Management of Sepsis in Infants and Children

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Key Amendments

Date	Amendment	Approved by
February 2019	Removal of wall poster	Paediatric QIM

Paediatric Intensive Care Units admit around 1000 children with severe sepsis annually. Each year severe sepsis causes more than 100 deaths in children less than four years of age. Studies suggest mortality is increased in children who receive less fluid resuscitation and inadequate vasoactive agent use. A simple guideline to encourage early aggressive management of children with severe sepsis and septic shock, along with monitoring of clinical and laboratory endpoints is aimed at significantly improving outcomes for this group of patients.

- Ensure appropriate team is involved early including paediatric consultant, anaesthetic / ICU consultant.
- Discussion with the Paediatric Intensive Care Unit (PICU) transfer team may be required at a later stage. (KIDS 0300 200 1100)
- A time line is suggested but would depend on the clinical status of the patient, area and personnel involved

1. Recognition of Sepsis

Sepsis

Defined as Systemic Inflammatory Response Syndrome (SIRS) in the presence of, or as a result of suspected or proven infection and includes the presence of two of the following four criteria, one of which must be abnormal temperature or leukocyte count:

- Core Temperature >38.5°C or <36°C
- Inappropriate tachycardia (See PEWS chart/admission documents) in the absence of external stimulus, chronic drugs, or painful stimuli; or otherwise unexplained persistent elevation over a 0.5 – to - 4 hour time period
  OR for children < 1 year old:
  bradycardia (See PEWS chart) in the absence of external vagal stimulus, β-blocker drugs or congenital heart disease; or otherwise unexplained persistent depression over a 0.5 – 1hr time period.
- Mean respiratory rate above normal for age (See PEWS chart) or mechanical ventilation for an acute process not related to underlying neuromuscular disease or the receipt of general anaesthesia.
- Leukocyte count elevated or depressed for age (not secondary to chemotherapy induced leucopenia)

Septic Shock

Defined as suspected infection with inadequate tissue perfusion exhibited by altered mental status, capillary refill time (CRT) > 2 seconds, diminished pulses, mottled peripheries (warm shock = flash CRT, bounding pulses, wide pulse pressure). This is a reflection of severe sepsis and requires aggressive resuscitation

In practice early recognition of paediatric septic shock should be defined using clinical examination not biomedical tests and diagnosis should occur before hypotension occurs as this is a pre-terminal sign. (See Severe Sepsis Screening Tool)

ANTIBIOTICS SHOULD BE GIVEN IN THE FIRST HOUR

Sepsis will be identified from the Sepsis screen on our PEWS charts on inpatients and the Sepsis screen on the admission documents ensuring all health professionals consider sepsis in the diagnosis.

2. Early Aggressive Fluid Management

Paediatric Septic shock is associated with severe hypovolaemia and children respond well to aggressive fluid management. It is important to aggressively resuscitate in the first hour as trials have demonstrated improved outcome with early fluid resuscitation with crystalloid being deemed as effective as colloid. Some studies have suggested an improved outcome for those who receive colloid (albumin) for septic shock. Rapid boluses are recommended of 20mL/kg over 5 minutes with reassessment. Initial volume resuscitation commonly requires 40-60mL/kg but can be as much as 200mL/kg. Colloid should be considered if more than 40mL/kg is required. These volumes DO NOT appear to increase the incidence of acute respiratory distress syndrome (ARDS) or cerebral oedema. It is good practice to consider intubation and ventilation once 40-60mL/kg has been administered.

3. Consider Early Inotrope Use

Inotropes should be used early. Delay in inotrope resuscitation for meningococcal sepsis led to a 23 fold increase the in adjusted odds ratio for mortality. For those children with hypodynamic shock with high systemic vascular resistance (SVR) (Cold and shut down) dopamine or adrenaline at low doses are recommended. Adrenaline has both inotropic and chronotropic activity and greater β2 effects in peripheral vasculature allowing vasodilatation.

