Meningococcal disease

(See Fig. 15.11; see also https://www.meningitis.org and https://www.nice.org.uk)

Meningococcal disease is unpredictable. Most children present acutely febrile and may not have a rash in the early stages.

Septicaemia

Children presenting with septicaemia may have:

- A history of fever/rigors but be afebrile at the time of presentation.
- Isolated severe limb pain in the absence of any other physical signs.
- Abdominal pain, diarrhoea, and vomiting are common in septicaemia.
- Alertness until late in the illness.

Septic shock without meningitis at presentation has the worst prognosis.

Meningitis

Young children may present with fever, vomiting, irritability, and confusion. Those aged <2y are less likely to have neck stiffness or photophobia. Take parental concerns about a child's responsiveness and alertness seriously. Older children typically present more classically with fever, vomiting, headache, stiff neck, and photophobia. However, teenagers may present atypically with a change of behaviour (eg confusion, aggression), which may be falsely attributed to alcohol or drugs.

Rash

Underlying meningococcal disease may be very advanced by the time a rash appears. This may initially be blanching, macular, or maculopapular. Children without a rash or with a blanching rash can still have meningococcal disease. The classic rapidly evolving petechial or purpuric rash may be a very late sign and can carry a poor prognosis.

Urgent treatment and experienced help are essential. Perform CT scanning of the brain if there is impaired conscious level or focal neurological signs or signs of ↑ ICP. CT scans must not delay treatment. LP has no immediate role in ED care of the critically ill child and can be fatal. LP is contraindicated if there is extensive purpura, shock, impaired consciousness, coagulopathy, local infection, or ↑ ICP on CT or clinically.

Give antibiotics (IV ceftriaxone in children aged >3 months; IV cefotaxime + amoxicillin or ampicillin if aged <3 months) immediately to:

- All children with fever and petechial/purpuric rash.
- Children in shock with or without a rash.
- Children with clinical meningitis, but LP contraindicated.

Add vancomycin if the child has travelled outside the UK recently or has had prolonged or multiple exposure to antibiotics (in the past 3 months). If meningoencephalitis is suspected, give aciclovir.

Take any haemorrhagic rash in a febrile child very seriously. Although many children with fever and petechiae have viral illnesses, there is no room for complacency. Ensure that all have their vital signs measured and are carefully checked for signs of meningitis or septicaemia.

Airway and ventilation

Intubate and ventilate:

- If impaired conscious level or ↑ ICP clinically.
- Prior to CT scanning if critically ill.
- If fluid resuscitation requirement is >40mL/kg.

Seek expert help for rapid sequence induction/intubation (RSI)—haemodynamic collapse is common. Consider using IV ketamine for induction if experienced in its use.

Fluid resuscitation

Vast quantities of IV fluids are required in meningococcal septicaemia—often up to 100mL/kg. Some UK authorities recommend 4.5% human albumin solution (HAS) for fluid resuscitation, but give crystalloid (0.9% saline) if HAS is not immediately available.

Inotropes

- Dopamine or dobutamine at 10–20mcg/kg/min. Make up 3× weight (kg) mg in 50mL of 5% glucose and run at 10mL/hr (= 10mcg/kg/min).
- These dilute solutions can be used via a peripheral vein.
- Start adrenaline via a central line only (seek expert help) at 0.1mcg/kg/min. Make up 300mcg/kg in 50mL of saline at 1mL/hr (= 0.1mcg/kg/min).

Hypoglycaemia (glucose <3mmol/L)

A 10% glucose bolus 2mL/kg IV and then a glucose infusion at 80% of maintenance requirements over 24hr.

Correction of metabolic acidosis (pH <7.2)

Sodium bicarbonate ($NaHCO_3$) 1mmol/kg IV = 8.4% $NaHCO_3$ 1mL/kg over 20min or 4.2% $NaHCO_3$ 2mL/kg in neonates.

If K^+ <3.5mmol/L

Give potassium chloride 0.25mmol/kg IV diluted in saline or glucose over 30min, with ECG monitoring. Caution if anuric.

If total Ca^{2+} <2mmol/L or ionized Ca^{2+} <1.0mmol/L

Give 10% calcium chloride (0.7mmol/mL) 0.1mL/kg over 30min IV (max 10mL) or 10% calcium gluconate (0.22mmol/mL) 0.3mL/kg over 30min (max 20mL).

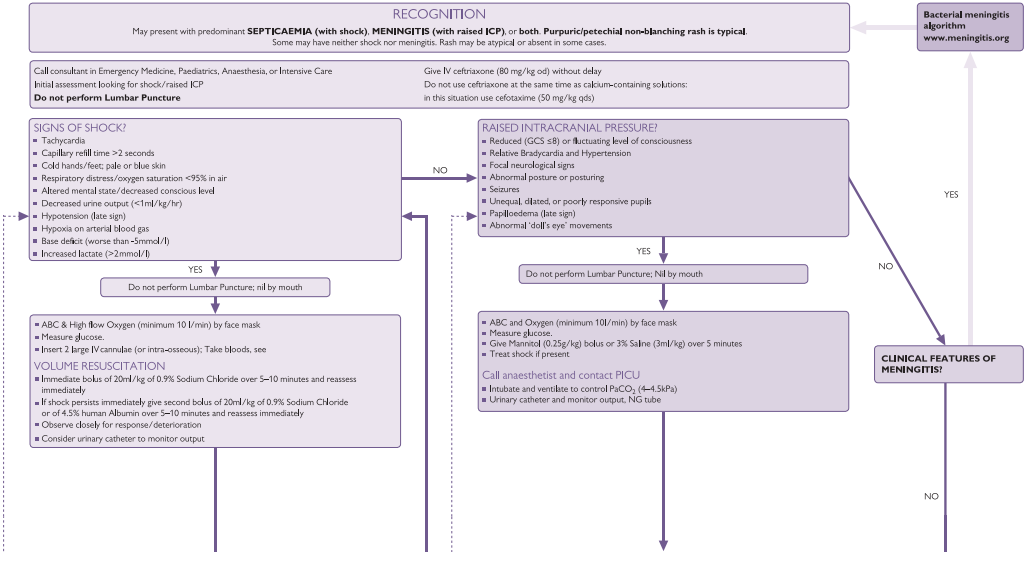
If Mg^{2+} <0.75mmol/L

Give 50% magnesium sulfate 0.2mL/kg IV over 30min (max 10mL).

Steroids in bacterial meningitis

NICE advises giving dexamethasone (0.15mg/kg to max of 10mg, qds for 4 days) for children aged >3 months with suspected or confirmed bacterial meningitis if LP reveals any of the following: frankly purulent CSF, CSF WCC >1000/microlitre, ↑ CSF WCC with protein concentration >1g/L, and bacteria on Gram stain.

Do not give steroids if TB meningitis is suspected.


RECOGNITION
May present with predominant SEPTICAEMIA (with shock), MENINGITIS (with raised ICP), or both. Purpuric/petechial non-blanching rash is typical.
Some may have neither shock nor meningitis. Rash may be atypical or absent in some cases.
Bacterial meningitis algorithm www.meningitis.org
Call consultant in Emergency Medicine, Paediatrics, Anaesthesia, or Intensive Care
Initial assessment looking for shock/raised ICP
Do not perform Lumbar Puncture
Give IV ceftriaxone (80 mg/kg od) without delay
Do not use ceftriaxone at the same time as calcium-containing solutions:
in this situation use cefotaxime (50 mg/kg qds)
SIGNS OF SHOCK?
Tachycardia
Capillary refill time >2 seconds
Cold hands/feet; pale or blue skin
Respiratory distress/oxygen saturation <95% in air
Altered mental state/decreased conscious level
Decreased urine output (<1ml/kg/hr)
Hypotension (late sign)
Hypoxia on arterial blood gas
Base deficit (worse than -5mmol/l)
Increased lactate (>2mmol/l)
NO
YES
Do not perform Lumbar Puncture; nil by mouth
ABC & High flow Oxygen (minimum 10 l/min) by face mask
Measure glucose.
Insert 2 large IV cannulae (or intra-osseous); Take bloods, see
VOLUME RESUSCITATION
Immediate bolus of 20ml/kg of 0.9% Sodium Chloride over 5–10 minutes and reassess immediately
If shock persists immediately give second bolus of 20ml/kg of 0.9% Sodium Chloride or of 4.5% human Albumin over 5–10 minutes and reassess immediately
Observe closely for response/deterioration
Consider urinary catheter to monitor output
RAISED INTRACRANIAL PRESSURE?
Reduced (GCS ≤8) or fluctuating level of consciousness
Relative Bradycardia and Hypertension
Focal neurological signs
Abnormal posture or posturing
Seizures
Unequal, dilated, or poorly responsive pupils
Papilloedema (late sign)
Abnormal 'doll's eye' movements
YES
NO
Do not perform Lumbar Puncture; Nil by mouth
ABC and Oxygen (minimum 10l/min) by face mask
Measure glucose.
Give Mannitol (0.25g/kg) bolus or 3% Saline (3ml/kg) over 5 minutes
Treat shock if present
Call anaesthetist and contact PICU
Intubate and ventilate to control $PaCO_2$ (4–4.5kPa)
Urinary catheter and monitor output, NG tube
CLINICAL FEATURES OF MENINGITIS?
YES
NO

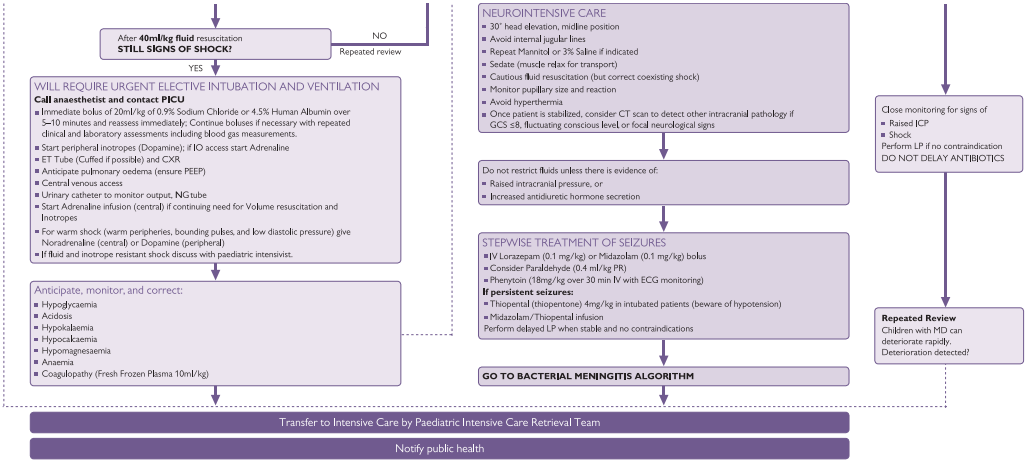


Fig. 15.11 Management of meningococcal disease in children and young people. Take blood for glucose, FBC, coagulation screen, U&E, Ca^{2+}, Mg^{2+}, PO_4^{3-}, blood cultures, ABG, lactate, cross-match, and PCR for *Neisseria meningitidis*.

Reproduced with kind permission from the Meningitis Research Foundation www.meningitis.org

Lumbar puncture

In the context of infectious disease, an LP can help to confirm a diagnosis of meningitis and to identify the organism responsible and its antibiotic sensitivities.

Contraindications to LP

If LP is performed in the presence of significantly ↑ ICP, there is a risk of 'coning' occurring. Take senior advice before performing an LP. The following are contraindications to performing an LP:

- Prolonged or focal seizure.
- Focal neurological signs.
- Purpuric rash.
- GCS <13/15.
- Pupillary dilatation.
- Impaired oculocephalic reflexes.
- Bradycardia.
- Coagulopathy and/or low platelets.
- Papilloedema.

Performing an LP

- Confirm that there is no contraindication.
- Prepare the parents, set up the equipment, and enlist help from an experienced nurse.
- Position the child to be lying curled up into a ball, lying on the side (see Fig. 15.12).
- Mark the skin with a pen in the midline at the level of the iliac crests.
- Scrub and don a sterile gown and gloves.
- Clean the skin with antiseptic solution, and cover with sterile drapes.
- Consider LA for the skin using 1% lidocaine solution.
- Slowly insert the 21G LP needle, aiming towards the umbilicus.
- If this causes much pain, withdraw the needle and use more lidocaine LA (but <3mg/kg—see ➲ Analgesia in specific situations, pp. 290–1.)
- If no CSF is obtained, withdraw the needle and reassess its direction, then try again.
- Collect four drops of CSF in each of three bottles and send for: microscopy and Gram staining, culture, and sensitivity; cell counts, glucose, and protein; and PCR.
- If a bloody tap is obtained, send the clearest sample for cell count analysis.

Fig. 15.12 Positioning for a lumbar puncture.

Skin lesions in multisystem disease

The appearance of the skin may provide a valuable clue to an underlying disease process. If suspected, refer all of the following diseases to a paediatrician.

Kawasaki disease (mucocutaneous lymph node syndrome)

This disease, believed to be related to a viral infection, was first reported in Japan in 1967 and has now spread worldwide. It is not contagious.

Most cases affect children aged <5y. Fever is often the first symptom and this usually lasts ≥5 days. Extensive skin and mucosal changes occur, including an erythematous rash, which may affect the palms and soles and desquamate. Conjunctivitis, uveitis, fissured lips, and a strawberry tongue may be seen. Other features include acute cervical lymphadenopathy, arthritis, and diarrhoea.

Coronary artery aneurysm (and subsequent thrombosis) is a significant complication, but the risk of this developing is ↓ for children who receive treatment (IV immunoglobulin), underlining the importance of making the diagnosis.

If Kawasaki disease is suspected, check FBC, ESR, and viral titres, and refer to a paediatrician.

Dermatitis herpetiformis

This is the skin manifestation of coeliac disease. Vesicles and papules occur over the knees, elbows, and buttocks. The lesions are very itchy and produce much scratching. Dapsone is effective treatment—refer to a paediatrician.

Erythema multiforme

Target lesions, often with pale, blistered centres, are symmetrically distributed, particularly over the extensor surfaces of the limbs, sometimes including the hands and feet. The skin lesions, combined with fever, systemic illness, and oral and genital ulceration, comprise the Stevens–Johnson syndrome.

Causes Include infection (herpes, *Mycoplasma*, TB) and drugs (sulfonamides, barbiturates).

Erythema nodosum

Painful red skin nodules or plaques on the anterior surfaces of both shins may be associated with fever, lethargy, and arthralgia. Erythema nodosum may occur in children and adults at any age but is most common between the ages of 12 and 25y. It may be due to streptococcal infection, TB, sulfonamides, ulcerative colitis, or sarcoid. Sometimes, no cause is found. If suspected, refer to the paediatric team for investigation and follow-up.

Erythema marginatum

A transient erythematous rash with raised edges occurs in 20% of cases of *rheumatic fever* (see ➲ Rheumatic fever, p. 513). Rheumatic fever is an autoimmune disease which follows infection with group A streptococci. Once common, it is now unusual in the UK.

Diagnose using the revised Duckett–Jones criteria (two or more major, or one major and two minor, plus evidence of preceding streptococcal infection, eg throat swab, ↑ anti-streptolysin O titre):

Major criteria Erythema marginatum, carditis, polyarthritis, Sydenham's chorea, subcutaneous nodules.

Minor criteria Fever, arthralgia, ↑ ESR, ↑ WCC, previous rheumatic fever, prolonged PR interval.

Erythema (chronicum) migrans

(See ➲ Infestations, pp. 240–1.)

The characteristic skin rash of Lyme disease begins as a red papule, which spreads to produce erythematous lesions with pale centres and bright edges. Lyme disease is a multisystem disorder resulting from tick-borne infection. It initially manifests with one or more of a variety of symptoms, including fever, headache, malaise, arthralgia, and myalgia. The rash is present in most cases. The diagnosis can be elusive, but consider it if there has been any history of travel to an affected area.

Identifying skin lesions

(See Table 15.4.)

Description

- Impalpable coloured lesion <1cm diameter = macule.
- Impalpable coloured lesion >1cm diameter = patch.
- Palpable lump <0.5cm diameter = papule.
- Palpable lump >0.5cm diameter = nodule.
- Palpable fluid-filled lesion <0.5cm diameter = vesicle.
- Palpable fluid-filled lesion >0.5cm diameter = bulla.

Table 15.4 Skin lesions and possible causes

Feature	Causes
Peeling skin	Toxic epidermal necrolysis ('scalded skin syndrome'), Kawasaki disease
	Streptococcal infection
Blistering lesions	*Staphylococcus* (impetigo and toxic epidermal necrolysis), scabies, chickenpox, herpes zoster, herpes simplex, Stevens–Johnson, pompholyx, Coxsackie A16 (hand, foot, and mouth disease), dermatitis herpetiformis, epidermolysis bullosa, drugs
Lesions on palms and soles	Coxsackie A16, Kawasaki disease, erythema multiforme, scables, pompholyx
Pruritus	Eczema, urticaria, psoriasis, chickenpox, scabies, lice, insect bites, dermatitis herpetiformis

Paediatric ENT problems

Background

Due to frequent infections and large concentrations of active lymphoid tissue, certain ENT problems are very common in general and paediatric practice. For example, acute suppurative otitis media (see ➔ Earache, pp. 566–7) has an incidence of 20% amongst preschool children; secretory otitis media ('glue ear') has a prevalence of 5% amongst all children. Rhinorrhoea from coryza and rhinitis is even more common.

Approach

Although many ENT diseases are usually considered as primary care problems, children often present to the ED suffering from them. It is obviously important to examine the ears and throat of any child presenting with a fever. Remember, however, that the ill, septic child with large red tonsils may also have a significant septic focus elsewhere (eg meningitis or pneumonia).

Examination

Examination of the ears and throat is generally disliked by children and, as a result, can sometimes prove to be rather a struggle to undertake. It is therefore sensible to leave this part of the full examination of a child until last. Help from parents can be invaluable in enabling examination of the slightly unco-operative toddler or younger child. Sit the child on a parent's lap for examination of the ears and throat, as shown in Fig. 15.13.

The difficult examination

Despite attempting a variety of manoeuvres, it can be very difficult to adequately visualize the throat of a child who adamantly refuses to open their mouth. A useful trick is to draw the face of a 'Smiley Man' on the end of a wooden spatula. The child may then consent to the 'Smiley Man' having a look at their throat (preferably with the ink side up!).

Presentation and treatment

The presentation, diagnosis, and treatment of specific ENT diseases in both children and adults are described in ➔ Chapter 12.

- See ➔ Ear, nose, and throat foreign bodies, pp. 562–3.
- See ➔ Earache, pp. 566–7.
- See ➔ Epistaxis, p. 568.
- See ➔ Nasal fracture, p. 569.
- See ➔ Sore throat, pp. 570–1.

Examining a child's ear In an infant, pull the pinna back and down (rather than up) for the best view.

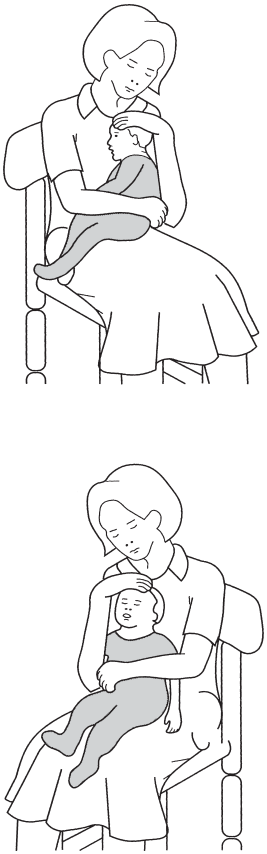


Fig. 15.13 Examining a child's ear and throat.

Stridor: upper respiratory infections

The upper airway may be blocked by: distortion (eg tongue falling back in coma), extrinsic compression (eg haematoma), swelling of its wall (eg burns, croup, epiglottitis, diphtheria), or FB within (see Table 15.5).

- *Signs of upper airway obstruction*: stridor, marked dyspnoea, drowsiness, subcostal/suprasternal recession, drooling of saliva, difficulty speaking, and cyanosis. Any of these warn of impending obstruction.
- *Stridor* is a high-pitched inspiratory noise. It occurs in croup, acute epiglottitis, inhaled FB, laryngeal trauma, laryngomalacia ('congenital laryngeal stridor'), and angioneurotic oedema.

