Resuscitation Council UK

GUIDELINES 2021

Paediatric emergency algorithms & resources

March 2024

version 2.2

Paediatric emergency algorithms & resource folder 03/2024

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2024 Updated Content

- Paediatric emergency drug chart - update to calcium gluconate dosages (Mar 2024)
- Paediatric out-of-hospital basic life support algorithm - clarity for paediatric modifiers (Jan 2024)

2023 Updated Content

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- Early management of diabetic ketoacidosis (DKA) in children Jan 2023))

Resuscitation Council UK

Paediatric emergency drug chart

GUIDELINES 2021

	Adrenaline	Fluid bolus	Glucose	Sodium bicarbonate		Tracheal tube		Defibrillation
						Uncuffed	Cuffed	
Strength	**1:10 000**	**Balanced isotonic crystalloid OR, 0.9% Saline**	**10%**	**4.2%**	**8.4%**			
Dose	**10 mcg kg^{-1}**	**10 mL kg^{-1}**	**2 mL kg^{-1}**	**1 mmol kg^{-1}**				**4 joules kg^{-1}**
Route	**IV, IO**	**IV, IO**	**IV, IO**	**IV, IO, UVC**	**IV, IO**			**Transthoracic**
Notes		**Consider warmed fluids**	**For known hypoglycaemia**				**Monitor cuff pressure**	**Monophasic or biphasic**
Age	**Weight kg**	**mL**	**mL**	**mL** (recheck glucose after dose and repeat as required)	**mL**	**mL**	**ID mm**	**ID mm**	**Manual**
< 1 month	3.5	0.35	35	7	7	–	3.0	–	20
1 month	4	0.4	40	8	8	–	3.0–3.5	3.0	20
3 months	5	0.5	50	10	10	–	3.5	3.0	20
6 months	7	0.7	70	14	–	7	3.5	3.0	30
1 year	10	1.0	100	20	–	10	4.0	3.5	40
2 years	12	1.2	120	24	–	12	4.5	4.0	50
3 years	14	1.4	140	28	–	14	4.5–5.0	4.0–4.5	60
4 years	16	1.6	160	32	–	16	5.0	4.5	60
5 years	18	1.8	180	36	–	18	5.0–5.5	4.5–5.0	70
6 years	20	2.0	200	40	–	20	5.5	5.0	80
7 years	23	2.3	230	46	–	23	5.5–6.0	5.0–5.5	100
8 years	26	2.6	260	**50**	–	26	–	6.0–6.5	100
10 years	30	3.0	300	**50**	–	30	–	7.0	120
12 years	38	3.8	380	**50**	–	38	–	7–7.5	120
14 years	**50**	**5.0**	**500**	50	**–**	**50**	**–**	**7–8**	**120–150**
Adolescent	**50**	**5.0**	**500**	50	**–**	**50**	**–**	**7–8**	**120–150**
Adult	**70**	**10.0**	**500**	50	**–**	**50**	**–**	**7–8**	**120–150**

Cardioversion	Synchronised Shock, 1.0 joules kg^{-1} escalating to 2.0 joules kg^{-1} if unsuccessful.
Amiodarone	5 mg kg^{-1} IV or IO bolus in arrest after 3rd and 5th shocks. Flush line with 0.9% saline or 5% glucose (max dose 300 mg).
Atropine	20 mcg kg^{-1}, maximum dose 600 mcg.
Calcium gluconate 10%	0.5 mL kg^{-1} for hypocalcaemia, hyperkalaemia (max dose 30 mL); IV over 2–5 min if unstable; arrhythmia over 5-10 min. repeat after 5 min if ECG changes persist.
Lorazepam	100 mcg kg^{-1} IV or IO for treatment of seizures. Can be repeated after 10 min. Maximum single dose 4 mg.
Adenosine	IV or IO for treatment of SVT: 150 mcg kg^{-1} (0–11 months of age); 100 mcg kg^{-1} (1–11 years of age) Increase dose in steps 50–100 mcg kg^{-1} every 1–2 min for repeat doses. 12–17 years: 3 mg, followed by 6 mg after 1–2 min if required, followed by 12 mg after 1–2 min if required. Requires large saline flush and ECG monitoring.
Anaphylaxis	Adrenaline 1:1000 **IM**: < 6 months 100–150 mcg (0.1–0.15 mL), 6 months–6 years 150 mcg (0.15 mL), 6–12 years 300 mcg (0.3 mL), > 12 years 500 mcg (0.5 mL); can be repeated after 5 min. After 2 IM injections treat as refractory anaphylaxis and start low dose adrenaline infusion IV.

