PALS Algorithms

1. PALS Systematic Approach Algorithm
2. Management of Shock Flowchart
3. Recognition of Shock Flowchart
4. Management of Respiratory Emergencies Flowchart
5. Recognition of Respiratory Problems Flowchart
6. Pediatric Cardiac Arrest Algorithm
7. Pediatric Bradycardia With a Pulse and Poor Perfusion Algorithm
8. Pediatric Tachycardia With a Pulse and Adequate Perfusion Algorithm
9. Pediatric Tachycardia With a Pulse and Poor Perfusion Algorithm
10. Pediatric Postresuscitation Care
PALS Systematic Approach Algorithm

The PALS Systematic Approach Algorithm outlines the approach to caring for a critically ill or injured child.

Initial Impression
(consciousness, breathing, color)

Is child unresponsive with no breathing or only gasping?

Yes
Shout for Help/Activate Emergency Response
(as appropriate for setting)

No

Is there a pulse?

Yes
Open airway and begin ventilation and oxygen as available

No
Is the pulse <60/min with poor perfusion despite oxygenation and ventilation?

Yes

If at any time you identify cardiac arrest

Start CPR
(C-A-B)

Go to
Pediatric Cardiac Arrest Algorithm

After ROSC, begin Evaluate-Identify-Intervene sequence (right column)

No
Evaluate

- Primary assessment
- Secondary assessment
- Diagnostic tests

Intervene

Identify

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# Management of Shock Flowchart

## Management of Shock Flowchart

- Oxygen
- Pulse oximetry
- ECG monitor

- IV/IO access
- BLS as indicated
- Point-of-care glucose testing

## Hypovolemic Shock

### Specific Management for Conditions

<table>
<thead>
<tr>
<th>Nonhemorrhagic</th>
<th>Hemorrhagic</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 20 mL/kg NS/LR bolus, repeat as needed</td>
<td></td>
</tr>
<tr>
<td>• Consider colloid</td>
<td></td>
</tr>
<tr>
<td>• Control external bleeding</td>
<td></td>
</tr>
<tr>
<td>• 20 mL/kg NS/LR bolus, repeat 2 or 3x as needed</td>
<td></td>
</tr>
<tr>
<td>• Transfuse PRBCs as indicated</td>
<td></td>
</tr>
</tbody>
</table>

## Distributive Shock

### Specific Management for Selected Conditions

<table>
<thead>
<tr>
<th>Septic</th>
<th>Anaphylactic</th>
<th>Neurogenic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management Algorithm:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Septic Shock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• IM epinephrine (or autoinjector)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Fluid boluses (20 mL/kg NS/LR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Albuterol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Antihistamines, corticosteroids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Epinephrine infusion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• 20 mL/kg NS/LR bolus, repeat PRN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Vasopressor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Cardiogenic Shock

### Specific Management for Selected Conditions

<table>
<thead>
<tr>
<th>Bradyarrhythmia/Tachyarrhythmia</th>
<th>Other (eg, CHD, Myocarditis, Cardiomyopathy, Poisoning)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management Algorithms:</td>
<td></td>
</tr>
<tr>
<td>• Bradycardia</td>
<td></td>
</tr>
<tr>
<td>• Tachycardia With Poor Perfusion</td>
<td></td>
</tr>
<tr>
<td>• 5 to 10 mL/kg NS/LR bolus, repeat PRN</td>
<td></td>
</tr>
<tr>
<td>• Vasoactive infusion</td>
<td></td>
</tr>
<tr>
<td>• Consider expert consultation</td>
<td></td>
</tr>
</tbody>
</table>

## Obstructive Shock

### Specific Management for Selected Conditions

<table>
<thead>
<tr>
<th>Ductal-Dependent (LV Outflow Obstruction)</th>
<th>Tension Pneumothorax</th>
<th>Cardiac Tamponade</th>
<th>Pulmonary Embolism</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Prostaglandin E₁</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Expert consultation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Needle decompression</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Tube thoracostomy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Pericardiocentesis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• 20 mL/kg NS/LR bolus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• 20 mL/kg NS/LR bolus, repeat PRN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Consider thrombolytics, anticoagulants</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Expert consultation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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## Recognition of Shock Flowchart

<table>
<thead>
<tr>
<th>Clinical Signs</th>
<th>Hypovolemic Shock</th>
<th>Distributive Shock</th>
<th>Cardiogenic Shock</th>
<th>Obstructive Shock</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong> Patency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiration rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory effort</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breath sounds</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B</strong> Systolic blood pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>C</strong> Pulse pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peripheral pulse quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>D</strong> Skin</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capillary refill</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urine output</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>E</strong> Level of consciousness</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Airway open and maintainable/not maintainable
- Increased
- Normal to increased
- Labored
- Normal (± crackles)
- Crackles, grunting
- Compensated Shock → Hypotensive Shock
- Narrow
- Variable
- Narrow
- Increased
- Weak
- Bounding or weak
- Weak
- Pale, cool
- Warm or cool
- Pale, cool
- Delayed
- Variable
- Delayed
- Decreased
- Irritable early
- Lethargic late
- Variable
### Management of Respiratory Emergencies Flowchart

