procedure *Urinary Catheterization* for rational and additional information on each step

	Pre-procedure
	1. Perform hand hygiene
	2. Confirm the patient's identity
	3. Provide privacy
	4. Explain procedure to patient or caregiver in his/her preferred language, including what the urinary catheter is for, why they require it and the benefits and risks of inserting one. Agree on a *stop signal* with the patient that can be used to indicate that he/she wishes to stop the procedure. Allow the patient/caregiver to ask questions and obtain verbal consent
	5. Ensure the patient does not have any allergies (including to latex)
	6. Ask the patient to perform peri-urethral cleaning with soap and water independently. If patient unable to do so, the caregiver or healthcare provider should perform the cleaning
	7. Perform hand hygiene
	8. Clean/disinfect trolley and allow to air dry
	9. Gather equipment and position on BOTTOM shelf of dry trolley - Sterile urine catheter in appropriate size for patient (preferable intermittent nelaton catheter, if not available use a foley catheter without inflating the balloon.) - Sterile urine collection pot (if needed for analysis) - Sterile lubricant sachet - x2 sterile drapes (1 critical aspetic field on trolley and 1 to cover gential area) - sterile gauze - sterile gallipot - sterile dressing forceps (if available) - Oral sucrose solution (for infants <6 months) - Sterile gloves - Alcohol based hand rub - Apron (according to risk of exposure) - Waterproof towel or disposable drawsheet) - Sterile kidney dish - Bed pan to collect the urine - Antiseptic for meatal disinfection - Detergent/disinfectant for surfaces - Sims speculum (FGM patients only) - Waste bin (s)
	10. Obtain assistance if needed.
	Procedure
	11. Perform hand hygiene
	12. Bring trolley to patient's bedside and position waste bin
	13. Place the sterilie drape on the top shelf of the dry trolley. Using a non-touch technique, open and prepare the equipment onto the sterile drape.
	14. Perform hand hygiene
	15. For infants 0-6 months, consider giving oral sucrose solution analgesia 2-3 minutes before the procedure.
	16. Assist patient to lie in supine position in bed. Position towel/draw sheet under patient's buttocks
	17. **For female patients**: have the patient bend their knees, hips flexed and feet resting about 60cms apart **For male patients**: the legs can be extended on the bed
	18. Using a non-touch technique, apply sterile drapes over genitals & between legs

	19. Apply apron and other PPE according to risk assessment and perform hand hygiene
	20. Apply sterile gloves
	21. Open the sterile plastic protective wrapping of the catheter and dip the tip into the small amount of sterile water or water-based lubricant. Ensure the catheter remains sterile by only placing it on sterile surface or sterile kidney basin.
	22. **For female patients**: with the non-dominant hand, spread the labia minora so that the urethral meatus is visualized. This hand will remain here throughout the rest of the procedure **For male patients**: with the non-dominant hand, lift the penis at a 60-90° angle and retract the foreskin (if present). This hand will remain here throughout the rest of the procedure
	23. Using a non-touch technique, use the dominant hand to disinfect the insertion site with the appropriate antiseptic and sterile gauze. If available, use sterile forceps
	24. Place the open end of the catheter inside the sterile kidney dish and place the sterile kidney dish between the patients legs, holding the tip of the catheter to remain sterile
	25. **For female patients**: using the dominant hand introduce the tip of the catheter into the urethra in an upward and backward direction. Advance the catheter until urine drains and then advance another 6-8cm **For male patients**: with the non-dominant hand holding the penis firmly at a 60-90° angle, insert the tip of the catheter into the urethra and slowly advance the catheter. Once urine flows, advance catheter another 6-8 cm. If resistance is felt at the external sphincter, pause for 10-20 seconds and instruct the patient to breathe deeply and evenly. Increase the traction on the penis slightly and apply steady, gentle pressure on the catheter while the patient exhales or while giving a cough
	26. If no urine flows, or resistance is still felt, stop the procedure, remove catheter and discard. Re- attempt with a new sterile catheter that has been lubricated as above.
	27. Use the bed pan to collect large amounts of urine from the bladder
	28. If **collecting urine for laboratory analysis**, use sterile collection pot and obtain sample from the end of catheter
	29. Note the colour, odour, clarity and quantity of urine drained into the kidney dish
	30. Once urine flow stops, gently remove the catheter
	Post-procedure
	31. Remove towel/draw sheet, assist patient to replace underwear or gown over genitals and ensure the bed linen is not soiled (if soiled or wet, replace with clean dry linen)
	32. Ensure waste is disposed of according to local procedure. Remove sterile gloves and PPE, discard single-use items.
	33. Perform hand hygiene
	34. Clean/disinfect trolley
	35. Perform hand hygiene
	36. Document the procedure in the patients file detailing: - Date/time of intermittent cathereterization - Type and size of the catheter used - Any difficulties during insertion - Quality (colour, odour, clarity) and quantity of urine drained at insertion - Name of nurse/clinican
	37. Follow-up as required with clinical team. Inform the patient/caregiver to notify when the first urine is passed after catheterisation

Appendix 15. Suprapubic aspiration of urine

Suprapubic bladder aspiration (SPA) is a safe and effective method for obtaining urine specimens in infants and children younger than 2 years when a urinary tract infection is suspected. It is the most reliable way to obtain an uncontaminated urine sample for culture and avoids delay in administration of antibiotics for unwell febrile children while awaiting a clean-catch sample. SPA should be performed by an experienced clinician who is trained in the procedure, ideally with the support of ultrasound to maximise success.

Contraindications

Ensure that there are no contraindications to SPA and that consent has been obtained from the patient or parent/carer.

Contraindications to SPA are:
- Obvious or unexplained bleeding disorder
- Abdominal distension
- Massive organomegaly
- Skin infection over the site for SPA

Equipment

You will need two people to perform this procedure – one trained clinician to carry out the SPA, and one assistant to hold the child in the correct position.

Equipment includes:
- 22G or 23G needle
- 3 mL or 5 mL syringe
- Antiseptic solution for skin
- Sterile gloves
- 4 x 4 sterile compress
- Urine specimen pot
- POCUS machine, if available and staff trained in its use

Analgesia and anaesthesia

Non-pharmacological measures should be used for all children, regardless of age, prior to and during the procedure. If the SPA is not urgent, local anaesthetic cream e.g. EMLA can be used, if available. See Chapter 15, Section 15.4.6 for details.