There is some evidence that dopamine used in hyperdynamic shock with a low SVR (warm shock) leads to a worse outcome and therefore it is advocated that low dose noradrenaline is used in this scenario.

Because of an increase in mortality with delay in time to inotrope use it is now recommended that peripheral inotropes can be used whilst central access is being obtained. The peripheral access site must be closely monitored.

4. Intubation and Ventilation

Oxygen should be optimized throughout the resuscitation. Intubation should be considered at all points in the initial resuscitation. Intubation can risk worsening of hypotension from the direct effects (myocardial depression and vasodilator effects) and indirect effects (blunting of catecholamine release) of induction agents. Adequate fluid management and inotropic support should be ongoing before induction of anesthesia in septic shock. Ketamine is the preferred induction agent of choice for sepsis. The use of a neuromuscular blocking agent should always be considered and a short acting blocker can facilitate intubation if the provider is confident they can maintain airway patency.

5. Ongoing Monitoring and Treatment

In children at risk of absolute adrenal insufficiency or adrenal pituitary axis failure (Purpura fulminans, congenital adrenal hyperplasia, prior recent steroid exposure, hypothalamic/pituitary abnormality) and who remains in shock despite inotrope infusion, the use of intravenous hydrocortisone may need to be

considered, ideally after a blood sample has been taken for subsequent determination of baseline cortisol concentration.

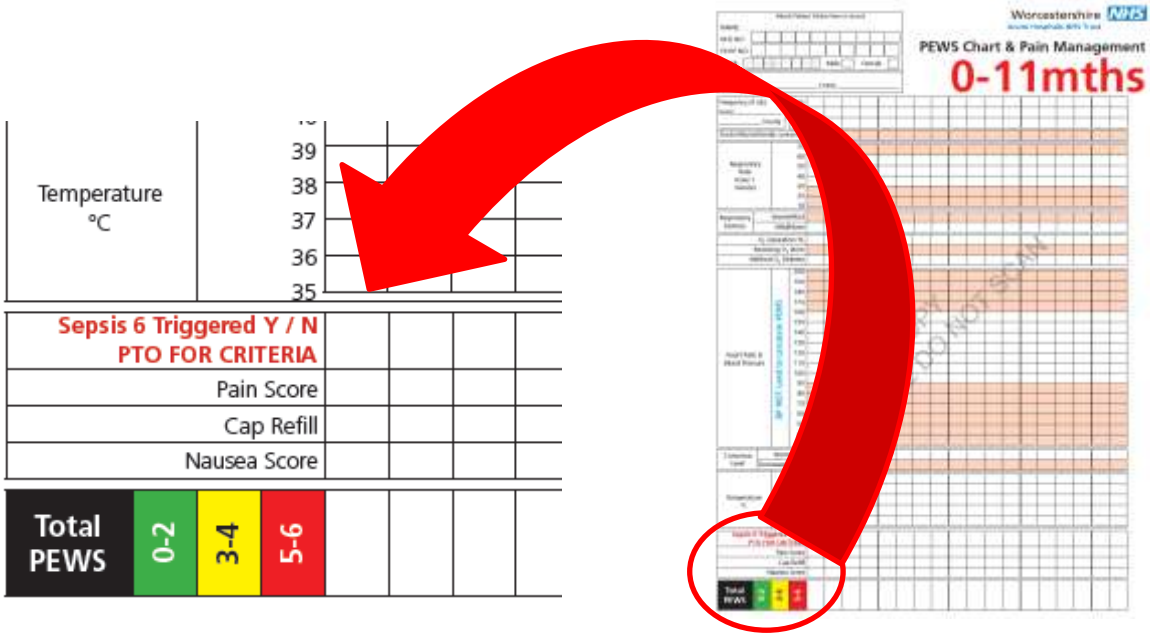
Further biochemical parameters requiring monitoring include

- Glucose (monitor for both hyper- and hypo-glycaemia)
- Calcium – hypocalcaemia has been shown to increase mortality
- Arterial Blood Gas (Base excess and anion gap)
- Clotting – FFP can be used to correct a prolonged INR but as infusion, not a bolus

