



## Clinical Guidelines

# Septic Shock

### Document Control Information

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## Septic Shock

Septic shock is suspected when children have a change in mental status manifested as irritability, inappropriate crying, drowsiness, confusion, poor interaction with parents, lethargy, or becoming unrousable, along with additional features such as tachypnoea and reduced urine output.

## Recognition

- Suspected infection
- Hypo or hyperthermia (temp  $<36^{\circ}$  or  $>38.5^{\circ}$ ) Tachycardia
- Tachypnoea
- Altered mental status
- Decreased urine output ( $<1$  ml/kg/hr) Other end organ dysfunction
- Signs of either cold or warm shock

For recognition of a child at risk refer to the Amber and Red signs on the Paediatric Sepsis 6 trigger bundle at the end of this guideline

Cold Shock	Warm Shock
Capillary Refill $>2s$	Flash Capillary Refill
Reduced Peripheral Pulses	Bounding Peripheral Pulses
Cool Mottled Extremities	Warm to edges
Narrow Pulse Pressure	Wide Pulse Pressure

Hypotension is not required for the clinical diagnosis of shock; however once it is present in a child with a suspected infection the diagnosis is confirmed.

Early signs and symptoms of shock are as a result of the body's compensatory mechanisms, while late signs are indicative of decompensation.

Normal ranges for age (APLS)

Age(years)	Respiratory rate	Heart rate	Systolic BP (mmHg)
$< 1$	30 - 40	110 - 160	80 - 90
1 - 2	25 - 35	100 - 150	85 - 95
2 - 5	25 - 30	95 - 140	85 - 100
5 - 12	20 - 25	80 - 120	90 - 110
$> 12$	15 - 20	60 - 100	100 - 120

There is evidence showing that aggressive optimisation of the haemodynamic status within the first few hours of critical illness reduces subsequent organ failure and improves overall survival.

Paediatric septic shock is typically associated with severe hypovolemia and children frequently respond well to aggressive volume resuscitation

Children are consistently under-resuscitated in the first few hours. For every hour that a child remains in septic shock the mortality risk double.

### **The First Hour of Resuscitation – GOALS to restore**

- Normal perfusion
- No difference in quality between central & peripheral pulses
- Warm extremities
- Capillary refill time <2s
- Normal range for age heart rate, blood pressure & respiratory rate for age (this may not be possible if the underlying cause is pneumonia)
- Normal mental status
- Urine output >1ml/kg/hr
- Serum lactate < 2
- ScvO<sub>2</sub> sats (where available) >70%
- Normal glucose and ionized calcium concentrations

### **Actions in the 1st Hour**

- Maintain or restore a patent airway
- High flow oxygen to achieve saturations >95% - intubate if indicated.
- Obtain secure intravenous or intraosseous access x2 quickly.
- Give high dose broad spectrum antibiotics- try to avoid Ceftriaxone (<1yr) due to risk of precipitation with calcium administration, use cefotaxime.

**Do not waste valuable time** - if difficult IV access, site an intraosseous (IO) needle. More than one is frequently required.

### **Resuscitate**

Signs of shock should be **immediately** treated

- 20 mls/kg over 5 minutes. Rapid infusion bolus administered either by push or pressure bag
- Use 0.9% Saline or Human Albumin Solution 4.5% (HAS).
- Correct hypoglycaemia, give 2 mls/kg of 10% Glucose

### **Reassess - What are the effects of every fluid bolus?**

- Have the heart rate, quality of peripheral pulses, CRT, mental state, blood pressure responded? Multiple fluid boluses may be necessary.
- Large fluid deficits often exist & initial fluid volumes of 40-60 ml/kg are quite usual, volumes of 80-100mls/kg may be necessary.

- Is there evidence of volume overload? (hepatomegaly, crackles, increased work of breathing or gallop rhythm), fluid is not recommended when rales or hepatomegaly are present – commence inotropic support

If after **15 minutes of optimal fluid resuscitation** (40-60 mls/kg) and there is still evidence of end organ dysfunction start peripheral or IO **Adrenaline** at 0.1mcg/kg/min up to 0.5mcg/kg/min

Please REFER to CATS at this point if not already done so.