Acute croup (laryngotracheobronchitis)

Viral (para-influenza in >80%) and common between 6 months and 5y. Spring and autumn epidemics occur. Illness lasts ~3–5 days. Coryzal symptoms usually precede harsh stridor, a barking cough ('seal's bark'), with hoarseness ↑ over several days. T° is only mildly ↑. Leave the child in a comfortable position, preferably in the arms of a parent, who can hold an O_2 mask near the child. Look for signs of significant airway obstruction, but do not examine the pharynx as this may precipitate laryngospasm or obstruction. If any signs are present, or if SpO_2 is <92% on air, refer urgently—intubation may be required. Use the modified Westley croup score by adding individual values as follows:

- *Stridor*: none = 0, only when upset or agitated = 1, at rest = 2.
- *Retractions*: mild = 1, moderate = 2, severe = 3.
- *Air entry*: normal = 0, mild ↓ = 1, marked ↓ = 2.
- *SpO_2 <92% on air*: none = 0, with agitation = 4, at rest = 5.
- *Level of consciousness*: normal = 0, altered conscious level = 5.

Admit moderate (score 3–5) or severe (score 6–11) croup or impending respiratory failure (score >11).

Give dexamethasone 0.15mg/kg PO or, if vomiting or severe respiratory distress, nebulized budesonide (2mg in 5mL of 0.9% saline). If severe (score >5), give nebulized adrenaline driven by O_2 at 8L/min (0.4mL/kg of 1:1000, max 5mL; repeat as required). Refer severe cases to PICU (<1% of croup is severe).

Consider discharging mild croup (score 0–2) from the ED after a brief period of observation—let an experienced clinician decide. Discharge in the evening may be inadvisable, as croup can worsen overnight.

Diphtheria

Although rare in the UK, the exotoxin of *Corynebacterium diphtheriae* may produce serious organ damage (especially myocarditis) and upper respiratory tract obstruction. The non-immunized child may present with pyrexia, sore throat, and dysphagia due to an adherent pharyngeal exudate. Cervical lymphadenopathy causes a 'bull neck' appearance. (Note that infectious mononucleosis may present similarly—see ➲ Infectious mononucleosis (glandular fever), p. 231.)

Treat With O_2, obtain ECG and venous access, send blood for FBC and blood culture, and obtain a throat swab. Refer for antitoxin (20,000U IM after a test dose) and IV antibiotics (eg erythromycin).

Acute epiglottitis

Increasingly uncommon, due to widespread Hib vaccination. Rapidly progressive airway obstruction may result. Children aged 2–7y are most usually involved, although it can affect older children and adults. Unlike croup, stridor is usually soft and may even be absent. Onset is typically acute. The child is systemically unwell with pyrexia >38.5°C, but little or no cough. In severe cases, the child may be ominously quiet and unable to speak, sitting upright drooling saliva in a 'sniffing position'.

Management Do not try to visualize the throat as this may precipitate total airway obstruction. Let the child adopt the most comfortable position; give humidified O_2 and call urgently for anaesthetic and ENT help. Nebulized adrenaline (0.4mL/kg of 1:1000, max 5mL) may 'buy time'. Defer blood tests (FBC, blood cultures) and treatment with IV cefotaxime until an anaesthetist has assessed the child. Lateral neck X-rays are unnecessary and potentially hazardous. Intubation, if required, may be very difficult to perform. A safe approach is for an experienced anaesthetist to use a gaseous induction in the presence of a surgeon who is prepared for a surgical airway. Airway swelling may require a smaller than expected diameter (and thus uncut) ET tube. If visualization of the tracheal orifice is difficult at laryngoscopy due to oedema, ask an assistant to squeeze the chest and look for an air bubble emerging from the trachea.

Loss of the airway If this happens, summon help and attempt to ventilate with O_2 using a bag and mask. If ventilation proves impossible, obtain a surgical airway (needle cricothyroidotomy if <12y, surgical cricothyroidotomy if ≥12y—see ➲ Airway obstruction: surgical airway, p. 336).

Bacterial tracheitis

May be due to *Staphylococcus aureus, Streptococcus*, or *Haemophilus influenzae*. The presentation of 'croup', plus moderate/severe pyrexia and production of copious secretions, suggests the diagnosis. If suspected, refer and treat as for acute epiglottitis (intubation is often required). Bacterial tracheitis can cause rapid onset of septic shock.

Table 15.5 Clinical presentations of upper airway obstruction

	Croup	Epiglottitis	Bacterial tracheitis	FB
Age	1–2y	2–6y	Throughout childhood	Throughout childhood
Onset	1–2 days	<24hr	<24hr	<24hr
History	Coryza, barking cough	Sore throat, dysphagia	Rattling cough, sore throat	
Signs	T° <38.5°C, non-toxic, harsh stridor, hoarseness	T° >38.5°C, toxic, upright position	T° >38.5°C, toxic, mucopurulent secretions, soft/absent stridor	Afebrile, non-toxic

Severe acute asthma in children

Assess

Conscious level, degree of breathlessness, degree of agitation, use of accessory muscles, amount of wheezing, pulse rate, and RR. Attempt to measure peak flow if age >5y (see Fig. 15.14 for normal peak flow).

Follow the 2019 BTS/SIGN guidelines based on age and severity (https://www.brit-thoracic.org.uk). Investigations, including blood gas estimations, rarely alter immediate management.

Cautions

Children with severe asthma attacks may not appear distressed. Wheeze and RR correlate poorly with severity of airway obstruction. ↑ tachycardia denotes worsening asthma, and a fall in heart rate in life-threatening asthma is pre-terminal.

Assessment in the very young (<2y) may be difficult—get expert help.

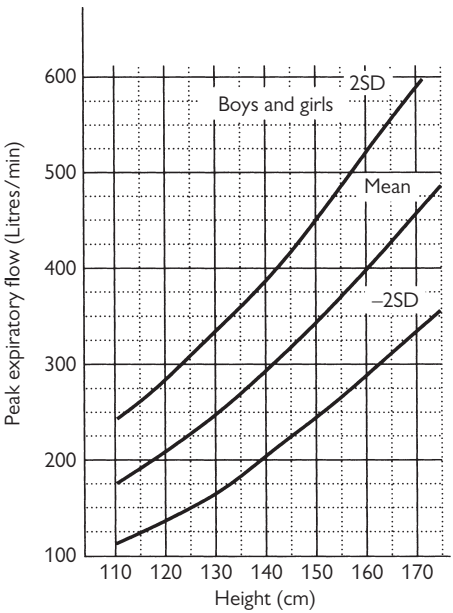


Fig. 15.14 Normal peak expiratory flow in children aged 5–18y.

Management of acute asthma in children aged >2y

(See Figs 15.15 and 15.16.)

- Summon senior ED/PICU/paediatric help if asthma is severe.
- Provide high-flow O_2 via a face mask (or nasal cannulae).
- Give an inhaled β-agonist. In mild or moderate asthma, use a metered-dose inhaler with a spacer, and 2–10 puffs of salbutamol.
- In severe or life-threatening asthma, use an O_2-powered nebulizer with salbutamol 2.5–5mg or terbutaline 5–10mg.
- Give oral prednisolone (20mg for children aged 2–5y; 30–40mg if aged >5y). If already taking maintenance steroids, give 2mg/kg (max 60mg). In children who vomit, give IV hydrocortisone 4mg/kg.
- Add ipratropium bromide 0.25mg if there is poor initial response to nebulized β-agonist.
- Repeat β-agonist and ipratropium every 20min up to 2hr as needed.
- Consider salbutamol (15mcg/kg) given IV over 10min in severe cases with a poor response to initial nebulized salbutamol and ipratropium bromide. Refer to PICU urgently and check K^+ levels.
- Consider an IVI of magnesium sulfate 40mg/kg over 20min.
- Aminophylline is not recommended in children with mild to moderate asthma. In severe or life-threatening asthma unresponsive to maximal doses of bronchodilators and systemic steroids, take specialist advice and consider IV aminophylline (5mg/kg over 20min; maintenance IVI at 1mg/kg/hr; omit loading dose if already receiving oral theophyllines).
- Do not give 'routine' antibiotics.

Note: if possible, repeat and record peak flow 15–30min after starting treatment. If the patient is not improving, give further nebulized β-agonist. Pulse oximetry is helpful in assessing response to treatment. An SpO_2 of ≤92% on air after initial bronchodilator therapy usually indicates the need for more intensive inpatient care usually in PICU. CXR is indicated for severe dyspnoea, focal chest signs, or signs of severe infection.

Consider the need for anaesthesia/intubation/IPPV and PICU transfer

- Deteriorating peak flow or worsening or persistent hypoxia or normal/↑ pCO_2 levels on ABG.
- Exhaustion, feeble respiratory effort, confusion, or drowsiness.
- Coma or respiratory arrest.

Management of acute asthma in children aged <2y

Assessing acute asthma in early childhood is difficult—get specialist help (see https://www.sign.ac.uk). Intermittent wheezing attacks are usually due to viral infection. Differential diagnosis includes: aspiration and other pneumonias, bronchiolitis, tracheomalacia, and complications of underlying conditions (eg congenital abnormalities, cystic fibrosis). If there is no response to inhaled bronchodilators, review the diagnosis:

- Use a metered-dose inhaler with a spacer to give β-agonist therapy.
- Consider systemic steroids early in the management of moderate to severe asthma in infants (10mg of soluble prednisolone).
- Consider adding inhaled ipratropium bromide (0.25mg) to inhaled β-agonists for more severe symptoms.

Fig. 15.15 Management of acute asthma in 2–5y olds (see: https://www.brit-thoracic.org.uk and https://www.sign.ac.uk).

This figure is reproduced from SIGN 158: *British guideline on the management of asthma*, by kind permission of the Scottish Intercollegiate Guidelines Network.

Fig. 15.16 Management of acute asthma in children aged >5y (see: https://www.brit-thoracic.org.uk and https://www.sign.ac.uk).

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Acute bronchiolitis

Viral infection of the small airways results in inflammation, oedema, and excessive secretions, presenting with signs of obstructive airways disease. Acute bronchiolitis is common, particularly in the winter months and predominantly involves infants (typically 3–6 months). Those at particular risk are the very young (aged <6 weeks), the premature (born <35 weeks), and those with chronic respiratory conditions, congenital heart disease, immunodeficiency, or neurological problems. Parental smoking ↑ the risk of bronchiolitis. Breastfeeding for >2 months appears to have a protective effect. Most infants recover completely within 2 weeks.

Agents responsible

75% are caused by respiratory syncytial virus (RSV). Other causes include influenza, para-influenza, and adeno- and enteroviruses.

Presentation

Coryza, rhinorrhoea, and mild fever progress to respiratory distress with dyspnoea, dry cough, feeding difficulties, and wheeze (variable). Some children may present with apnoea. Inspection may reveal cyanosis, dehydration, tachypnoea (>50/min), nasal flaring, grunting, and subcostal and intercostal recession. The chest is usually visibly hyperinflated in bronchiolitis. There may be tachycardia and prolonged expiration (± wheeze), with fine end-inspiratory crepitations.

Complications

These include feeding difficulties, apnoeic spells, and respiratory failure (hence, adopt a low threshold for admission). Secondary bacterial infection can occur but is uncommon. Long-term airway damage may occasionally occur (obliterative bronchiolitis).

Investigations

- Apply a pulse oximeter, and check the pulse and CRT.
- Do not do routine blood tests unless the infant is febrile or an alternative diagnosis, such as pneumonia or sepsis, is more likely.
- Consider CXR and ABG/capillary gas only for those with progressive, atypical, or severe illness. Do not obtain a CXR routinely.
- Fluorescent antibody tests on nasopharyngeal aspirate to demonstrate the presence of RSV are recommended; these help with cohorting and isolation arrangements on the wards (see ➲ Avoiding cross-infection, p. 699), particularly during the annual epidemic season in winter.
- Assess feeding difficulties by offering a bottle feed.

CXR Shows hyperinflation, with downward displacement of the diaphragm due to small airway obstruction and gas trapping. There may also be collapse or consolidation (usually upper lobe) or perihilar infiltrates hard to distinguish from pneumonia.

Differential diagnoses for bronchiolitis Include congenital heart disease, asthma, pneumonia, cystic fibrosis, inhaled FB, and septicaemia.

Treatment

(See NICE guideline, published in 2015, available at: https://www.nice.org.uk)

Emergency treatment is largely supportive, comprising one or more of:

- Providing humidified O_2 if SpO_2 is <92%.
- Performing nasal suctioning if the presentation is with apnoea.
- Ensuring adequate hydration—give fluid by NG or orogastric tube if unable to take enough PO; give IV fluid if unable to tolerate NG or orogastric fluids or there is impending respiratory failure.
- Calling for expert help and considering CPAP for impending respiratory failure.

Do not give antibiotics for bronchiolitis, but consider for severe illness suggestive of coexisting pneumonia or septicaemia. There is no benefit from using ipratropium, salbutamol, montelukast, PO or inhaled steroids, or nebulized adrenaline—do not use these therapies in acute bronchiolitis.

Hospital admission/discharge

Refer for admission all infants with respiratory distress, feeding difficulties (50–75% of usual fluid intake in previous 24hr), SpO_2 <94% on air, apnoeic episodes, or dehydration. When considering discharge, consider the family and social situation and the ability of parents to be able to identify and respond to deterioration. Provide advice to parents of children being discharged on how to recognize deterioration (eg apnoea, cyanosis, ↑ work of breathing/exhaustion, fluid intake ↓ to 50–75% of usual, or no wet nappy for 12hr) and how to seek help if needed.

PICU referral and ventilatory support

This is indicated for those with recurrent apnoea, persistent acidosis with pH <7.25, infants with ↓ conscious level, poor chest wall movement, and low SpO_2 (<92%) despite FiO_2 >60%, and those with hypercapnia.

Avoiding cross-infection

This is important during epidemics. Ensure all persons entering a cubicle containing a child with bronchiolitis clean their hands before and after seeing the patient, and use gloves and plastic aprons.

Prevention

Palivizumab is a humanized monoclonal RSV antibody, which is used as a prophylactic agent to reduce the severity of RSV disease in at-risk infants. It can be considered for use on a case-by-case basis in infants who:

- Were born prematurely (<35 weeks' gestation).
- Have acyanotic congenital heart disease.
- Have chronic lung disease.
- Have severe congenital immunodeficiency.

Infants are selected for this treatment by a local lead paediatric specialist.

Whooping cough[ND]

Caused by *Bordetella pertussis*, whooping cough is a notifiable disease, with an incubation period of 5–14 days (see ➲ Incubation periods, pp. 228–9). It is common (particularly in autumn) in children not immunized against it. A similar disease may also occur with other viral infections (*Bordetella parapertussis* and adenoviruses).

Presentation

Coryza is followed by ↑ cough (typically worse at night and tending to occur in bouts, often culminating in vomiting). Severe coughing bouts may result in conjunctival haemorrhages. The characteristic 'whoop' is an inspiratory noise produced after a coughing bout. It is not present in all infants with whooping cough. The cough may persist for several weeks.

Complications

Illness is often prolonged. There is a risk of neurological damage and bronchiectasis. Infants are at particular risk of death from apnoeic episodes.

Investigation

Take cultures by nasopharyngeal/per nasal swabs. Send blood for viral titres, *Mycoplasma* antibodies, and FBC (usually reveals markedly ↑ lymphocytes). CXR may be normal or show a 'shaggy' right heart border.

Treatment

(See NICE CKS, available at: https://cks.nice.org.uk)

Criteria for admission

- Infants aged <6 months (due to risk of apnoea).
- Significant breathing problems (apnoeic episodes, cyanosis, or severe paroxysms).
- Other complications (eg seizures, pneumonia).

Management of those discharged

If the child is fit for discharge, inform the infectious diseases consultant and prescribe a 7-day course of PO clarithromycin, provided the onset of the cough was within the past 21 days. Suggest simple analgesics (paracetamol or ibuprofen). Advise that children should be kept off school or nursery until 48hr of antibiotics have been taken (or until 21 days after onset of symptoms if not treated). Explain that even with treatment, whooping cough is likely to result in a prolonged (non-infectious) cough, lasting for several weeks. Arrange GP follow-up, and give PO clarithromycin as prophylaxis to unimmunized infant siblings.

Prevention

Encourage immunization.

Pulmonary tuberculosis[ND]

TB is being seen increasingly frequently again (see ➲ Tuberculosis, p. 242). It is more common in visitors from overseas or in HIV +ve children. TB may present in a variety of ways in children: persistent cough and fever, growth retardation, meningitis, pleural effusion, monoarticular arthritis, lymphadenopathy, back pain, and hepatosplenomegaly.

Investigations CXR.

Treatment Refer suspected cases for specialist evaluation, including Mantoux (0.1mL of intradermal tuberculin), and treatment.

Cystic fibrosis

Recurrent respiratory infections in neonates and infants raise the possibility of cystic fibrosis, tracheo-oesophageal fistula, cleft palate, or a defect in immunity. Cystic fibrosis is an autosomal recessive disorder, affecting 1 in 2000 children. It may present neonatally with meconium ileus or later with respiratory infections (± finger clubbing), failure to thrive, rectal prolapse, and steatorrhoea. Once diagnosed, a child will remain closely monitored and treated by both the GP and a specialist cystic fibrosis respiratory team. Involve this team at an early stage if a child with cystic fibrosis presents with respiratory infection.

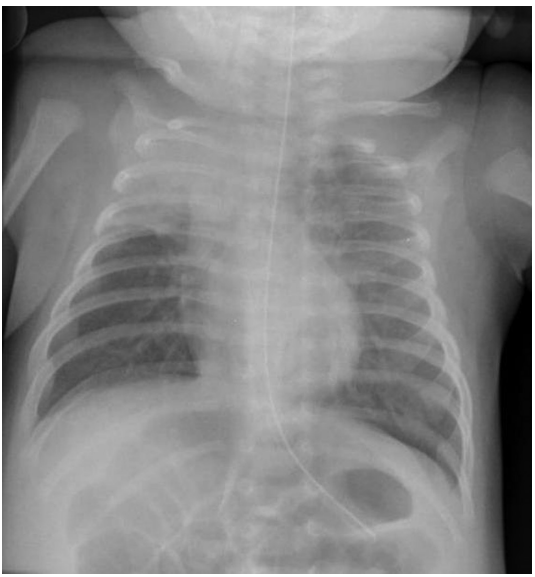


Fig. 15.17 CXR of an infant with right upper lobe consolidation.

Pneumonia

Pneumonia is relatively common at all ages throughout childhood, but the infective agents likely to be responsible vary considerably (see Table 15.6). Viruses are most commonly found as a cause in younger children. In older children, when a bacterial cause is found, it is most commonly *Streptococcus pneumoniae*.

Table 15.6 Infective agents responsible for pneumonia

Age	Common causes
Neonates	*Escherichia coli*, β-haemolytic *Streptococcus, Chlamydia trachomatis, Listeria monocytogenes*, CMV
Infants and toddlers	RSV, para-influenza viruses, *S. pneumoniae, Haemophilus influenzae, Mycoplasma*
Older children	S. *pneumoniae, H. influenzae, Mycoplasma*

Symptoms

Often an URTI is followed by ↑ fever, cough, dyspnoea, lethargy, feeding difficulties, and dehydration. Pleuritic chest pain, abdominal pain, and neck stiffness may occur.

The combination of headache, abdominal pain, maculopapular rash, and joint pains suggests *Mycoplasma* infection.

Signs

- The child is usually dyspnoeic, pyrexial, and unwell.
- Classic signs of consolidation (see ➲ Pneumonia, pp. 114–15) are often absent, especially in infants and younger children (so if suspected, adopt a lower threshold for obtaining a CXR).
- Look for evidence of dehydration and of infection elsewhere (including the ears and throat).
- If wheeze is present in a preschool child, bacterial pneumonia is unlikely, although it does occur occasionally with mycobacteria in older children.