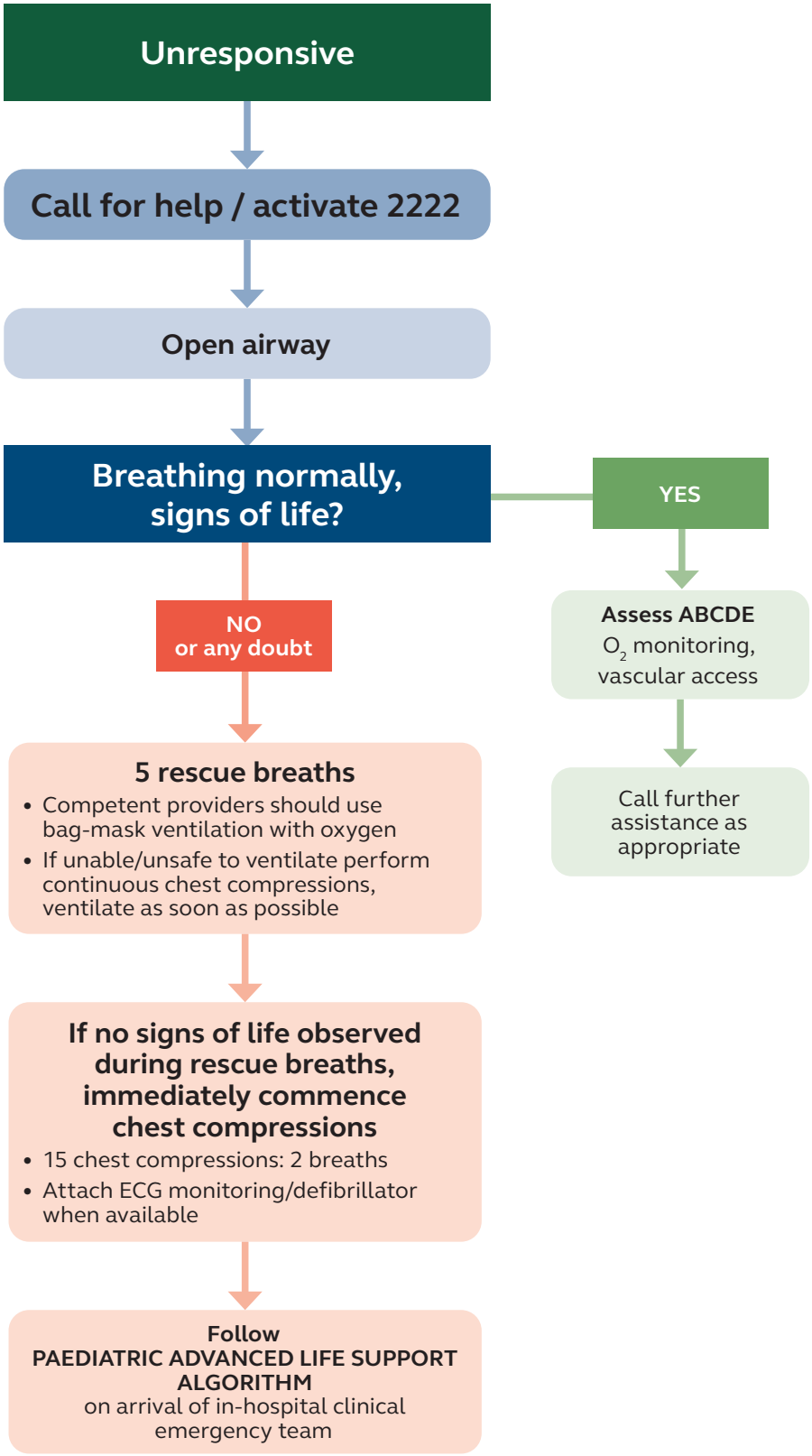
Weights averaged on lean body mass from 50th centile weights for males and females.

Drug doses based on Resuscitation Council UK Guidelines 2021 recommendations.

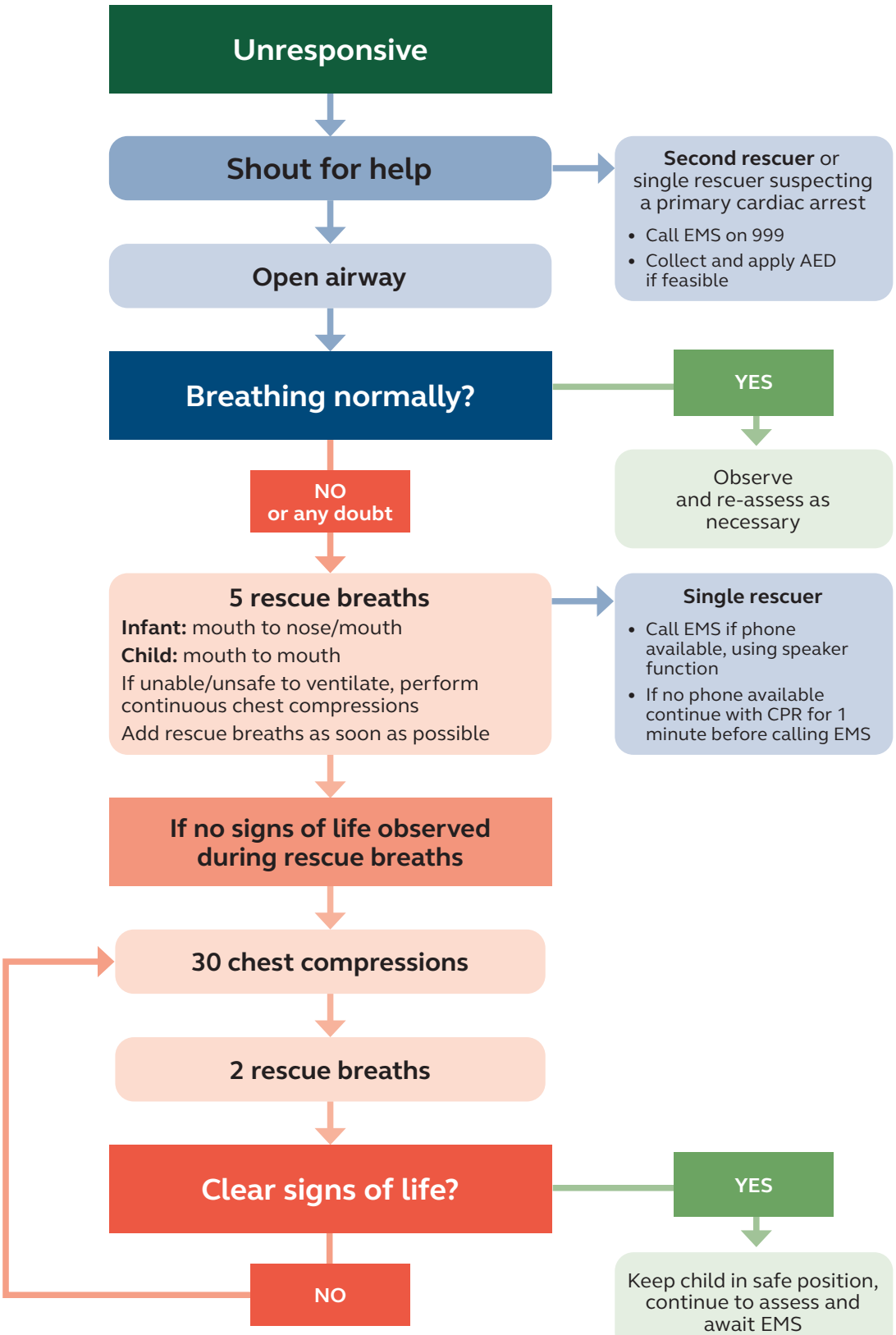
Recommendations for tracheal tubes are based on full term neonates.

For newborns glucose at 2.5 mL kg^{-1} is recommended.