#### **Inotrope choice:**

- Use Adrenaline for COLD SHOCK
- Use Noradrenaline for WARM SHOCK

#### **Hydrocortisone Therapy**

- **If a child is at risk of adrenal failure or has purpura fulminans and is in catecholamine resistant shock then intravenous hydrocortisone should be administered at 1mg/kg qds. for children (2.5mg/kg for neonates).**

Obtain Central Access

Insert an Arterial line for haemodynamic monitoring.

#### **Indications for Intubation**

- Impending cardiovascular collapse
- Poor airway reflexes
- Depressed level of consciousness -Glasgow Coma Score (GCS)  $\leq 8$  or AVPU  $\leq P$  Worsening tachypnoea or oxygen requirement
- Fluid refractory shock ( $\geq 40$  mls/kg fluid resuscitation in the first 30 minutes **without** reversal of shock)

#### **Cardiovascular instability around intubation can be minimised by**

- Optimal volume replacement prior to intubation.
- Fluid bolus attached.
- Adrenaline or Dopamine infusion drawn up and attached if not running.
- Pre oxygenation with 100% O<sub>2</sub>.
- A “good fit” ETT. This is necessary to ventilate in the presence of pulmonary oedema.
- Use of a cuffed ETT is preferred.
- Ensuring the most experienced team members perform the intubation  
Anaesthetic / ICU Consultant with Paediatric Consultant support.
- Use of optimal drugs for induction:
  - Ketamine 0.5-2.0 mg/kg +/- Fentanyl 2-5mcg/kg
  - Suxamethonium 1-2 mg/kg (Unless contraindicated)
- Modified rapid sequence induction (Cricoid pressure).

Inhalational anaesthetics present a significant risk of cardiovascular depression. They should only be used if the risk of a difficult airway outweighs this.

Thiopentone, propofol & benzodiazepines all carry a similar risk of significant cardiovascular depression.

## Once Intubated

- End tidal CO<sub>2</sub> monitoring is mandatory
- Secure ETT – do not cut the ETT
- Check appropriate position with CXR (Tip at T2-T3)
- Sedate & muscle relax as per CATS guidelines
- These children are at risk of acute respiratory distress syndrome (ARDS). A low tidal volume strategy of 4-7 ml/kg with an initial PEEP of 5 cm/H<sub>2</sub>O should be used. PEEP can be titrated up depending on blood gases & evidence of pulmonary oedema.

## ACTIONS: The First 6 hours: STABILISATION

### Coagulopathy

- Consider treatment with 10-20 mls/kg of Fresh Frozen Plasma (FFP)
- Low platelet counts in the absence of active bleeding should not be supplemented unless < 20 x 10<sup>6</sup>/microlitre
- Low fibrinogen is suggestive of DIC give 5-10mls/kg of Cryoprecipitate.

### Electrolytes

- Treat **Hypocalcaemia** (0.5 mls/kg 10% calcium gluconate).
- Treat **Hypomagnesaemia** 0.5 ml/kg 20% magnesium sulphate (or 1ml/kg 10% magnesium sulphate).

(This can cause hypotension, give slowly over 30 minutes with additional fluid bolus if necessary)

### Ongoing Fluid Resuscitation

Fluid shift and hypotension secondary to capillary leak can continue for several days.

Continued fluid administration should be titrated against clinical end points such as, heart rate, perfusion pressure, cardiac output, urine output, serum lactate and ScvO<sub>2</sub> saturations.

If Hb >10g/dl use crystalloid.

Consider packed red cells if Hb <10g/dl

Consider Fresh Frozen Plasma for coagulopathy.

### Indicators of disease severity regardless of “how good they look”

- Low neutrophils
- Low platelets
- Rapid onset (<6 hours)
- Rapidly spreading rash
- High volume requirement

## References:

Davis, A et al., (2017). American College of Critical Care Medicine Clinical Practice Parameters for Hemodynamic Support of Pediatric and Neonatal Septic Shock. *Critical Care Medicine*, 45(6), pp.1061-1093.