Preparation

To ensure maximum success, ensure that the child has not urinated in the last 30 minutes. If they have, give fluids (water by mouth or IV maintenance fluids if unable to drink, see Chapter 15, Section 15.2) and wait 30 minutes before performing the procedure. Check that the bladder is dull to percussion before starting the procedure or use POCUS, if available, to confirm that the bladder is full. If the bladder is empty, SPA is not recommended.

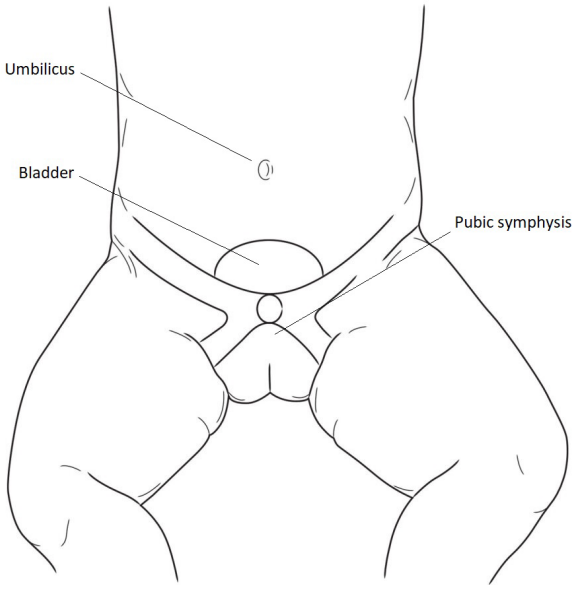
Position

With the child in the supine position, use one arm to hold the legs extended in a frog-leg position and the other on the upper abdomen/torso to keep the child still. Only get the child into position and remove the nappy immediately before the procedure to avoid stimulating urination. Occlude the urethral opening just before needle insertion because the procedure will stimulate urination in many children.

Procedure

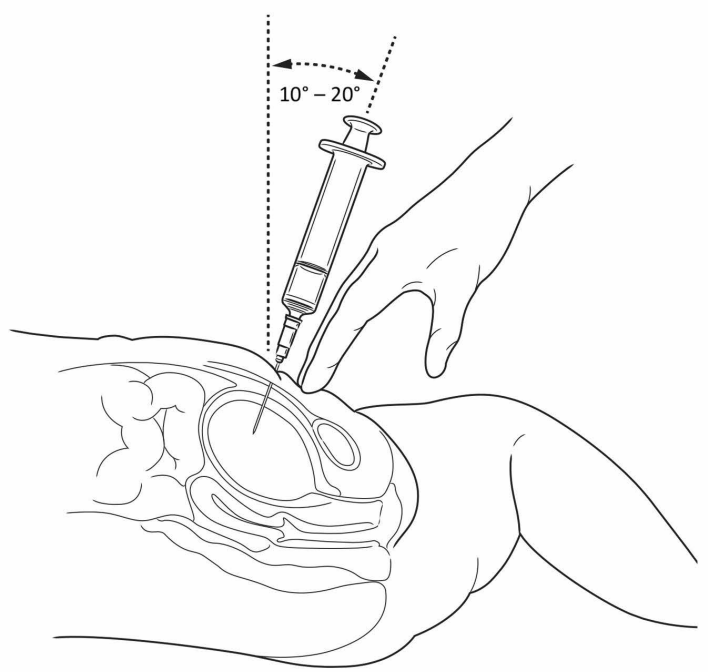
– Identify the puncture site by visualising a line between the umbilicus (belly button) and pubic symphysis. The site for needle insertion is in the midline, about 1-2 cm above the pubic symphysis, approximately at the lower abdominal crease (see Figure 15.1).

Figure 15.1 - Landmarks to identify needle insertion site



– Wash and disinfect your hands with an alcohol-based solution.
– Put on sterile gloves and take standard precautions.
– Disinfect the abdomen around the insertion site in a large circular motion from centre to periphery using antiseptic solution.
– Attach a 22G or 23G needle to a 3 mL or 5 mL syringe.
– Angle the needle 10 to 20 degrees towards the head, keeping it perpendicular to the skin (see Figure 15.2).
– Insert the needle into the skin using a quick puncture motion.
– Advance the needle while pulling the plunger of the syringe, creating suction in the syringe to aspirate urine as soon as the bladder is reached.
– If urine is obtained, remove needle and place sample in urine specimen collection pot.
– If unsuccessful, partially withdraw the needle to just below the skin and angle slightly more perpendicular to the frontal plane before advancing the needle under suction again.
– Do not repeat this manoeuvre more than once if unsuccessful.

Figure 15.2 - Needle insertion



Post-procedure care

– Apply a light dressing to cover the puncture site.
– No specific post-procedure care is required.

Complications

– Microscopic haematuria is common and not a concern.
– Rare complications include bladder haematoma, macroscopic haematuria, bladder haemorrhage, intestinal perforation.

Appendix 16. Body surface area estimation in children

Body surface area can be estimated based on weight alone using the following tables, reproduced from reference[1].

Body weight (kg)	Surface area (m^2)
2	0.16
2.5	0.19
3	0.21
3.5	0.24
4	0.26
4.5	0.28
5	0.3
5.5	0.32
6	0.34
6.5	0.36
7	0.38
7.5	0.4
8	0.42
8.5	0.44
9	0.46
9.5	0.47
10	0.49
11	0.53
12	0.56
13	0.59
14	0.62
15	0.65
16	0.68