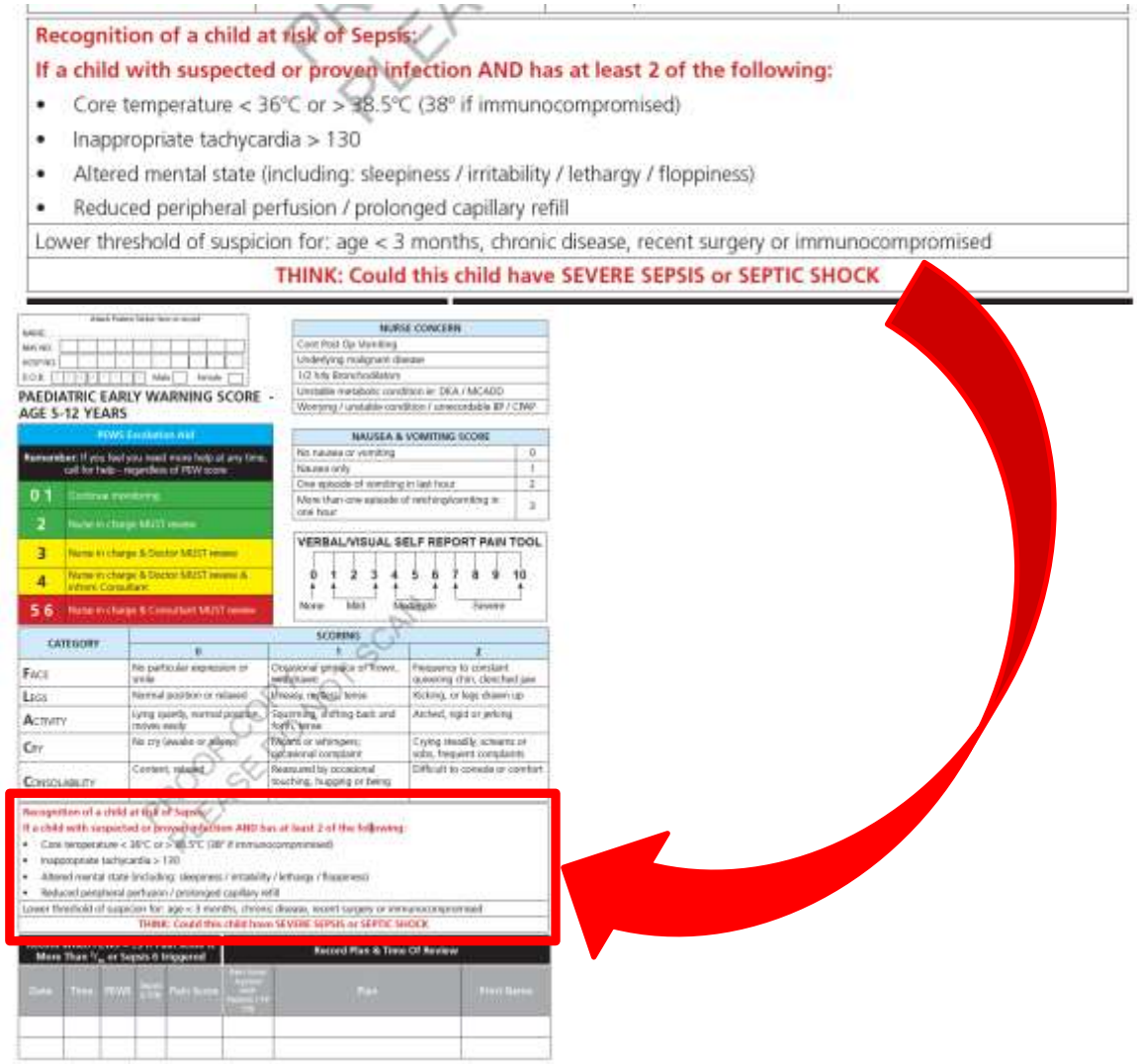
Observations should be done every hour as a minimum but may need to be done more frequently in the initial stages of resuscitation (every 15 minutes). This will be determined by the PEWS score (see table below).

