

# Medi Quest BRS Hospital

A monthly News letter from BRS Hospital

## Hemodynamic Principles in the Management in Pediatric Septic Shock

**Dr. S. Ramesh. M.D., D.C.H.**

Consultant Pediatrician and Neonatologist

**BRS HOSPITAL**

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Editors

**Dr.B.Madhusudhan,**  
MS.MCh.,DNB(Plastic)

**Dr.S.Ramesh,MD,DCh**

28,Cathedral garden Rd,  
Nungambakkam,  
Chennai - 600 034.

Phone:

044 - 61434250

044 - 61434230

Email:

brsmadhu@yahoo.co.in

Web:

www.brshospital.com

### Excerpted from

Hemodynamic management strategies in pediatric septic shock - Ten Concepts for the bedside practitioner Dr Suchitra Ranjit and Dr Rajeswari Natraj Published Online Jan 2024 Indian Pediatrics and Septic Shock guidelines from Children's Hospital of Philadelphia website ( CHOPS)

### How does one diagnose Pediatric Septic Shock ?

Sepsis is a clinical syndrome in which an infection triggers an dysregulated/ exaggerated immune response which leads to diminished tissue perfusion , organ dysfunction and organ failure. Sepsis can

defined as infection with organ dysfunction . Septic shock is infection with cardiovascular dysfunction. Cardiovascular dysfunction manifesting as tachycardia , wide or narrow pulse pressure , fall in systolic and or diastolic pressure. Hypotension is a late sign and is a confounding feature in pediatric septic shock . MAP can be normal in early septic shock.

Management principles in Septic Shock include

- 1.Hemodynamic management
- 2.Respiratory support
- 3.Antibiotics (given within the first hour of admission)

This issue focuses on hemodynamic management

### Signs and Symptoms Concerning for Sepsis and Septic Shock

<b>Temperature Abnormality</b>	Fever, hypothermia ( $< 36^{\circ}\text{C}$ ). Normothermia with concern for infection may also be suggestive of sepsis or septic shock
<b>The Following Clinical Criteria May Be Suggestive of Sepsis or Septic Shock</b>	
<b>Mental Status Abnormality</b>	Anxiety, restlessness, agitation, irritability, inappropriate crying Drowsiness, confusion, lethargy, obtundation
<b>Perfusion Abnormality</b>	Cool extremities, mottling, delayed capillary refill ( $> 3$ sec), diminished pulses Warm extremities, flushed, flash capillary refill ( $< 1$ sec), bounding pulses Urine output of $< 0.5$ mL/kg/hr

### Heart Rate Abnormality

Age	Tachycardia (beats per minute)	Systolic BP (mmHg)	Diastolic BP (mmHg)	Tachypnea (breaths per min)
1 month - 1 year	> 180	< 75	< 30	> 65
2 - 5 years	> 140	< 74	< 35	> 60
6 - 12 years	> 130	< 83	< 45	> 30
13 - 18 years	> 120	< 90	< 50	> 30

Vital signs cut offs and integration of heart rate parameters in Sepsis. **Remember, heart rate may be affected by pain, anxiety, medications and hydration status.**

### PLUS, Any of the Following

Existing Laboratory Findings	Metabolic acidosis, elevated lactate, thrombocytopenia, coagulopathy, or elevated creatinine
Other Factors	Other physical exam findings, including petechial and/or purpuric rash or erythroderma
High-risk Conditions	<p>&lt; 60 days of age</p> <p>Presence of a central line</p> <p>Immunocompromised (e.g., Stem cell transplant, solid organ transplant, malignancy, asplenia/sickle cell disease, immunodeficiency, immunosuppressive medications)</p> <p>Pre-existing neurologic dysfunction that limits mental status evaluation</p> <p>Conditions that alter level of consciousness</p>

<p>Laboratory Studies to Consider Based on Clinical Presentation</p>	<ul style="list-style-type: none"> <li>Blood Culture</li> <li>POC glucose</li> <li>Super gas with lactate</li> <li>CBC with differential</li> <li>Type and screen</li> <li>CRP</li> <li>Procalcitonin</li> </ul>	<ul style="list-style-type: none"> <li>Serum Na, Chloride, Bicarb, K, Urea, Creatinine, Sugar, Calcium</li> <li>Magnesium</li> <li>Phosphorus</li> <li>Hepatic function panel</li> <li>Amylase, lipase</li> <li>PT/INR/PTT/fibrinogen</li> </ul>
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### Three pathophysiologic features of septic shock