Paediatric basic life support



Paediatric out-of-hospital basic life support

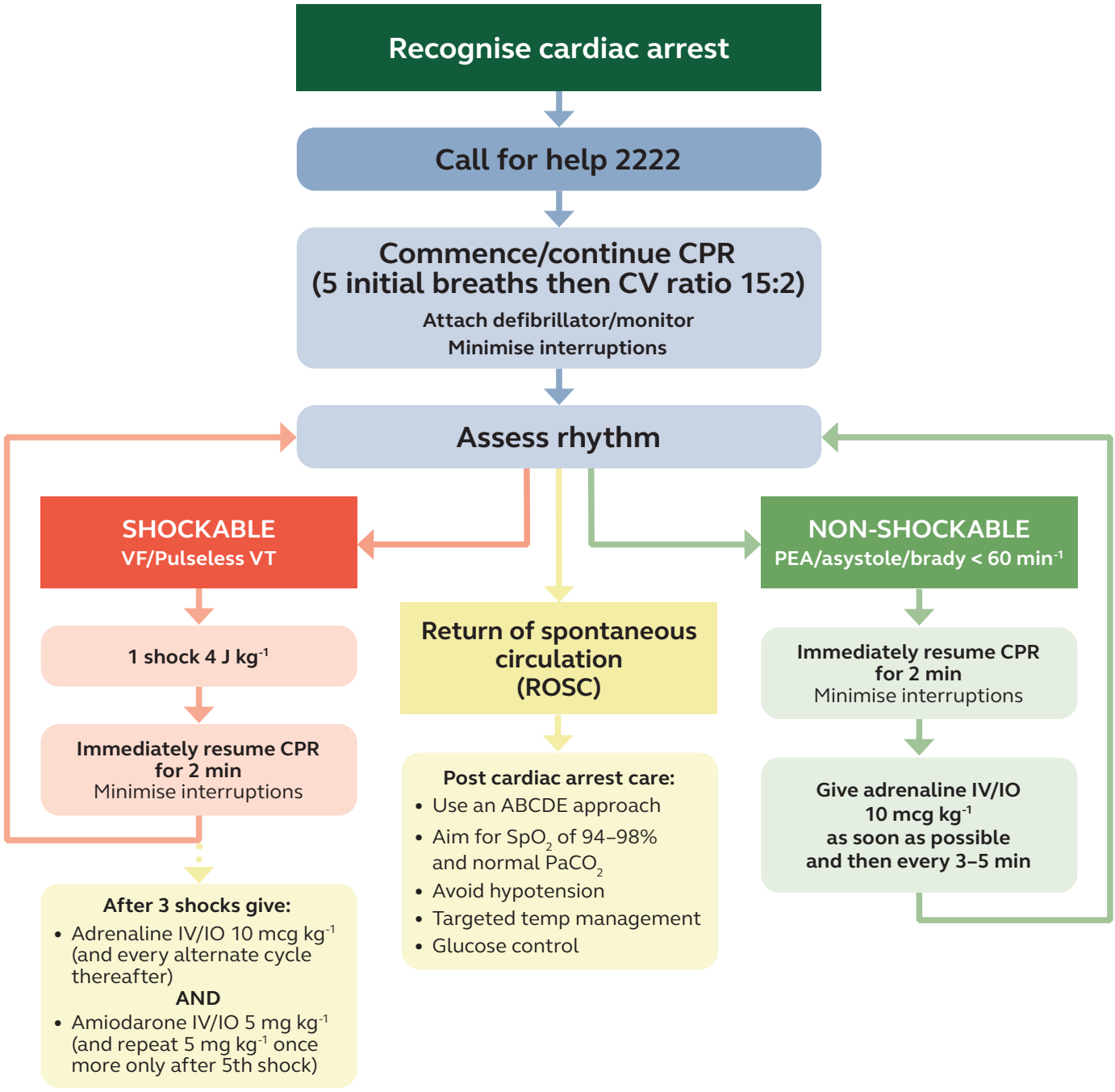


* Chest compression : Ventilation ratio can be 30:2 or 15:2 depending on what the bystander is familiar with/or is directed to do by the emergency dispatcher.

Those trained only in 'adult' BLS (may include healthcare providers and lay rescuers) who have no specific knowledge of paediatric resuscitation, should use the adult sequence they are familiar with, including paediatric modifications.

(January 2024)

Paediatric advanced life support



During CPR

- **Ensure high quality chest compressions are delivered:**
  - Correct rate, depth and full recoil
- Provide BMV with 100% oxygen (2 person approach)
- Provide continuous chest compressions when a tracheal tube is in place.
- Competent providers can consider an advanced airway and capnography, and ventilate at a rate (breaths minute^{-1}) of:

Infants: 25	1–8 years: 20	8–12 years: 15	> 12 years: 10–12

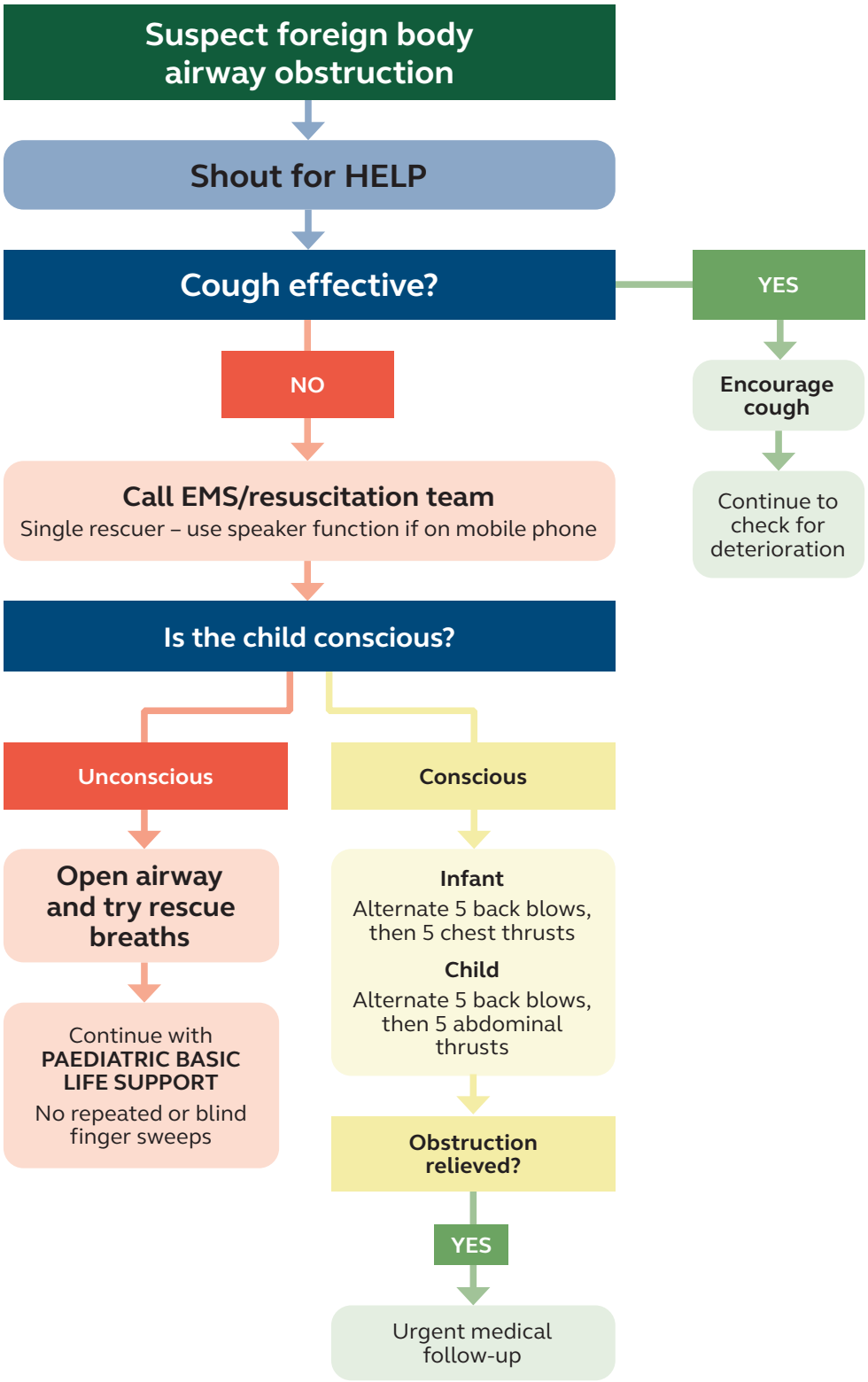
- Vascular access IV/IO
- Once started, give Adrenaline every 3-5 min
- Maximum single dose Adrenaline 1 mg
- Maximum single dose Amiodarone 300 mg

Identify and treat reversible causes

- Hypoxia
- Hypovolaemia
- Hyperkalaemia, hypercalcaemia, hypermagnesemia, hypoglycaemia
- Hypo-/hyperthermia
- Thrombosis – coronary or pulmonary
- Tension pneumothorax
- Tamponade – cardiac
- Toxic agents

Adjust algorithm in specific settings (e.g. special circumstances)

Paediatric foreign body airway obstruction



Anaphylaxis

Anaphylaxis?

A = Airway **B** = Breathing **C** = Circulation **D** = Disability **E** = Exposure

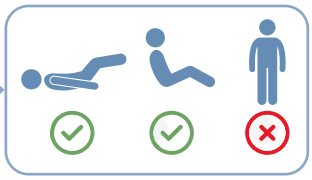
Diagnosis – look for:

- Sudden onset of Airway and/or Breathing and/or Circulation problems[1]
- And usually skin changes (e.g. itchy rash)

Call for HELP

Call resuscitation team or ambulance

- Remove trigger if possible (e.g. stop any infusion)
- Lie patient flat (with or without legs elevated)
  - A sitting position may make breathing easier
  - If pregnant, lie on left side



Give intramuscular (IM) adrenaline[2]

Inject at **anterolateral aspect** – middle third of the thigh

- Establish airway
- Give high flow oxygen
- Apply monitoring: pulse oximetry, ECG, blood pressure

If no response:

- Repeat IM adrenaline after 5 minutes
- IV fluid bolus[3]

If no improvement in Breathing or Circulation problems[1] despite TWO doses of IM adrenaline:

- Confirm resuscitation team or ambulance has been called
- Follow REFRACTORY ANAPHYLAXIS ALGORITHM

1. Life-threatening problems

Airway
Hoarse voice, stridor

Breathing
↑work of breathing, wheeze, fatigue, cyanosis, SpO_2 <94%

Circulation
Low blood pressure, signs of shock, confusion, reduced consciousness

2. Intramuscular (IM) adrenaline
Use adrenaline at 1 mg/mL (1:1000) concentration

Adult and child >12 years:	500 micrograms IM (0.5 mL)
Child 6–12 years:	300 micrograms IM (0.3 mL)
Child 6 months to 6 years:	150 micrograms IM (0.15 mL)
Child <6 months:	100–150 micrograms IM (0.1–0.15 mL)

The above doses are for IM injection **only**.
Intravenous adrenaline for anaphylaxis to be given **only by experienced specialists** in an appropriate setting.

3. IV fluid challenge
Use crystalloid

Adults:	500–1000 mL
Children:	10 mL/kg

Refractory anaphylaxis

No improvement in respiratory or cardiovascular symptoms despite 2 appropriate doses of intramuscular adrenaline

Establish dedicated peripheral IV or IO access

Seek expert[1] help early
Critical care support is essential

Give rapid IV fluid bolus
e.g. 0.9% sodium chloride

&

Start adrenaline infusion
Adrenaline is essential for treating all aspects of anaphylaxis

Give IM* adrenaline every 5 minutes until adrenaline infusion has been started
*IV boluses of adrenaline are not recommended, but may be appropriate in some specialist settings (e.g. peri-operative) while an infusion is set up

Give high flow oxygen
Titrate to SpO_2 94–98%

Monitor HR, BP, pulse oximetry and ECG for cardiac arrhythmia
Take blood sample for mast cell tryptase

Follow local protocol
OR
Peripheral low-dose IV adrenaline infusion:
- 1 mg (1 mL of 1 mg/mL [1:1000]) adrenaline in 100 mL of 0.9% sodium chloride
- Prime and connect with an infusion pump via a dedicated line

DO NOT 'piggy back' on to another infusion line
DO NOT infuse on the same side as a BP cuff as this will interfere with the infusion and risk extravasation

- In both adults and children, start at 0.5–1.0 mL/kg/hour, and **titrate according to clinical response**
- Continuous monitoring and observation is mandatory
- ↑↑ BP is likely to indicate adrenaline overdose

Continue adrenaline infusion and treat ABC symptoms
Titrate according to clinical response

[1]Intravenous adrenaline for anaphylaxis to be given only by experienced specialists in an appropriate setting.

