

# SEPSIS, SEPTIC SHOCK

## Definitions

Table 1. Definitions of sepsis and shock

<b>SIRS</b> (Systemic Inflammatory Response Syndrome)	non-specific systemic inflammatory response to infection, trauma, burns, surgery etc. Characterized by abnormalities in 2 or more of the following [one of which must be abnormal temperature or leukocyte count]: <ul style="list-style-type: none"><li>• body temperature</li><li>• heart rate</li><li>• respiratory function</li><li>• peripheral leucocyte count</li></ul>
<b>Sepsis</b>	SIRS in the presence of or as a result of suspected or proven infection.
<b>Severe sepsis</b>	Sepsis plus one of the following <ul style="list-style-type: none"><li>• cardiovascular organ dysfunction</li><li>• acute respiratory distress syndrome</li><li>• two or more other organ dysfunction</li></ul>
<b>Septic shock</b>	Severe sepsis with cardiovascular organ dysfunction i.e. hypotension (systolic blood pressure [SBP] < 5th centile for age).
<b>Early septic shock</b> (WARM shock)	Compensated warm phase of shock. Prompt response to fluids and pharmacologic treatment.
<b>Refractory septic shock</b> (COLD shock)	Late decompensated phase. Shock lasting more than 1 hour despite vigorous therapy necessitating vasopressor support.

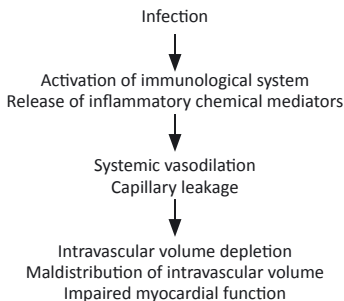
(based on the International Pediatric Sepsis Consensus Conference)

## Incidence

Non hospitalized immunocompetent children may develop community acquired sepsis. More commonly, hospitalized immunocompromised patients are at higher risk of developing serious nosocomial sepsis.

## Pathophysiology

Figure 1. Pathophysiology



## Clinical features

Sepsis, severe sepsis and septic shock are a clinical continuum.

- SEPSIS is present when 2 or more of the following features are present
    - fever ( $> 38.5^{\circ}\text{C}$ ) or hypothermia, often in neonate ( $< 36^{\circ}\text{C}$ )
    - hyperventilation
    - tachycardia
    - white blood count abnormalities: leukocytosis or leucopenia
- AND there is clinical evidence of infection.

Other constitutional symptoms such as poor feeding, diarrhea, vomiting, lethargy may be present.

- with progression to SEVERE SEPSIS, there are features of compromised end organ perfusion such as

Table 2. Features of compromised end organ perfusion

Neurology	altered sensorium, irritability, agitation, confusion, unresponsiveness or coma
Respiratory	tachypnoea, increase breathing effort, apnoea / respiratory arrest, cyanosis (late sign)
Renal	oliguria less than 0.5ml/kg per hour

- when SEPTIC SHOCK sets in, look for features of *warm* or *cold* shock (Table 3)

Table 3. Features of warm and cold shock

	WARM shock	COLD shock
Peripheries	warm, flushed	cold, clammy, cyanotic
Capillary refill	$< 2$ sec	$> 2$ sec
Pulse	bounding	weak, feeble
Heart rate	tachycardia	tachycardia or bradycardia
Blood pressure	relatively maintained	hypotension
Pulse pressure	widened	narrowed

Look out for localizing signs - most useful but not always present (Table 4)

Table 4. Localising signs

<b>Central nervous system</b> meningism, encephalopathy	<b>Bone and soft tissue</b> focal erythema, tenderness and oedema
<b>Respiratory</b> localized crepitations, evidence of consolidation	<b>Head and neck</b> cervical lymphadenopathy, sinus tenderness, inflamed tympanic membrane, stridor, exudative pharyngotonsillitis
<b>Cardiovascular</b> changing murmurs	<b>Skin</b> pustular lesions
<b>Gastrointestinal</b> focal or rebound tenderness, guarding	

## Complications

Multiorgan Failure:

- acute respiratory distress syndrome
- acute renal failure
- disseminated intravascular coagulopathy
- central nervous system dysfunction
- hepatic failure

## Investigations

As in Table 5.