Investigations

- Check SpO_2.
- Take throat swabs.
- Obtain blood samples for FBC, cultures, viral titres, and *Mycoplasma* antibodies.
- CXR may demonstrate widespread bronchopneumonia or lobar consolidation (see Fig. 15.17)—there may be an accompanying pleural effusion. The presence of cavitation suggests staphyloccocal pneumonia or TB.

Treatment

- If SpO_2 is <93%, give O_2.
- Treat dehydration with IV fluids.
- Refer for admission and antibiotics—PO is often sufficient.
- IPPV is rarely required.

ICU treatment

Refer to ICU those children who have one or more of:

- Inability to maintain SpO_2 >93% with 60% O_2.
- Signs of shock.
- ↑ RR/pulse rate with respiratory distress and exhaustion.
- Slow, irregular breathing or recurrent apnoea.

Choice of antibiotic

This depends upon the likely infective agent and local/national protocols (see BTS guidelines, available at https://www.brit-thoracic.org.uk, see also Box 15.2).

Box 15.2 Antibiotic treatment for suspected bacterial pneumonia

Uncomplicated community-acquired pneumonia

- *Neonate*: benzylpenicillin and gentamicin.
- *Neonate and child under 6 months*: cefuroxime or co-amoxiclav (or benzylpenicillin if lobar pneumonia or *S. pneumoniae* suspected).
- *Child 6 months to 5y*: PO amoxicillin or PO clarithromycin.
- *Child 5–18y*: PO clarithromycin (or PO amoxicillin if *S. pneumoniae* suspected).

Add flucloxacillin if *Staphylococcus* is suspected, eg in influenza or measles. Use clarithromycin if atypical pathogens are suspected or penicillin allergy.

Severe community-acquired pneumonia of unknown aetiology

- *Neonate*: benzylpenicillin and gentamicin.
- *1 month to 18y*: cefuroxime or co-amoxiclav (or benzylpenicillin if lobar pneumonia or *S. pneumoniae* suspected).

Use clarithromycin if atypical pathogens, such as *Mycoplasma* (more common in children over 5y) or *Chlamydia*, are suspected or penicillin allergy. Add flucloxacillin if *Staphylococcus* is suspected.

Fits in children

A careful history is crucial and may take some time to piece together. Epileptic fits may take many forms:

Grand mal (tonic/clonic) Loss of consciousness and shaking of all limbs.

Petit mal ('absences') Child pauses in speech or other activity and is unaware of episode.

Focal fit Involves one part of body (progression to grand mal = Jacksonian march).

Myoclonic fit May be violent and includes drop attacks.

Infantile spasm (Salaam attack) May involve truncal flexion and cause a fall.

Temporal lobe epilepsy Numerous bizarre presentations.

The fitting patient

(See ➲ Status epilepticus, p. 705.)

The child who is still fitting on arrival to hospital is likely to have had a prolonged fit, so provide immediate attention:

- Give O_2.
- Secure the airway. If teeth are clenched, do not try to prise them open to insert an airway. Instead, if the airway is obstructed, try a nasopharyngeal airway (see ➲ Insertion of nasopharyngeal airway, p. 335).
- Give IV lorazepam (0.1mg/kg) or if venous access is unsuccessful, buccal midazolam (0.5mg/kg, max 10mg) or PR diazepam (0.5mg/kg).
- Check bedside strip measurement of venous/capillary BMG, and treat hypoglycaemia with glucose IV 0.2g/kg (2mL/kg of 10%).
- Treat fever >38°C with PR paracetamol.
- If fits continue, follow the algorithm for status epilepticus (see ➲ Status epilepticus, p. 705).

After the fit has finished

Reassess Airway, Breathing, and Circulation. Continue O_2 and place in the recovery position until consciousness is regained. Check for any injuries sustained as a result of the fit, and perform regular observations.

First fit

Refer for investigation of possible causes. U&E, blood glucose, Ca^{2+}, Mg^{2+}, FBC, and urinalysis will be required.

Subsequent fit

If appropriate, check serum anticonvulsant level and arrange for follow-up at the GP/outpatient clinic to receive the results and adjust the dose appropriately. Allow home those patients with known epilepsy who have fully recovered and have no obvious underlying medical cause for the fit needing treatment (eg meningitis, hypoglycaemia).

Status epilepticus

Definition A fit (or consecutive fits without complete recovery in between) lasting >30min. The duration of the seizures is often underestimated because the intensity of the jerking diminishes with time and small-amplitude twitching may be easily missed.

Status epilepticus usually involves tonic–clonic fits and, as in adults, is associated with significant mortality (~4%) and morbidity (up to 30% have long-term neurological damage). Prompt treatment with termination of the fit is crucial to ↓ these risks.

Causes Meningitis, head injury, altered drug therapy or non-compliance in known epileptic child, metabolic disturbances, encephalopathy (including Reye's syndrome), 'febrile status', poisoning.

Managing the fitting child (See *APLS Manual*, sixth edition, 2016.)

- Open and maintain airway, and give O_2.
- Do not prise open clenched teeth—consider a nasopharyngeal airway.
- Rapidly obtain venous access, and check BMG.

If convulsion continuing at 5min

- If the fit has lasted for 5min, give lorazepam 0.1mg/kg IV/IO over 30–60s, or if venous access is unsuccessful, give buccal midazolam (0.5mg/kg, max 10mg) or PR diazepam (0.5mg/kg).
- Treat hypoglycaemia with glucose 2mL/kg IV of 10%.
- Apply pulse oximeter and send blood for investigations (see ➲ Investigations, p. 705).
- Check T°—if >38°C, give paracetamol 15mg/kg PR.

If convulsion continuing after a further 10min

- Repeat lorazepam 0.1mg/kg IV/IO over 30–60s. Do not give >2 doses of benzodiazepines, including prehospital treatment.
- Get senior help and call for senior ED/anaesthetic/PICU help.

If convulsion continuing after a further 10min

- Start phenytoin 20mg/kg IVI over 20min (monitor BP and ECG), or if already on phenytoin, consider instead phenobarbital (20mg/kg IV over 20min) or levetiracetam or sodium valproate.
- Whilst preparing to give phenytoin IVI, consider giving a dose of PR paraldehyde (0.4mL/kg) mixed with an equal volume of olive oil (thus making a total volume of 0.8mL/kg of the paraldehyde + oil mixture).

If convulsion continuing after a further 20min

- Paralyse, intubate, and ventilate using IV thiopental (induction dose 4mg/kg), and consider a thiopental infusion. Alternatively, consider midazolam IVI (0.1–1mg/kg/hr)—if this fails to control the fit, use thiopental.
- Transfer to ICU/PICU.

Investigations BMG and blood glucose, U&E, Ca^{2+}, Mg^{2+}, PO_4^{3-}, LFTs, FBC, ABG/capillary gas, blood cultures, coagulation screen, CXR. If taking anticonvulsant(s)—check serum level(s). Obtain brain CT scan if intracranial disease is suspected (unless clinically meningitis, in which case treat immediately—see ➲ Meningococcal disease, pp. 682–3).

Febrile convulsions

Definition

Grand mal seizures lasting <5min and secondary to pyrexia of febrile illness. By definition, children already diagnosed as epileptic do not have febrile convulsions, but 'further fits'.

Background

Febrile convulsions are the most common cause of convulsions in children aged between 6 months and 5y. They affect 3% of children. Although 30% recur in childhood, only 1% go on to develop epilepsy in adult life.

When the patient first presents to ED either still having a fit or post-ictal, it is often not immediately apparent that the underlying problem is a febrile convulsion.

Management

- Treat patients who arrive having a convulsion with O_2, airway care, and IV lorazepam, PR diazepam, or buccal midazolam, as described in ➲ The fitting patient, p. 704.
- Check T°.
- Check BMG and treat hypoglycaemia.
- Give PR (or, if conscious, PO) paracetamol (15mg/kg).
- Examine thoroughly for a source of infection (throat, ears, chest, and particularly for meningitis).
- Consider the need for an infection screen: U&E, FBC, blood cultures, MSU, CXR, and LP.

Admission or discharge

Aim to discharge children aged >2y with a second or subsequent febrile convulsion and an obvious benign and treatable cause for pyrexia, with appropriate treatment. Liaise with the GP to consider arranging for parents to administer PR diazepam or buccal midazolam to terminate future febrile fits.

Refer for admission children with one or more of the following:

- Age <2y.
- A first febrile fit.
- Underlying serious infection.
- An unknown cause of pyrexia.

Funny turns

Only a minority of reported 'funny turns' are epileptic fits. Most require referral and investigation. The history is crucial—the likely underlying causes vary according to the age of the child.

Infants

Irregular and varying depth of respiration during sleep is normal but can cause parental alarm. Self-limiting apnoeic or cyanotic episodes may be due to: fits, inhaled FBs, near-miss cot death, gastro-oesophageal reflux and laryngeal spasm, or arrhythmias (eg SVT).

Toddlers

Breath-holding attacks commonly accompany frustration in toddlers. They may cause the toddler to turn blue, lose consciousness, and even have a brief fit. Reflex anoxic episodes ('pallid syncope') are due to excess vagal stimulation in illness or after injury. Bradycardia, pallor, and loss of consciousness are occasionally accompanied by a short fit.

Older children

Syncope on exertion is suggestive of a cardiac cause—consider aortic stenosis, SVT, coarctation, or hypertrophic cardiomyopathy. Vasovagal episodes and hyperventilation also cause 'collapse'. Atypical or unheralded collapse or fits may be a feature of inherited long QT syndrome and is associated with torsades de pointes. Obtain an ECG in any child who presents with collapse or 'first fit'.

The decision to refer/admit or discharge depends upon the exact circumstances, including the past history of similar episodes.

Diabetic ketoacidosis

DKA usually presents in a child who is known to have diabetes, but occasionally it can be the first presentation of diabetes.

Features include: altered conscious level, polyuria, polydipsia, nausea, vomiting, and abdominal pain. Children with DKA can die from cerebral oedema (unpredictable but has 25% mortality), aspiration pneumonia, or hypokalaemia. All of these are potentially avoidable with appropriate treatment.

Be careful not to misdiagnose the abdominal pain of DKA as a 'surgical abdomen' or to dismiss the child as 'hyperventilating' (the ↑ RR reflects profound metabolic acidosis). Call senior ED and paediatric staff when DKA is suspected.

Causes

First presentation of diabetes in a previously well child. In a child with known diabetes, lack of insulin, change of therapy, and intercurrent viral illness can cause DKA. Fever suggests sepsis (it is not part of DKA).

Initial assessment and management

(See https://www.bsped.org.uk and https://www.nice.org.uk for detailed guidance.)

- Open and maintain airway if not fully conscious.
- Give high-flow O_2.
- Weigh the child if possible.
- Consider inserting an NG tube if unconscious or vomiting to ↓ the risk of aspiration.
- Attach a cardiac monitor (look for tall T waves) and record the CRT/BP.
- Rapidly obtain venous access and check BMG (remember BMG often underestimates blood glucose in DKA), and estimate the weight.
- Take blood for glucose, U&E, FBC, and VBG (and ketones if available).
- Only if evidence of shock (tachycardia, prolonged CRT, hypotension), give 10mL/kg of 0.9% saline IV as a bolus; discuss with senior/expert if repeated boluses are required. Consider sepsis if there is any of: fever, hypothermia, hypotension, refractory acidosis, and lactic acidosis.

Confirm the diagnosis of DKA

Check the history with the child and parents: polyuria, polydipsia, vomiting, abdominal pain, drowsiness, and ↑ RR.

Biochemical diagnosis is: glucose >11mmol/L, acidosis (pH <7.3), bicarbonate <15mmol/L, and capillary blood ketones >3mmol/L.

Assess severity/dehydration

Make a clinical assessment of the degree of dehydration.

The degree of dehydration/severity of DKA can be determined by pH:

- pH ≥7.1 implies mild or moderate DKA(~5% dehydration).
- pH <7.1 implies severe DKA (~10% dehydration).

The major concern is cerebral oedema—aim for slow metabolic correction over 48hr.

Involve senior paediatric ± PICU staff

Involve PICU if aged <2y, severe acidosis (pH <7.1), severe dehydration, or ↓ conscious level (↑ risk of aspiration and cerebral oedema).

Management

Oral or IV fluids

- Treat DKA with PO fluids and SC insulin only if the child is alert, not vomiting, and not dehydrated.
- Treat with IV fluids and IV insulin if the child is not alert, is dehydrated, or has nausea/vomiting.
- Only give an IV fluid bolus (10mL/kg) if shocked. Only give further boluses on expert advice (and if >20mmol/L is given, subtract any additional bolus volume from the 48hr total fluid calculation).

IV fluid management

Calculate the total fluid requirement for the first 48hr by adding the esimated fluid deficit to the maintenance requirement. Assume a 5% fluid deficit if pH is ≥7.1, and a 10% deficit if pH is <7.1.

Calculate maintenance fluid requirement using the 'reduced volume' rules:

- If weight is <10kg, give 2mL/kg/hr maintenance.
- If weight is 10–40kg, give 1mL/kg/hr maintenance.
- If weight is >40kg, give a fixed maintenance volume of 40mL/hr.

The fluid therapy calculator on https://www.bsped.org.uk is useful.

- Replace the deficit evenly over 48hr to ↓ the risk of cerebral oedema.
- Start replacing with 0.9% saline + 40mmol/L KCl (unless renal failure), but any initial fluid bolus should be 0.9% saline without KCl.
- Change fluid to 0.9% saline + 40mmol/L KCl + 5% glucose once plasma glucose level falls to below 14mmol/L.
- If plasma glucose falls <6mmol/L, ↑ glucose concentration of IVI—if there is persisting ketosis, continue insulin IVI at least 0.05U/kg/hr.
- Consider stopping IV fluids if ketosis is resolving and the child is alert and able to take PO fluids without nausea/vomiting.

Insulin

- Do not start insulin until IV fluids have been running for at least 1hr—earlier insulin ↑ risk of cerebral oedema. Give 0.05–0.1U/kg/hr (adding 50U of insulin to 50mL solution of 0.9% saline provides a concentration of 1U/mL (so 0.1U/kg/hr = 0.1mL/kg/hr).
- Do not administer bicarbonate.

Monitoring

- Perform hourly observations (pulse, BP, RR, T°, GCS).
- Monitor fluid balance (input/output chart).
- Monitor ECG whilst receiving IV therapy (look for U waves).
- Check blood glucose hourly and blood ketones every 2hr.
- Check U&E after 2hr of treatment.

Cerebral oedema

Suspect cerebral oedema if headache, agitation, ↓↓ pulse, and ↑ BP develops. Get expert help. Give mannitol (20%, 0.5–1g/kg over 15min) if ↓ GCS, pupil dilatation or inequality, oculomotor palsy, and respiratory pauses.

Hypokalaemia

If K^+ drops to <3mmol/L, get expert help and consider temporarily suspending insulin IVI.

Urinary tract infection

UTI in children requires prompt investigation, since progressive renal failure and hypertension may occur insidiously. 35% have proven vesico-ureteric reflux—early treatment may help to prevent renal failure. UTI may present in a variable and non-specific fashion. Consider and exclude UTI as part of the initial approach to any ill child presenting to the ED.

Presentations

Older children typically present with lower abdominal pain, dysuria, frequency, offensive urine, haematuria, or fever. However, dysuria and frequency do not always reflect UTI. Children <3y old often present unwell with fever and irritability, but no specific signs. Infants may present with poor feeding, vomiting, and failure to thrive.

Examination

Always check the BP, and feel for loin tenderness (pyelonephritis) and abdominal masses (polycystic kidneys). Check T° and assess as for ➲ The sick febrile child, p. 680.

Investigation

Obtain a clean-catch specimen of urine for urinalysis, microscopy, and culture and sensitivity. This can be difficult, but try the following approaches.

Neonates and infants

- Clean the perineum with sterile water, then tap with two fingers (or rub the skin gently with a gauze swab soaked with cold water) just above the symphysis pubis (ideally 1hr post-feed) and catch the urine which is forthcoming, trying to avoid the first few millilitres.
- Clean the perineum as above and use a urine collection pad according to the manufacturer's instructions.
- Suprapubic aspiration is useful if the baby is seriously ill. Clean the skin with antiseptic solution, then using sterile gloves and an aseptic technique, insert a 21G needle in the midline 2.5cm above the pubic crest and aspirate urine.

Toddlers and older children

- Co-operation will enable an MSU to be obtained [in the ♂, gently retract the foreskin (if possible) and clean the glans first; in the ♀, separate the labia and clean the perineum front to back first].
- If the child is unco-operative, try a urine collection pad or bag.

Dipstick urinalysis at the bedside will reveal the presence of blood, protein, sugar, bilirubin, ketones, or nitrite. A positive nitrite test is accepted as good evidence of UTI. Urine pH is not usually helpful, for although pH <4.6 or >8.0 may reflect infection, it may also be due to various acid–base disorders. Urinalysis may be normal, despite bacteriuria. Urinary leucocyte esterase may also help to identify UTI. Urine microscopy allows a search for pyuria and bacteriuria (highly suggestive of UTI) and an accurate assessment of other constituents (see Table 15.7). Perform FBC, U&E, blood glucose, and blood cultures if septicaemic, loin pain, or ↑ T°.

Treatment

(See NICE guideline CG54, updated 2018, available at: https://www.nice.org.uk)

- *Children with suspected pyelonephritis or who appear toxic*: resuscitate as necessary with IV fluids (see The sick febrile child, p. 680), and refer for admission and IV antibiotics (eg cefuroxime) (see *BNFC*). Consider children who have a T° >38°C or those who present with loin pain/tenderness and bacteriuria to have pyelonephritis.
- *Symptomatic children with abnormal urinalysis (+ve nitrite, proteinuria, or haematuria)*: start a 3-day course of antibiotics PO (eg trimethoprim or cefalexin—dose according to age; refer to *BNFC*). Encourage plenty of PO fluids and complete voiding of urine. Offer advice to the child and parents (eg avoid tight underwear, use toilet paper wiping from front to back).
- *Organize paediatric or GP follow-up to receive results of MSU and to arrange subsequent investigations*: this may include U&E, blood glucose, USS, and a variety of other tests (eg isotope renography and micturating cysto-urethrography), according to local policy.
- Recurrent UTIs with anogenital signs may be due to sexual abuse.

Table 15.7 Urine microscopy findings and their significance

Red cells	Normally <3/mm^3
White cells	Normally <3/mm^3
Epithelial cells	Present normally—shed from urinary epithelium
Bacteria or fungi	Always abnormal, reflecting infection or specimen contamination
Casts	Hyaline casts: comprise Tamm–Horsfall protein—may be normal, but ↑ in fever, exercise, heart failure, and after diuretics Fine granular casts—may be present normally, eg after exercise Coarse granular casts—abnormal, seen in various renal disorders Red cell casts—imply glomerular disease and glomerular bleeding White cell casts—occur in glomerulonephritis and pyelonephritis Epithelial casts—usually reflect tubular damage
Crystals	Phosphate, urate, and oxalate crystals may not be pathological but are also seen in *Proteus* UTI and hyperuricaemia

Haematuria

Background

Dark or discoloured urine is frightening for both the child and parents. Although it may reflect haematuria, it may reflect other causes: very concentrated urine, beetroot, porphyria, conjugated hyperbilirubinaemia, and free Hb or myoglobin (usually black, as seen in rhabdomyolysis and malaria). Certain drugs or foods may discolour the urine (see Table 15.8).

Table 15.8 Possible alternative causes of discoloured urine

Drug/food	Colour
Rifampicin	Orange/pink
Desferrioxamine, senna, rhubarb	Brown
Methylthioninium chloride (methylene blue)	Green

If haematuria is confirmed by urinalysis, obtain a detailed history, remembering to ask about preceding illnesses and trauma, foreign travel, drug history, and family history of renal or bleeding disorders.

A full relevant examination includes BP and a careful check for abdominal masses and oedema.

Causes of macroscopic haematuria

- UTI (including schistosomiasis).
- Glomerulonephritis.
- Trauma.
- Wilm's tumour.
- Bleeding disorder.
- Urinary tract stones.
- Drugs (warfarin, cyclophosphamide).
- Factitious.