PEWS SCORE	Action & Frequency of observations
0-1	Continue monitoring – at current frequency
2	Nurse in charge must review – 2 hourly
3	Nurse in charge must review and Dr must review – 1-2 hourly
4	Nurse in charge and Dr must review Consultant informed – Hourly, continuous monitoring (minimum of saturations monitor)
5-6	Nurse in charge and Cons must review – hourly + continuous monitoring

All PEWS charts have a sepsis trigger question for PEWS to be completed at the bottom of the charts for all ages.



On the reverse of the chart is a check list to be considered each time the PEWS is calculated.



Recognition of a child at risk of Sepsis:

If a child with suspected or proven infection AND has at least 2 of the following:

- Core temperature < 36°C or > 38.5°C (38° if immunocompromised)
- Inappropriate tachycardia > 130
- Altered mental state (including: sleepiness / irritability / lethargy / floppiness)
- Reduced peripheral perfusion / prolonged capillary refill

Lower threshold of suspicion for: age < 3 months, chronic disease, recent surgery or immunocompromised

THINK: Could this child have SEVERE SEPSIS or SEPTIC SHOCK

PAEDIATRIC EARLY WARNING SCORE - AGE 5-12 YEARS

NURSE CONCERN

NAUSEA & VOMITING SCORE

VERBAL/VISUAL SELF REPORT PAIN TOOL

The Sepsis trigger must be completed at every set of observations and documented as Y/N.
If the Sepsis trigger is triggered, then how this has been escalated and what action taken must be documented on the back of the PEWS or on PEWS continuation sheet as required. Please see below for example.

Date	Time	PEWS	Sepsis	Pain score	Agreed With parents	Plan	Print name
28/09/16	2100	4	Y			Consultant to review in 15mins, rpt obs 15mins.	SarahW

Monitoring will continue on all inpatients to ensure sepsis developing on the ward will also be identified. Admission sheets also have the Sepsis 6 criteria embedded to ensure that it is considered in each

Management on the ward will include placement according to the Paediatric Side Room Priority Matrix (WAHT-PAE-129) and antibiotics according to the Paediatric Antibiotic Prescribing Guideline: http://nww.worcsacute.nhs.uk/EasysiteWeb/getresource.axd?AssetID=81490&servicetype=Attachment
Intensive monitoring will include:

- Continuous pulse oximetry
- Continuous cardiac monitoring
- Temperature
- Urine output

- Assessment of conscious level
- Regular blood glucose measurements
- Base excess

References

1.) *Brierley et al*. Clinical practice parameters for haemodynamic support of pediatric and neonatal septic shock: 2007 update from the American College of Critical Care Medicine. Crit. Care. Med. 2009; 37(2): 666-688
2.) *Inwald et al.* Emergency management of children with severe sepsis in the United Kingdome: the results of the Paediatric Intensive Care Society sepsis audit. Arch. Dis. Child. 2009;94:348-343
3.) *Goldstein et al.* International pediatric sepsis consensus conference: definitions for sepsis and organ dysfunction in pediatrics. Paed. Crit. Care Med. 2005 Jan; 6(1):2-8
4.) Advanced Paediatric Life Support – The Practical Approach. 6th Ed. London: BMJ Books; 2016
5.) *Lampin ME et al.* Noradrenaline use for septic shock in children: doses, routes of administration and complications. Acta Paediatrica. 2012 Sept; 101(9):e426-30

SEPSIS 6 CRITERIA WALL POSTER

Box 1: Red Flag Sepsis Criteria for Children

- *Hypotension, defined as Systolic Bloods Pressure <2 SD for age, (age in yrs x 2) + 70
- Heart rate of >30 above the normal upper rate limit for age (see Box 2)
- Blood gas lactate >4mmol/L
- Prolonged capillary refill >5 seconds
- Pale/mottled/ashen/blue or non-blanching (purpuric) rash
- Oxygen needed to maintain saturations >92%
- Respiratory rate >60min^{-1} or >5 below the normal, or grunting
- AVPU = V, P or U
- Parents report excessively dry nappies, lack of response to social cues, significantly decreased activity or weak, high-pitched or continuous cry