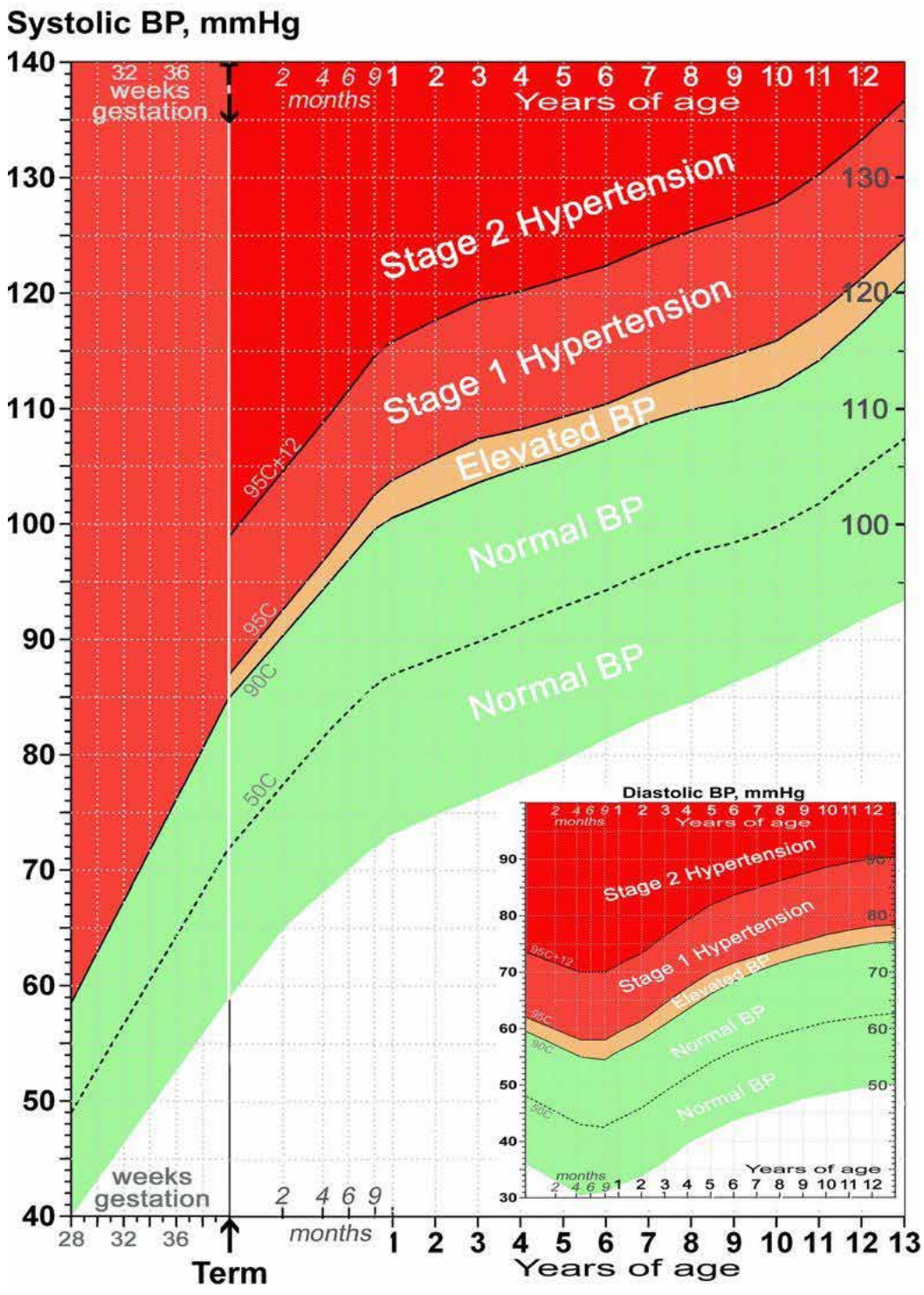
Body weight (kg)	Surface area (m^2)
17	0.71
18	0.74
19	0.77
20	0.79
21	0.82
22	0.85
23	0.87
24	0.9
25	0.92
26	0.95
27	0.97
28	1.0
29	1.0
30	1.1
31	1.1
32	1.1
33	1.1
34	1.1
35	1.2
36	1.2
37	1.2
38	1.2
39	1.3

Body weight (kg)	Surface area (m^2)
40	1.3
41	1.3
42	1.3
43	1.3
44	1.4
45	1.4
46	1.4
47	1.4
48	1.4
49	1.5
50	1.5
51	1.5
52	1.5
53	1.5
54	1.6
55	1.6
56	1.6
57	1.6
58	1.6
59	1.7
60	1.7

Values calculated using the Boyd equation.
The same calculations and tables are used in the British National Formulary for Children (BNFC).

1. Sharkey I, Boddy AV, Wallace H, et al. Body surface area estimation in children using weight alone: application in paediatric oncology. Chemotherapy Standardisation group of the United Kingdom Children's Cancer Study Group. Br J Cancer. 2001;85(1):23-28. https://doi.org/10.1054/bjoc.2001.1859

Appendix 17. Blood pressure centiles for age[1]