Microscopic haematuria may be associated with exercise or hypercalciuria or can be familial.

Investigations

Send MSU and obtain USS of the urinary tract if there is abdominal pain suggesting stones (relatively rare). Check U&E, blood glucose, FBC, clotting screen, and, if significant bleeding (or if haematuria follows trauma), cross-match. Further tests may be required (throat swab, urine and serum osmolalities, viral titres, anti-streptolysin O, antinuclear antibodies, complement levels), but do not assist emergency treatment.

Management

Severe haematuria with clots requires resuscitation with IV fluids (± blood) but is uncommon in children, except after trauma. Treat associated severe hypertension or hyperkalaemia associated with renal failure as described in ➲ Acute kidney injury, pp. 714–15. Refer children with haematuria of non-traumatic origin to the paediatrician.

Glomerulonephritis

Glomerulonephritis in children is often an immune reaction following an URTI due to β-haemolytic streptococcal infection 2–3 weeks previously. It may present with haematuria, oliguria ± hypertension and uraemia. Refer for admission and further investigation.

A similar presentation can occur with Henoch–Schönlein purpura (see ➔ Purpuric rashes, p. 681), SLE, or Berger's disease (mesangial IgA nephropathy).

Acute kidney injury

Causes

Pre-renal Hypovolaemia (bleeding, dehydration, sepsis), heart failure, nephrotic syndrome.

Renal Haemolytic uraemic syndrome, glomerulonephritis, acute tubular necrosis, drugs.

Post-renal Obstruction following trauma or calculi.

Presentation and investigation

Presentation varies according to the cause. Emergency investigations include MSU for microscopy, culture and sensitivity, urine and plasma osmolality, U&E, blood glucose, FBC, albumin, LFTs, clotting screen, and ECG monitoring.

Treatment

Get expert help early. Pre-renal failure from hypovolaemia (urine:plasma osmolality ratio usually >5) should respond to treatment of the underlying condition and an IV fluid challenge (20mL/kg of 0.9% saline ± blood products, depending on the cause). Urinary catheter and close monitoring may help to assess fluid status. Urgent USS can assess for obstruction of the urinary tract, the presence of stones, and vascular filling status. ED treatment of renal failure focusses on hyperkalaemia and hypertension.

Hypertension

Hypertension related to volume overload in renal failure may require IV nitrate therapy (± diuretic) in the ED (as for pulmonary oedema), but otherwise seek expert help for further intervention.

Hyperkalaemia

Children presenting with hyperkalaemia (K^+ >7) in advanced renal failure may require emergency measures prior to dialysis.

Adopt the following approach to manage hyperkalaemia:

- Obtain expert help.
- Place the child on a cardiac monitor and obtain an ECG.
- If there are ECG changes (widened QRS complexes or tall T waves), give 0.5mL/kg of 10% calcium gluconate over 5min to stabilize the myocardium. This will not significantly alter the blood K^+ level.
- Give nebulized salbutamol (2.5mg if <3y; 5mg if 3–7y; 10mg if >7y). This redistributes and forces K^+ into cells within 30min and may be repeated after 2hr.
- Recheck K^+ and if falling after salbutamol, give calcium resonium 1g/kg PO or PR. If K^+ remains high after salbutamol, assess the pH—if pH <7.34, give sodium bicarbonate 1–2mmol/kg IV; if pH >7.34, give 10% glucose 5mL/kg/hr IV and insulin 0.05U/kg/hr.
- Plan dialysis as necessary.

Note that this approach is also appropriate for other causes of hyperkalaemia (eg adrenal insufficiency, acidosis, cell lysis).

Nephrotic syndrome

Most cases of oedema, heavy proteinuria, and hypoalbuminaemia (± hypercholesterolaemia) are idiopathic ('minimal change nephropathy'). The presentation is diverse and includes: anorexia, lethargy, frothy urine, mild diarrhoea, abdominal pain, ascites, oliguria, and peri-orbital or genital oedema. The prognosis is generally good, but peritonitis and renal or cerebral venous thrombosis may occur.

Check U&E, albumin, LFTs, FBC, complement, cholesterol, and lipids. Refer for further investigation/treatment.

Haemolytic uraemic syndrome

Micro-angiopathic haemolytic anaemia, thrombocytopenia, and renal failure of haemolytic uraemic syndrome typically affect infants/toddlers following a diarrhoeal illness (*Escherichia coli* O157, verocytotoxin, or *Shigella*). The disease is also associated with SLE, HIV, and various tumours. The child may present oliguric or anuric, with ↓ conscious level due to encephalopathy. Mortality is >5%.

FBC reveals anaemia with visible RBC fragments, thrombocytopenia, and leucocytosis. Coombs' test is –ve. Urea and creatinine levels are usually ↑, and there may be electrolyte disturbances.

Treat life-threatening hyperkalaemia as above, and refer for possible dialysis and transfusion.

Poisoning in children

Paediatric poisoning may take many forms:

- Neonatal poisoning from drugs taken by the mother prior to birth (eg opioids, benzodiazepines).
- 'Accidental' (unintentional) poisoning is the most common form of poisoning. It largely involves toddlers and preschool children (boys > girls), who are at particular risk because of their innate curiosity and considerable indiscretion in putting things in their mouths. Children may be poisoned by any drugs that they can get their hands on, but also mushrooms, berries, plants, household items (eg disinfectant), and other objects misinterpreted as drink, food, or sweets (eg button batteries).
- Inadvertent self-poisoning with recreational drugs (including alcohol and volatile agents).
- Iatrogenic poisoning by administration of the wrong dose ± wrong drug can happen with frightening ease. Paediatric dosage charts, calculators, obsessional checking, attention to detail, and automatic checks via electronic prescribing should help to prevent this.
- Deliberate self-poisoning in an apparent suicide attempt occurs in (mostly) older children.
- Intentional poisoning by a parent, guardian, or carer is a sinister aspect of child abuse, which includes fabricated or induced illness (see ➲ Fabricated or induced illness, p. 760). The child may present in a bizarre fashion, with a non-specific illness, for which the diagnosis is not immediately apparent.

Approach

Follow the general guidelines described in ➲ Poisons: background, pp. 188–9; ➲ Diagnosis of poisoning, p. 190; ➲ Poisons: supportive care, p. 191; ➲ Reducing absorption of poison, pp. 192–3; and ➲ Antidotes for poisons, pp. 194–5 to treat poisoned patients, with initial attention to oxygenation (airway), ventilation (breathing), and circulation. The National Poisons Information Service (🖱 https://www.toxbase.org) provides advice for specific poisonings (see ➲ Poisons: background, pp. 188–9). With some notable exceptions (eg paracetamol, opioids, iron, and digoxin), there are few 'antidotes' available—treatment is often largely supportive.

Try to elicit the substance(s) ingested, the amount involved, and the time since ingestion. The majority of ingestions are unintentional and the time to presentation is often short.

Gastric emptying

Procedures designed to empty gastric contents (eg gastric lavage) are rarely indicated—consider only if advised by TOXBASE®. Do not use 'ipecac' (ipecacuanha), which is ineffective in ↓ drug absorption and can be dangerous. *Never* try to empty the stomach following ingestion of petrol or corrosives (see ➲ Petrol and paraffin poisoning, p. 213).

Charcoal

The role of charcoal (dose 1g/kg PO in infants; 15–30g in older children) in paediatric poisoning is limited by its lack of palatability. Attempts are currently being made to make charcoal more palatable, yet remaining effective.

Prevention of paediatric poisoning

Background

Poisoning in children is very common. More than 40,000 children present to hospital in the UK each year, many of whom are admitted for observation. Thankfully, relatively few (10–15/y) die. More than 75% of paediatric unintentional ingestions involve drugs and poisons in the home that are plainly visible to the child. Poisoning is particularly likely to occur at times of 'stress' (eg arrival of new baby, disturbed parental relationships, moving house) when there may be ↓ supervision and disruption of the usual routine. Perhaps partly for this reason, children who present with a first episode of poisoning are at ↑ risk of further episodes. It is therefore important to advise the parents of ways of preventing poisoning in children (see list in ➲ Advice for parents (consider providing a leaflet), p. 717).

Official measures: packaging of drugs

Legislation has been introduced to try to tackle the problem of poisoning in children. Perhaps the most successful has been the widespread adoption of child-resistant drug containers. Unfortunately, it is not yet mandatory for these containers to be used for liquid drugs or potentially dangerous household items such as bleach. Some drugs are presented in 'strip packaging', in the hope that an impulsive child would lose interest before gaining access to a significant quantity.

Advice for parents (consider providing a leaflet)

- Provide adequate supervision for toddlers and young children, particularly when visiting friends and relatives.
- Keep all medicines locked out of reach in a cupboard.
- Only purchase those drugs presented in child-resistant containers.
- Dispose of out-of-date drugs and those no longer required.
- Never refer to drugs as 'sweets' in an attempt to encourage the child to take them.
- Take medicines out of sight of the child to help prevent imitation.
- Keep all alcohol, perfumes, cosmetics, detergents, and bleaches out of reach.
- Ensure that all turpentine, paints, and weed killers are securely locked and inaccessible.
- Give away all toxic plants.
- Keep ashtrays and waste baskets empty.

Gastroenteritis in children

(See also an overview in ➲ Gastroenteritis/food poisoning, pp. 236–7.)

A baby's parents may seek advice about diarrhoea when, in fact, the stools are normal. Breastfed babies almost always have loose stools, which may be yellow or green and very frequent, often after every feed. However, gastroenteritis is relatively rare in fully breastfed babies. In children aged >6 months, normal stool frequency ranges from one stool on alternate days to three stools daily.

Assessment of dehydration

Clinical evidence of mild dehydration (<5%)

- Thirst.
- ↓ urinary output (in a baby <4 wet nappies in 24hr).
- Dry mouth.

Clinical evidence of moderate dehydration (5–10%)

- Sunken fontanelle in infants.
- Sunken eyes.
- Tachypnoea (due to metabolic acidosis).
- Tachycardia.

Clinical evidence of severe dehydration (>10%)

- ↓ skin turgor on pinching the skin.
- Drowsiness/lethargy or irritability.

Admission decision

It can be difficult to decide whether or not to admit a child to hospital for treatment. Admit if the child looks seriously ill, is clinically >5% dehydrated, has not passed urine for >12hr, or has a high fever, or there is doubt about the diagnosis or the family are unlikely to cope at home.

Refer for admission children with bloody and/or mucoid diarrhoea—to exclude *Escherichia coli* O157 infection, which may ↑ the risk of developing haemolytic uraemic syndrome.

Babies aged <3 months may be difficult to assess and can deteriorate rapidly—refer for admission.

In children who are less seriously ill, consider making the decision about admission based upon the response to oral rehydration therapy.

Management

Treat severely dehydrated (>10%) children with immediate IV fluids, initially 0.9% saline (10mL/kg over 5min, repeated as necessary).

Consider IV fluids for children with moderate dehydration, especially if they are vomiting and unable to keep oral fluids down.

Give a trial of oral rehydration therapy to children with mild dehydration, with the aim of discharging them if the trial feed is successful (see ➲ Oral rehydration therapy, p. 719).

Oral rehydration therapy

(See NICE guidance—https://www.nice.org.uk)

If a child with mild dehydration makes a satisfactory response to a test feed, consider discharge with oral rehydration therapy. Standard products (eg Dioralyte®) contain glucose, Na^+, K^+, Cl^-, and citrate (details in *BNF*). Glucose is important to enhance absorption of Na^+ and water.

Rehydrate according to age:

- Children aged ≤5y: give 50mL/kg of oral rehydration therapy for fluid deficit replacement over 4hr, as well as maintenance fluid (see Table 15.9).
- Children >5y: give 200mL of oral rehydration therapy after each loose stool, in addition to maintenance fluid (see Table 15.9).

Advice for parents

- Give oral replacement therapy frequently and in small amounts, and seek urgent medical advice if the child vomits repeatedly or is unable to drink.
- If the child is slow to recover, give 5mL/kg of oral rehydration therapy after each large watery stool.
- Avoid solid food until dehydration has been corrected, then reintroduce the usual diet, but avoid fruit juice and fizzy drinks until diarrhoea has stopped, as these often have high osmolarity and may worsen diarrhoea.

Additional treatments

Do not prescribe anti-diarrhoeal agents, probiotics, or antiemetic drugs for children with gastroenteritis. Similarly, do not give antibiotics without specialist advice (eg proven *Salmonella* in immunocompromised or young babies).

Table 15.9 Daily maintenance fluid requirements in children

Child weight	Daily maintenance fluid volume
0–10kg	100mL/kg
10–20kg	1000mL + 50mL/kg for every kg over 10kg
>20kg	1500mL + 20mL/kg for every kg over 20kg

Abdominal pain in children

The approach to the initial assessment and management of children presenting with abdominal pain is similar in many ways to that in adults (see ➲ Approach to abdominal pain, pp. 520–1). Beware underlying 'medical' causes (eg DKA, pneumonia). Disease processes may progress with great rapidity in children, so adopt a low threshold for referring children with abdominal pain to the surgical team. Whilst many of the common causes of abdominal pain are the same in children as in adults (eg ➲ Acute appendicitis, p. 523), be aware of causes that are typically paediatric (eg intussusception). Likewise, certain causes of intestinal obstruction are seen almost exclusively in children. Avoid performing PR examination.

Paediatric causes of intestinal obstruction

- Congenital (eg oesophageal/duodenal atresia, Hirschsprung's disease).
- Meconium ileus.
- Hypertrophic pyloric stenosis.
- Intussusception.
- Hernia (inguinal, umbilical).

Hypertrophic pyloric stenosis

Features

Relatively common, this typically presents with effortless vomiting at 2–10 weeks. It occurs more often in boys than girls and in first-born children. Vomiting becomes projectile, with progressive dehydration and constipation. The vomit is not bile-stained. After vomiting, the baby appears hungry and keen to feed again. In advanced cases, there may be profound hypochloraemic alkalosis, with associated hypokalaemia.

Diagnosis

Look for visible peristalsis. Abdominal palpation confirms the diagnosis if an olive-sized lump is felt in the epigastrium (most prominent during a test feed). If the diagnosis is suspected, but not proven clinically, resuscitate (as below) and arrange USS.

Management

Once diagnosed, keep the infant nil by mouth. Insert an IV cannula and send blood for U&E, glucose, and FBC. Start fluid resuscitation under senior guidance and refer to the surgeon—operative treatment will be delayed until dehydration and electrolyte abnormalities have been corrected (this may take >24hr). Defer insertion of an NG tube for appropriately experienced staff.

Volvulus

This is associated with congenital malrotations but may occur in other circumstances also (eg Meckel's diverticulum, adhesions from previous surgery). It can present with abdominal pain and other features of intestinal obstruction (vomiting, distension), sometimes with a palpable mass. Obtain an abdominal X-ray and refer promptly to the surgical team in order to maximize the chance of intervening to preserve bowel.

Intussusception

Telescoping of one segment of bowel into another may affect the small or large bowel, but most cases are ileocolic. This typically affects children aged between 6 months and 4y. The child may suddenly become distressed, roll up into a ball, and appear unwell. Vomiting may develop and the child may pass a 'redcurrant jelly' stool. These features, however, together with pyrexia and a palpable mass, are not invariably present—sometimes the presentation is shock without an obvious cause. X-rays may be normal or reveal an absent caecal shadow.

If intussusception is suspected, refer urgently to the surgical team. The diagnosis may be confirmed by air or barium enema, which may also be curative, by reducing the intussusception. A barium enema characteristically reveals a 'coiled spring' sign or sudden termination of the barium but is contraindicated if there is evidence of perforation.

Acute appendicitis

(See ➲ Acute appendicitis, p. 523.)

Consider this diagnosis in any child presenting with abdominal pain. Acute appendicitis can occur in children of all ages. It can be a difficult diagnosis to make, especially in the very young. 'Atypical' clinical presentation (eg diarrhoeal illness) is often associated with delayed diagnosis and an ↑ rate of perforation. Do not perform a PR examination—in the unlikely event of this being considered essential, leave it to the surgical team.

Abdominal mass

There are many causes of abdominal masses in children, many of which may be relatively benign and asymptomatic:

- Full bladder.
- Full colon.
- Enlarged liver and/or spleen.
- Pregnancy in older children.
- Hydronephrosis.
- Hypertrophic pyloric stenosis (see ➲ Hypertrophic pyloric stenosis, p. 720).
- Appendix mass.
- Intussusception.
- Volvulus.
- Neuroblastoma.
- Nephroblastoma (Wilm's tumour).

Intra-abdominal malignancy

Neuroblastoma and nephroblastoma may reach a large size before causing symptoms (eg haemorrhage into the tumour).

Neuroblastomas Arise most commonly from the adrenal glands but may occur at any point along the sympathetic chain.

Nephroblastomas (Wilm's tumours) Arise from the kidneys and may present with haematuria.

All children with suspected malignant abdominal masses require CT scan and/or USS investigation—refer urgently to the surgical team.

Inguinal and scrotal swellings

Painless groin and scrotal lumps

The parent or child who discovers a lump may become very concerned. The absence of pain is, to some extent, reassuring, in that an acute surgical problem is unlikely. Ascertain when the swelling appeared, whether it changes in size or disappears, or whether there are any other symptoms.

Reducible inguinal hernia

Inguinal hernias in childhood result from a persistent patent processus vaginalis and are therefore indirect in nature. They are more common in boys than girls and often bilateral. The history is typically of an intermittent swelling, which appears with coughing or straining. If the swelling can be demonstrated, it will be impossible to get above it. If it cannot be demonstrated, a thickened spermatic cord may be palpated (sometimes known as the 'silk sign'). Refer neonatal hernias for admission and surgery, and refer infants and older children to a surgical clinic for elective surgery.

Painless irreducible inguinal hernia

Refer all irreducible inguinal hernias for admission and surgery (preceded by gallows traction in the infant).

Hydrocele

This transilluminable painless scrotal swelling has a similar aetiology to inguinal hernia. It appears gradually, rather than suddenly, and does not empty or reduce on palpation. Refer to a surgical clinic. An encysted hydrocele of the cord may be impossible to distinguish from an irreducible inguinal hernia and therefore requires surgical exploration.

Undescended, retractile, or ectopic testis

Complete descent of the testis has yet to occur in 3% of term infants and 30% of premature infants. Arrange surgical follow-up if the testis cannot be brought down to the fundus of the scrotal sac—orchidopexy will be required if the testis fails to descend by 4y.

Inguinal lymphadenopathy

This is on the list of differential diagnoses of painless inguinal swellings. Look for a potential source of infection in the leg and for involvement of any other lymph node groups.

Idiopathic scrotal oedema

An obscure allergic condition of the scrotal skin is possibly a variant of angioneurotic oedema. Redness, mild tenderness, and oedema are not limited to one hemiscrotum. The testis is normal. The condition settles spontaneously, a process helped by antihistamines (eg chlorphenamine PO, doses: child 1–2y require 1mg bd; 2–5y require 1mg qds; 6–12y require 2mg qds). If in doubt—refer.

Painful groin and scrotal lumps

Painful irreducible inguinal hernia

Likely to contain obstructed or strangulated small bowel. Confirm clinical suspicion of intestinal obstruction (pain, vomiting, and abdominal distension) by X-ray. Resuscitate as necessary with IV fluids; give analgesia, and refer for surgery.

Testicular torsion

Most common in the neonatal period and around puberty. In the neonatal period, torsion is extravaginal in nature and often diagnosed late. Later in childhood, torsion of a completely descended testis is intravaginal due to high insertion of the tunica vaginalis. Undescended testes are also at particular risk of torsion. Classical presentation is with sudden-onset severe pain and vomiting. Occasionally, the pain is entirely abdominal. Examination reveals a red, tender, swollen testis. The opposite testis may be seen to lie horizontally, rather than vertically (Angell's sign). Fast and refer all suspected torsions for urgent surgery: exploration, untwisting, and bilateral orchidopexy.

The diagnosis of testicular torsion is not always clear-cut—USS can sometimes be helpful in making the diagnosis, but do not allow this to delay referral to the surgical team.

