

NHS Children's Acute Transport Service



Clinical Guidelines

Septic Shock

Document Control Information

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Septic Shock

The inflammatory triad of fever, tachycardia & abnormal perfusion is very common in children with benign infections.

Septic shock should be considered in children who manifest this triad with additional features such as tachypnoea, reduced urine output, irritability & lethargy / drowsiness.

Recognition

Suspected infection
 Hypo or hyperthermia (temp <36° or >38.5°)
 Tachycardia
 Tachypnoea
 Altered mental status
 Decreased urine output (<1 ml/kg/min)
 Other end organ dysfunction
 Signs of either cold or warm shock

| Cold Shock | Warm Shock |
|---------------------------|----------------------------|
| Capillary Refill >3s | 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.

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.

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

The First Hour of Resuscitation - GOALS

To restore

1. Normal perfusion
2. No difference in quality between central & peripheral pulses
3. Warm extremities
4. Capillary refill time <3s
5. Normal range for age heart rate, blood pressure & respiratory rate (this may not be possible if the underlying cause is pneumonia)
6. Normal mental status
7. Urine output >1ml/kg/hr
8. Serum lactate < 2
9. ScvO₂ sats (where available) >70%

ACTIONS - 1st Hour

- Maintain or restore a patent airway
- High flow oxygen to achieve sats >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 site an intraosseous (IO) needle.

RESUCITATE

Signs of shock should be **immediately** treated

- 20 mls/kg over 5 mins.
- Use 0.9% Saline or Human Albumin Solution 4.5% (HAS).

Correct hypoglycaemia

- 2 mls/kg 10% dextrose

REASSESS

What are the effects of **every** fluid bolus?

- Have the heart rate, quality of peripheral pulses, CRT, mental state responded?
- Is there evidence of volume overload? (hepatomegaly, crackles, increased work of breathing or gallop rhythm)

Multiple fluid boluses may be necessary.

Large fluid deficits often exist & initial fluid volumes of 40-60 ml/kg are quite usual, much larger volumes may be necessary.

If volume overloaded **do not give further fluids - commence inotropes**

If after **15 minutes of optimal fluid resuscitation** (40-60 mls/kg) there is still evidence of end organ dysfunction start peripheral or IO **dopamine**

- Up to 20 mcg/kg/min
- Watch tissue integrity

If obtaining Central Access

The 1st choice for central access is the femoral vein

Inotropes:

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

Insert an Arterial line for haemodynamic monitoring. In the awake child consider using Ketamine for sedation to insert lines and the use of local anaesthetic.

INDICATIONS FOR INTUBATION

Impending cardiovascular collapse

Poor airway reflexes

Depressed level of consciousness -Glasgow Coma Score (GCS) ≤ 8 or AVPU $\leq P$

Worsening tachypnoea or oxygen requirement

Fluid refractory shock (≥ 60 mls/kg fluid resuscitation in the first hour **without** reversal of shock)

Induction of anaesthesia presents a significant risk of hypoxia, myocardial depression and afterload reduction.

This can be minimised by

- Optimal volume replacement prior to intubation.
- Having fluid running with a bolus attached.
- Dopamine infusion drawn up or running.
- Pre oxygenation with 100% O₂.

- A “good fit” ETT. This is necessary to ventilate in the face of pulmonary oedema.
- Using a cuffed ETT if available.
- 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 2-5 mcg/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 CO₂ 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 maintenance of anaesthesia 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/H₂O should be used. PEEP can be titrated up depending on blood gases & evidence of pulmonary oedema.

Ventilation provides cardiovascular support

Up to 40% of cardiac output may be required to support the work of breathing. This can be reduced by mechanical assistance allowing blood flow to be diverted to other vital organs.

Increased intra thoracic pressure reduces left ventricular afterload which is particularly helpful in patients with low cardiac index & high systemic vascular resistance.

Mechanical support also aids patients with increased pulmonary vascular resistance (if ventilated at or around the functional residual capacity (FRC)).

OTHER ISSUES

- **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 $< 20 \times 10^6$ /microlitre

Low fibrinogen is suggestive of DIC give 5-10mls/kg of Cryoprecipitate.

- **Electrolytes**

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)

Treat **Hypocalcaemia** (0.5 mls/kg 10% calcium gluconate).

ACTIONS: The First 6 hours: Stabilisation

Keep reassessing the adequacy of resuscitation – many cases have persistent “cryptic shock”.

Treating this with fluid or inotrope/vasopressors reduces mortality rates dramatically.

Use the same goals as for early resuscitation.

ONGOING FLUID RESUSCITATION

Fluid shift & 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 ScvO₂ saturations.

If Hb >10g/dl use crystalloid or 4.5% human albumin solution.

Consider packed red cells if Hb <10g/dl.

Consider Fresh Frozen Plasma for coagulopathy.

Potential Pitfalls

Inadequate Access

Failure to rapidly establish vascular access in the severely shocked child

Do not persist in peripheral access if difficult - use an **intraosseous needle**

Inadequate fluid resuscitation

Give 20 mls/kg and reassess - these patients can require >100 mls/kg

Large volume requirements = severe disease

Failure to recognise volume overload

Increasing work of breathing with worsening oxygenation following fluid administration is suggestive of volume overload. Crackles on auscultation do not absolutely indicate pulmonary oedema as a pneumonic process may be the underlying source of sepsis.

Hepatomegaly is highly suggestive of volume overload.

Delay in intubation

Children in comparison to adults delay a drop in blood pressure by vasoconstriction & elevation of heart rate. **A “normal” blood pressure can be falsely reassuring.**

Once hypotension occurs there is usually a rapid progression to cardiovascular collapse.

False reassurance after initial response to resuscitation

Reassess, reassess, reassess

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

Low neutrophils

Low platelets

Rapid onset (<6 hours)

Rapidly spreading rash

High volume requirement

