Recognition and Treatment of Sepsis and Septic Shock in Children (Embrace)

Reference:	1840v2
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Purpose

This guideline is written to guide recognition and treatment of sepsis and septic shock in children.

Intended Audience

All medical and nursing staff at Embrace who assess and treat unwell children.

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1. Introduction

This guideline is intended to aid the clinician in the recognition and treatment of sepsis and septic shock in children (including babies above 37 weeks corrected gestational age being cared for in a paediatric setting).

All febrile, unwell children should be assessed with the intention of ruling out or ruling in sepsis. Early recognition and appropriate treatment improves outcomes.

2. Intended Audience

All clinicians at Embrace who assess and treat unwell children.

3. Guideline Content

A. Definition of sepsis and septic shock

Sepsis - life threatening organ dysfunction caused by a dysregulated host response to infection

Septic shock – severe infection leading to cardiovascular dysfunction (including hypotension, need for treatment with a vasoactive medication or impaired perfusion)

Sepsis associated organ dysfunction – severe infection leading to cardiovascular and/or non-cardiovascular organ dysfunction

B. Recognition of sepsis

In the early stages it may be difficult to differentiate a child with severe sepsis from a child with a benign infection (especially in babies). This is because a child with a fever can often demonstrate abnormal physiological parameters due to the fever alone. Most children who present febrile with deranged physiology do not have serious infections BUT may act very similar to those with early severe sepsis.

When a child has an infection and signs of shock, profoundly altered physiology, altered conscious level or is unwell despite simple antipyretics then sepsis can be presumed to be present.

If a child demonstrates clear signs of wellness such as playing, being cheerful or ambulatory, sepsis is very unlikely.

If there is uncertainty, then the traffic light system (Appendix 1) is helpful along with the involvement of an experienced senior clinician. Referring clinicians can be directed to the ‘Paediatric Sepsis Screening Tool’ (Appendix 2).

It is important that significantly unwell children have a full set of observations documented including BP and level of consciousness and that these observations continue to be monitored frequently until they are normal or an appropriate clinician decides that sepsis can be safely ruled out.

C. High risk groups:

- Age <6 months
- Recent illnesses
    - Concurrent/recent chicken pox or recent burns
        - Risk of invasive Group A Streptococcus and Stapylococcal aureus
    - Post influenza A or B
        - Risk of Streptococcus pneumoniae, Neisseria meningitidis, invasive Group A Steptococcus, Staphylococcus aureus
- Chronic illness
    - Consider carrier status – Pseudomonas, ESBL, MRSA and other multi-resistant organisms
- Neonates
    - Gram negative organisms (especially in those with probable galactosaemia), Group B Streptococcus, Herpes Simplex
- Immunodeficiency
- Indwelling vascular catheter, ventriculo-peritoneal shunt, prosthesis
- Post-operative
- Learning disability

D. Identification, control and treatment

- Identification: examine abdomen, bones, joints, sites of indwelling catheters, devices, prosthesis, review CXR, consider imaging
- Control: consider removal of vascular catheter or antibiotic lock, drainage of abscesses/empyema, laparotomy etc. Remove sanitary tampons
- Treatment: Management of sepsis in children depends of the severity of the sepsis. In all cases give broad spectrum antibiotics given as early as possible and consider organisms requiring specific therapy e.g. Herpes simplex. Refer to the SC(NHS)FT antibiotic guidelines. In severe sepsis and septic shock it is also essential to ensure that good circulation is maintained. Escalation to a senior clinician must take place immediately.

E. Management of presumed sepsis and septic shock

SEPSIS 6 PLUS - GOLDEN HOUR MANAGEMENT

RECOGNITION

IS THIS SEPSIS?

Proven/suspected infection and at LEAST 2:

- Core temperature <36°C or > 38.5°C
- Inappropriate tachycardia/ bradycardia
- Increased capillary refill / decreased peripheral perfusion / reduced urine output
- Altered mental status – drowsy, irritable, lethargic, floppy

IS THIS RED FLAG SEPSIS?