Torsion of the hydatid of Morgagni

This remnant of the paramesonephric duct on the superior aspect of the testis is prone to undergo torsion, causing pain and vomiting. The pain is typically less severe than in testicular torsion, with a more gradual onset. A discrete, tender (~3cm) nodule may be palpable near the upper pole of the testis—the classic description is of it transilluminating as a blue dot, but this is rarely seen in practice. In contrast to testicular torsion, the remainder of the testis is not tender.

Refer to the surgical team and consider an urgent USS. If testicular torsion is excluded and a definite diagnosis of torsion of the hydatid of Morgagni is made, the surgical team can choose between conservative treatment (analgesia and rest) or surgical excision of the hydatid.

Epididymo-orchitis

Relatively unusual in the paediatric age group but may be associated with UTI. A painful, swollen red testis and epididymis usually develop over a longer period of time. Treatment is with antibiotics (eg ciprofloxacin), but it may be difficult to distinguish from testicular torsion, so refer for an urgent surgical opinion.

Mumps orchitis

The diagnosis is usually apparent because of parotitis (see ➲ Childhood infectious diseases, pp. 230–1). Refer if there is doubt or symptoms are severe.

Henoch–Schönlein purpura

Occasionally, testicular pain may be one of the initial presenting complaints of Henoch–Schönlein purpura (see ➲ Purpuric rashes, p. 681).

Foreskin problems and zip entrapment

Phimosis

The foreskin may normally remain non-retractile up to age 5y. Foreskin that remains non-retractile after this, which 'balloons' on micturition, or is associated with recurrent balanitis may benefit from surgery (preputial stretch or circumcision). Advise the parents to see their GP to discuss referral to a paediatric surgeon.

Balanitis

Balanitis produces redness, swelling, and even pus. Take a swab; check for glucose in the urine and send an MSU. Treat with PO flucloxacillin or clarithromycin, and suggest GP follow-up. If redness and swelling involve the whole penis, refer for IV antibiotics.

Paraphimosis

An irreducible, retracted foreskin results in pain and swelling of the glans. As in the adult, cold compresses and lubricating jelly may allow manual reduction to be performed. If this is not successful, refer for reduction under GA.

Penile zip entrapment

Unfortunately, underpants do not completely protect boys (and sometimes men) from catching their foreskins in trouser zips. On many occasions, the entrapment will be released quickly by the child or parent. On others, the child will present to the ED.

The optimal method to achieve release depends upon the entrapment

- 15% of entrapments follow the foreskin moving through the moveable part of the zip, so that it is simply caught between the teeth of the zip alone. In this case, achieve easy release by cutting transversely through the zip below the entrapment.
- 85% of entrapments involve the foreskin being caught between the teeth and the moveable part of the zip. LA (either injection using plain lidocaine or topical gel) may allow manipulation and release. If this fails, the least traumatic option is to divide the moveable part of the zip into two parts by dividing the central section ('median bar' or 'bridge') using bone cutters or wire cutters (use gauze to protect against parts of the zip flying off) (see Fig. 15.18). Older children and adults may tolerate this in the ED, but in younger boys referral for release under GA is sensible. Circumcision is rarely required.

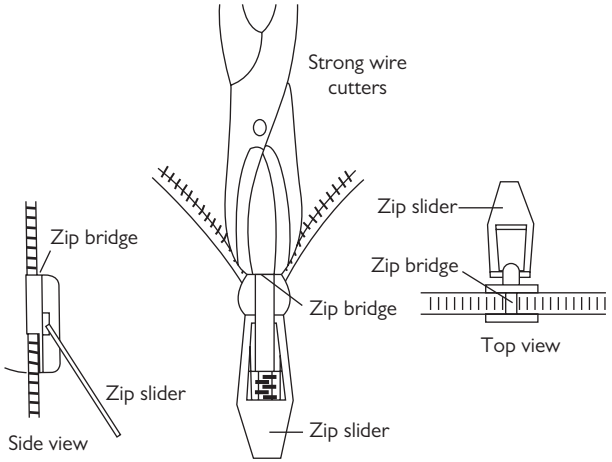


Fig. 15.18 Method to achieve release from zip entrapment.

The limping child

This common problem can cause diagnostic difficulty, particularly in the young child who cannot provide a history and is difficult to examine. Start by searching for, and trying to, exclude some causes of a limp that will require urgent treatment.

Consider the following

- Trauma (fractures, soft tissue injury, FB in foot, NAI).
- Specific hip problems (Perthes', slipped epiphysis, irritable hip—see ➔ The painful hip, pp. 728–9).
- Infection (osteomyelitis, septic arthritis).
- Arthritis (juvenile idiopathic arthritis, juvenile ankylosing spondylitis).
- Osteochondritis (see ➔ Osteochondritis, pp. 730–1).
- Referred pain from an inflammatory process elsewhere.
- Malignant disease (Ewing's sarcoma, leukaemia).
- Sickle-cell crisis (see ➔ Sickle-cell disease, pp. 184–5).

Adopt the following approach.

History

Ascertain whether the problem developed suddenly (eg after trauma) or gradually. Enquire about recent illness and other symptoms, including joint pains elsewhere.

Examination

Check T°. If the child is walking, assess the gait. Carefully inspect all of the painful leg for erythema, swelling, and deformity, and note the position adopted. Exclude a relatively simple problem such as a FB embedded in the foot. Note any skin rashes. Palpate the limb for tenderness, joint effusions, and range of movement (compare with the other side). If the child will not walk but can crawl without any apparent discomfort, this localizes the problem to below the knee (thereby avoiding the need to request 'routine' X-rays of the hips).

Investigation

If the child can walk and looks well, and there is no abnormality apparent on examination, consider providing analgesia and arranging to review after a couple of days, rather than undertaking all of the following investigations immediately. Ensure the parents are told that they should return earlier if the limp gets worse.

X-ray the tender or swollen part, particularly if there is a history of injury. If there is no obvious tenderness, X-ray the pelvis to include both hips. If the X-rays do not reveal a fracture, check WCC and CRP (or plasma viscosity/ESR). If the hip is implicated, but X-rays are normal, request USS of the hip (some experts prefer to use USS as the initial investigation). MRI is emerging as having a potentially useful role. Follow local ED protocols where available.

Management

Treat according to the cause (see below; see also ➔ The painful hip, pp. 728–9; ➔ Osteochondritis, pp. 730–1).

Trauma

Treat according to the cause, which may include a FB in the soft tissues. There may not always be a clear history of injury—this particularly applies to toddler's fracture (see ➲ Tibial fractures in children, p. 754). However, the abrupt onset of a limp in a toddler may be a clue to an underlying traumatic cause.

Osteomyelitis

Acute osteomyelitis usually results from blood-borne spread of a distant pathogen (eg from the respiratory tract). *Staphylococcus aureus* is usually responsible, with almost invariable involvement of the metaphysis of a long bone (most commonly proximal or distal femur, or distal tibia).

Features ↑ T°, lethargy, localized tenderness (which may be misdiagnosed as trauma). Septic shock may occur (especially in infants).

Investigations ↑ WCC, ↑ CRP, ↑ ESR >50mm/hr (but all may be normal initially). Send blood cultures which may help to guide later antibiotic use. X-ray changes occur after ~10 days. MRI may enable an earlier diagnosis.

Treatment If suspected, refer for admission, IV antibiotics ± surgical drilling/drainage.

Septic arthritis

Most commonly, *S. aureus* infection in the hip or knee, particularly affecting preschool children. Occasionally secondary to penetrating injury, but usually haematogenous spread from a distant site. Constitutional symptoms, fever, and joint pain occur. Joint movement is likely to be severely impaired. A joint effusion may be clinically evident (and confirmed on USS). Investigations may reveal ↑ WCC, ↑ CRP, and ↑ ESR. Refer for urgent confirmatory joint aspiration and treatment.

Traditionally, the four Kocher criteria (T° ≥38.5°C; non-weight-bearing on the affected side; ESR >40mm/hr; WCC >12 × 10^9/L) have been used to estimate the chance of a child having septic arthritis of the hip. The presence of three criteria is associated with a >90% chance of septic arthritis.

Non-septic arthritis

Multiple painful joints are more likely to be due to a juvenile arthritic process (eg juvenile idiopathic arthritis or ankylosing spondylitis) than septic arthritis. Pain felt in several joints frequently accompanies a variety of infections and other diseases (eg rubella, rheumatic fever, Lyme disease, Henoch–Schönlein purpura). Refer to the paediatrician for further investigation.

The painful hip

The limping child may be able to localize pain to the hip, but hip pain may be referred to the knee. Hip problems causing a limp include trauma, infection, and other disorders, as described in ➲ The limping child, pp. 726–7. Specific hip problems include the following.

Perthes' disease (Legg–Calvé–Perthes' disease)

Aseptic necrosis of the upper femoral (capital) epiphysis presents with a painful limp in children aged 3–10y. Boys are affected more than girls (♂:♀ = 4:1); 15% are bilateral. Aetiology is unclear, but Perthes' disease is often grouped with osteochondritides (see ➲ Osteochondritis, pp. 730–1). Often ↓ range of hip movement due to pain. FBC, CRP, ESR, and blood cultures are normal.

X-ray changes Reflect the stage of disease and are progressive (as shown in Fig. 15.19):

1 ↑ joint space on medial aspect of capital epiphysis (compare sides).
2 ↑ bone density in affected epiphysis (appears sclerotic).
3 Fragmentation, distortion (flattening), and lateral subluxation of upper femoral epiphysis (leaving part of the femoral head 'uncovered').
4 Rarefaction of the adjacent metaphysis in which cysts may appear.

Treatment Refer for specialist assessment and treatment. Most cases respond satisfactorily to conservative therapy.

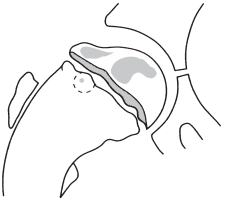


Fig. 15.19 Changes in the hip in Perthes' disease.

Irritable hip ('transient synovitis')

Common cause of sudden painful hip and limp in children of all ages. Aetiology is unclear, but many cases may follow viral illness. Presentation varies from a slight limp to great difficulty weight-bearing. X-rays are normal. USS may show hip effusion and allow aspiration for microscopy and culture. (Apply tetracaine cream over the hip before USS.) Pyrexia, ↑ WCC, ↑ CRP (and/or ↑ ESR/plasma viscosity) suggest infection.

Treatment If significant physical signs (significant pain, ↓ movement, difficulty weight-bearing) or there is evidence suggesting infection, refer to the orthopaedic team for admission for rest, traction, and further investigation. If physical signs are not dramatic and X-rays and blood tests are normal, discharge with NSAID, advise rest, and review within a few days.

Slipped upper femoral (capital) epiphysis

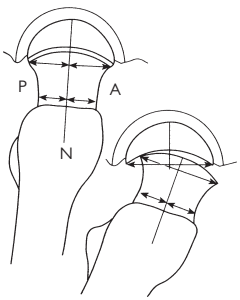
Sometimes occurs during puberty and has been attributed to hormonal imbalance (see Fig. 15.20). It occurs in children (particularly boys: ♂:♀ = 3:1) who have one of two body types: obese with underdeveloped genitalia or tall, thin, rapidly growing adolescent with normal sexual development. It may present with knee (not hip) pain.

Presentation A child aged 10–16y develops a painful limp suddenly or gradually. Often there is a history of trauma. The leg may be slightly adducted, externally rotated, and shortened. Movement of the affected hip is ↓, compared with the other side (especially abduction and internal rotation).

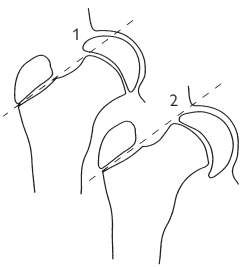
X-ray Obtain AP pelvis and lateral hip views ± 'frog leg' views. Subtle slips may only be seen on the lateral view. Larger slips will be obvious on all views. Look for Trethowan's sign—a line drawn along the superior border of the femoral neck normally cuts through the epiphysis (see Fig. 15.21).

Treatment Refer to orthopaedics for internal fixation ± manipulation.

Complications Avascular necrosis, chondrolysis, and osteoarthritis.



Lateral view showing normal (left) and abnormal (right)



AP view: Trethowan's sign; (1) normal, (2) abnormal hip

Fig. 15.20 Diagrams of slipped upper femoral epiphysis.

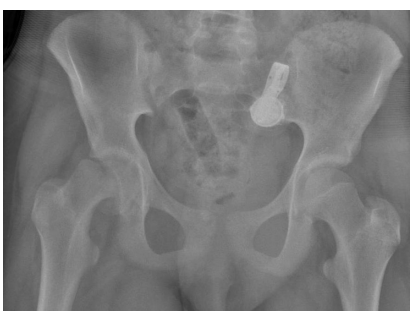


Fig. 15.21 X-ray showing slipped right upper femoral epiphysis.

Osteochondritis

This term is applied to a heterogenous array of non-infectious disorders affecting various epiphyses. They may be divided into three groups, according to the proposed aetiology (see Table 15.10).

Crushing osteochondritis

Apparently spontaneous necrosis of an ossification centre occurs at a time of rapid growth. This is followed by new bone formation.

Perthes' disease See ➲ The painful hip, pp. 728–9.

Scheuermann's disease Fragmentation of low thoracic/upper lumbar vertebral epiphyseal plates of adolescents results in chronic back pain and a 'round-shouldered' kyphotic appearance. X-rays show anterior wedging of vertebral bodies, with sclerotic notches (Schmorl's nodes) on inferior or superior vertebral borders. Diagnostic criteria are >50° of kyphosis and wedging in three adjacent vertebrae. Treat symptomatically with NSAID and refer for orthopaedic follow-up.

Kohler's disease Avascular necrosis of the navicular affects children (particularly boys) aged 3–5y. A painful limp develops, with tenderness on the dorsum of the foot over the navicular. The sclerotic fragmented navicular seen on X-ray is also seen in many asymptomatic children. Treat symptoms with rest, NSAID, and orthopaedic follow-up. If symptoms are severe, consider a BKPOP.

Kienbock's and Freiberg's disease Usually affect young adults.

Traction apophysitis

The pull of a strong tendon causes damage to the unfused apophysis to which it is attached.

Osgood–Schlatter's disease Traction apophysitis of the tibial attachment of the patellar tendon is especially seen in boys aged 10–15y. Symptoms may start after a period of excessive activity. Anterior knee pain after exercise is characteristic. The tibial tuberosity is prominent and tender. The pain may be reproduced by attempted extension against resistance.

X-rays are not always needed but may show an enlarged and sometimes fragmented tibial tuberosity. Treat symptomatically with rest, NSAID, and orthopaedic follow-up. Most settle with conservative measures, although children may find this process to be frustrating.

Johansson–Larsen's disease (Sinding Larsen's disease) Traction apophysitis of the lower pole of the patella in young adolescents results in local tenderness. Treat with rest, NSAID, and orthopaedic follow-up.

Sever's disease Traction apophysitis of the calcaneal attachment of the Achilles tendon occurs in 8–14y olds. The resulting limp is associated with local calcaneal tenderness. X-rays may reveal a fragmented sclerotic calcaneal apophysis. Treat with rest, NSAID, a heel raise, and orthopaedic follow-up.

Osteochondritis dissecans

A piece of articular cartilage and adjacent bone become partially or completely separated as an avascular fragment. The cause is believed to be an osteochondral fracture from repeated minor trauma. The lateral aspect of the medial condyle of the distal femur is the most commonly affected site (see Fig. 15.22). Intermittent pain, swelling, and joint effusion result. If the fragment becomes detached as a loose body, locking or giving way may occur.

X-ray Demonstrates a bony fragment or defect. Often the small bony fragment is accompanied by a larger piece of cartilage (which is not seen on X-ray). MRI will demonstrate both.

Treatment Refer the locked knee immediately. Treat the remainder with rest; consider crutches, and arrange orthopaedic follow-up.

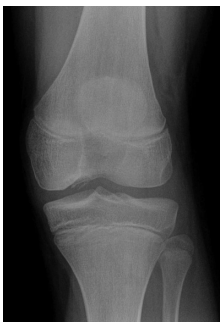


Fig. 15.22 X-ray of osteochondritis dissecans in a 13y old.

Table 15.10 Classification of osteochondritis

Type of osteochondritis	Bone affected	Eponym
Crushing osteochondritis	Femoral head	Perthes' disease (see ➲ The painful hip, pp. 728–9)
	Vertebrae	Scheuermann's disease
	Second metatarsal head	Freiberg's disease
	Navicular	Kohler's disease
	Lunate	Kienbock's disease
	Capitulum	Panner's disease
Osteochondritis dissecans	Medial femoral condyle	
	Talus	
	Elbow	
	Metatarsal	
Traction apophysitis	Tibial tuberosity	Osgood–Schlatter's disease
	Lower pole of patella	Johansson–Larsen's disease
	Calcaneum	Sever's disease

Major paediatric trauma

Background

Trauma is the largest single cause of death in children: ~500 deaths per year in the UK (see Table 15.11). As in adults, blunt injury in children is far more common than penetrating injury. The number of deaths in children after trauma is dwarfed by the number who sustain serious injuries. Most serious injuries result from road traffic collisions.

Table 15.11 Causes of trauma deaths in children

Road traffic collisions	48%
Fires	15%
Drowning	12%
Hanging	8%
Falls	8%
NAI	5%
Other	4%

More than 70% of paediatric trauma deaths occur in the prehospital setting. Most of these children are either dead when found or have sustained overwhelming injuries. The greatest potential for reducing trauma deaths clearly lies with injury prevention. However, there is enormous potential to reduce the number of permanently disabled children by early identification of injuries and expert treatment. The best outcome results from involvement of senior and experienced staff at an early stage. Prompt recognition of the seriously injured child is crucial to this.

Pattern of injuries

Anatomical and physiological differences mean that the pattern of injuries in children differ considerably from those in adults. Compared with adults, children have: smaller physical size, a relatively larger head, more compliant bones, a higher ratio of surface area to body weight, and epiphyses. Experience and an awareness of the patterns of paediatric injury will assist resuscitation efforts. The smaller size and physical proximity of internal organs frequently result in the dissipated forces causing injuries to multiple structures (multiple injuries). The compliance of the bony thoracic cage in children allows significant underlying organ injury without rib fractures. Similarly, certain injuries not uncommon in adults (eg rupture of the thoracic aorta) rarely occur in children.

Injury prevention

Terminology

The term 'accident' implies an unforeseen unintentional event, one which occurs by chance. The implication is that 'accidents' cannot be prevented. However, there is much evidence that 'accidents' are far from random events but are relatively predictable and amenable to prevention. For this reason, experts now prefer to avoid use of the terms 'accidents' and 'accident prevention' and refer to 'injury prevention' instead. Similarly, 'accident and emergency deparments' have become 'emergency departments'.

Background

Injuries to children tend to occur more frequently in certain groups and at certain times:

- Boys sustain more injuries than girls.
- Injuries are associated with social deprivation.
- Injuries often occur at times of family stress and change (including marital disharmony, moving house, and holidays).

Prevention theory

Prevention of injury does not simply refer to physical injuries, but poisonings also. Injuries and/or the effects of injuries may be prevented in a number of different ways:

Primary prevention measures Stop injuries occurring, eg installing fences around domestic swimming pools may reduce drowning and locked medicine cabinets might prevent inadvertent poisoning.

Secondary prevention measures Reduce the extent of harm caused by an injurious event. The most obvious examples are helmets, seat belts, and air bags in the context of road traffic collisions.

Tertiary 'prevention' Includes first aid and hospital treatment, and aims to limit the effect of an injury after it has already happened (eg surgery to stop intra-abdominal haemorrhage, antidotes for certain poisons).

Prevention strategies and the role of ED staff

The focus of staff treating injured patients has understandably always been the injuries themselves ('tertiary prevention'). In addition to any possible issues of NAI, ED staff need to consider how future injuries to children might be prevented (eg by discussing with parents the benefits of bicycle helmets). In the context of an individual child, it may sometimes be appropriate to contact the GP/health visitor with a view to seeing if interventions might prevent future injuries to a particular child and siblings.