Patient name
DOB
Hospital number
Please affix label

# Paediatric Sepsis 6

Date:

**Child unwell? EWS concern?  
 THINK Could this be Sepsis?**

**Recognition of child at risk**  
 If a child with suspected or proven infection AND at least 2 of:

- Core temperature of <36°C or >38.5°C (38.0°C if Immunocompromised)
- Tachycardia (refer to Early Warning Score)
- Altered mental state (sleepiness, irritability, lethargy, floppiness)
- Prolonged capillary refill (> 2s)
- Immunocompromised
- Hypotension

**OR**

**Red flag signs (Any 1 flag present)**

- Lactate >2mmol/l
- Extreme tachycardia/tachypnoea
- SpO2 <90%/grunting/cyanosis/apnoea
- P or U on AVPU
- Persistent hypotension (3x consecutive measurements in 1hr)
- Non blanching rash/mottled skin

**CONSULT DOCTOR OR SENIOR STAFF MEMBER  
 – COULD THIS CHILD HAVE SEPSIS OR SEPTIC SHOCK?**

START TIME	Yes or high suspicion – start Sepsis 6	
Commence all elements within 1 hour	1] Give high flow oxygen	Time Sign
	2] Obtain IV/IO access and take blood tests	Time Sign
	<ul style="list-style-type: none"> <li>Blood gas and lactate (+/- FBC, U&amp;E, CRP if able)</li> <li>Blood glucose – treat hypoglycaemia (2mls/kg 10% glucosa)</li> <li>Blood cultures</li> </ul>	
	3] Give IV or IO antibiotics	Time Sign
	4] Consider fluid resuscitation	Time Sign
	<ul style="list-style-type: none"> <li>Aim to restore normal physiological parameters, U/O &gt;0.5mls/kg/hr</li> <li>Give 10-20ml/kg isotonic fluid over 5-10 mins</li> <li>Repeat as necessary, monitor urine output</li> </ul>	
END TIME	5] Involve senior clinicians early	Time Sign
	6] Consider inotropic support early	Time Sign
	<ul style="list-style-type: none"> <li>If normal physiological parameters not restored after ≥40ml/kg fluids consider CATS referral. Ring Hotline no. 0800 085 0003</li> </ul>	

No or unsure	
Review hourly and document below	
Not sepsis – document reasons	Time Sign
Unsure – review within 1 hour	Time Sign
REVIEW WITHIN 1 HOUR (Repeat obs every 30mins)	
Not sepsis – document reasons	Time Sign
Sepsis – start Sepsis 6	Time Sign
Unsure – review within 1 hour	Time Sign
REVIEW WITHIN 1 HOUR (Repeat obs every 30mins)	
Not sepsis – document reasons	Time Sign
Sepsis – start Sepsis 6	Time Sign
Unsure – review within 1 hour	Time Sign
REVIEW WITHIN 1 HOUR (Repeat obs every 30mins)	
Not sepsis – document reasons	Time Sign
Sepsis – start Sepsis 6	Time Sign
Unsure – review within 1 hour	Time Sign
REVIEW WITHIN 1 HOUR	

