

FLUID THERAPY AND VASOPRESSOR SELECTION ALGORITHM IN THE MANAGEMENT OF SEPTIC SHOCK IN CHILDREN

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Septic shock remains one of the most life-threatening emergencies in pediatric intensive care, characterized by impaired perfusion, cellular dysfunction, and high mortality. The success of treatment depends heavily on early recognition, timely fluid resuscitation, and appropriate selection of vasopressor support. Unlike adults, children frequently present with **cold shock**, making therapeutic strategies uniquely pediatric-oriented.

Initial Fluid Resuscitation Strategy

Early fluid therapy targets restoration of intravascular volume and improvement of cardiac output. International guidelines, including the **Surviving Sepsis Campaign (SSC)** and **Pediatric Advanced Life Support (PALS)**, recommend administering **20 mL/kg boluses of isotonic crystalloids** over 5–10 minutes, followed by immediate reassessment.

Preferred fluids:

- Balanced crystalloids (Lactated Ringer's, Plasma-Lyte)
- Normal saline (acceptable alternative)

Fluids to avoid:

- Hydroxyethyl starch (HES)
- Gelatin-based colloids (*Due to increased renal injury and mortality in pediatric sepsis*)

Total recommended volume is **40–60 mL/kg within the first hour**, but only in settings with ventilatory and monitoring capabilities. In limited-resource settings, excessive fluids are associated with higher mortality; therefore, fluid administration must be more conservative.

Clinical Indicators for Halting Fluid Administration

Despite being essential, aggressive fluid resuscitation carries a risk of **fluid overload**, which can precipitate pulmonary edema, hepatomegaly, abdominal compartment syndrome, and cardiovascular collapse. Fluid boluses must be discontinued immediately if:

- New or worsening **respiratory distress** develops
- **Hepatomegaly** appears during resuscitation
- Coarse crackles are heard in the lungs
- Perfusion parameters (capillary refill, pulse quality) fail to improve

These findings necessitate escalation to **vasopressor therapy**.

Hemodynamic Reassessment and Monitoring

Continuous reassessment is a cornerstone of pediatric septic shock management. Key parameters include:

- Heart rate and rhythm
- Pulse pressure
- Mental status
- Capillary refill time (>3 seconds indicates poor perfusion)
- Urine output (<1 mL/kg/h indicates inadequate renal perfusion)

Advanced tools:

- Point-of-care ultrasound (POCUS) to assess cardiac function and IVC variability
- Arterial blood pressure monitoring
- Lactate trends for tissue perfusion assessment

Indications for Vasopressor Therapy

Vasopressors must be initiated when:

- Perfusion remains inadequate after **40–60 mL/kg** fluids
- Child presents with refractory hypotension
- Symptoms of fluid overload appear before full resuscitation is complete

Early initiation of vasopressors improves outcomes and reduces the risk of multi-organ failure.

Vasopressor Selection Based on Shock Type

1. Cold Shock (Most common in children)

Characterized by:

- Cold extremities
- Narrow pulse pressure
- Delayed capillary refill
- Weak pulses

First-line agent: Epinephrine

- Increases cardiac output
- Improves perfusion and contractility
- Corrects low systemic flow

2. Warm Shock (Less common)

Characterized by:

- Warm extremities
- Wide pulse pressure

- Vasodilation
- Bounding pulses

First-line agent: Norepinephrine

- Increases systemic vascular resistance
- Restores blood pressure

Other vasopressors and inotropes:

- **Dopamine:** no longer preferred due to arrhythmia risk
- **Vasopressin:** adjunct for catecholamine-resistant shock
- **Dobutamine:** indicated in myocardial dysfunction
- **Milrinone:** useful when cardiac output is low and SVR is high

Stepwise Algorithm for Pediatric Septic Shock Management**Step 1. Early Recognition**

- Tachycardia
- Cold or mottled extremities
- Prolonged capillary refill
- Altered mental status
- Hypotension (late sign in children)

Step 2. Initial Fluid Boluses

- 20 mL/kg isotonic crystalloid
- Reassess after each bolus
- Maximum 40–60 mL/kg (with monitoring)

Step 3. Determine Overload Signs

If present → **stop fluids immediately**

Step 4. Start Vasopressors Early

- Cold shock → **Epinephrine**
- Warm shock → **Norepinephrine**

Step 5. Escalate if Shock Persists

- Add vasopressin for refractory cases
- Add dobutamine or milrinone if cardiac dysfunction suspected
- Consider hydrocortisone for catecholamine-resistant shock

Step 6. Supportive Care

- Early broad-spectrum antibiotics (within first hour)
- Maintain glucose (avoid hypo/hyperglycemia)
- Correct electrolytes (Ca, K, Mg)
- Mechanical ventilation if needed
- Continuous hemodynamic monitoring

Discussion

Pediatric septic shock physiology differs markedly from adult shock, necessitating tailored therapeutic strategies. Over-resuscitation with fluids remains a

major concern, highlighting the importance of individualized management based on clinical response. The shift toward early vasopressor use—especially epinephrine for cold shock—reflects updated evidence demonstrating improved survival and reduced complications.

Utilizing advanced monitoring tools such as POCUS enhances decision-making accuracy. Implementing a structured algorithm reduces variability in care and improves overall outcomes.

Conclusion

Effective management of pediatric septic shock requires a balanced approach between fluid administration and vasopressor therapy. Crystalloids remain the primary fluid choice, but their administration must be guided by strict monitoring to prevent overload. Epinephrine is the first-line vasopressor in cold shock, while norepinephrine is recommended for warm shock. Early recognition, rapid intervention, and adherence to an evidence-based algorithm significantly improve survival and reduce organ dysfunction.

This structured, pediatric-specific approach is essential for optimizing care in critically ill children with septic shock.

References

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