More general interventions include:

- Leaflets and posters in the waiting room to target a captive audience.
- Media involvement (eg to minimize risks of fireworks and sparklers).

Further details of children's injuries and injury prevention are available from the Royal Society for the Prevention of Accidents (https://www.rospa.org.uk) and the Child Accident Prevention Trust (https://www.capt.com).

Resuscitation of the injured child

The priorities in managing major paediatric trauma (Airway, Breathing, Circulation) are the same as in adults (see ➲ Major trauma: treatment principles, p. 330). Staff accustomed to treating adults may have difficulty with equipment sizes and drug doses. Establish/estimate the child's weight (see ➲ Weight estimation, p. 649). Call for help as soon as a seriously injured child arrives (or is expected) in the ED—senior ED doctor, ICU/PICU doctor, and surgeon. It is often very helpful to seek the help of a paediatrician to assist with vascular access and calculation of drug doses, particularly for preschool children.

Apply pressure to stop catastrophic external haemorrhage, and give tranexamic acid slow IVI (15mg/kg, up to max 1g) as soon as possible.

Airway with cervical spine control

Clear and secure the airway (suction and adjuncts), and provide O_2 as required. If the airway is obstructed, use jaw thrust (not head tilt/chin lift), and call for expert help (senior ED/PICU/ICU) as intubation may be required. Ensure manual immobilization of the cervical spine is maintained whilst a patent airway is being obtained. When the airway is secure, consider the possibility of neck injury and the need for tape and sandbags until injury to the cervical spine has been excluded.

Breathing

Quickly exclude and treat life-threatening chest injuries. Children are prone to swallow air, placing them at risk of massive gastric dilatation (can cause ↓ BP and subsequent aspiration)—consider an orogastric tube.

Circulation with haemorrhage control

Hypotension is a late sign of hypovolaemia. Look for other evidence: tachycardia, tachypnoea, agitation, lethargy, and pale cold skin, with ↓ CRT (best elicited on the sternum). Get venous access (consider IO, as described in ➲ Intra-osseous infusion, pp. 656–7). Treat hypovolaemia by stopping haemorrhage (splinting fractures, applying pressure to wounds, prompt surgery) and giving IV blood. The approach to treat haemorrhage in trauma has changed in recent years—instead of giving large amounts of IV crystalloid, it is better to replace blood with blood. If blood products are not immediately available, give warmed 0.9% saline 10mL/kg IV.

If the child remains shocked, give 5mL/kg boluses of warmed packed red cells and FFP, aiming for a red cells:FFP ratio of 1:1.

Request a major haemorrhage pack (packed red cells, FFP, and platelets) and transfuse as required, monitoring Hb (aim no higher than 120g/L).

After blood products 40mL/kg, give platelets 10–15mL/kg IV—aim to keep the platelet count >100 × 10^9/L.

After blood products 40mL/kg, give calcium chloride 0.1mL/kg IV—aim to keep ionized Ca^{2+} >1mmol/L.

Discuss the need for cryoprecipitate (10mL/kg) and activated factor VII with the haematologist.

Disability

Make a rapid assessment of the child's neurological status, using the 'AVPU' system (see ➔ Head injury: triage and monitoring, p. 364).

Exposure

Early complete inspection is mandatory, but subsequently cover the child as much as possible in order to ↓ anxiety and prevent excessive heat loss.

Analgesia

(See ➔ Analgesia in specific situations, pp. 290–1.)

Analgesia is often forgotten or not considered early enough, even with major injuries. Prompt and adequate analgesia given to injured children will gain their confidence, enhancing assessment and treatment. Give IV analgesia titrated according to response. Do not use IM or SC analgesia.

In *severe pain*, give morphine IV:

- Up to 100mcg/kg over 5min if 6–12 months.
- Up to 200mcg/kg over 5min if >12 months.

Certain fractures are amenable to LA nerve block techniques (eg femoral nerve block for femoral shaft fractures—see ➔ Femoral nerve block, p. 313). Nasal diamorphine (see ➔ Analgesia in specific situations, pp. 290–1) and Entonox® (see ➔ Analgesics: Entonox® and ketamine, p. 287) may also be useful for analgesia before IV access is available.

Further history

After completing the primary survey and initial resuscitation, gain a more detailed history of how the injury occurred, together with the personal history, including:

- Allergies.
- Medication.
- Past medical history (and immunizations).
- Last mealtime.
- Events and environment relating to the injury.

Imaging

A whole body ('pan') CT scan is the quickest way to determine the nature and extent of major injuries, but this needs to be balanced against the risk of a relatively large dose of radiation in a young person. Therefore, the team leader will aim to target CT to minimize radiation exposure. X-rays still have a role to play in some situations (see https://rcr.ac.uk).

Parents

Remember the parents' needs—allocate a member of staff to this task (see ➔ Interacting with parents, p. 648). Children who have suffered a traumatic event are at risk of developing post-traumatic stress disorder—inform the parents or guardians about this. Briefly describe possible symptoms (sleep disturbance, nightmares, difficulty concentrating, and irritability). Suggest to the parents/guardians that they contact the child's GP if symptoms persist beyond 1 month (see NICE guideline NG116, published 2018, available at: https://www.nice.org.uk).

Assessing head injuries in children

The principles of head injury management in children are the same as in adults (see ➲ Head injury: imaging, pp. 370; ➲ Management of serious head injury, pp. 372–3; ➲ Minor head injury, pp. 374–5), but there are some important differences (including the assessment of conscious level in small children).

Background

Of those children who die from trauma, most succumb to head injuries. Anatomical differences are relevant. In infants, unfused sutures allow the intracranial volume to ↑ with intracranial haemorrhage, causing relatively large bleeds and even shock. Similarly, scalp wounds in infants and young children may bleed profusely and can result in significant hypovolaemia.

Causes of head injury

Most head injuries in children are due to falls, but few of these cause serious injury. Severe head injury is often the result of a child running out in front of a vehicle. Some deaths are caused by NAI (see ➲ Head injuries, p. 760), especially in babies who have been shaken violently, dropped, or thrown.

Assessment of a head-injured child

History

Assessment of children may prove to be difficult. An isolated episode of vomiting after minor head injury is a frequent occurrence.

Record details of the injurious event, the time it occurred, and the condition of the child before and after the injury. Ascertain if the child was previously well. In particular, elicit any history of fits or bleeding disorder. An infection can render a child prone to falls and also cause subsequent symptoms—a small child who vomits after a fall may be suffering from otitis media, rather than the effects of a head injury.

Determine the condition of the child immediately after injury—if he cried at once, he did not lose consciousness. Record if he was unconscious, confused, or drowsy (and for how long), and whether he vomited or was unsteady or dizzy. Ask about headache. Remember to take into account the fact that a child might normally be asleep at the time he is examined.

Examination

To assess level of consciousness, use the standard GCS (see ➲ Glasgow coma score (adults), p. 369) for children aged ≥4y.

Do not use the standard adult GCS in children aged <4y—instead use the adapted scale (see ➲ Glasgow coma score (children), p. 737).

Exclude hypoglycaemia. Note whether the child looks well and is behaving normally. Measure pupil size and check reactivity. Examine the head for signs of injury, but also look for injuries elsewhere, particularly the neck. Check T°, and consider coexisting illness such as ear, throat, or urinary infections, or occasionally meningitis.

Glasgow coma score (children)

The 'Eye' and 'Motor' components of the GCS are similar as for adults (see ➲ Glasgow coma score (adults), p. 369), but a modified 'Verbal' score is used in small children. The paediatric version of the GCS is shown in Table 15.12 (see https://www.nice.org.uk). Assessment of the best verbal response is likely to require assistance from the parent/guardian/carer.

Table 15.12 Paediatric version of the Glasgow coma score

Best eye response	**Score**
Eyes opening spontaneously	4
Eyes opening to verbal command	3
Eyes opening to pain	2
No eye opening	1
Best verbal response	**Score**
Alert, babbles, coos, words, or sentences to usual ability	5
Less than usual ability and/or spontaneous irritable cry	4
Cries inappropriately	3
Occasionally whimpers and/or moans	2
No vocal response	1
Best motor response	**Score**
Obeys commands or has normal spontaneous movements	6
Localizes to painful stimuli or withdraws to touch	5
Withdrawal to painful stimuli	4
Abnormal flexion to pain (decorticate)	3
Abnormal extension to pain (decerebrate)	2
No motor response to pain	1
Total	**3–15**

In pre-verbal or intubated patients, the 'best grimace response' may be used in place of the 'best verbal response', as shown in Table 15.13.

Table 15.13 'Best grimace response'

	Score
Spontaneous normal facial/oro-motor activity	5
Less than usual spontaneous ability and/or only responds to touch	4
Vigorous grimace to pain	3
Mild grimace to pain	2
No response to pain	1

Managing head injuries in children

Investigation

When faced with a child with severe injuries, summon senior help and follow standard resuscitation guidelines (see ➔ Management of serious head injuries, pp. 372–3). If there is any suspicion of NAI, involve the paediatrician at an early stage (see ➔ Management of child abuse, pp. 762–3).

Indications for immediate CT scan

(See https://www.nice.org.uk)

- Suspicion of NAI.
- Post-traumatic seizure, with no history of epilepsy.
- GCS <14 on initial assessment or paediatric GCS <15 in infants <1yr.
- GCS <15 at 2hr after the injury.
- Suspected open or depressed skull fracture or tense fontanelle.
- Clinical evidence of base of skull fracture.
- Focal neurological signs.
- For children <1y: bruise, swelling, or laceration >5cm on the head.

If no indication for immediate CT, assess for risk factors

- Witnessed loss of consciousness >5min.
- Abnormal drowsiness.
- ≥3 discrete episodes of vomiting.
- Dangerous mechanism (high-speed road traffic collision, fall >3m, high-speed injury from object).
- Amnesia (antegrade or retrograde) lasting >5min (hard to assess in children <5y).

Action after assessing risk factors

- If >1 risk factor is present, obtain a CT scan.
- If one factor is present, observe for ≥4hr post-head injury—obtain a CT scan if, during observation, the child drops GCS to <15 and has further vomiting or further episodes of abnormal drowsiness.
- If no risk factor is present, no imaging is required, unless the child is taking an anticoagulant, in which case obtain a CT scan within 8hr of injury.

Management

Discuss children with abnormal CT scans with the neurosurgical team and treat accordingly.

Admit and observe children with continuing symptoms or signs, or an abnormal CT. When contemplating discharge, ensure adequate supervision from a responsible adult is available. Provide the parents with a verbal explanation and a written advice sheet (see ➔ Discharging patients, p. 375) (see also https://www.sign.ac.uk or https://www.nice.org.uk).

Transient cortical blindness after head injury

Occasionally, children present with blindness immediately or soon after an apparently minor head injury. The mechanism is unclear, but in most cases, blindness resolves spontaneously within a few hours. In the meantime, arrange a CT scan to exclude intracranial haematoma.

Spinal injury in children

Background

Cervical spine injury is relatively uncommon in children, but keep the spine immobilized until history, examination ± imaging exclude injury. Injuries in children tend to involve upper (C1–3 level), rather than lower, cervical spine. Rotatory subluxation may cause significant cervical spine injury without fracture—the clue is the combination of injury, neck pain, and torticollis. Interpretation of cervical spine X-rays in younger children is frequently complicated by pseudo-subluxation of C2 on C3 and of C3 on C4.

Imaging the cervical spine in children

In a child with a head injury, obtain an urgent cervical spine CT scan if any of the following criteria is present (🔊 https://www.nice.org.uk):

- GCS <13/15 on initial assessment.
- The child has been intubated.
- Focal peripheral neurological signs.
- Paraesthesiae in the arms or legs.
- A definitive diagnosis is required urgently (eg prior to surgery).
- Multiple injuries affecting >1 body region.
- Strong suspicion of injury despite normal X-rays.
- X-rays show a significant bony injury.
- X-rays are technically difficult or inadequate.

If there is neck pain/tenderness, but no indication for CT, get X-rays if there is a dangerous mechanism (eg high fall >1m or five stairs, high-speed crash, rollover, ejection). Perform an assessment of the spine if safe to do so and the patient has one 'low-risk' factor (also applies to adults):

- A crash involving a 'simple' rear-end collision.
- Comfortable in a sitting position in the ED.
- Ambulatory at any time since injury.
- There is no midline cervical tenderness.
- There is a delayed onset of pain.

On assessment of the spine, if the patient can actively rotate the neck 45° right and left, no imaging is needed; if unable to do this, obtain X-rays.

Spinal cord injury without radiological abnormality (SCIWORA)

The paediatric spine is inherently more elastic, so momentary intersegmental displacement may endanger the cord without disrupting bones or ligaments. This can result in spinal cord injury without radiological abnormality. Usually there are objective signs of injury, but these can be delayed. Therefore, if children present with transient neurological symptoms after neck injury, ensure careful assessment.

Considerations in paediatric trauma

Chest injury

Children have little respiratory reserve and can desaturate quickly. Significant thoracic visceral injuries may occur without rib fractures. There is a relatively high incidence of pulmonary contusion. In children with major trauma, obtain a CT scan; otherwise, if there is an isolated chest injury, consider obtaining a CXR (and then a CT scan only if that is abnormal).

If a chest drain is needed to treat a pneumothorax or haemothorax, use a size appropriate for the size of the child (as indicated by chart/tape).

Abdominal and pelvic injury

Check for hypovolaemia. Abdominal palpation cannot yield useful information until the child's co-operation and confidence are gained. Restrict any PR and PV examinations to the senior surgeon. Consider a CT scan if there is abdominal injury with hypovolaemia, abdominal bruising, tenderness or distension, or bleeding PR or via the NG tube. FAST scanning is not of proven benefit in paediatric abdominal injury, but formal USS may help (eg to help exclude an isolated splenic injury).

Gastric tubes can help to treat air swallowing and gastric dilatation prevalent in injured children. Insert an appropriately sized urinary catheter if urine cannot be passed spontaneously or if accurate output measurement is required (eg after severe burns).

Burns

Burns and smoke inhalation from house fires still cause death in many children each year. Even more frequently, children present with scalds from hot or boiling liquids. Most of these result from simple incidents in the home—ensure that treatment includes injury prevention advice for parents (see ➲ Injury prevention, p. 733). Remember that some (occasionally characteristic) burns may reflect NAI.

Assessment and treatment of the burnt child follow similar lines to those in adults; urgent priorities include securing the airway (with an uncut ET tube) and adequate analgesia (see ➲ Major trauma: treatment principles, p. 330).

IV fluid requirements in major burns depend upon the extent of the burn (use Lund–Browder charts for the appropriate age of the child—see Fig. 8.25) and clinical response (see ➲ Burns: assessment, p. 398).

Drowning and submersion incidents

Children continue to die from drowning each year despite improved swimming education. Their high surface area to body weight ratio makes them prone to hypothermia. Cardiac arrest after immersion warrants prolonged resuscitation (see ➲ Drowning and near drowning, pp. 268–9). Presume cervical spine injury and immobilize the neck. Prolonged submersion (>8min), no respiratory effort after 40min of CPR, persistent coma, persistent pH <7.0, and persistent PaO_2 <8kPa imply a poor prognosis. Hypothermia favours a better prognosis. Of those who survive after hospital CPR, 70% do make a complete recovery.

Wounds in children

Some children may allow wounds to be explored, cleaned, and sutured under LA, providing they are given an appropriate explanation (sometimes it is worth demonstrating on a teddy first) and a parent is allowed to stay with them. Injection of LA is least painful if a fine needle is employed and the LA is warmed, buffered, and injected slowly. Some children, however, do not tolerate LA. Whilst some superficial wounds may be cleaned and closed (Steri-Strips™ or tissue glue) without anaesthesia, often sedation or GA is needed. Anaesthesia is important in order to allow adequate exploration and cleaning of the wound and to ↓ the risks of infection and tattooing from embedded dirt. Never allow a lack of co-operation to compromise treatment—this is particularly important with facial wounds where wound closure under GA may be needed to provide the best cosmetic result.

Ketamine

Ketamine can be used in the ED as an alternative to GA and provides excellent analgesia for undertaking minor procedures in children (see Analgesics: Entonox® and ketamine, p. 287) (see also the RCEM guideline 2016, available at: https://www.rcem.ac.uk). Ketamine should only be used by clinicians experienced in its use and capable of managing any airway complications.

Ketamine is *contraindicated* if:

- There is a high risk of laryngospasm (active respiratory infection, active asthma, age <12 months).
- There are severe psychological problems (cognitive or motor delay or severe behavioural problems).
- Cardiovascular disease (congenital heart disease, cardiomyopathy, ↑ BP).
- Significant head injury or neurological disease, porphyria, and hyperthyroidism.

Paediatric fractures and dislocations

Many paediatric fractures are similar to those in adults and prone to similar complications. Bones in children differ from those in adults in two important respects—they have epiphyses and are softer (hence fractures are more common than significant ligament injuries). Certain types of paediatric fractures reflect these differences:

Greenstick fracture An incomplete fracture in which one cortical surface of a bone breaks, whilst the other side bends.

Torus ('buckle') fracture Another form of incomplete fracture characterized by buckling of the cortex.

Plastic deformation ('bowing deformation') Traumatic bending of the long bone shaft without a visible fracture occasionally occurs in young children.

Epiphyseal injuries

Injuries to the traction epiphyses are avulsion injuries (eg peroneus brevis insertion into the base of the fifth MT).

Injuries to the pressure epiphyses at the end of long bones adjacent to the articular surface have been classified into five types—the Salter–Harris classification (see Fig. 15.23):

- *Type I*: the epiphysis separates or slips on the metaphysis.
- *Type II*: a small piece of metaphysis separates with the epiphysis (most common type—see Fig. 15.24).
- *Type III*: a vertical fracture through the epiphysis joins that through the epiphyseal plate (see Fig. 15.25).
- *Type IV*: a fracture passes from the articular surface through the epiphyseal plate into the metaphysis (see Fig. 15.26).
- *Type V*: a crush injury to the epiphyseal plate (X-rays may be normal).

Note that Salter–Harris types I and V may not be apparent on the initial X-ray. Undisplaced type I fractures often affect the distal tibia and fibula and may present with circumferential tenderness around the growth plate. Treat with POP and immobilization according to clinical findings.

Epiphyseal growth plate injury

A concern specific to any epiphyseal injury is that premature fusion of a growth plate may result, with resultant limb shortening and deformity. The risk correlates to some extent with the mechanism of injury and amount of force involved. The different Salter–Harris fractures carry a different level of risk of long-term growth plate problems. The risk is low for types I and II (particularly if undisplaced), moderate for type III, and highest for types IV and V. Problems are usually averted if Salter–Harris type III and IV injuries are accurately reduced and held (eg by internal fixation). Type V fractures are notoriously difficult to diagnose and often complicated by premature fusion—fortunately, they are relatively rare.

Dislocations

Dislocated joints are relatively unusual in children. Most commonly involved are the patella (see ➲ Paediatric knee injuries, p. 753) or the radial head ('pulled elbow'—see ➲ Elbow injuries in children, p. 750). Similarly, due to the relative strengths of bone and ligament, injuries to ligaments are much less common in children than in adults.

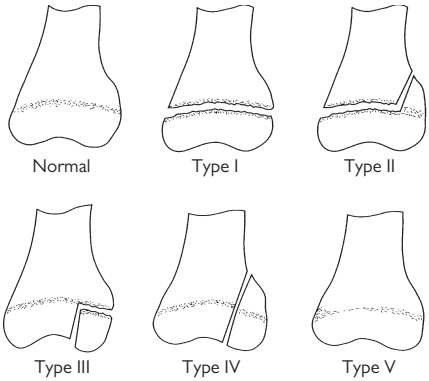


Fig. 15.23 Salter–Harris classification of epiphyseal injuries.

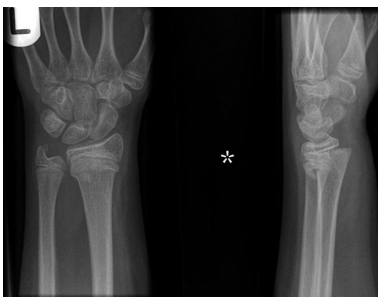


Fig. 15.24 Salter–Harris II fracture of the distal radius in an 11y old.