1. Hypovolemia
2. Loss of vascular tone or vasoplegia
3. Myocardial dysfunction

### Three pillars of Cardiovascular Support

1. Fluid bolus to restore adequate circulating volume .
2. Vasopressor to maintain vasomotor tone
3. Inotropes

### Three endpoints of effective resuscitation

1. Adequate Cardiac output
  - a . Normal CRT/good extremity perfusion
2. Normal MAP
3. Normal Diastolic pressure

### FLUID BOLUS IN SEPTIC SHOCK

1. Fluid loading sometimes aggravates sepsis associated vasoplegia in some patients , resulting in increased vascular permeability and interstitial fluid shifts and fall in MAP and diastolic BP
2. Hence in Septic shock only one bolus of 20 ml /kg in two aliquots of 10 ml/kg subsequent boluses to be judged and given.
3. The exception here is ongoing fluid losses as in diarrhoea and vomiting then fluid boluses may be repeated and titrated to match losses.
4. The choice of fluid is a crystalloid

### DECREASED VASCULAR TONE OR VASOPLEGIA AND ITS MANAGEMENT

You diagnose Vasoplegia ( Decreased Peripheral Vascular Resistance , Vasodilated state )

1. Low Diastolic Pressure
  - Less than 50 adults
  - Less than 20 Infants
  - Less than 30 older children
- 2 . Wide pulse pressure ( bounding pulses PP > 1/2 Systolic)
3. Low or normal MAP

### Management of Vasoplegia

If septic shock is unresolved after FB upto 20 ml/kg or if vasoplegia present , early vasoactive support is recommended . In hypotensive septic shock , concurrent vasoactive with FB achieves rapid control of the BP and perfusion

In septic shock it seems prudent to Start Vasoactives concurrently with fluid bolus or after the first fluid bolus The preferred vasoactive agent is Nor Adrenaline with a starting dose of 0.05mcg to 0.1 mcg/kg/min.

### Septic Myocardial Dysfunction (SMD)

Myocardial dysfunction may be present in 40-50 % of septic shock patients . However in the presence of vasoplegia or low SVR , the SMD is masked as low afterload promotes forward flow . However when after load is raised by vasoactive agents the SMD is unmasked .

### Management plan for masked and unmasked SMD

During the masked LV dysfunction stage start low dose NE 0.05 to 0.1 mcg/kg /min which while acting against vasoplegia, NE also has a modest inotropic effect. When LV dysfunction is unmasked or when LV dysfunction is severe add Epinephrine 0.05 to 0.1 mcg/kg/min or Dobutamine 5-10 mcg/kg/min to run concurrently with NE infusion. Milrinone which is a inodilator should be avoided in this stage.

The " unmasking of LV dysfunction and need for inotropy " is assessed by serial clinical examinations and echocardiography if available

Bed side Approach to fluid and vasoactive titration

Serial clinical monitoring, lab investigations , available monitoring tools with repeated assessments are of paramount importance in the management of Septic Shock.

Assessment of Flow/ Pressure /and Filling parameters after each intervention

Flow parameters relate to perfusion include CRT, extremity temperature,

Pressure parameters - Systolic, diastolic, pulse pressure and MAP

Filling parameters Respiratory mechanics, hepatomegaly, increasing oxygen requirements

1.The initial FB may be considered a fluid test and evaluation of flow /pressure /filling parameters may aid planning the next intervention

If the initial FB (Fluid Bolus) fails to match the fluid losses , the hypoperfusion will persist with narrow pulse pressure and unchanged lung mechanics.

Those with significant myocardial dysfunction, will continue to have poor perfusion with narrow pulses and worsening lung mechanics

In those with hyperdynamic phenotype may lead to unchanged pressure parameters or lead to lowering of DBP by worsening or unmasking the vasoplegic state.

However, if the underlying pathophysiology is unclear after FB , it would be prudent to start with a low dose nor epinephrine 0.05 to 0.1 mcg/kg/min keeping in mind that 85 % of children with septic shock are vasodilated despite a clinical cold shock phenotype.

Hemodynamic management of pediatric septic shock in a nut shell

1. Most children improve with fluid bolus + nor epinephrine infusion.
2. If significant clinical improvement not seen , then children may need the one or more of three additional therapies , more fluid, more pressors, more inotropy.
3. More fluid at 10 ml/kg aliquots if on going fluid losses.
4. Additional pressors if wide pulse pressure , bounding pulses, low DBP and pressure parameters unchanged . Options include increase NE to 0.2 mcg/kg/min or adding vasopressin.
5. More inotropy in a child with low volume pulses, prolonged CRT, low /normal MAP and DBP and filling parameters of lung congestion, hepatomegaly. Inotrope choices include Dobutamine or Epinephrine depending on the pressure parameters.

Non responders to these measures needs advanced care by experienced intensivists.