Chapter 4
Pediatric Pearls: Management of Shock in Children

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Abstract The chapters on resuscitation and shock are incredibly valuable in the undifferentiated shock patient. It will set you up for success with initial stabilization while performing evidence-based care. The assistance with dosing for the common "code drugs" is a valuable reference in a high-anxiety situations like the crashing pediatric patient.

Shock

Defined as abnormal physiologic state in which there is an inability to deliver adequate oxygen to meet the metabolic needs of the body.

Types of shock
Hypovolemic
Cardiogenic
Distributive
Obstructive

- Vitals are extremely variable in pediatric shock. Evaluate the patient.
- Tachycardia is an early finding, while bradycardia is a late finding.
- Tachypnea is an early finding. Widened pulse pressure may be an early subtle finding.
- Prompt recognition of shock is important for aggressive treatment.

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- More than one type of shock may be present.

$$\text{Cardiac Output}\left(\text{CO}\right) = \text{Heart Rate}\left(\text{HR}\right) \times \text{Stoke Volume}\left(\text{SV}\right)$$

Quick Hit Cardiac Pearls

Cardiac output (CO) is the amount of blood the heart pumps through the circulatory system in a minute. Children compensate for cardiac output with increased heart rates. Children tolerate high heart rates.

Hypovolemic Shock

- Most common cause of shock around the world. Most of the time from sensible GI losses.
- Requires aggressive fluid management!
- Treatment is isotonic fluid bolus (20 ml/kg) up to 60–80 ml/kg with two large-bore IVs.
- Consider resuscitation with blood products at 10 mL/kg if signs of bleeding are present and with no improvement with IV fluid boluses.

Cardiogenic Shock:

- Assess for cardiac arrythmias prior to fluid administration
- Use 10 ml/kg isotonic crystalloid fluid bolus.

Septic Shock: The Golden Hour

- Maintain perfusion, oxygenation, and ventilation.
- Inadequate early fluid resuscitation is associated with increased mortality.
- Start empiric antibiotic therapy within 1 h of presentation

Definition of Hypotension by Systolic Blood Pressure and Age

Age	Systolic BP (mmHg)
Term neonates (0–28 days)	<60
Infants (1–12 m)	<70
Children 1–10 years (fifth percentile)	<70 + (age in years × 2)
Children >10	<90

Heart Rate and Perfusion Pressure for Age

Current age	Heart rate	MAP-CVP
Term neonate	120–180	55
<1	120–180	60
<2	120–160	65
<7	100–140	65
<15	90–140	65

Adapted from Carcillo JA, Fields AI, American College of Critical Care Medicine Task Force Committee Members: Clinical practice parameters for hemodynamic support of pediatric and neonatal patients in septic shock. *Crit Care Med*. 2002;30:1371

Pediatric CPR

The most common causes of cardiac arrest in children are respiratory failure and hypotensive shock.

- Emphasis on effective CPR—Most important: *compressions*
- CPR sequence: Chest compressions, airway, breathing
- Depress 1/3 of the anterior–posterior diameter of the chest. Allow full recoil!
  - Approximately 1 1/2 inches in infant
  - Approximately 2 inches in children
- "Push hard, push fast."
- Rate: 100 compressions/minute. Single rescuer: 30:2 (compressions: ventilations).
- Two rescuers trained in CPR: 15:2 (compressions: ventilations). NEW 2020 PALS guideline change! Once intubated, provide continuous compressions with breaths every 2–3 s. Shock energy for defibrillation: First shock 2 J/kg, second shock 4 J/kg, any subsequent shocks >4 J/kg, with maximum 10 J/kg or adult dose.

Pediatric Pearls

Do Not Hyperventilate!

Excessive ventilation increases intrathoracic pressure:

- Decreased cardiac output, cerebral flow, and coronary flow
- Air trapping
- Risk of stomach inflation and aspiration

If patient has perfusion and return of spontaneous circulation (ROSC), but still not breathing or intubated, then ventilation should be 12–20 breaths per minute.

SIRS Criteria

In children, the SIRS criteria are modified and must include at least two of the following:

1. **Heart rate** >2 standard deviations above normal for age in the absence of stimuli such as pain and drug administration or unexplained persistent elevation for greater than 30 min. In infants, it also includes heart rate <10th percentile for age in the absence of vagal stimuli, beta-blockers, or congenital heart disease or unexplained persistent depression for greater than 30 min.
2. **Body temperature** obtained orally, rectally, from Foley temp catheter probe, or from central venous catheter probe <36 °C or >38.5 °C. *Temperature must be abnormal to qualify as SIRS in pediatric patients.*
3. **Respiratory rate** >2 standard deviations above normal for age or the requirement for mechanical ventilation not related to neuromuscular disease *or* the administration of anesthesia.
4. **White blood cell** count elevated or depressed for age not related to chemotherapy or greater than 10% bands.

Common Pediatric Medications for Resuscitation and Cardiac Arrest

Epinephrine

- 0.01 mg/kg of 1:10,000 IV/IO or 0.1 mg/kg of 1:1000 endotracheal (ET). (IV or IO route is preferred.)
- Repeat every 3–5 min as needed.

Atropine

- 0.02 mg/kg IV/IO or 0.04–0.06 mg/kg ET
- *New 2020 update!* Minimum dose 0.1 mg.
- Maximum single dose 0.5 mg
- May repeat once if needed.
- Not used routinely for pre-treatment or sedation

Adenosine

- 0.1 mg/kg IV/IO, followed by 0.2 mg/kg
- Maximum dose 6 mg first dose, 12 mg second dose

Amiodarone

- 5 mg/kg IV/IO bolus, may repeat up to 3 total doses of 15 mg/kg total.
- Maximum dose 300 mg

Lidocaine

- 1 mg/kg loading dose

Procainamide

- 15 mg/kg IV/IO over 30–60 min

Magnesium Sulfate (for Torsades)

- 25–50 mg/kg IV/IO over several minutes
- Maximum dose of 2 g