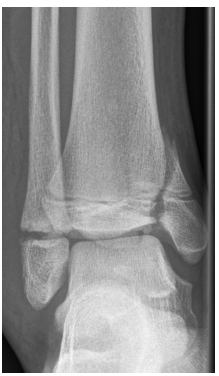


Fig. 15.26 Salter–Harris IV fracture of the distal tibia in a 15y old.

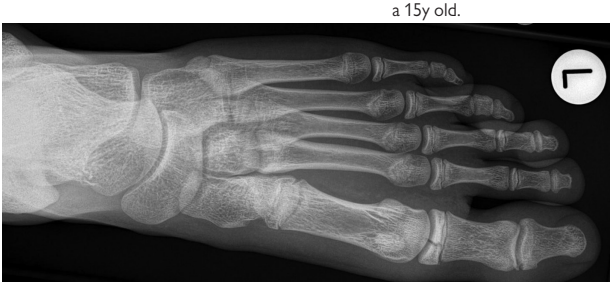


Fig. 15.25 Salter–Harris III fracture of the proximal phalanx of the big toe in a 14y old.

Approach to limb injuries in children

Limb injuries are very common in children. Whilst most of the points outlined in the general approach to trauma in adults may be successfully applied, certain modifications may be required.

History

Carefully elicit the mechanism of injury. The history may be confused or not forthcoming—try to establish a rapport with the child (and parents) nevertheless, in order to gain the child's confidence for the examination.

Examination

Search for evidence of a fracture (swelling, deformity, bony tenderness) and any associated neurovascular injury. Remember the adage that the most easily missed fracture is the second fracture—examine also for additional injuries to adjacent bones and joints.

Is an X-ray required?

If in doubt, obtain an X-ray. The ease with which children's bones fracture and the difficulties with history and examination mean that it is sensible to adopt a low threshold for requesting X-rays. Ensure that two views at right angles are taken (eg AP and lateral), including associated joints.

Interpreting X-rays

Many fractures are subtle and easily missed. To minimize the chance of this occurring, visually trace around the cortex of each bone, looking for any irregularities. Interpretation of paediatric X-rays is complicated by the presence of various ossification centres and accessory ossicles. Both are commonly mistaken for fractures (eg the olecranon epiphysis, the os trigonum, and the bipartite patella). Ossification centres appear and fuse in a relatively predictable fashion, although the rate at which this occurs varies slightly from child to child (see Table 15.14). Knowledge of this process, combined with experience of seeing many paediatric X-rays, greatly assists interpretation. If in doubt about an X-ray, obtain a second opinion (there is no justification for X-raying the uninjured side to see what 'normal' is). As an additional safeguard, most EDs now operate a policy of all X-rays being reported by a radiologist or reporting radiographer within 24hr.

Treatment

Give prompt, appropriate analgesia (see ➲ Analgesia, p. 735). Follow the treatment suggested for specific fractures (see ➲ p. 747). Many undisplaced fractures will unite satisfactorily with a period of immobilization in POP (eg fractured distal radius), collar and cuff (eg fractured radial head), or broad arm sling (eg fractured clavicle). Minor angulation at the fracture site can be accepted, particularly in young children. Often, however, angulated fractures require MUA.

Open fractures and dislocations

Give analgesia and IV antibiotics (eg cefuroxime 25mg/kg slow IV bolus), and ensure tetanus cover. Take a digital photograph of the wound and keep it covered to minimize the risk of infection. Apply a dressing, splint the injured limb, and refer the patient to the orthopaedic surgeon.

Table 15.14 Ossification centres

Centre	First appears	Fuses
Humeral head	0–6 months	18–21y
Capitulum	3–6 months	14–16y
Medial epicondyle	4–7y	18–21y
Lateral epicondyle	9–13y	14–16y
Trochlea	9–10y	14–16y
Radial head	4–5y	14–17y
Distal radius	6–12 months	17–19y
Olecranon	9–11y	13–16y
Distal ulna	4–5y	16–18y
Capitate	Birth to 3 months	–
Hamate	Birth to 4 months	–
Triquetral	1–3y	–
Lunate	2–4y	–
Trapezium	2–4y	–
Trapezoid	3–5y	–
Scaphoid	3–5y	–
Pisiform	9–12y	–
First MC base	1–3y	14–17y
Femoral head	Birth to 6 months	15–19y
Greater trochanter	3–4y	17–19y
Lesser trochanter	11–14y	15–18y
Distal femur	Birth	17–20y
Patella	2–6y	4–8y
Proximal tibia	Birth	15–18y
Distal tibia	Birth to 6 months	14–17y
Proximal fibula	2–4y	16–19y
Distal fibula	Birth to 1y	14–17y
Posterior calcaneum	5–8y	13–16y
Central calcaneum	Birth	13–16y
Talus	Birth	–
Navicular	2–3y	–
Cuneiform bones	1–3y	–

These dates are subject to individual variation. In general, epiphyses in girls fuse before those in boys.

Normal X-rays in children

It is useful to have an idea of the normal appearance of X-rays in children. Some examples are shown in Figs. 15.27–15.30.

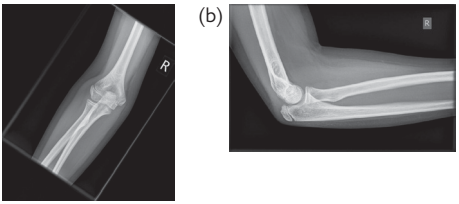


Fig. 15.27 (a), (b) Normal elbow in a 10y old.

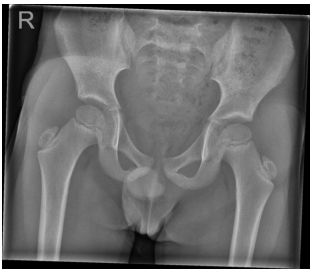


Fig. 15.28 Normal pelvis X-ray in a 6y old boy.

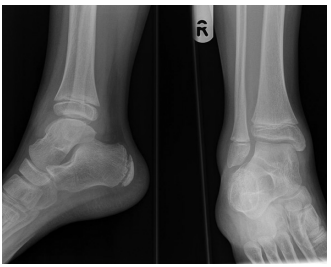


Fig. 15.29 Normal ankle X-rays in a 10y old.

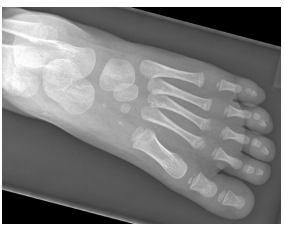


Fig. 15.30 Normal foot in a 2y old.

Shoulder and humeral shaft fractures

Clavicle fracture

This is a common injury in children and adults alike. Most clavicle fractures with no or only minor angulation/displacement heal satisfactorily with conservative management, comprising oral analgesia and rest in a broad arm sling. Follow-up is not usually necessary—give the child/parents an advice leaflet with a contact telephone number to call if there are questions/problems (see ➲ Fracture clinic and alternatives, pp. 436–7). The advice leaflet should include the following advice:

- Use the sling for 3 weeks and painkillers as required. Extra pillows to support the arm may help in the first few days.
- Start exercises of the hand, wrist, and elbow as early as possible.
- Expect a lump (callus) to form at the fracture site.
- Avoid rough play and contact sports for 6 weeks.
- To seek medical attention if the child becomes suddenly short of breath or if there is a problem involving the skin over the fracture.

Sometimes a clavicle fracture is strongly suspected clinically, but not apparent on X-ray—treat as for an undisplaced fracture.

Treat children who have comminuted, very angulated, or displaced fractures (see Fig. 15.31) similarly, but check carefully for neurovascular damage and the X-ray for associated rib fractures and pneumothorax. Arrange fracture clinic follow-up.

Acromio-clavicular joint injuries

These become more common in older children. Treat with analgesia, rest, sling, and physiotherapy/follow-up as for adults (see ➲ Acromio-clavicular (AC) joint injuries, p. 471).

Shoulder injuries

Shoulder dislocations are relatively rare in children. Salter–Harris type I and II epiphyseal fractures may occur in the proximal humerus—refer to the orthopaedic team if significant displacement or >20° angulation. Otherwise, give analgesia, collar and cuff, and fracture clinic follow-up.

Humeral shaft fracture

Check particularly for injury to the radial nerve which runs close to the humeral shaft in the spiral groove. Remember to consider the possibility of NAI, especially if the patient is <3y old or the fracture is spiral. Treat as for adults (see ➲ Shaft of humerus fracture, p. 465) with analgesia, backslab POP, and sling support, with fracture clinic follow-up.

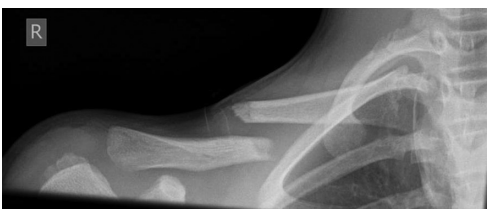


Fig. 15.31 A 13y old with a displaced clavicle fracture.

Supracondylar humeral fracture

This follows a fall on an outstretched hand. Swelling may be considerable. Check for associated neurovascular deficit (particularly brachial artery and median and radial nerves). 25% of supracondylar fractures are undisplaced and may not be obvious on X-ray, although a joint effusion will be seen. Most fractures are displaced, angulated, or rotated. The extent of angulation (both in sagittal and coronal planes) is easy to underestimate. Viewed from laterally, the capitulum normally makes an angle of 45° with the humeral shaft (see Fig. 15.32). The anterior humeral line (drawn along the front of the humeral shaft on the lateral view) normally passes through the middle of the ossification centre of the capitulum in the distal humerus. Also, the normal carrying angle (seen in AP view) is 10°. Record the radial pulse frequently, and consider compartment syndrome.

Treatment

Provide analgesia (eg nasal diamorphine), and refer for manipulation under GA if:

- Neurovascular deficit: operation is urgent if circulation is compromised.
- >50% displacement (see Fig. 15.33).
- >20° angulation of the distal part posteriorly (see Fig. 15.34).
- >10° medial or lateral angulation.

If there is no indication for manipulation under GA, refer for admission and observation if there is much swelling. If no significant angulation, displacement, or swelling, discharge with analgesia, a collar and cuff under a body bandage (elbow at 90°, with confirmed radial pulse present), and fracture clinic follow-up. Consider using a padded backslab POP if significant pain is present.

Complications

Malunion with persistent deformity, stiffness (including myositis ossificans), neurovascular deficit (eg Volkmann's contracture).

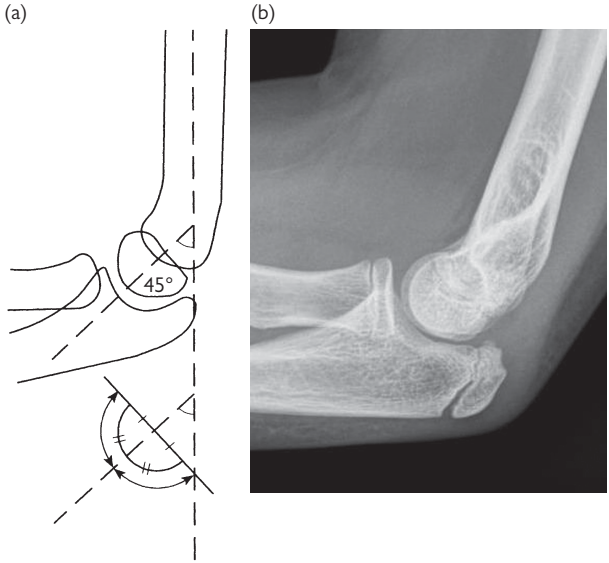


Fig. 15.32 Normal lateral view—the capitulum makes an angle of 45° with the humeral shaft.

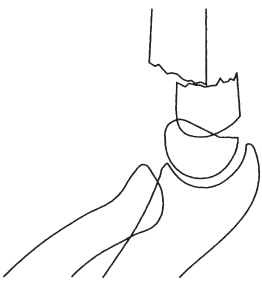


Fig. 15.33 Supracondylar fracture with >20° angulation and ~50% displacement.

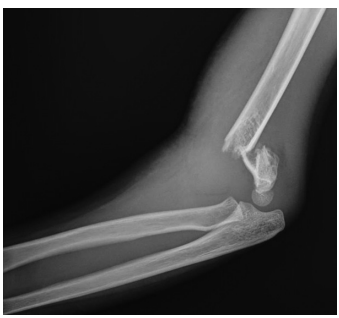


Fig. 15.34 A 4y old with a supracondylar fracture with >20° angulation and >100% displacement.

Elbow injuries in children

Lateral epicondylar epiphyseal injury

Salter–Harris type II injury may follow a fall on an outstretched hand. The elbow is swollen, with ↓ movement and maximum tenderness on the lateral aspect. X-rays demonstrate the fracture, which may be displaced by the pull of the forearm extensors, requiring surgical reduction. Treat undisplaced fractures with a long arm backslab POP, collar and cuff at 90°, analgesia, and fracture clinic follow-up.

Medial epicondylar epiphyseal injury

Maximal tenderness is apparent on the medial side of the elbow. Check carefully for ulnar nerve damage. Refer immediately if the ulnar nerve is involved or if the fracture is displaced. Treat undisplaced fractures with analgesia, collar and cuff at 90° under clothes (confirm the radial pulse is present), and fracture clinic follow-up.

Radial head/neck fracture

The radiocapitellar line is drawn down the axis of the proximal radius on the lateral view of the elbow and should bisect the capitellum. Failure to do so suggests an occult radial neck fracture or radial head dislocation. Most of these fractures can be managed satisfactorily with analgesia, collar and cuff, advice leaflet, and no need for follow-up (see ➲ Elbow injuries, pp. 462–3). Refer to the fracture clinic if there is significant angulation.

Elbow injury without obvious fracture

Treat elbow injuries where there is clinical suspicion of fracture, but none seen on X-ray, along the same lines as for an undisplaced fracture (analgesia, collar and cuff, advice leaflet, no follow-up). This includes children who have ↓ range of movement and whose X-rays show an elbow effusion ('fat pad sign') (see ➲ Elbow injuries, pp. 462–3).

Subluxation of the radial head ('pulled elbow')

A direct pull on the arm of a child aged 1–5y may result in the radial head being pulled out of the annular ligament ('nursemaid's elbow'). The child then refuses to use the arm. If there is a characteristic history, there is no need to X-ray. The traditional reduction technique involves flexing the elbow to 90°, then supinating the elbow fully. However, manipulating the elbow into full pronation may give a better reduction rate (https://www.bestbets.org.uk). A click is sometimes felt or heard during reduction. If full pronation fails, try full supination and leave for 10min. Allow the child to play and watch—he will usually use the arm again soon. If he does not, obtain X-rays and senior help. Repeat manipulation can be done once, but if that does not lead to a rapid improvement in function, then place the arm in a sling; give analgesia, and arrange review in 1–2 days. The elbow may reduce spontaneously or may need further manipulation. Rarely, repeated manipulation is unsuccessful until sedation is given. After successful manipulation, advise the parents to avoid pulling the arm forcefully. A pulled elbow may recur up to about age 5y if the arm is pulled, but after that the child should have no long-term problems with the elbow.

Forearm and wrist injuries

Radius/ulna shaft fractures

Radius and ulna shaft fractures often cause significant displacement or angulation—provide IV analgesia (or nasal diamorphine), immobilize in a broad arm sling, obtain X-rays, and refer for manipulation under GA. Never accept an isolated forearm shaft fracture without X-rays demonstrating the entire radius and ulna; otherwise, a Monteggia or Galeazzi fracture–dislocation may be missed (see ➲ Forearm fractures and related injury, pp. 460–1).

Distal radial fracture (including Salter–Harris type II injuries)

A common fracture in all ages of children (and adults) after a fall on an outstretched hand. The fracture results in localized tenderness and variable swelling. Check carefully for a second injury (eg involving the thumb or scaphoid). X-rays will demonstrate the nature of the fracture.

Salter–Harris type II fractures

Often have displacement of the distal radial epiphysis (eg see Fig. 15.24), in which case, refer for MUA under GA.

Moderate displacement or slight angulation

May be accepted (particularly in younger children): if in doubt, treat in a backslab POP and arrange fracture clinic follow-up.

Minimally displaced or undisplaced greenstick, buckle, or torus fractures

Commonly occur just proximal to the distal radial epiphysis. Treat with analgesia, elevation, a wrist splint, and written advice, with no follow-up unless problems arise (see ➲ Fracture clinic and alternatives, pp. 436–7). Treat children who present with discrete tenderness over the distal radial growth plate, but no fracture apparent on X-ray, identically to those with a radiologically proven fracture—presume a growth plate injury (sometimes a subperiosteal haematoma can be seen on USS). Beware osteomyelitis, which can cause tenderness over the distal radius and be mistaken for trauma. Parents and children report better functioning and fewer days off school with the use of removable splints, compared with POPs, for minor wrist fractures. Advise that the splint should be retained until pain wears off (usually <3 weeks) and that follow-up is not required if pain settles as expected.

Scaphoid fracture

Despite being uncommon, particularly in younger children, seek clinical evidence of scaphoid fracture in any child with wrist/forearm injury and obtain scaphoid views if appropriate (see ➲ Scaphoid fracture, pp. 450–1). Treat radiologically evident and suspected fractures as for adults, as described in ➲ Scaphoid fracture, pp. 450–1.

Metacarpal and phalangeal injuries

Treat these injuries along similar lines to those described for adults (see ➲ Hand fractures and dislocations, pp. 444–5). Remember, however, that children may not tolerate manipulation under LA—anaesthetic help may be required.

Hip and femoral fractures in children

Hip fracture

Children rarely sustain neck of femur fractures similar to those seen in adults. In the pre-adolescent child, trauma may precipitate a slipped upper femoral epiphysis (see ➲ The painful hip, pp. 728–9). Younger children who have been subjected to considerable violence may suffer a Salter–Harris type I injury to the proximal femoral epiphysis—carefully exclude other injuries and refer to the orthopaedic surgeon.

Femoral shaft fracture

May be spiral (the majority) or transverse, depending upon the mechanism of injury (see Figs. 15.35 and 15.36). Considerable energy is required to break a femur—check for other injuries. Resuscitate as necessary with IV fluids and provide nasal diamorphine (see ➲ Nasal diamorphine for analgesia in children, p. 291) or IV opioid analgesia (see ➲ Analgesia in specific situations, pp. 290–1). Perform a femoral nerve block (as described in ➲ Femoral nerve block, p. 313) to provide additional analgesia, using 0.2mL/kg of 0.5% plain bupivacaine (1mg/kg). Allow 20min for this to work, then apply skin traction. Gallows traction may be used on infants and children <2y but is best erected on the ward. A true spiral fracture in a non-ambulatory child suggests child abuse—swelling is often not dramatic.

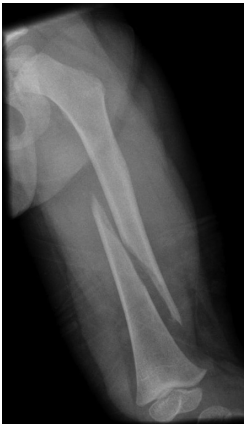


Fig. 15.35 Femoral shaft fracture in a 3y old.

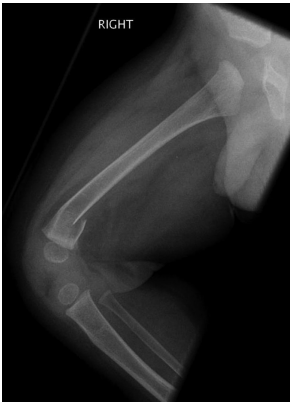


Fig. 15.36 A 9 month old with a transverse fracture of the distal femur.

Paediatric knee injuries

Knee injuries

Knee ligament injuries are rare in children, compared with adults—suspect a fracture or epiphyseal injury instead. This is a reflection of the relative strengths of the ligament and bone in the child. So, for example, an injury which might cause anterior cruciate ligament rupture in the adult will often produce avulsion of its tibial attachment in the child. This tibial plateau fracture will produce a haemarthrosis and will be apparent on the lateral X-ray. Provide analgesia and refer to the orthopaedic surgeon.