A = Airway

Partial upper airway obstruction/stridor:
Nebulised adrenaline (5mL of 1mg/mL)

Total upper airway obstruction:
Expert help needed, follow difficult airway algorithm

B = Breathing

Oxygenation is more important than intubation

If apnoeic:
- Bag mask ventilation
- Consider tracheal intubation

Severe/persistent bronchospasm:
- Nebulised salbutamol and ipratropium with oxygen
- Consider IV bolus and/or infusion of salbutamol or aminophylline
- Inhalational anaesthesia

C = Circulation

Give further fluid boluses and titrate to response:
Child 10 mL/kg per bolus
Adult 500–1000 mL per bolus
- Use glucose-free crystalloid (e.g. Hartmann's Solution, Plasma-Lyte®)

Large volumes may be required (e.g. 3–5 L in adults)

Place arterial cannula for continuous BP monitoring

Establish central venous access

IF REFRACTORY TO ADRENALINE INFUSION
Consider adding a second vasopressor **in addition** to adrenaline infusion:
- Noradrenaline, vasopressin or metaraminol
- In patients on beta-blockers, consider glucagon

Consider extracorporeal life support

Cardiac arrest – follow ALS ALGORITHM

- Start chest compressions early
- Use IV or IO adrenaline bolus (cardiac arrest protocol)
- Aggressive fluid resuscitation
- Consider prolonged resuscitation/extracorporeal CPR

Paediatric cardiac arrhythmias

Assess with ABCDE approach – recognise and treat reversible causes

Oxygen if SpO_2 < 94%, respiratory rate, heart rate, CRT, cardiac monitoring, blood pressure, vascular access, AVPU

Signs of circulation?

NO → Follow **ADVANCED LIFE SUPPORT ALGORITHM**

YES

Decompensated – seek expert help

Signs of vital organ perfusion compromise:
Reduced LOC, tachypnoea, bradycardia /tachycardia, BP < 5th centile*, CRT > 2 secs, weak or impalpable peripheral pulses

Compensated

Normal LOC, +/- respiratory distress and signs of circulatory compromise, BP > 5th centile*

Monitor for clinical deterioration and seek expert help

Treat the cause:

If bradycardia, consider oxygenation and vagal tone

If SVT, consider vagal manoeuvres

Reassess

Consider adenosine

Bradycardia

< 1 year < 80 min^{-1}
> 1 year < 60 min^{-1}

Optimal oxygenation with positive pressure ventilation if required

If unconscious and HR < 60 min^{-1} despite oxygenation, start chest compressions

No response to oxygenation:

If vagal stimulation possible cause – atropine

If no response to oxygenation or atropine consider adrenaline

Pacing – very rarely required and guided by aetiology.

Tachycardia

Narrow complex

Sinus tachycardia

Infant typically 180–220 min^{-1}
Child typically 160–180 min^{-1}
Gradual onset

Treat the cause:

Physiological response:
- Crying
- Exercise
- Anxiety/fear
- Pain

Identify precipitant

Compensatory mechanism:
- Respiratory/circulatory failure
- Hypovolaemia
- Sepsis
- Anaemia

SVT

Infant > 220 min^{-1}
Child > 180 min^{-1}
Abrupt onset

Synchronised cardioversion with appropriate sedation + analgesia (e.g. IM/intranasal ketamine if delay in IV access)

Chemical cardioversion may be 1st choice if suitable IV access is in place and delay in synchronised cardioversion.

Adenosine

Consider amiodarone before 3rd shock

Broad complex

VT

Could be VT or SVT, if unsure treat as VT

If conscious:
Synchronised cardioversion with appropriate sedation + analgesia (e.g. IM/intranasal ketamine if delay in IV access, *do not delay cardioversion*).

If unconscious:
Immediate synchronised cardioversion

Consider amiodarone before 3rd shock

Drug	Atropine	Adrenaline	Adenosine	Amiodarone	Synchronised cardioversion	Magnesium
Treatment	**Up to 11 years:** 20 mcg kg^{-1}. **12–17 years:** 300–600 mcg, larger doses may be used in emergency.	**For bradycardia:** 10 mcg kg^{-1} repeat if necessary.	**Up to 1 year:** 150 mcg kg^{-1}, increase 50–100 mcg kg^{-1} every 1–2 min. Maximum single dose: Neonates 300 mcg kg^{-1}, Infants 500 mcg kg^{-1}) **1–11 years:** 100 mcg kg^{-1} increase 50–100 mcg kg^{-1} every 1–2 min. Maximum single dose: 500 mcg kg^{-1} (max. 12 mg) **12–17 years:** 3 mg IV, if required increase to 6 mg after 1–2 min, then 12 mg after 1–2 min	5 mg kg^{-1} – by SLOW IV infusion (> 20 min) before 3rd cardioversion in discussion with paediatric cardiologist/expert	With appropriate sedation + analgesia (e.g. IM/intranasal Ketamine if delay in IV access + airway management) – IV access attempts must not delay cardioversion **1st shock:** 1 J kg^{-1} **2nd shock:** 2 J kg^{-1}, consider up to 4 J kg^{-1}	25–50 mg kg^{-1} Maximum per dose 2 g to be given over 10–15 min, may be repeated once if necessary, in Torsades de pointes VT

Age	*Systolic BP 5th centile mmHg
1 month	50
1 year	70
5 years	75
10 years	80

Acute asthma in children

Acute asthma in children aged 2–12 years

These clinical features increase the probability of a diagnosis of asthma:

- More than one of the following: wheeze, cough, difficulty breathing and chest tightness. The risk is increased if these symptoms are recurrent, worse at night or in the early morning, occur during or after exercise or trigger dependent (e.g. with exposure to pets, cold, humidity, heightened emotions or occurring independent of upper respiratory tract infections).
- Personal history of atopic disorder.
- Family history of atopic disorder and/or asthma.
- Widespread wheeze heard on auscultation.
- History of improvement in symptoms or lung function in response to adequate therapy.