Any 1 of these present:

- O_2 needed to maintain saturations >92%
- Tachypnea (RR >60/min), grunting, apneoas (underlying diagnosis not LRTI)
- Capillary refill time greater than 5 seconds
- Pale / mottled / ashen / blue / non-blanching (purpuric) rash
- Hypotension (appears late - check BP)
- Serum lactate >2 mmol/L

High index of suspicion if any of the following:
Age <six months, immunocompromised, burns, post-operative, co-morbidities, indwelling catheter(s)
Children with profound neuro-disability may be difficult to assess

Age	RR	HR	Systolic BP		
	5 - 95 th centile	5 – 95th centile	5 th centile	50 th centile	95 th centile
Birth - 1 mth	25-50	120-170	65-75	80-90	105
3 - 6 mths	25-45	115-160	65-75	80-90	105
6 - 12 mths	20-40	110-160	65-75	80-95	105
12-18 mths	20-40	110-160	70-75	85-95	105
18 mths - 2 yrs	20-35	100-155	70-75	85-95	105
2 - 3yr	20-30	90-150	70-80	85-100	110
3 - 5yr	20-30	80-135	70-80	85-100	110
5 - 7yr	20-30	80-130	80-90	90-110	111-120
8 - 11yr	15-25	70-120	80-90	90-110	111-120
over 12 yr	12-24	60-115	90-105	100-120	125-140

RESPONSE

IMMEDIATE ACTIONS:

- **CALL FOR SENIOR HELP**
- Oxygen: 15L/min via reservoir mask
- IV /IO access x 2
- *FBC, coagulation, biochemistry: renal, liver, bone, Mg, glucose, lactate, gas, CRP, group & save*
- Culture: blood (vascular catheters – all lumens, peripheral venous sample), urine, respiratory secretions and, if applicable, empyema fluid, pus samples, swabs
- **Do not delay giving antibiotics to obtain these samples**
- IV/IO broad spectrum antibiotics
- Fluid bolus: PlasmaLyte, Hartmans or 0.9% sodium chloride 20mL/kg – “push” with syringe

REASSESS CONTINUOUSLY: aim to achieve resuscitation goals below

- Reassess and repeat 20mL/kg fluid bolus if required
- Correct hypoglycaemia
- Consider the benefits of non-invasive ventilatory support
- ***Consider endotracheal intubation after 40 - 60mL/kg IV fluid resuscitation***

RESUSCITATION GOALS to achieve normal perfusion:

- Equal quality central and peripheral pulses
- Warm extremities / capillary refill time less than 3 seconds
- Normal HR, RR, BP (monitor every 5 minutes)
- Urine output >1mL/kg/hour
- Serum lactate <2 mmol/L
- Central venous oxygen saturation >70% via internal jugular venous catheter if present

Monitor for fluid overload:

- Limit fluid bolus therapy and intubate early if hepatomegaly or pulmonary oedema present

REASSESS

GOLDEN HOUR AND BEYOND

FLUID REFRACTORY SHOCK i.e., normal perfusion not restored after 60 mL/kg fluid:
Start vasoactive agents and prepare to intubate and ventilate
Induction of anaesthesia and institution of IPPV may cause cardiovascular collapse

Indications:

- Respiratory failure, signs of exhaustion, impending cardiovascular collapse
- Decreased or fluctuating consciousness (GCS ≤ 8, AV**P**U), signs of raised intracranial pressure

Preparation and procedure:

- Most experienced clinician should intubate
- Prepare fluid boluses, and adrenaline and atropine for rescue
- Fluid refractory shock: consider peripheral adrenaline and >60mLs/kg fluids prior to intubation
- Suggest Ketamine 0.5 - 2mg/kg (low dose if haemodynamically unstable), and Rocuronium
- Use a cuffed endotracheal tube if available
- Avoid nasal endotracheal tube if coagulopathic or thrombocytopaenic

Post intubation:

- Sedate and muscle relax – Do not use midazolam in babies <6 months or any child who is shocked
- Early chest x-ray: check endotracheal tube position, exclude pneumonia/effusion
- High PEEP if pulmonary oedema

VASOACTIVE AGENTS:

- DO NOT delay commencing inotropes – adrenaline may be given peripherally in a dilute solution
- Intraosseous needle / external jugular veins may be used as central access in the early stages
- Gain central venous and arterial access as soon as possible, this may be after transfer completed
- Start adrenaline or noradrenaline initially
- Avoid dopamine and dobutamine
- Continue fluid bolus therapy as required, unless signs of fluid overload

CATECHOLAMINE RESISTANT SHOCK i.e., hypotension despite two vasoactive agents:

- Rule out failed delivery of drugs, pericardial effusion, pneumothorax, blood loss, and intracranial event
- Hydrocortisone 1mg/kg 6 hourly, (neonates 2.5mg/kg initially)
- Further fluid resuscitation, consider targeted blood products depending on results
- Start Vasopressin
- Control source of infection
- Consider IV immunoglobulin in toxic shock
- Consider early referral for ECMO if above strategies fail

Monitor electrolytes (target ranges):

Blood glucose 4 – 12 mmol/L (do not use insulin)
Ionised Calcium >1.0 mmol/L
Potassium 3.5 - 5.5 mmol/L
Magnesium >0.8 mmol/L

IV electrolyte correction doses:

10% Glucose 2mL/kg
10% Calcium Gluconate 0.11mmol/kg (max 4.5mmols)
Potassium Chloride

- 0.5-1mmol/kg (up to 40mmol) at 0.2mmol/kg/hr
- Central maximum concentration 0.5mmol/ml
- Peripheral: maximum concentration 40mmol/L

Magnesium Sulphate 0.4mmol/kg over 30 mins (max 20mmol)

Blood product transfusions:

Packed red blood cells:
Haemoglobin <70 g/dL and/or central venous oxygen saturations <70%

Octaplas/FFP, platelets, cryoprecipitate:
Coagulopathy with active bleeding or before invasive procedures

Doses/ volumes:
Vitamin K 300 microgram/kg (max10mg)
Packed red blood cells 20mL/kg
Octaplas/FFP 15 - 20mL/kg
Platelets 10mL/kg
Cryoprecipitate 5 - 10mL/kg

Aids to monitoring response to therapy:

- Plasma lactate
- Skin perfusion and urine output (hourly output via urinary catheter)
- Temperature gradient – central to peripheral
- Invasive arterial blood pressure: target blood pressure to achieve adequate urine output
- Central venous pressure
- Central venous O_2 saturation: maintain >70% (sample from internal jugular vein if catheter present)
- Echocardiography: to assess intravascular volume status and cardiac function

Top tips:

- Use ideal body weight to calculate fluid bolus therapy
- Do not use bedside clinical signs alone to categorise septic shock as ‘warm’ or ‘cold’
- Do not use insulin therapy
- Invasive ventilation is not mandatory
- Consider a trial of non-invasive mechanical ventilation in children with sepsis induced ARDS without a clear indication for intubation and who are responding to initial resuscitation
- Monitor patients on NIV very carefully.
- Use iNO as a rescue therapy in children with sepsis induced ARDS and refractory hypoxaemia after other oxygenation strategies have been optimised - refer these patients to ECMO
- Refer to ECMO if there is septic-shock refractory to all treatments

Be aware of co-existing raised ICP:

Signs:

- Decreased or fluctuating level of consciousness
- Relative bradycardia
- Focal neurological signs
- Abnormal posture or posturing
- Seizures
- Un-equal, dilated or poorly reacting pupils
- Papilloedema (late sign)
- Abnormal ‘doll’s eyes’ movements

Treatment:

- ABC including treatment of shock if present
- IV 3% or 2.7% Sodium Chloride 3ml/kg or 20% Mannitol 0.25g/kg over 20 minutes
- Intubate and ventilate to PCO_2 4.0 – 4.5kPa
- Urinary catheter
- Patients >3months with suspected meningitis should receive Dexamethasone 150microgram//kg 6 hourly (maximum 10mg)