**Is there a likely source of infection?**

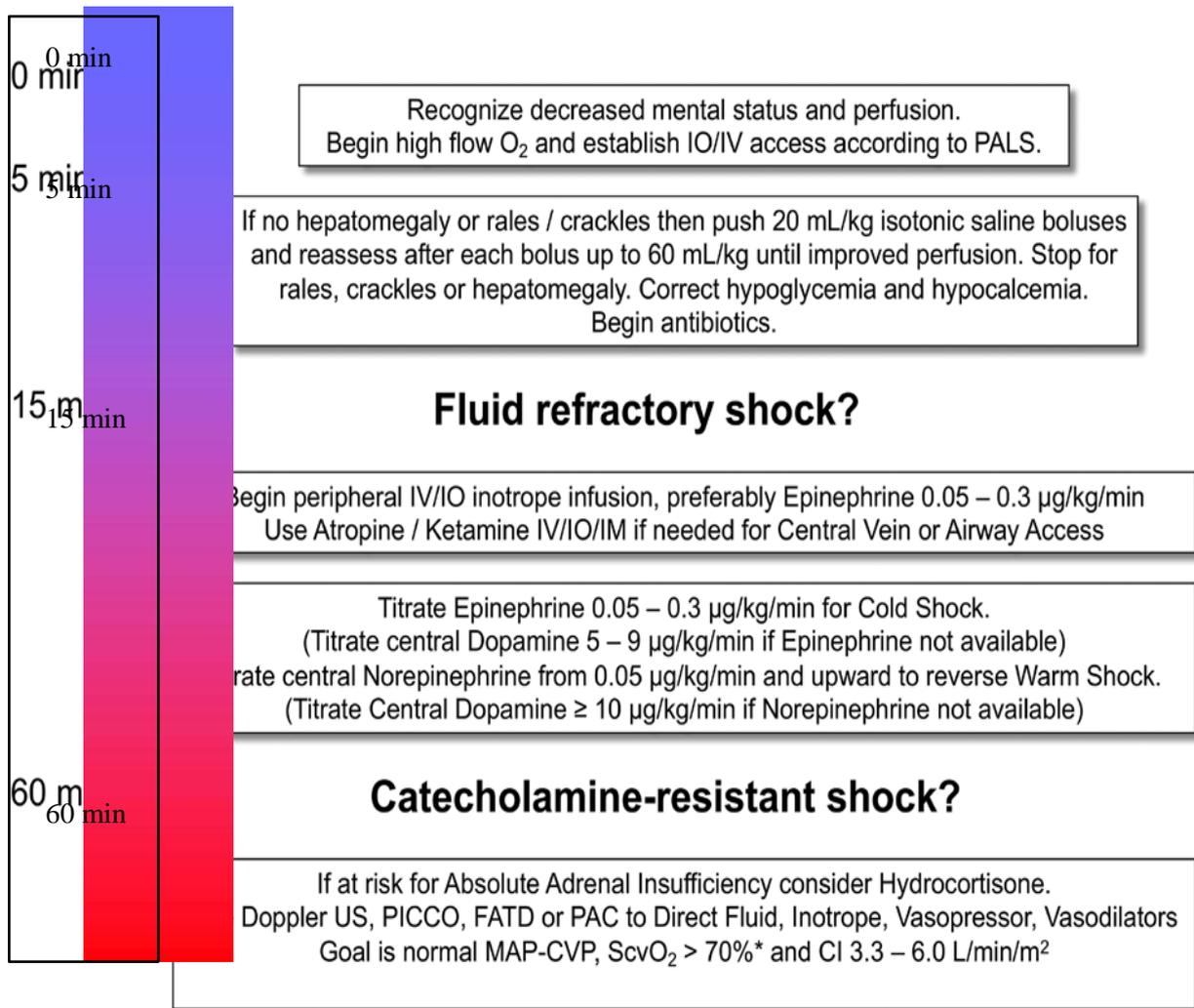
- |   |  |  |  |
|---|--|--|--|
| <input type="checkbox"/> Yes, but source unclear at present | <input type="checkbox"/> Line infection  | <input type="checkbox"/> VP shunt                | <input type="checkbox"/> Pneumonia/likely chest source |
| <input type="checkbox"/> Meningitis/encephalitis            | <input type="checkbox"/> Intra-abdominal | <input type="checkbox"/> Urinary tract infection |  |
| <input type="checkbox"/> Febrile Neutropenia                | <input type="checkbox"/> Surgical Site   | <input type="checkbox"/> Other – details         |  |

Any questions, please contact Claire Fraser (Claire.Fraser@gosh.nhs.uk) or Rhannon Follett (Rhannon.Follett@gosh.nhs.uk)

Adapted from the Paediatric Sepsis 6 version 11.1 August 2015 in collaboration with the UK Sepsis Trust Paediatric Group



1.



Normal Blood Pressure  
Cold Shock  
ScvO<sub>2</sub> < 70%\* / Hgb > 10g/dL  
on Epinephrine?

Low Blood Pressure  
Cold Shock  
ScvO<sub>2</sub> < 70%\* / Hgb > 10g/dL  
on Epinephrine?

Low Blood Pressure  
Warm Shock  
ScvO<sub>2</sub> > 70%\*  
on Norepinephrine?

Begin Milrinone infusion.  
Add Nitroso-vasodilator if CI < 3.3L/min/m<sup>2</sup> with High SVRI and/or poor skin perfusion.  
Consider Levosimendan if unsuccessful.

Add Norepinephrine to Epinephrine to attain normal diastolic blood pressure. If CI < 3.3 L/min/m<sup>2</sup> add Dobutamine, Enoximone, Levosimendan, or Milrinone.

If euvolemic, add Vasopressin, Terlipressin, or Angiotensin. But, if CI decreases below 3.3 L/min/m<sup>2</sup> add Epinephrine, Dobutamine, Enoximone, Levosimendan.

**Persistent Catecholamine-resistant shock?**

Evaluate Pericardial Effusion or Pneumothorax,  
Maintain IAP < 12mmHg

**Refractory Shock?**

ECMO