Acute asthma in children under 2 years

The assessment of acute asthma in early childhood can be difficult.

- Intermittent wheezing attacks are usually due to viral infection and the response to asthma medication is inconsistent.
- Prematurity and low birth weight are risk factors for recurrent wheezing.
- The differential diagnosis of symptoms includes: aspiration pneumonitis, pneumonia, bronchiolitis, tracheomalacia, complications of underlying conditions such as congenital anomalies and cystic fibrosis.

Classification of severity of acute presentation

Moderate asthma
Normal mental state
Ability to talk in sentences or vocalise as normal
Some accessory muscle use
PEF ≥ 50% of best or predicted
O_2 saturations > 92% in air
Moderate tachycardia
HR ≤ 125 min^{-1} (> 5 years)
HR ≤ 140 min^{-1} (2–5 years)
RR ≤ 30 min^{-1} (> 5 years)
RR ≤ 40 min^{-1} (2–5 years)
Management
Continuous O_2 saturation monitoring
High-flow O_2 via NRB mask titrated to achieve O_2 saturations 94–98%
ß2 agonist 2–10 puffs via pMDI + spacer
+/-face mask, repeat dose every 20 min reviewing effect; no improvement in 1 h treat as acute severe
Ipratropium bromide given early via pMDI
+ spacer +/- face mask, particularly if poorly responsive to ß2 agonist
Oral steroids: prednisolone 20 mg for children aged 2 to 5 years; 30 to 40 mg for children > 5 years

Acute severe asthma
Agitated, distressed
Can't complete sentences in one breath
Moderate to marked accessory muscle use
PEF 33–50% of best or predicted
O_2 saturations < 92% in air
HR > 125 min^{-1} (> 5 years)
HR > 140 min^{-1} (2–5 years)
RR > 30 min^{-1} (> 5 years)
RR > 40 min^{-1} (2–5 years)
Management
Continuous O_2 saturation monitoring
High-flow O_2 via NRB mask titrated to achieve O_2 saturations 94–98%
ß2 agonist nebulised (salbutamol 2.5–5 mg) every 20 min with Ipratropium bromide (250 mcg) for first 2 h; review frequently
Oral steroids: 20 mg prednisolone for children aged 2 to 5 years; 30 to 40 mg for children > 5 years
Consider intravenous magnesium and aminophylline if if the child is unresponsive to maximal doses of bronchodilators and steroids
Consider ABG if poor response to early treatment
Refer to PICU

Life-threatening asthma
Confused, drowsy, exhausted
Unable to talk
Maximal accessory muscle use (poor respiratory effort is **pre-terminal**)
Marked tachycardia (sudden fall in HR is **pre-terminal**)
PEF < 33% of best or predicted
O_2 saturations < 92% in air
Silent chest
Cyanosis
Hypotension
Management
Continuous O_2 saturation monitoring
High-flow O_2 via NRB mask titrated to achieve O_2 saturations 94–98%
Refer to PICU
ß2 agonist nebulised (salbutamol 2.5–5 mg) every 20 min with Ipratropium bromide (250 mcg) for first 2 h; review frequently
Oral steroids: 20 mg prednisolone (2–5 years); 30 to 40 mg (> 5 years). Repeat dose if vomiting or consider intravenous steroids (hydrocortisone 4 mg kg^{-1} every 4 h)
Give bolus of intravenous magnesium.
Consider early single bolus dose of IV salbutamol where child has responded poorly to inhaled therapy followed by an infusion
Consider aminophylline if child unresponsive to maximal doses of bronchodilators and steroids
Consider ABG if poor response to early treatment.

NRB – non-rebreather mask with reservoir

pMDI – pressurised metered-dose inhalers

Note: Evidence is unclear which of intravenous salbutamol, aminophylline or magnesium should be the first line in severe asthma.

Early management of asthma – September 2019. Based on the British Thoracic Society, Scottish Intercollegiate Guidelines Network, British guideline on the management of asthma revised 2019

Treating convulsive status epilepticus in children

SEIZURE STARTS

Management

- Confirm clinically
- Check ABC, high-flow O_2, attach monitoring
- Check blood glucose, treat < 3 mmol L^{-1}

5 MIN

1st line agents

- Consider pre-hospital treatment already given: 2 doses of benzodiazepines max
- **Midazolam** 0.3 mg kg^{-1} buccal or intranasal (max 10 mg) (see BNFc for exact age related dose)

OR

- **Lorazepam** 0.1 mg kg^{-1} IV/IO (max 4 mg)

OR

- **Midazolam** 0.15 mg kg^{-1} IV/IO (max 10 mg)

10–15 MIN

- **Lorazepam** 0.1 mg kg^{-1} IV/IO (max 4 mg)

OR

- **Midazolam** 0.15 mg kg^{-1} IV/IO (max 10 mg)

(Reconfirm epileptic seizure and prepare second-line agent of choice for next step.)

15–35 MIN

2nd line agents

- **Levetiracetam** 40 mg kg^{-1} IV (over 5 min, max 3 g)

OR

- **Phenytoin** 20 mg kg^{-1} IV (over 20 min with ECG monitoring)

OR

- **Phenobarbital** 20 mg kg^{-1} IV (over 5 min)

Call anaesthetist and PICU

20–40 MIN

2nd or 3rd line agents

- If preparation for deeper anaethesia with I+V complete, proceed to next step

OR

- Administer further alternative second-line drug (levetiracetam, phenytoin, phenobarbitol)

3rd line agents

- Rapid sequence induction of anaesthesia using thiopental sodium 4 mg kg^{-1} IV

OR

- Propofol 1–1.5 mg kg^{-1} IV (with single dose recuronium if using NMB); ketamine and midazolam alternatives
- Intubation and ventilation; monitoring neurological signs
- Ongoing seizures are not always easy to identify (EEG)