Box 2: Age-specific RED FLAG parameters for vital signs and laboratory variables

	Heart Rate, Beats/Min	Heart Rate, Beats/Min	Respiratory Rate	Leukocyte Count	Systolic Blood Pressure
	Tachycardia	Bradycardia	Breaths/Min	Leukocytes $10^3/mm^3$	mmHg
Birth to 1 week	>180	<100	>50	>34	<60
1 week to 1 month	>180	<100	>40	>19.5 or <5	<60
1 month to 1 year	>180	<90	>34	>17.5 or <5	<70
2 to 5 years	>140	NA	>22	>15.5 or <6	<*
6 to 12 years	>130	NA	>18	>13.5 or <4.5	<*
13 to 18 years	>110	NA	>14	>11 or <4.5	<*

Box 3: High Certainty of Sepsis

High Certainty of Sepsis
Respond with Paediatric Sepsis 6:

Complete all elements within 1 hour

1. **Give high flow oxygen**
2. **Obtain IV / IO access & take blood tests**
   a. Blood cultures
   b. Blood glucose – treat low blood glucose
   c. Blood gas
3. **Give IV or IO antibiotics**
   - Broad spectrum cover as per local policy
4. **Consider fluid resuscitation**
   - Aim to restore normal circulating volume and physiological parameters
   - Titrate 20ml/kg Isotonic Fluid over 5 -10min and repeat if necessary
   - Caution with fluid overload:
     Examine for crepitations & hepatomegaly
5. **Involve Senior Clinicians / Specialists early**
6. **Consider Inotropic support early**
   - If normal physiological parameters are not restored after ≥ 40ml/kg fluids
   - NB Adrenaline or Dopamine may be given via peripheral IV or IO access

High Certainty of Sepsis

- **Give High Flow O2**
- **Obtain IV/IO Access & take bloods**
- **Give IV or IO antibiotics**
- **Consider fluid resuscitation**
- **Involve Senior Clinicians / Specialists Early**
- **Consider Inotropic Support**

For every hour that a child remains in Septic Shock the mortality risk doubles.

ULN = Upper limit of normal ICE = Electronic results reporting system PEWS = Paediatric Early Warning Score

Consider Early Inotropes:

For central access see KIDS Drug calculator.
http://kids.bwc.nhs.uk/healthcare-professionals-2/drug-calculator/

Peripheral administration whilst awaiting central access should be closely monitored:
Dopamine and Dobutamine peripheral strengths are available on the KIDS Calculator.

Noradrenaline
Noradrenaline 0.02mg/ml strength could be started at a dose of 0.1 micrograms/kg/min and titrated up to a maximum of 5micrograms/kg/min whilst gaining central access.
A good cannula or intraosseous needle should **only** be used for this inotrope infusion.

Adrenaline

Adrenaline 0.01 – 1.0 microgram/kg/min can be used the same strength as peripherally while obtaining central access.

A good cannula or intraosseous needle should **only** be used for this inotrope infusion.

If blood pressure drops check the cannula site before increasing the infusion rate.

SEPSIS SIX Sepsis Diagnosis Time:	Time Completed (24hr clock) & initials	Reason not done c result
1. Oxygen: high flow 15l/min via non-rebreathe mask. Maintain SPO2 94% or more		
2. IV/IO Access Blood Cultures Blood glucose Blood Gas inc Lactate	B/C: BM: B/G	
3. IV/IO Antibiotic as per trust guidelines – Antibiotic given:		
4. IV/IO Fluids: 20mL/kg of 0.9% Saline STAT (10mL/kg alliquots if cardiac patient). Caution with fluid overload . Maintain STRICT Fluid Balance		
5. Involve senior clinicians early/Specialists Early (KIDS)		
6. Consider inotropic support early		