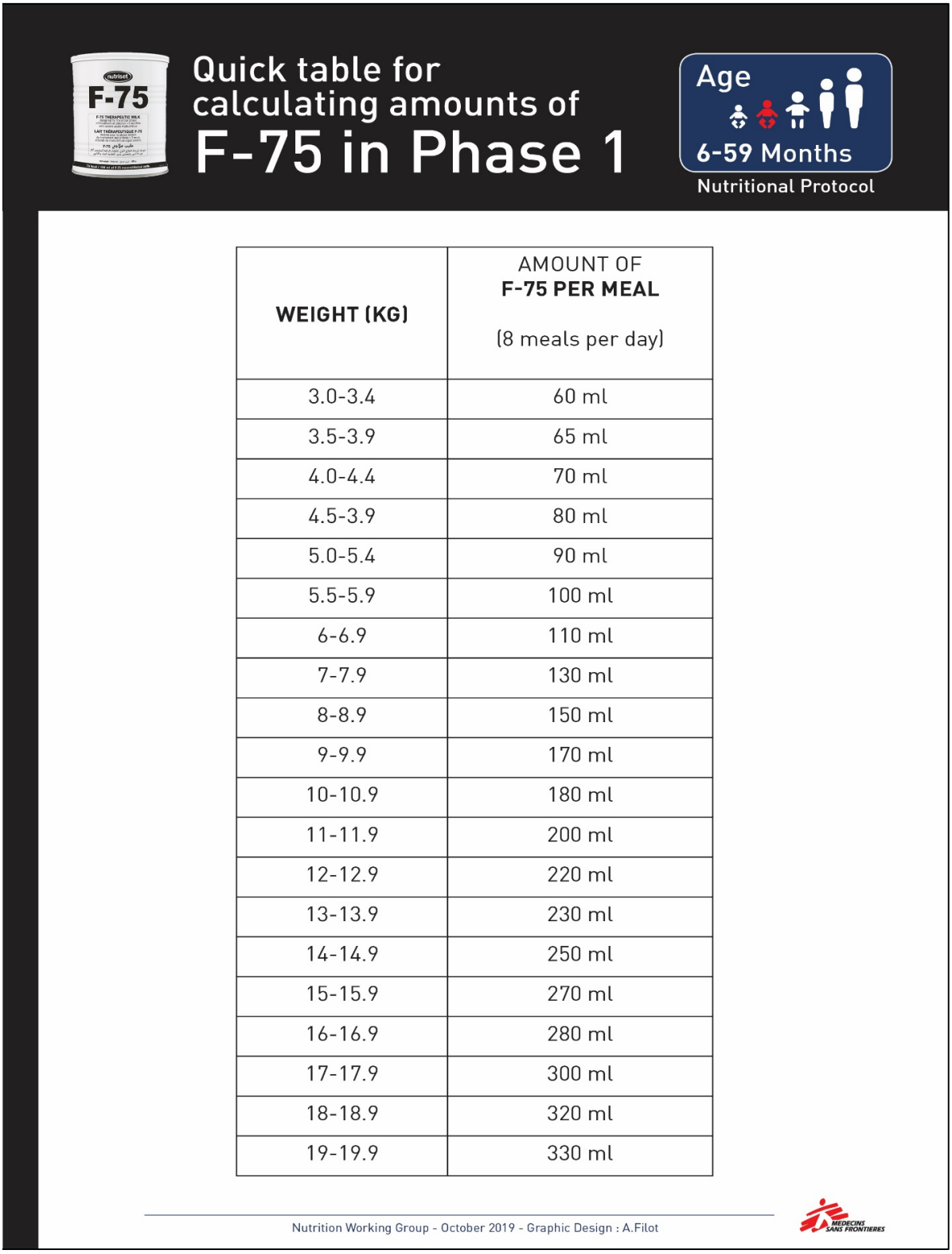


Reproduced with permission from:

1. Coulthard MG. Single blood pressure chart for children up to 13 years to improve the recognition of hypertension based on existing normative data. Arch Dis Child. 2020;105(8):778-783. https://doi.org/10.1136/archdischild-2019-317993

Appendix 18. F-75 feed volumes in Phase 1

Copied with permission from MSF ITFC Nutritional Care Protocol 2021, Children 1-59 months: Inpatient, page 158.



WEIGHT (KG)	AMOUNT OF **F-75 PER MEAL** (8 meals per day)
3.0-3.4	60 ml
3.5-3.9	65 ml
4.0-4.4	70 ml
4.5-3.9	80 ml
5.0-5.4	90 ml
5.5-5.9	100 ml
6-6.9	110 ml
7-7.9	130 ml
8-8.9	150 ml
9-9.9	170 ml
10-10.9	180 ml
11-11.9	200 ml
12-12.9	220 ml
13-13.9	230 ml
14-14.9	250 ml
15-15.9	270 ml
16-16.9	280 ml
17-17.9	300 ml
18-18.9	320 ml
19-19.9	330 ml

Appendix 19. ARV prophylaxis in PMTCT

Adapted from MSF Prevention of mother to child transmission of HIV guidelines.

19.1 Low-risk HIV-exposed infants

Low risk infants are infants whose mothers:
– Have been on successful ART for more than 4 weeks prior to delivery[a].

Start **nevirapine** (**NVP**) syrup once daily as soon as possible after birth for 6 weeks (see Table 19.1).

Table 19.1 - Daily ARV prophylaxis for low-risk neonates and infants

Birth weight	NVP syrup (10 mg/mL)
≥ 1.5 to < 2 kg and ≥ 35 weeks GA	2 mg/kg once daily
2 to < 2.5 kg	10 mg once daily
≥ 2.5 kg	15 mg once daily

19.2 High-risk HIV-exposed infants

High-risk infants include infants whose mothers:
– Have received less than 4 weeks of ART at the time of delivery, or
– Are on ART but with recorded antenatal viral load of > 1000 copies/mL at delivery, or
– Have incidental HIV infection during pregnancy or breastfeeding[b], or
– Were first identified as HIV-positive at delivery, or
– Were first identified during the breastfeeding period with or without a negative HIV test during pregnancy.

Start combination ARV prophylaxis as soon as possible after birth.

Simplified ARV prophylaxis regimen for high-risk neonates and infants

The simplified regimen should be used unless national protocols recommend the standard WHO ARV prophylaxis regimen (see below). From birth to 6 weeks, give one quarter of **AZT/3TC/NVP**[c] fixed dose combination (FDC) dispersible tablet two times daily. Teach the parents/carer how to use a cutter to obtain 4 equal parts.

At 6 weeks, switch to **AZT** 60 mg/**3TC** 30 mg dispersible tablet: 1 tab two times daily **plus NVP** 50 mg dispersible tablet: ½ tablet once daily, **or NVP** alone for 6 weeks (see also Table 19.2).

a Treatment success is best defined by maternal viral load < 1000 copies/mL during the last 6 months of pregnancy, at delivery and during breastfeeding.
b Defined as a new HIV diagnosis in a pregnant or breastfeeding woman with a previous negative test during pregnancy.
c AZT = zidovudine; 3TC = lamivudine; NVP = nevirapine.

Table 19.2 - Simplified ARV prophylaxis for high-risk neonates and infants[d]

Age	Simplified prophylaxis for high-risk neonate and infant	
Birth to 6 weeks	AZT 60 mg/3TC 30 mg/NVP 50 mg: ¼ tab, two times daily	
> 6 to 12 weeks	AZT 60 mg/3TC 30 mg: 1 tab, two times daily	Plus NVP 50 mg: ½ tab, once daily
	Or NVP 50 mg alone: ½ tab, once daily	

Standard WHO recommended (2016) ARV prophylaxis regimen for high-risk neonates

To be used if part of the national recommendation. Where available, give **NVP** and **AZT** combined regimen from birth to 12 weeks. Adjust dose according to birth weight for LBW neonates receiving ARV prophylaxis at or around birth (see Table 19.3).