- Definition of convulsive status epilepticus (CSE) is a seizure that continues for greater than 5 min, so treatment usually starts once seizure has lasted > 5 min
- After 5 min seizures are unlikely to spontaneously terminate
- The risk of a seizure becoming refractory increases with increasing seizure duration.
- *ESETT/**ECLIPSE/***ConSEPT trials showed equal potency for phenytoin, levetiracetam and valproate
- Levetiracetam has a good safety profile and is easy to administer
- Children who frequently have seizures or CSE usually have an individually tailored guideline.
- Do not give phenytoin too rapidly as it will cause bradycardia and/or asystole.
- In sepsis consider measuring calcium and magnesium levels as they are sometimes low.
- Monitor glucose aim for 4-8 mmol L^{-1}
- Measure serum sodium and treat if < 125 mmol L^{-1} (3 mL kg^{-1} 3% sodium chloride)
- Consider temperature control measures if hyperthermic
- Consider meningitis, encephalitis and Raised ICP
- Consider CNS haemorrhage if signs of trauma
- There is no evidence for the ideal third line agent: thiopentone, propofol, ketamine and midazolam may all be used

* Kapur et al. Randomized Trial of Three Anticonvulsant Medications for Status Epilepticus. N Engl J Med 2019;381:2103-2113.doi:10.1056/NEJMoa1905795

** Lyttle M, Rainford NE et al. Levetiracetam versus phenytoin for second-line treatment of paediatric convulsive status epilepticus (EcLiPSE): a multicentre, open-label, randomised trial. Lancet, Volume 393, Issue 10186, 2125 – 2134

*** Dalziel SR, Borland ML et al; PREDICT research network. Levetiracetam versus phenytoin for second-line treatment of convulsive status epilepticus in children (Concept): an open-label, multicentre, randomised controlled trial. Lancet. 2019 May 25;393(10186):2135-2145

Updated January 2023

Early management of diabetic ketoacidosis (DKA) in children

adapted from NICE NG18 (updated 2020) & BSPED Guideline for the Management of Children & Young People under the age of 18 years DKA 2021

Recognition

History of polyuria, polydipsia and weight loss.
May have confusion, abdominal pain and hyperventilation.

- Blood glucose > 11 mmol L^{-1}
- pH < 7.3
- Blood bicarbonate < 15 mmol L^{-1}
- Ketones: blood beta-hydroxybutyrate > 3 mmol L^{-1} or urine ketonuria ++ and above

Note: Usually not vomiting, acidotic or drowsy unless more than 5% dehydrated

Severity of DKA and degree of dehydration	
Mild: 5% dehydration	Venous pH 7.2–7.29 or Bicarbonate < 15 mmol L^{-1}
Moderate: 5% dehydration	Venous pH 7.1–7.19 or Bicarbonate < 10 mmol L^{-1}
Severe: 10% dehydration	Venous pH < 7.1 or Bicarbonate < 5 mmol L^{-1}

Management

Resuscitation

A ensure airway patency, insert NG tube if reduced conscious level or vomiting to decrease gastric distension

B 100% oxygen via a face mask with reservoir bag + titrate to oxygen saturations 94–98%; avoid intubation unless respiratory arrest or respiratory failure when anaesthetic assistance urgently required

C establish IV access, take venous bloods (pH, $PaCO_2$, bicarbonate, sodium, potassium, urea, creatinine, beta-hydroxybutyrate levels, glucose), monitor ECG, identify shock

- Give a fluid bolus 10 mL kg^{-1} of balanced isotonic crystalloid or 0.9% sodium chloride over 30 min to children with NO shock
- Give a fluid bolus 10 mL kg^{-1} of balanced isotonic crystalloid or 0.9% sodium chloride over 5–10 min and re-assess; repeat to a maximum of 40 mL kg^{-1}; inform PICU if shock is persists

D seek and identify signs and symptoms of raised intracranial pressure – headache, confusion, irritability, posturing, falling GCS, rising BP with bradycardia. Treat with 3% sodium chloride or mannitol, seek PICU advice and call an anaesthetist. Consider CT brain to determine the cause.

E Consider sepsis if fever, hypothermia, hypotension, lactic acidosis, refractory acidosis

Intravenous therapy: fluids and insulin

For children with dehydration, nausea and vomiting:

Calculate fluid requirements (FR) for each child

Aim: to correct fluid deficit over 48 h

FR = Maintenance fluids for 48 h + fluid deficit

Subtract 10 mL kg^{-1} from fluid requirement for children who did not present with shock

Do not subtract resuscitation fluid volumes from fluid requirements for children who presented in shock

Isotonic balanced crystalloids or 0.9% sodium chloride initial fluid of choice - add potassium once passing urine and serum potassium is in normal range (usually < 5.5 mmol L^{-1}); add 5% dextrose to fluid when glucose less than 14 mmol L^{-1}

1–2 h after intravenous fluids commenced, start insulin infusion at 0.05–0.1 units kg^{-1} h^{-1} (0.05 units kg^{-1} h^{-1} for children < 5 years old recommended)

Monitor serum potassium and treat hypokalaemia

Do not give intravenous bicarbonate to correct acidosis

Observations

Strict fluid balance

Hourly capillary blood gas and blood glucose measurements

Capillary blood ketone levels 1–2 h (ideally point of care testing)

Initially two-hourly U+E's

Hourly BP, HR, RR, temperature

Hourly assessment of level of consciousness

Half hourly neuro observations including level of consciousness in children with severe DKA and children < 2 years old.

Urgently escalate symptoms of headache, bradycardia, changes in level of consciousness or changes in ECG (ST and T wave changes may indicate hypokalaemia)

Maintenance fluids calculation
4 mL kg^{-1} h^{-1} for first 10 kg of body weight
2 mL kg^{-1} h^{-1} for second 10 kg of body weight (11–20 kg)
1 mL kg^{-1} h^{-1} for each kg of body weight above 20 kg (up to max of 75 kg)

Fluid deficit (mL) = % dehydration x weight (kg) x 10
Fluid requirement (FR) over 48 h for a 10 kg child = maintenance requirement for 48 h + (fluid deficit – initial fluid given) (if no shock)
(Note: max FR allowance for 5% dehydration = 3750 mL, 10% dehydration = 7500 mL)
Example: 5% dehydrated, no shock at presentation, given 10 mL kg^{-1} 0.9% saline = (4 x 10 x 48) + (5 x 10 x 10) – (10 x 10) = 1920 + 500 – 100 = 2320 mL over 48 h = 48 mL h^{-1}

Updated January 2023

Septic shock and sepsis-associated organ dysfunction in children

RECOGNITION

Assess with ABCDE approach

A, B assessment

- Airway, RR, work of breathing, oxygen saturations, breath sounds, recognition respiratory distress/failure.
- Open airway and start high-flow oxygen via non-rebreather mask with reservoir or BMV as appropriate.