Table 5. Investigations

Septic work - up	Monitoring severity and progress
blood C&S	full blood count
urine C&S	renal profile
Where appropriate	electrolytes, calcium, magnesium
CSF C&S	blood sugar
tracheal aspirate C&S	blood gases
pus / exudate C&S	+/- lactate levels
fungal cultures	coagulation profile
serology, viral studies	liver function test
imaging studies	
e.g. Chest X-ray	
ultrasound, CT scan	

### Supporting evidence of infection:

#### Full blood count

leukocytosis or leukopenia

#### Peripheral blood film

increase in immature neutrophil count

#### C-reactive protein

elevated c-reactive protein levels

Abbreviation. C&S, culture and sensitivity

## Management

### • Initial resuscitation - ABC

- Secure airway, Support breathing, Restore circulation

*Caution: the use of sedation in septic or hypotensive children may result in crash of blood pressure. If sedation is required, use low dose IV Midazolam or Ketamine, volume infusion should be continued and inotropes should be initiated, if time permits.*

### • Fluid therapy

- aggressive fluid resuscitation with crystalloids or colloids at 20 mls/kg as rapid IV push over 5-10 mins. Can be repeated up to 60 mls/kg or more.
- correct hypoglycaemia and hypocalcaemia

### • Inotropic Support

- if fluid refractory shock\*, establish central venous access

Start inotropes – IV Dopamine 5 - 15 µg/kg/min *or*

IV Dobutamine 5 - 15 µg/kg/min

- for fluid refractory and dopamine/dobutamine refractory shock with

• warm shock : titrate IV Noradrenaline 0.05 – 2.0 µg/kg/min

• cold shock : titrate IV Adrenaline 0.05 – 2.0 µg/kg/min

- the aim of titration of inotropes include normal clinical endpoints and where available,  $S_{cVO_2} > 70\%$ .

- inotropes should be infused via a central line (whenever possible) or a large bore peripheral canula.

- use dedicated line or lumen. Avoid concurrent use for other IV fluids, medication.

- fluids and inotropes to be titrated to optimal vital signs, urine output and conscious level.

\*hypotension, abnormal capillary refill or extremity coolness

- **Antimicrobial therapy**
  - IV antibiotics should be administered immediately after appropriate cultures are taken. Start empirical, broad spectrum to cover all likely pathogens, considering
    - risk factors of patient and underlying illness
    - local organism prevalence and sensitivity patterns
    - protocols of the institution
  - antibiotic regime to be modified accordingly once C&S results are back.
  - source control:
    - evaluate patient to identify focus of infection
    - drainage, debridement or removal of infected devices to help control infection

- **Respiratory Support**

- use PEEP and FIO<sub>2</sub> to keep SaO<sub>2</sub> > 90%, PaO<sub>2</sub> > 80 mmHg

Caution: use sufficient PEEP to ensure alveolar recruitment in cases of sepsis with acute lung injury. Too high PEEP can result in raised intrathoracic pressure which can compromise venous return and worsen hypotension.

- **Supportive Therapy**

- packed cells transfusion if Hb <10g%
- platelet concentrate transfusion if platelet count < 20 000
- if overt clinical bleeding, correct coagulopathy or DIVC
- bicarbonate therapy: give bicarbonate only in refractory metabolic acidosis, if pH < 7.1 (ensure adequate tissue perfusion and ventilation to clear by-product CO<sub>2</sub>)
- aim to maintain normal electrolytes and blood sugar

- **Monitoring**

- frequent serial reevaluation is essential to guide therapy and gauge response, as in Table 6.

Table 6. Monitoring in children with sepsis

Clinical	Laboratory
<i>Vital signs</i>	<i>As outlined in Table 5</i>
heart rate via cardiac monitor	
capillary return	
skin temperature	
pulse volume	
blood pressure	
- non invasive	
- invasive – ideal if available	
SpO <sub>2</sub> via pulse oximeter	
central venous pressure (CVP)	
<i>Urine output via continuous bladder drainage</i>	
<i>Head chart (GCS)</i>	