4. References

1. Sheffield Children's NHS Foundation Trust (2017) Recognition and treatment of sepsis in the critical care unit SCH Guideline (CG1834)
2. National Institute for Health and Care Excellence (2019) Fever in under 5s: assessment and initial management. NICE guideline (NG143)
3. National Institute for Health and Care Excellence (2015) Meningitis (bacterial) and meningococcal septicaemia in under 16s: recognition, diagnosis and management. NICE guideline (CG102)
4. Surviving sepsis campaign international guidelines for the management of septic shock and sepsis associated organ dysfuntion in children. Ped crit care med. 2020 Feb;21(2):e52-e106
5. Advanced Life Support Group. Advanced Paediatric Life Support: A Practical Approach to Emergncies (APLS) 6th Edition, UK 2016. Wiley-Blackwell

Appendix 1: NICE Traffic light system for identifying risk of serious illness

NICE National Institute for Health and Care Excellence

Traffic light system for identifying risk of serious illness

	Green – low risk	Amber – intermediate risk	Red – high risk
Colour (of skin, lips or tongue)	• Normal colour	• Pallor reported by parent/carer	• Pale/mottled/ashen/ blue
Activity	• Responds normally to social cues • Content/smiles • Stays awake or awakens quickly • Strong normal cry/not crying	• Not responding normally to social cues • No smile • Wakes only with prolonged stimulation • Decreased activity	• No response to social cues • Appears ill to a healthcare professional • Does not wake or if roused does not stay awake • Weak, high-pitched or continuous cry
Respiratory		• Nasal flaring • Tachypnoea: – RR >50 breaths/ minute, age 6–12 months – RR >40 breaths/ minute, age >12 months • Oxygen saturation ≤95% in air • Crackles in the chest	• Grunting • Tachypnoea: RR >60 breaths/minute • Moderate or severe chest indrawing
Circulation and hydration	• Normal skin and eyes • Moist mucous membranes	• Tachycardia: – >160 beats/minute, age <12 months – >150 beats/minute, age 12–24 months – >140 beats/minute, age 2–5 years • CRT ≥3 seconds • Dry mucous membranes • Poor feeding in infants • Reduced urine output	• Reduced skin turgor
Other	• None of the amber or red symptoms or signs	• Age 3–6 months, temperature ≥39°C • Fever for ≥5 days • Rigors • Swelling of a limb or joint • Non-weight bearing limb/not using an extremity	• Age <3 months, temperature ≥38°C* • Non-blanching rash • Bulging fontanelle • Neck stiffness • Status epilepticus • Focal neurological signs • Focal seizures

CRT, capillary refill time; RR, respiratory rate
* Some vaccinations have been found to induce fever in children aged under 3 months

This traffic light table should be used in conjunction with the recommendations in the NICE guideline on fever in under 5s.

Appendix 2: SEPSIS screening tool acute assesment

SEPSIS SCREENING TOOL ACUTE ASSESSMENT — AGE 0-5

PATIENT DETAILS:

DATE: **TIME:**
NAME: **HOSPITAL:**
DESIGNATION:
SIGNATURE:

01 START IF CHILD LOOKS UNWELL, IF THERE IS PARENTAL CONCERN OR PEWS HAS TRIGGERED

RISK FACTORS FOR SEPSIS INCLUDE:

- ☐ Recent trauma / surgery / invasive procedure
- ☐ Impaired immunity (e.g. diabetes, steroids, chemotherapy)
- ☐ Indwelling lines / broken skin

02 COULD THIS BE DUE TO AN INFECTION?

YES

LIKELY SOURCE:

- ☐ Respiratory
- ☐ Brain
- ☐ Urine
- ☐ Surgical
- ☐ Skin / joint / wound
- ☐ Other
- ☐ Indwelling device

NO → **SEPSIS UNLIKELY, CONSIDER OTHER DIAGNOSIS**

03 ANY RED FLAG PRESENT?

YES

- ☐ Doesn't wake when roused / won't stay awake
- ☐ Looks very unwell to healthcare professional
- ☐ Weak, high-pitched or continuous cry
- ☐ Severe tachycardia (see chart)
- ☐ Severe tachypnoea (see chart)
- ☐ Bradycardia (<60 bpm)
- ☐ Non-blanching rash / mottled / ashen / cyanotic
- ☐ Temperature <36°C
- ☐ If under 3 months, temperature >38°

YES → **RED FLAG SEPSIS**
START **PAEDIATRIC SEPSIS SIX** (PTO)