C assessment

- HR, CRT, BP, peripheral and central perfusion, rhythm recognition; recognition circulatory failure/shock.
- Establish IV/IO access (take blood cultures, full blood count, blood glucose, urea and electrolytes, lactate*, blood gas and other bloods as indicated**) and give fluid resuscitation as below.

D assessment

- AVPU score; recognition of altered mental status secondary to poor perfusion.

E assessment

- Rash, temperature (high or low).

Sepsis is diagnosed if there is evidence of infection as cause of the acute illness (suspected or proven) plus at least two of the following: core temperature < 36°C or > 38.5°C; white cell count elevated or depressed for age; inappropriate tachycardia; altered mental state; reduced peripheral perfusion.

10–15 MIN

Initial resuscitation

- If no signs fluid overload (hepatomegaly, crackles at lung bases) then give 10 mL kg^{-1} balanced crystalloids*** IV bolus over 5–10 min and re-assess after each bolus up to 40–60 mL kg^{-1} or until perfusion improved.
- Therapeutic end points: CRT < 2 s; normal BP for age; UO > 1 mL kg^{-1} h^{-1}, normal pulses, normal mental state.
- Watch for signs of fluid overload; if present stop bolus therapy and start inotropic support.
- Correct hypoglycaemia and hypocalcaemia.
- Start broad-spectrum antibiotics; seek and aggressively control any infection source.
- Call for more senior help and an anaesthetist urgently; call PICU for bed +/- PICU transfer team.
- If mechanical ventilation is required, then cardiovascular instability during intubation is less likely after appropriate cardiovascular resuscitation.

15–60 MIN

Fluid refractory shock?

Start IV/IO inotrope infusion; central (preferable) or peripheral IV (clinical signs unreliable at differentiating 'warm' and 'cold' shock in children).

Adrenaline 0.05–0.3 mcg kg^{-1} min^{-1} (use more dilute infusion if peripheral)

and/or

Noradrenaline via central IV or IO, starting infusion rate 0.05 mcg kg^{-1} min^{-1}

Titrate inotropes upwards according to clinical response and haemodynamic effects using haemodynamic monitoring (where possible)****

Use ketamine +/- atropine IV/IO/IM to gain central access and airway if needed.

Fluid and catecholamine-resistant shock?

Further management as per Paediatric Intensive Care/retrieval service advice.

Warm shock – high cardiac output with low systemic vascular resistance.	**Cold shock** – low cardiac output with high systemic vascular resistance.	**Fluid in mL kg^{-1} should be dosed for ideal body weight (max bolus 500 mL)**

* lactate measurements are useful if available as they have prognostic ability if measured serially.

** Other bloods that may be indicated: coagulation studies, liver function tests, magnesium levels or any others indicated by the child's clinical picture.

*** Balanced (buffered) fluids are used in preference to 0.9% sodium chloride, but if not available, 0.9% sodium chloride should be used.

**** These are starting dose ranges for these inotropes, and increases may be necessary but should be guided by PICU retrieval team/senior clinicians. Choice of inotropes is dictated by clinician preference, response to treatment and monitored parameters, and again decisions should be made in conjunction with PICU teams.

Emergency Paediatric Tracheostomy Management

Basic Response

SAFETY - STIMULATE - SHOUT FOR HELP - OXYGEN

SAFE: **Check Safe area, Stimulate, and Shout for help**
AIRWAY: **Open child's airway:** head tilt / chin lift / pillow or towel under shoulders may help
OXYGEN: Ensure **high flow oxygen** to the **tracheostomy AND the face** as soon as oxygen available
CAPNOGRAPHY: Exhaled carbon dioxide waveform may indicate a patent airway (advanced response)

SUCTION TO ASSESS TRACHEOSTOMY PATENCY

Remove attachments: humidifier (HME), speaking valve
Change inner tube (if present)
Inner tubes may need re-inserting to connect to breathing circuits

Can you pass a SUCTION catheter?

Yes → **The tracheostomy tube is patent**
Perform tracheal suction
Consider partial obstruction
CONTINUE ASSESSMENT (ABCDE)

No → **EMERGENCY TRACHEOSTOMY TUBE CHANGE**

Deflate cuff (if present). Reassess patency after any tube change
1st change – same size tube
2nd change – one-half size smaller tube
3rd change - over suction catheter to guide

IF UNSUCCESSFUL – REMOVE THE TUBE

IS THE PATIENT BREATHING? - Look, listen and feel at the mouth and tracheostomy/stoma

Yes → **Continue oxygen**
Stabilize
Reassess
Review

Plan for definitive airway if tube change failure

No → **CALL FOR HELP: 2222 in hospital, 999 in community**

5 RESCUE BREATHS

Patent Upper Airway – use the nose/mouth
Obstructed Upper Airway – use the tracheostomy/stoma

NO SIGNS OF LIFE? START CPR

15 compressions : 2 rescue breaths
Ensure help or resuscitation team called

Advanced Response

Primary emergency oxygenation

Standard **ORAL airway** manoeuvres
Cover the stoma (swabs / hand).
Use:
- Bag-valve-face mask
- Oral or nasal airway adjuncts
- Supraglottic Airway (SGA)
- e.g. Laryngeal Mask Airway (LMA)

Tracheostomy STOMA ventilation
- Paediatric face-mask applied to stoma
- SGA applied to stoma

Secondary emergency oxygenation

ORAL intubation with endotracheal tube
Uncut tube, advanced beyond stoma
One half-size smaller than tracheostomy tube
'Difficult Airway' Expert and Equipment*

Attempt **intubation of STOMA**
3.0 ID tracheostomy or endotracheal tube
'Difficult Airway' Expert and Equipment*

***EQUIPMENT: Fibreoptic scope, bougie, airway exchange catheter, Airway trolley**

NTSP (Paediatric Working Group) www.tracheostomy.org.uk Review January 2022