Table 19.3 - WHO recommended ARV prophylaxis for high-risk neonates and infants

Birth weight or age	NVP 10 mg/mL syrup or 50 mg tablet	AZT 10 mg/mL syrup or 60 mg tablet
≥ 1.5 to < 2 kg and ≥ 35 weeks GA[e]	2 mg/kg*, once daily	4 mg/kg*, two times daily
≥ 2 to < 2.5 kg	1 mL syrup, once daily	1 mL syrup, two times daily
≥ 2.5 kg Birth to 6 weeks	1.5 mL syrup, once daily	1.5 mL syrup, two times daily
> 6 to 12 weeks	½ tab or 2 mL syrup, once daily	1 tab, two times daily
	Or NVP alone, according to weight	

* For low birthweight (LBW) neonates, the dose is expressed in mg/kg in order to be very precise (less than 1 mL).

– If this is too complicated for the mother, choose the simplified regimen above.
– If appropriate formulations are not available, give NVP alone from birth to 12 weeks.

In addition, for all HIV-exposed neonates and infants start cotrimoxazole prophylaxis from 4 to 6 weeks of age and continue until HIV infection has been excluded (see Chapter 13, Section 13.4.4).

d This simplified prophylactic regimen has not been formerly evaluated yet but has been discussed with WHO experts who recognize the importance of simplicity for success.

e *Note*: Very preterm neonates will need further reduced doses.

Appendix 20. Causes of fever of unknown origin (FUO)

Table 20.1 - Typical pathogens causing FUO according to clinical diagnosis. Adapted from reference[1]

Clinical diagnosis	Infectious causes				Non-infectious causes
	Bacterial	Viral	Parasitic	Fungal	
Systemic; sepsis; shock	Gram-positive: *S. pyogens*, *S. aureus*, *Pneumococcus*. Gram-negative: *N. meningitidis*, enteric Gram-negatives, *Pseudomonas* spp. Rickettsial agents (RMSF, *Ehrlichiosis*)	Dengue, HIV, VHF	Malaria		HLH MAS Acute leukaemia/ lymphoma Neuroblastoma Drug fever Lupus
Meningitis; parameningeal infection (mastoiditis, subdural/epidural abscess)	Leptospirosis, *M. tuberculosis*, *C. tetani*	Lymphocytic choriomeningitis, HIV	*Naegleria* spp., *Baylisascaris*, *Trypanosoma brucei gambiense* or *rhodesiense*	*Cryptococcus, coccidiodomyses, histoplasma, blastomyces*	Ruptured craniopharyngioma IVIG use NSAID use
Cervical lymphade-nopathy (predominant); pharyngitis/tonsillitis; peritonsillar or parapharyngeal abscess	Non-group A *Streptococcus*: Groups C and G *Arcanobacterium*; *Fusobacterium*, other anaerobes	EBV, CMV, HIV, Adenovirus	Toxoplasmosis, African and American trypanosomiasis		Kikuchi-Fujimoto disease HLH Kawasaki disease ALPS
Endocarditis; pericarditis; peripheral venous infection	HACEK bacteria, *Bartonella*, *Coxiella*, *Legionella*, CONS, *Streptobacillus*, *Enterococci*, enteric gram-negative bacteria, *S. aureus*, pyogenic organisms, *Mycobacteria*		American trypanosomiasis		Kawasaki disease Rheumatic disease PAN Postinfectious SLE

Clinical diagnosis	Infectious causes				Non-infectious causes
	Bacterial	Viral	Parasitic	Fungal	
Pneumonitis	*Legionella*, *Nocardia*, *C. pneumoniae* or *C. psittaci*; *P. jiroveci*, *M. tuberculosis*	HIV, measles		*Blastomyces, Histoplasma, Cryptococcus, Coccidiodomyces, Aspergillus, Mucor*	Sarcoid Wegener syndrome Aspiration Foreign body Sequestered lobe
Hepatitis; hepatomegaly; splenomegaly	*Bartonella, Leptospira, Borrelia*,	Hepatitis B, C, E, EBV, CMV, HSV, HIV, Lassa	Toxoplasmosis, Malaria, Visceral Leishmaniasis, Schistosomiasis, Q fever	*Histoplasma, Candida*	Cholecystitis/cholangitis IBD Autoimmune hepatitis Drug hypersensitivity
Gastroenteritis; peri-appendiceal or pelvic abscess; pyelonephritis; renal abscess	*S. typhi*, *Yersinia*, *C. difficile*, *E. coli*, *Brucella*, *Aeromonas* Mycobacterial: *M. bovis* and *tuberculosis*, *S. hominis*, *anaerobes*	Adenovirus	*Giardia, Cryptosporidium, Entamoeba*		IBD Pancreatitis
Osteomyelitis; pyomyositis; myositis	Group B *Streptococcus*, *K. kingae*, *Salmonella* spp., *M. tuberculosis*, *S. aureus*, gram-negative enteric agents	Influenza A and B	Dengue, Chikungunya		Rheumatic disease, JIA Histiocytosis Ankylosing spondylitis Relapsing multifocal osteomyelitis Malignancy
Skin infections (pustular, necrotic, bullous); eruptions	*Streptobacillus*, *S. aureus*, *Pseudomonas* spp., *N. meningitidis*, Group A *Streptococcus*, Rickettsiosis	HIV, measles			Lupus JIA Kawasaki disease IBD

Abbreviations: VHF, viral hemorrhagic fever; RMSF, Rocky Mountain spotted fever; CONS, coagulase negative staphylococci; HACEK, *Haemophilus*, *Aggregatibacter*, *Cardiobacterium*, *Eikenella*, *Kingella*; HSV, Herpes simplex virus; UTI, Urinary tract infections, ALPS, autoimmune lymphoproliferative syndrome; GABS, Group AB hemolytic *Streptococcus*; IBD, Inflammatory bowel disease; HLH, Hemophagocytic Lymphohistiocytosis, MAS, macrophage activation syndrome; IVIG, intravenous immune globulin, NSAID, Non-steroidal anti-inflammatory drugs, PAN, polyarteritis nodosa, JIA, Juvenile idiopathic arthritis, HIB, *Haemophilus influenzae* type B.