04 ANY AMBER FLAG PRESENT?

NO

- ☐ Not responding normally / no smile
- ☐ Reduced activity / very sleepy
- ☐ Moderate tachypnoea (see chart)
- ☐ Moderate tachycardia (see chart)
- ☐ SpO_2 < 92% or increased O_2 requirement
- ☐ Nasal flaring
- ☐ Capillary refill time ≥ 3 seconds
- ☐ Reduced urine output (<1 ml/kg/h if catheterised)
- ☐ Leg pain or cold extremities
- ☐ Immunocompromised

YES → **FURTHER REVIEW REQUIRED:**

- SEND BLOODS AND REVIEW RESULTS
- ENSURE SENIOR CLINICAL REVIEW within 1HR

TIME OF REVIEW: ☐☐ : ☐☐
ANTIBIOTICS REQUIRED:
☐ Yes ☐ No

NO AMBER FLAGS = ROUTINE CARE / CONSIDER OTHER DIAGNOSIS

Age (years)	Tachypnoea (breaths per minute)		Tachycardia (beats per minute)	
	Severe	Moderate	Severe	Moderate
<1	≥60	50-59	≥160	150-159
1-2	≥50	40-49	≥150	140-149
3-4	≥40	35-39	≥140	130-139

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SEPSIS SCREENING TOOL - THE PAEDIATRIC SEPSIS SIX

AGE 0-5

PATIENT DETAILS:	DATE: TIME: NAME: DESIGNATION: SIGNATURE:

COMPLETE ALL ACTIONS WITHIN ONE HOUR

01 ENSURE SENIOR CLINICIAN ATTENDS — TIME ☐☐:☐☐

NOT ALL PATIENTS WITH RED FLAGS WILL NEED THE 'SEPSIS 6' URGENTLY. A SENIOR DECISION MAKER MAY SEEK ALTERNATIVE DIAGNOSES/ DE-ESCALATE CARE. RECORD DECISIONS BELOW

NAME: GRADE:

02 OXYGEN IF REQUIRED — TIME ☐☐:☐☐

START IF O_2 SATURATIONS LESS THAN 92% OR EVIDENCE OF SHOCK

03 OBTAIN IV / IO ACCESS, TAKE BLOODS — TIME ☐☐:☐☐

BLOOD CULTURES, BLOOD GLUCOSE, LACTATE, FBC, U&Es, CRP AND CLOTTING, LUMBAR PUNCTURE IF INDICATED

04 GIVE IV / IO ANTIBIOTICS — TIME ☐☐:☐☐

MAXIMUM DOSE BROAD SPECTRUM THERAPY
CONSIDER: LOCAL POLICY / ALLERGY STATUS / ANTIVIRALS

05 CONSIDER IV / IO FLUIDS — TIME ☐☐:☐☐

IF LACTATE IS ABOVE 2 mmol/L GIVE FLUID BOLUS 20 ml/kg WITHOUT DELAY
IF LACTATE >4 mmol/L CALL PICU. (10ml/kg neonates, REPEAT IF REQUIRED)

06 CONSIDER INOTROPIC SUPPORT — TIME ☐☐:☐☐

CONSIDER INOTROPIC SUPPORT IF NORMAL PHYSIOLOGY IS NOT RESTORED AFTER ≥20 mL/kg FLUID (10 mL/kg IN NEONATES). CALL PICU OR A REGIONAL CENTRE URGENTLY

RED FLAGS AFTER ONE HOUR – ESCALATE TO CONSULTANT NOW

RECORD ADDITIONAL NOTES HERE:

e.g. allergy status, arrival of specialist teams, de-escalation of care, delayed antimicrobial decision making, variance from Sepsis Six

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SEPSIS SCREENING TOOL ACUTE ASSESSMENT — AGE 5-11

PATIENT DETAILS:

DATE: **TIME:**
NAME: **HOSPITAL:**
DESIGNATION:
SIGNATURE:

01 START IF CHILD LOOKS UNWELL, IF THERE IS PARENTAL CONCERN OR PEWS HAS TRIGGERED

RISK FACTORS FOR SEPSIS INCLUDE:

- ☐ Recent trauma / surgery / invasive procedure
- ☐ Impaired immunity (e.g. diabetes, steroids, chemotherapy)
- ☐ Indwelling lines / broken skin

02 COULD THIS BE DUE TO AN INFECTION?

YES

LIKELY SOURCE:

- ☐ Respiratory
- ☐ Urine
- ☐ Skin/joint/wound
- ☐ Indwelling device
- ☐ Brain
- ☐ Surgical
- ☐ Other

NO → **SEPSIS UNLIKELY, CONSIDER OTHER DIAGNOSIS**

03 ANY RED FLAG PRESENT?

YES

- ☐ Objective evidence of new or altered mental state
- ☐ Doesn't wake when roused / won't stay awake
- ☐ Looks very unwell to healthcare professional
- ☐ Temperature <36°C
- ☐ Severe tachycardia (see chart)
- ☐ Severe tachypnoea (see chart)
- ☐ Bradycardia (<60 bpm)
- ☐ Needs O_2 to keep $SpO_2 \geq 90\%$
- ☐ Non-blanching rash / mottled / ashen / cyanotic

YES → **RED FLAG SEPSIS**
START **PAEDIATRIC SEPSIS SIX** (PTO)

04 ANY AMBER FLAG PRESENT?

NO

- ☐ Behaving abnormally / not wanting to play
- ☐ Parental concern
- ☐ Moderate tachypnoea (see chart)
- ☐ Moderate tachycardia (see chart)
- ☐ $SpO_2 < 92\%$ on air
- ☐ Capillary refill time ≥ 3 seconds
- ☐ Reduced urine output (<1ml/kg/h if catheterised)
- ☐ Leg pain
- ☐ Temperature <36°C
- ☐ Immunocompromised

YES → **FURTHER REVIEW REQUIRED:**

- SEND BLOODS AND REVIEW RESULTS
- ENSURE SENIOR CLINICAL REVIEW within 1HR

TIME OF REVIEW: ☐☐ : ☐☐
ANTIBIOTICS REQUIRED:
☐ Yes ☐ No

NO AMBER FLAGS = ROUTINE CARE / CONSIDER OTHER DIAGNOSIS

Age (years)	Tachypnoea (breaths per minute)		Tachycardia (beats per minute)	
	Severe	Moderate	Severe	Moderate
5	≥29	24-28	≥130	120-129
6-7	≥27	24-26	≥120	110-119
8-11	≥25	22-24	≥110	104-114

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SEPSIS SCREENING TOOL - THE PAEDIATRIC SEPSIS SIX

AGE 5-11

PATIENT DETAILS:	DATE: TIME:
	NAME:
	DESIGNATION:
	SIGNATURE:

COMPLETE ALL ACTIONS WITHIN ONE HOUR

01 ENSURE SENIOR CLINICIAN ATTENDS
NOT ALL PATIENTS WITH RED FLAGS WILL NEED THE 'SEPSIS 6' URGENTLY. A SENIOR DECISION MAKER MAY SEEK ALTERNATIVE DIAGNOSES/ DE-ESCALATE CARE. RECORD DECISIONS BELOW
NAME: GRADE:
TIME ☐☐:☐☐

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START IF O_2 SATURATIONS LESS THAN 92% OR EVIDENCE OF SHOCK
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BLOOD CULTURES, BLOOD GLUCOSE, LACTATE, FBC, U&Es, CRP AND CLOTTING LUMBAR PUNCTURE IF INDICATED
TIME ☐☐:☐☐

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TIME ☐☐:☐☐

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IF LACTATE IS ABOVE 2 mmol/L GIVE FLUID BOLUS 20 ml/kg WITHOUT DELAY
IF LACTATE >4 mmol/L CALL PICU.
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CONSIDER INOTROPIC SUPPORT IF NORMAL PHYSIOLOGY IS NOT RESTORED AFTER ≥20 mL/kg FLUID, CALL PICU OR A REGIONAL CENTRE URGENTLY
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e.g. allergy status, arrival of specialist teams, de-escalation of care, delayed antimicrobial decision making, variance from Sepsis Six

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