Patella fractures

Do not confuse a congenitally bipartite patella for a fracture. The small bony fragment in a bipartite patella lies superolaterally and has rounded edges.

Patellar sleeve fractures

These are not uncommon in children and adolescents. These osteochondral fractures typically result from high-impact jumping activities or sports. Suspect clinically if there is local pain and tenderness and an inability to actively extend the knee. X-rays can be misleading as only a small bony fragment is avulsed, usually from the inferior pole; however, a large part of the articular surface is removed with it but is impossible to see on plain X-ray. Provide analgesia and splintage, and refer to the orthopaedic team for MRI to confirm the diagnosis ± ORIF.

Patella dislocation

This is seen relatively frequently in children and is treated in a similar way to that in adults (see ➲ Dislocations of the patella and knee, p. 490). Examine the X-rays carefully, as associated osteochondral 'chip' fractures of the undersurface of the patella occur relatively frequently in children. Refer for fracture clinic follow-up and MRI to establish the extent of the injury.

Tibial fractures in children

Tibial shaft fracture

Treat most fractures as for adults—splintage, IV analgesia, and referral for elevation and admission. Compound fractures require IV antibiotics and wound surgery. Displaced or angulated fractures require MUA and POP; undisplaced fractures respond to treatment with above-knee non-weight-bearing POP and subsequent mobilization using crutches.

Toddler's fracture

Minor trauma in 1–4y olds may result in characteristic spiral undisplaced distal tibial fractures (see Fig. 15.37). These may not be apparent on the initial X-rays—localized warmth and tenderness with a history of trauma may suggest the diagnosis in the otherwise wide differentials of the limping child (see ➲ The limping child, pp. 726–7). If a fracture is visible on initial X-rays, treat by rest in a POP and arrange fracture clinic follow-up. If the diagnosis is made without a visible fracture, treat in POP and review clinically and radiologically at 10 days—further X-rays may then demonstrate a long strip of new periosteal tibial bone formation. Continue to treat according to symptoms.

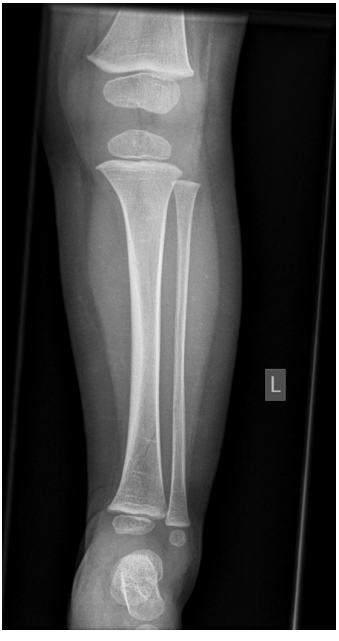


Fig. 15.37 An 18 month old with an oblique ('toddler's') fracture of the distal tibia which is hard to see. Note the adjacent white horizontal (Harris) growth arrest lines of no relevance to this injury.

Ankle and foot injuries in children

Ankle injuries

Ankle ligament injuries are less common in children than in adults, partly reflecting the fact that ligaments are often stronger than the bone to which they attach. The presence of epiphyses can make it difficult to establish whether or not a fracture is present on X-rays. If there is no obvious fracture on X-ray, but there is much tenderness/swelling over the distal tibial or fibular epiphysis, treat it as a growth plate injury (undisplaced Salter–Harris type I fracture) with BKPOP, crutches, elevation, analgesia, and follow-up in the ED or fracture clinic. Some fractures (see, for example, Fig. 15.38) require admission for manipulation under GA.

Foot injuries

A wide range of foot injuries occur in children. A common difficulty is distinguishing between the normal apophysis at the base of the fifth MT (see Fig. 15.39) and a fracture. The normal apophysis is typically longitudinally parallel to the fifth MT (as opposed to a fracture which is typically transverse or oblique—as shown in Fig. 9.7).

Calcaneal injuries

(See ➲ Foot fractures and dislocations, pp. 504–5.)

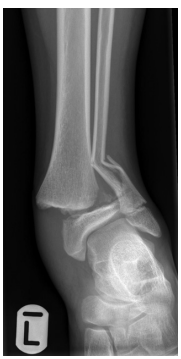


Fig. 15.38 Ankle fracture in a 12y old.

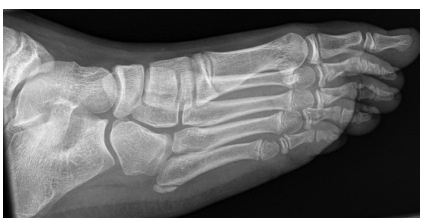


Fig. 15.39 Normal foot in an 11y old.

Child abuse

The boundaries of what defines acceptable behaviour and what constitutes child abuse are open to some debate and are certainly affected by historical and cultural factors. For example, corporal punishment, once considered normal and usual, is now unacceptable. The extremes of child abuse, however, are easily defined. There is ↑ evidence that adverse childhood experiences (including abuse) can have negative effects on individuals throughout the rest of their lives.

Types of child abuse

- Physical abuse/NAI—including bruises, fractures, wounds, burns, poisoning, suffocation, FGM, fabricated or induced illness.
- Neglect.
- Emotional abuse.
- Child sexual abuse.

Prevalence

It is impossible to be sure how common child abuse is. It is generally agreed that it is much more prevalent than was previously believed. 4% of children are brought to the attention of professional agencies for suspected abuse. It is estimated by the National Society for the Prevention of Cruelty to Children (NSPCC) that over 500,000 children are abused in the UK each year.

Aetiology

Child abuse affects both boys and girls. The first-born child is more frequently affected. Disabled children are particularly vulnerable to abuse or neglect. Infants and young children are at most risk of serious injury or death, partly reflecting their physical vulnerability. The abuser is often a parent or cohabitant of a parent, more commonly ♂, and may have suffered abuse themselves as a child. Sometimes the child may be targeted because they are unwanted (eg 'she should have been a boy'). Whilst the abuser may be a young parent with unrealistic expectations and living in difficult socio-economic circumstances (unemployment, alcohol/drug abuse, poor living conditions), often they do not conform to this standard description. Child abuse affects all levels of society.

Clear links have been identified between domestic abuse and physical abuse of children. Children whose parents have mental health problems may be more vulnerable to abuse and neglect. The 'toxic trio' of domestic abuse, mental health issues, and substance misuse has been identified as comprising recurrent common factors in families where child abuse has occurred. The term 'developmental trauma' has been used to describe the impact of early, repeated abuse, neglect, separation, and adverse experiences within a child's important relationships (https://www.beaconhouse.org.uk).

Child behaviour as indicators of child abuse

Consider the possibility of child abuse or neglect (current or past) if a child exhibits any of the following:

- Alcohol and substance misuse (including overdosing).
- Bullying/being bullied.
- Self-harm.
- Developmental delay.
- Eating disorder.
- Escalating or concerning behaviours (violence/aggression, inappropriate or harmful sexual behaviours).
- Features of neglect: failing to attend appointments ('was not brought'), failure to thrive, inappropriate clothing, poor appearance/hygiene.
- Missing episodes and/or exclusion from school.
- Poor or deteriorating parent/peer interactions and/or relationships.

Role of the junior ED clinician

Managing the child and family where there is suspected child abuse is an extremely delicate skill, requiring considerable tact and experience. The role of the junior clinician is to consider the possibility of child abuse and to involve senior staff at an early stage—see relevant NICE guidance (https://www.nice.org.uk) updated in 2017.

The 2018 publication '*Working together to safeguard children*' outlines how protecting children is everyone's responsibility and should follow a child-centred approach.

The suspicious history

Certain features should alert to the possibility of child abuse:

- Injuries inconsistent with the history given.
- Injuries inappropriate for developmental age, paying particular consideration to non-mobile babies (eg a baby aged <4 months 'rolled off a bed').
- Changing history of injury or vague history, lacking vivid details.
- Delay in seeking medical attention.
- Concerning parental attitudes (eg apparent lack of concern for child).
- Frequent ED attendances.
- Occasionally, children may verbally disclose abuse. It is paramount to document the voice of the child—capture the child's disclosure in their own words in 'inverted commas'.

Child criminal exploitation and trafficking

Child criminal exploitation may involve individual groups or gangs manipulating, exploiting, or coercively controlling children into the supply and distribution of drugs from cities to rural locations using mobile phone lines (County lines). Children and young people may present to unscheduled health care settings due to being victims of extreme violence from gang members. County lines can be linked to modern slavery and the sexual exploitation of children.

Children and young people may be trafficked for a variety of reasons, including sexual exploitation, forced marriage, and domestic servitude. If suspected, refer to social care and the police to investigate.

Presentation of child abuse: bruising

Physical child abuse is commonly referred to as NAI. Children may present with a variety of injuries, which may occur in isolation or in combination.

Bruising

Children naturally sustain bruises during minor incidents as part of 'growing up'. Bruising over the knees and shins is a normal finding in children, particularly toddlers, who are also prone to sustaining injuries to their foreheads and chins as a result of falls. Older children frequently sustain bruises over the lateral aspect of their elbows and hips, during normal play and sport activities. Bruises in non-mobile babies, however, deserve particular attention and investigation.

As well as considering the possibility of NAI, remember that bruising may occur as part of an unusual pathological disease process (eg Henoch–Schönlein purpura, haemophilia, ITP, leukaemia, and other causes of thrombocytopenia). A Mongolian blue spot is an innocuous congenital finding on the lower back of some young children (especially non-Caucasians), which may be confused with bruising.

The following features warrant prompt consideration of NAI:

- Bruising in unusual sites (eg medial aspect of upper arms or thighs).
- Bruising in non-mobile babies.
- Multiple bruising of different ages (very difficult for the non-expert to judge) at less common sites.
- Uncommon injuries bilaterally.
- Finger 'imprinting' (eg grip complexes around upper limbs or slap marks).
- Imprints or marks from other objects (eg belt, stick).
- Human bite marks (probably adult if canines >3cm apart—ensure photographs next to a ruler are planned after admission).
- Petechiae on the face may reflect smothering and asphyxiation (it has been previously suggested that 2–10% of SIDS may have been smothered), but remember that petechiae also occur with forceful coughing or vomiting.

Natural progression of bruises

Swelling and tenderness of bruising suggest a relatively recent origin, but this is not very reliable. Accurate assessment of the age of bruising according to its colour is not possible, except that a yellow bruise is almost certainly >18hr old. Oft-quoted natural temporal progression of colour changes of bruising allows only a guess at the age of a bruise—avoid being drawn on this issue, which may have considerable legal implications. Instead, record the findings as accurately as possible—describe the colour, size, and distribution of the bruising. Usually a child suspected of having suffered physical abuse will also be examined by a relevant expert such as a paediatrician and/or a forensic physician (previously called 'police surgeon').

Child abuse: fractures

Fractures occur in a significant proportion of physically abused children—studies quote figures ranging from 11% to 55%, with ~80% of these fractures occurring in children aged <18 months.

Certain fractures are very common in children. Pay attention to the history of injury and whether or not it appears to be consistent with the fracture(s) sustained. Multiple fractures of different ages (especially if previously undiagnosed and/or not brought to medical attention) should arouse suspicion of NAI.

To help assess the approximate age of a bony injury, see Table 15.15, but bear in mind the fact that the times quoted are approximate and vary according to the age of the child.

Table 15.15 Natural progression of fractures

Presence of soft tissue swelling	0–10 days
Periosteal new bone formation	10–14 days
Loss of definition of the fracture line	14–21 days
Callus formation	14–42 days
Remodelling	~1y

Fractures arousing particular suspicion

The following fracture patterns are particularly suggestive of NAI:

- Multiple fractures of different ages.
- Rib and spinal fractures.
- Fractures in infants who are not independently mobile.
- Long bone fractures in children <3y old.
- Epiphyseal separation and metaphyseal 'chip' fractures of the knee, wrist, elbow, and ankle. These Salter–Harris type I and II injuries are associated with traction, rotation, and shaking.

Note that a few rare bone diseases may mimic NAI

- Osteogenesis imperfecta (blue sclerae, dental abnormalities, and brittle bones—autosomal dominant).
- Pathological fractures (through multiple cystic bone lesions).
- Rickets (enlarged, cupped epiphyses, craniotabes, 'bow legs').
- Copper deficiency (eg Menkes' kinky hair syndrome).

Child abuse: head injuries, wounds and burns

Head injuries

Most head injuries result from unintentional incidents ('accidents'). In infants, they often result from the parent or carer dropping the child. The skull fractures caused by this tend to be single and linear and involve the parietal bone.

Consider NAI if the following occur:

- Retinal haemorrhages (characteristic, but not diagnostic of shaking—they may also rarely be seen in CO poisoning, for example). In the context of NAI, retinal haemorrhages are often associated with subdural haematomas.
- Occipital skull fracture.
- Multiple, wide, or comminuted fractures.
- Subdural haematoma in an infant or toddler.

Wounds and burns

Children commonly sustain wounds and burns unintentionally. However, deliberately inflicted burns are found in a significant proportion of physically abused children.

The following suggest the possibility of NAI:

- Torn frenulum of upper lip (can also reflect a 'normal' toddler injury).
- Perineal wounds and burns (see ➲ Sexual abuse, p. 761).
- Small, deep, circular burns with raised edges suggest cigarette burns.
- Hand, lower limb, and buttock burns may follow forced immersion in bath water that is too hot. These burns tend to be of the 'stocking and glove' type, without higher splash burns. Parts of the buttocks may be spared where skin has been in contact with the bath, not the water.

Fabricated or induced illness

Previously known as 'Munchausen syndrome by proxy', this describes the situation where a parent/carer may invent a history of illness in a child and fabricate physical signs to substantiate it. The history often involves one or more of the following: apnoeic episodes, fits, bowel disturbances, rashes, allergies, or fevers. Classically, the deceiver is the mother. The child may be made ill by administering drugs or poisons. If suspected, do not confront the deceiver, but take blood and urine samples for a toxicology screen and refer to the paediatric team.

Bear in mind that some parents may be naturally very anxious and may exaggerate symptoms, rather than deliberately fabricate them.

Neglect

The neglected child may be dirty and unkempt, fail to thrive, and/or fall below the third centile for height and weight. Occasionally, nutritional deficiencies may be extreme (eg rickets). Developmental milestones are often delayed (and may even regress).

Emotional abuse

Ongoing emotional maltreatment of a child is sometimes referred to as psychological abuse. It can cause significant harm to the child development. It can involve deliberately humiliating, isolating, or ignoring a child.

There will likely be an element of emotional abuse as part of other forms of abuse, which may be manifest in various ways: personality/behavioural changes, sleep disturbance, soiling, and nocturnal enuresis.

Note the apparent attitudes of the parents/carers towards their child (eg critical and hostile or remote and unconcerned) and the child's attitude to the parents/carers (if in doubt as to whether this seems appropriate, ask an experienced nurse).

Sexual abuse

This may affect boys or girls and takes many forms. Child sexual abuse can be contact or non-contact, ranging from exposure to indecent acts, grooming online, through to rape. The abuser is often a ♂ relative or carer who is well known to the child, but women are also capable of committing sexual abuse, as are other children.

The child may present in a variety of ways:

- Injury to the genitalia or anus.
- Perineal pain, discharge, or bleeding.
- Behavioural disturbance, enuresis, and encopresis.
- Inappropriate sexual behaviour.
- The child may allege sexual abuse.
- STI (including anogenital warts).
- Pregnancy.
- Repeated UTIs.

Accurately record statements made by the child 'word for word' using quotation marks. Do not pursue a genital examination, but involve a senior doctor at an early stage. The ED staff will aim to treat injuries that need urgent attention, but to defer examination of the genitalia using a colposcope to the relevant forensic experts. Bear in mind that in the context of an allegation of recent sexual assault, a collection of forensic samples for DNA analysis is likely to be required, so ensure that appropriate advice is given to avoid destroying evidence. Refer to local policies and procedures regarding recent and historical disclosures of child sexual abuse.

Management of child abuse

Role of the junior ED doctor and nurse

Junior ED staff need to be vigilant in considering abuse when initially assessing and treating children. See NICE guidance, updated in 2017, on when to suspect maltreatment (https://www.nice.org.uk).

Any suspicion of child abuse should prompt the involvement of an expert senior doctor (paediatrician or ED consultant). In every hospital system, there will be a designated doctor for child protection who is available for advice. He or she will examine the child and arrange hospital admission for further investigations (eg skeletal survey) as necessary. Social care and the police may need to be involved. The child may require examination by a forensic physician, and samples/photographs obtained. Follow local procedures for making a social care multi-agency referral.

The chief consideration is treatment and protection of the child, so do not delay treatment of painful or life-threatening problems, whilst awaiting an 'expert'. Ensure that all documentation is legible and meticulous (use body maps). Remember that siblings may also be at risk.

UK law: The Children Act 1989 and 2004

These Acts replace previous statutes. Central is the concept that the welfare of the child is paramount. In the short term, the 1989 Children Act may be used to obtain orders to protect children. A variety of orders may be obtained.

Police Protection Order

A police officer has legal powers to take any child into 'police protection' for up to 72hr if deemed necessary for his/her own protection. This order may be used to prevent a child from being taken away from the ED by a parent or guardian against medical advice.

Emergency Protection Order

This has replaced the 'Place of Safety Order'. A court order valid for up to 8 days may be obtained if the child is believed to be at significant risk of harm. Such an order would normally be requested by a social worker.

Child Assessment Order

This court order may be applied by the local authority or NSPCC in order to allow an assessment to be performed of a child who appears to be at risk of injury. This order is valid for up to 7 days.

Care Order

This transfers the care of a child from the parent(s) to the local authority's social care department. If a care order is in force, matters requiring parental consent should be referred to the social worker (not the foster carer). Care orders can last until the child is 18y old. Parental responsibility can be transferred to another person through adoption or special guardianship via a court order. Only the courts are able to lift this order.

Residence Order

This court order defines where a child should live and who has parental responsibility.

Child Protection Plan

The details of all children who are subject to a Child Protection Plan are maintained by social care. ED staff should be aware of how to access Child Protection Plan information. Refer to local hospital alert systems. Previous hospital case notes are also very useful in this respect. When searching for previous records, remember that many children may be known by several surnames.

Child protection case conferences

A conference may be called by social care if it is suspected that a child has been abused. Child protection case conferences should be held promptly and aim to define a protection plan for the future protection of the child and family. Unlike the criminal courts, where the onus is on the prosecution to prove abuse 'beyond reasonable doubt', child protection case conferences will determine whether a child is deemed to be at risk of significant harm and whether a protection plan is required. Case conferences consist of a number of individuals, including: an independent chairman (usually a senior member of the social care department), a hospital consultant, a GP, a social worker, the police, a health visitor/school nurse, a teacher, an education welfare officer, and a local authority solicitor. Parents are always invited and older children may also attend.

Sharing information

Failure to share information is implicated in many serious case reviews—Child Protection Information Sharing is at the heart of protecting children. The General Data Protection Regulation (GDPR) and Data Protection Act 2018 do not prevent the sharing of information for the purpose of keeping children safe. Information can be shared without consent, if requesting consent would place the child at risk (eg suspected fabricated or induced illness). Discuss with a senior clinician. Multi-agency safeguarding hubs may enable effective sharing of information.

See '*Information sharing: advice for practitioners providing safeguarding services to children, young people, parents and carers*', published by HM Government in 2018 (https://www.gov.uk). The seven golden rules to information sharing in this document are summarized as follows:

1. The GDPR, Data Protection Act 2018, and human rights law provide a framework to ensure that personal information about living individuals is shared appropriately.
2. Be open and honest with the individual (and/or family where appropriate) about information sharing, unless this is unsafe or inappropriate.
3. Get advice from other practitioners (or information governance lead) if unsure, without disclosing the individual's identity where possible.
4. Where possible, share information with consent, and where possible, respect the wishes of those who do not consent to having their information shared, unless there are good reasons (eg there is a risk to safety).
5. Base decisions about information sharing on safety and well-being.
6. Ensure information shared is necessary, proportionate, relevant, adequate, timely, and secure.
7. Record what is shared and what is not shared, and the reasons why.

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