Table 20.2 - Vector-borne and zoonotic causes of FUO

Cause	History	Epidemiology/ exposures	Clinical findings	Laboratory	Treatment
Brucella *Brucella*	Sustained fever patterns, night sweats, chills, asthenia, joint and muscle pain. Osteoarticular pain: sacroiliitis, arthritis, orchitis. Meningoencephalitis	Worldwide, mainly rural areas animal or animal products (unpasteurized milk/ cheese, insufficiently cooked/raw meat)	Hepato-splenomegaly, and/ or lymphadenopathy	Rose-Bengal test (RBT), mild elevation of hepatic enzymes, lymphocytopenia	Children < 8 years: **co-trimoxazole** PO, 20 mg/kg SMX (max. 800 mg) + 4 mg TMP/ kg (max. 160 mg), 2 times daily + **rifampicin** PO, 15-20 mg/kg (max. 600 mg) once daily for 6 weeks (or **gentamicin** IM, 5 mg/kg once daily for 2 weeks). Children ≥ 8 years: **doxycycline** PO, 2-2.2 mg/kg (max. 100 mg) 2 times daily for 6 weeks + **rifampicin** (or **gentamicin**), as above.
Leptospirosis *Leptospira*	Mild form: high fever, rigors, myalgia, headache, anorexia, abdominal pain, nausea, vomiting, cough, chest pain. Severe form (Weil's syndrome): onset same as mild + acute hepatorenal manifestations, jaundice, oligo-anuria, purpura, ecchymosis, epistaxis, hemoptysis, myocarditis, pericarditis.	Animal urine (rodents), contaminated soil or water, infected animal tissue Flooding	Relative bradycardia, bulbar conjunctivitis, pharyngeal hyperemia	Thrombocytopenia Proteinuria Pyuria Granular casts Chest X- ray: small nodular densities	Mild form: **doxycycline** PO, 2-2.2 mg/kg (max. 100 mg) 2 times daily for 7 days. Alternatively, **azithromycin** PO, 10 mg/kg (max. 500 mg) once on D1, then 5 mg/kg (max. 250 mg) once daily on D2 and D3, especially in children < 8 years old. Severe form: **ceftriaxone** IV, 80-100 mg/kg (max. 2 g) once daily for 7 days. Alternatively, **benzylpenicillin** IV, 50 000 IU (30 mg)/kg (max. 2 MIU or 1200 mg) every 6 hours for 7 days.

Cause	History	Epidemiology/ exposures	Clinical findings	Laboratory	Treatment
Schistosomiasis *Schistosoma* (*haematobium, mansoni, japonicum*)	Acute infection (Katayama fever): sudden onset of fever, urticaria and angioedema, chills, myalgias, arthralgias, dry cough, diarrhea, abdominal pain, and headache.	Contaminated water	Lymph-node enlargement	Eosinophilia, Hematuria	Children over 4 years old: **praziquantel** PO, 40 mg/kg single dose. Give pre-treatment prednisolone for 7 days in Katayama fever.
Borrelia/Relapsing fever Louse borne (epidemic): *Borrelia recurrentis*	Febrile episodes separated by afebrile periods of approximately 7 days. High fever, headache, asthenia, diffuse pain, anorexia, abdominal pain, vomiting, diarrhea	Body lice, Cold climate/season, Overcrowding, Poor sanitation	Splenomegaly, bleeding signs, jaundice, neurological symptoms	Blood smear for spirochetes	**doxycycline** PO, 4 mg/kg (max. 100 mg) single dose or **erythromycin** PO 250 mg single dose (< 5 years old); 500 mg single dose (≥ 5 years old) or **azithromycin** PO, 10 mg/kg (max. 500 mg) single dose
Borrelia/Relapsing fever Tick borne (epidemic): *Borrelia duttoni*	Fever, headache, asthenia, muscle and bone pain, photophobia, cough Cranial nerve palsies, meningitis Fever lasts 3-6 days and re-appears after 7-10 days	Temperate/ warm regions Rural areas in SSA	Splenomegaly Hepatomegaly Conjunctival hyperemia Lymphadenopathy	Blood smear for spirochetes, CSF analysis for spirochetes if CNS involvement	**doxycycline** PO, 2-2.2 mg/kg (max. 100 mg) 2 times daily for 7-10 days or **azithromycin** PO, 10 mg/kg (max. 500 mg) once daily for 7-10 days, especially in children < 8 years old or **ceftriaxone** IV, 50-75 mg/ kg (max. 2 g) once daily for 10-14 days, if CNS involvement

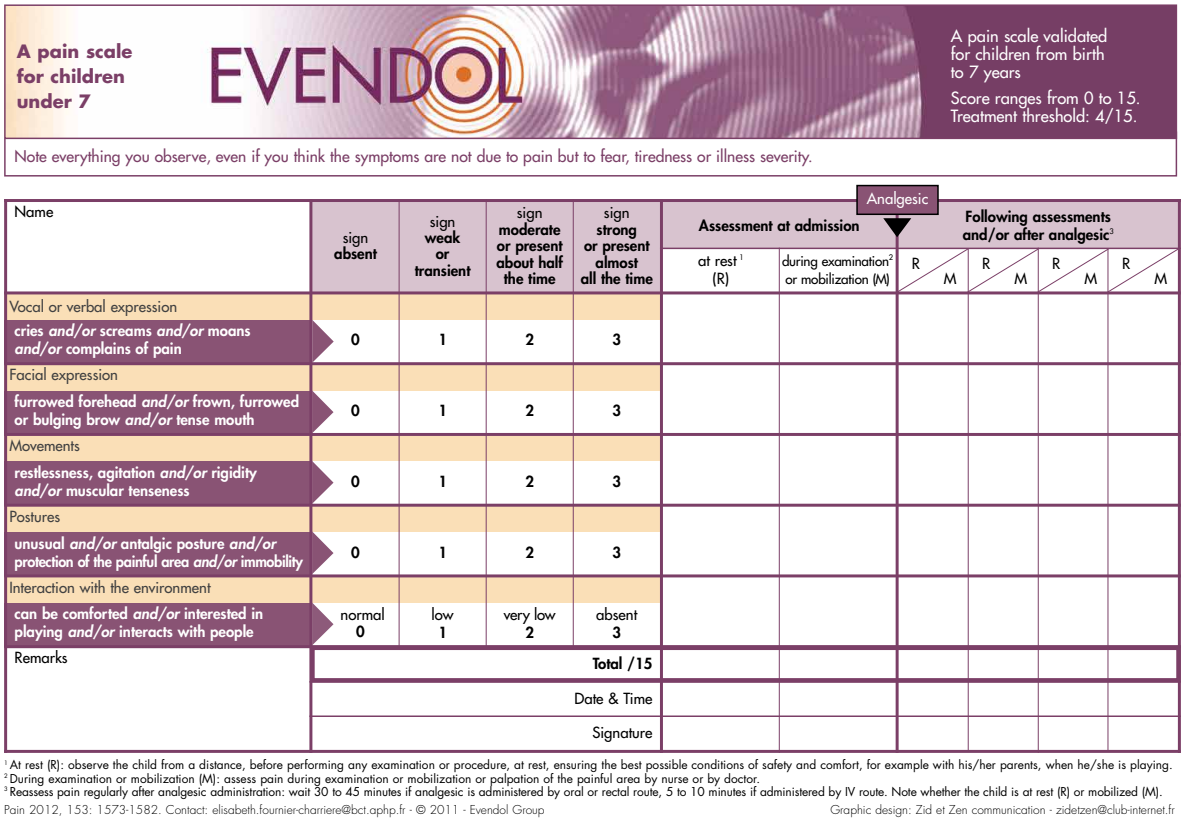
Cause	History	Epidemiology/ exposures	Clinical findings	Laboratory	Treatment
Q Fever *Coxiella burnetii*	Flu-like symptoms (fatigue, headache, myalgias) with a prolonged fever (1-3 weeks), hepatitis, pneumonia, endocarditis	Contact with farm animals (cattle, goats, sheep) Consumption of raw milk	Minimal auscultatory abnormalities, Hepatomegaly	Elevated liver enzymes, thrombocytopenia	**doxycycline** PO, 2-2.2 mg/kg (max. 100 mg) 2 times daily for 14 days or or **co-trimoxazole** PO, 2-10 mg/kg of the trimethoprim component 2 times daily (max. 320 mg/ 24 hours) for 14 days (especially in children < 8 years old)
Amoebic abscess *Entamoeba histolytica*	Right upper quadrant pain, fever (38.5 to 39.5ºC) Cough, sweating, malaise, weight loss, anorexia, and hiccup	More frequent young adults	Hepatomegaly	Leukocytosis, elevated alkaline phosphatase and hepatic enzymes	**tinidazole** PO, 50 mg/kg (max. 2 g) once daily for 5 days or **metronidazole** PO, 15 mg/kg 3 times daily for 5-10 days
Cat scratch disease *Bartonella henselae*	Cutaneous lesion at the site of inoculation that evolves through vesicular, erythematous, and papular phases with enlarged lymph nodes proximal to the inoculation site. Visceral involvement (liver, spleen) is rare but presents with persistent fever, abdominal pain, and/or weight loss Parinaud oculo-glandular syndrome, Neuroretinitis, encephalopathy.	Scratch or bite from an infected cat, exposure to cat fleas, contact with cat saliva through broken skin or mucosal surfaces (i.e., mouth and eyes).	Regional lymphadenopathy, hepato-splenomegaly, or ocular manifestation	Nonspecific tests, Serology	**azithromycin** PO, 10 mg/kg (max. 500 mg) once on D1, then 5 mg/kg (max. 250 mg) once daily for 4 days

Cause	History	Epidemiology/ exposures	Clinical findings	Laboratory	Treatment
African tick bite fever *Rickettsia africae* **Mediterranean spotted fever** *Ricketssia conorii*	Mild headache, fever, myalgias, solitary or multiple eschars with regional lymphadenopathy Generalized rash (vesicular or maculopapular) overlooked or completely absent. Long-lasting subacute neuropathy and myocarditis Fever, headache, maculopapular rash with eschar or black necrotic scabbed lesion (tache noire) at the site of the inoculating tick bite.	Rural Africa Mediterranean area	Patients with severe infections may have neurologic, cardiac, ocular, or renal complications.	Liver function tests mildly abnormal, thrombocytopenia	**doxycycline** PO, 2.2 mg/kg (max. 100 mg) 2 times daily for 5-7 days (or until 3 days after disappearance of fever). In severe infections, add a loading dose of **doxycycline** PO, 4.4 mg/kg (max. 200 mg) on D1 before continuing twice daily dosing as above.

1. Chusid MJ. Fever of Unknown Origin in Childhood. Pediatr Clin North Am. 2017;64(1):205-230. https://doi.org/10.1016/j.pcl.2016.08.014

Appendix 21. EVENDOL chart

The EVENDOL behavioural score was developed by a multi-professional group of experts in child pain, to better identify and assess the intensity of pain in young children, from birth to 7 years of age; studies have validated this scale in emergencies (medical or traumatic), in pre-hospital medical transport, in post-operative and neonatal care and for newborns in maternity wards.



A pain scale for children under 7

EVENDOL

A pain scale validated for children from birth to 7 years

Score ranges from 0 to 15. Treatment threshold: 4/15.

Note everything you observe, even if you think the symptoms are not due to pain but to fear, tiredness or illness severity.

Name	sign **absent**	sign **weak or transient**	sign **moderate or present about half the time**	sign **strong or present almost all the time**	**Assessment at admission**		**Following assessments and/or after analgesic**[3] (Analgesic)							
					at rest[1] (R)	during examination[2] or mobilization (M)	R	M	R	M	R	M	R	M
Vocal or verbal expression														
cries *and/or* screams *and/or* moans *and/or* complains of pain	**0**	**1**	**2**	**3**										
Facial expression														
furrowed forehead *and/or* frown, furrowed or bulging brow *and/or* tense mouth	**0**	**1**	**2**	**3**										
Movements														
restlessness, agitation *and/or* rigidity *and/or* muscular tenseness	**0**	**1**	**2**	**3**										
Postures														
unusual *and/or* antalgic posture *and/or* protection of the painful area *and/or* immobility	**0**	**1**	**2**	**3**										
Interaction with the environment														
can be comforted *and/or* interested in playing *and/or* interacts with people	normal **0**	low **1**	very low **2**	absent **3**										
Remarks				**Total /15**										
				Date & Time										
				Signature										

[1] At rest (R): observe the child from a distance, before performing any examination or procedure, at rest, ensuring the best possible conditions of safety and comfort, for example with his/her parents, when he/she is playing.
[2] During examination or mobilization (M): assess pain during examination or mobilization or palpation of the painful area by nurse or by doctor.
[3] Reassess pain regularly after analgesic administration: wait 30 to 45 minutes if analgesic is administered by oral or rectal route, 5 to 10 minutes if administered by IV route. Note whether the child is at rest (R) or mobilized (M).

Pain 2012, 153: 1573-1582. Contact: elisabeth.fournier-charriere@bct.aphp.fr - © 2011 - Evendol Group

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Score rating:
- Score 1/15 to 3/15: mild pain
- Score 4/15 to 7/15: moderate pain
- Score 8/15 to 15/15: severe pain

1. Fournier-Charrière E, Tourniaire B, Carbajal R, et al. EVENDOL, a new behavioral pain scale for children ages 0 to 7 years in the emergency department: Design and validation. *Pain*. 2012;153(8):1573-1582. https://doi.org/10.1016/J.pain.2012.02.024

Appendix 22. Daily enteral feed volumes and administration in critically unwell children

The following tables give target daily enteral feed volumes during the acute phase of critical illness only (up to maximum of 7 days), calculated using the Schofield energy equations which estimate basal metabolic rate (BMR). All volumes have been rounded for ease of administration. Enteral feeds using these calculations should only be continued in infants and children who are unable to eat and drink by mouth, up to a maximum of 7 days. As soon as they improve, feeds should be increased in infants and children should be commenced on full oral feeds as per usual diet.

22.1 Infants < 1 year old

a) Target daily enteral feed volumes according to weight in the acute phase of critical illness

Feed	Weight (kg)	Target daily acute phase enteral feed volume (mL)[a]
Expressed breastmilk/ standard infant formula	3	210
	4	295
	5	375
	6	460
	7	545
	8	630
	9	715
	10	800

b) Titrated administration of 3-hourly feeds in the acute phase of critical illness

Feed	Weight (kg)	Acute phase			
		30% of 3-hourly feed volume (mL)	50% of 3-hourly feed volume (mL)	70% of 3-hourly feed volume (mL)	Target 3-hourly feed volume (mL)
Expressed breastmilk/ standard infant formula	3	8	15	18	30
	4	12	20	28	40
	5	15	25	35	50
	6	18	30	42	60
	7	20	35	50	70
	8	24	40	56	80
	9	28	45	62	90
	10	30	50	70	100

a For standard enteral fluid volumes in infants, see Chapter 15, Table 15.16.

22.2 Children 1 to < 3 years old

a) Target daily enteral feed volumes according to weight in the acute phase of critical illness

Feed	Weight (kg)	Target daily acute phase enteral feed volume (mL)
Isocaloric enteral nutrition product (1 kcal/mL)/F-100	8	440
	9	500
	10	555
	11	620
	12	675
	13	740
	17	790
	15	850

b) Titrated administration of 3-hourly feeds in the acute phase of critical illness

Feed	Weight (kg)	Acute phase			
		30% of 3-hourly feed volume (mL)	50% of 3-hourly feed volume (mL)	70% of 3-hourly feed volume (mL)	Target 3-hourly feed volume (mL)
Isocaloric enteral nutrition product (1 kcal/mL)/ F-100	8	15	28	40	55
	9	20	32	45	65
	10	20	35	50	70
	11	25	40	55	80
	12	25	42	60	85
	13	28	48	65	95
	14	30	50	70	100
	15	32	52	75	105

22.3 Children 3 to < 10 years old

a) Target daily enteral feed volumes according to weight in the acute phase of critical illness

Feed	Weight (kg)	Target daily acute phase enteral feed volume (mL)	
		Male	Female
Isocaloric enteral nutrition product (1 kcal/mL)/F-100	12	775	730
	13	800	750
	14	825	770
	15	845	790
	16-19	900	840
	20-24	1000	930
	25-30	1125	1050

b) Titrated administration of 3-hourly feeds in the acute phase of critical illness

Feed	Weight (kg)	Acute phase							
		30% of 3-hourly feed volume (mL)		50% of 3-hourly feed volume (mL)		70% of 3-hourly feed volume (mL)		Target 3-hourly feed volume (mL)	
		Male	Female	Male	Female	Male	Female	Male	Female
Isocaloric enteral nutrition product (1 kcal/mL)/F-100	12	30	30	50	45	70	65	95	90
	13	30	30	50	50	70	70	100	95
	14	30	30	55	50	75	70	105	95
	15	30	30	55	50	75	70	105	100
	16-19	35	30	60	55	80	75	115	105
	20-24	40	35	65	60	90	85	125	120
	25-30	45	40	70	65	100	90	140	130

22.4 Children 10 to 15 years old

a) Target daily enteral feed volumes according to weight in the acute phase of critical illness

Feed	Weight (kg)	Target daily acute phase enteral feed volume (mL)	
		Male	Female
Isocaloric enteral nutrition product (1 kcal/mL)/F-100	25-30	1150	1050
	31-35	1240	1130
	36-40	1330	1200
	41-45	1420	1270
	46-50	1510	1330

b) Titrated administration of 3-hourly feeds in the acute phase of critical illness

Feed	Weight (kg)	Acute phase							
		30% of 3-hourly feed volume (mL)		50% of 3-hourly feed volume (mL)		70% of 3-hourly feed volume (mL)		Target 3-hourly feed volume (mL)	
		Male	Female	Male	Female	Male	Female	Male	Female
Isocaloric enteral nutrition product (1 kcal/mL)/F-100	25-30	45	40	70	65	100	90	145	130
	31-35	50	40	80	70	110	100	155	140
	36-40	50	45	85	75	115	105	165	150
	41-45	55	50	90	80	125	110	180	160
	46-50	60	50	95	85	135	115	190	165

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