**Upper Airway Obstruction**
Specific Management for Selected Conditions

<table>
<thead>
<tr>
<th>Croup</th>
<th>Anaphylaxis</th>
<th>Aspiration Foreign Body</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Nebulized epinephrine&lt;br&gt;• Corticosteroids</td>
<td>• IM epinephrine (or autoinjector)&lt;br&gt;• Albuterol&lt;br&gt;• Antihistamines&lt;br&gt;• Corticosteroids</td>
<td>• Allow position of comfort&lt;br&gt;• Specialty consultation</td>
</tr>
</tbody>
</table>

**Lower Airway Obstruction**
Specific Management for Selected Conditions

<table>
<thead>
<tr>
<th>Bronchiolitis</th>
<th>Asthma</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Nasal suctioning&lt;br&gt;• Bronchodilator trial</td>
<td>• Albuterol ± ipratropium&lt;br&gt;• Corticosteroids&lt;br&gt;• Subcutaneous epinephrine&lt;br&gt;• Magnesium sulfate&lt;br&gt;• Terbutaline</td>
</tr>
</tbody>
</table>

**Lung Tissue Disease**
Specific Management for Selected Conditions

<table>
<thead>
<tr>
<th>Pneumonia/Pneumonitis</th>
<th>Pulmonary Edema Cardiogenic or Noncardiogenic (ARDS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious Chemical Aspiration</td>
<td>• Consider noninvasive or invasive ventilatory support with PEEP&lt;br&gt;• Consider vasoactive support&lt;br&gt;• Consider diuretic</td>
</tr>
<tr>
<td>• Albuterol&lt;br&gt;• Antibiotics (as indicated)</td>
<td></td>
</tr>
</tbody>
</table>

**Disordered Control of Breathing**
Specific Management for Selected Conditions

<table>
<thead>
<tr>
<th>Increased ICP</th>
<th>Poisoning/Overdose</th>
<th>Neuromuscular Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Avoid hypoxemia&lt;br&gt;• Avoid hypercarbia&lt;br&gt;• Avoid hyperthermia</td>
<td>• Antidote (if available)&lt;br&gt;• Contact poison control</td>
<td>• Consider noninvasive or invasive ventilatory support</td>
</tr>
</tbody>
</table>
## Pediatric Advanced Life Support
### Symptoms of Respiratory Problems

<table>
<thead>
<tr>
<th>Clinical Signs</th>
<th>Upper Airway Obstruction</th>
<th>Lower Airway Obstruction</th>
<th>Lung Tissue Disease</th>
<th>Disordered Control of Breathing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patency</td>
<td>Airway open and maintainable/not maintainable</td>
<td>Increased</td>
<td></td>
<td>Variable</td>
</tr>
<tr>
<td>Respiratory Rate/Effort</td>
<td></td>
<td></td>
<td>Grunting Crackles Decreased breath sounds</td>
<td>Normal</td>
</tr>
<tr>
<td>Breath Sounds</td>
<td>Stridor (typically inspiratory) Barking cough Hoarseness</td>
<td>Wheezing (typically expiratory) Prolonged expiratory phase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Movement</td>
<td>Decreased</td>
<td></td>
<td></td>
<td>Variable</td>
</tr>
<tr>
<td>Heart Rate</td>
<td>Tachycardia (early) Bradycardia (late)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skin</td>
<td>Pallor, cool skin (early) Cyanosis (late)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level of Consciousness</td>
<td>Anxiety, agitation (early) Lethargy, unresponsiveness (late)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>Variable</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Pediatric Advanced Life Support
### Identification of Respiratory Problems by Severity

<table>
<thead>
<tr>
<th>Respiratory Distress</th>
<th>Respiratory Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open and maintainable</td>
<td>Not maintainable</td>
</tr>
</tbody>
</table>

- **A**: Grading based on airway patency.
- **B**: Work of breathing and air movement.
- **C**: Heart rate and skin condition.
- **D**: Level of consciousness.
- **E**: Temperature.
Pediatric Cardiac Arrest Algorithm

Pediatric Advanced Life Support

Shout for Help/Activate Emergency Response

1. Start CPR
   - Give oxygen
   - Attach monitor/defibrillator

2. Rhythm shockable?
   - Yes
   - VF/VT
   - No
   - Asystole/PEA

3. Shock

4. CPR 2 min
   - IO/IV access

5. Rhythm shockable?
   - Yes
   - Shock
   - No

6. CPR 2 min
   - Epinephrine every 3-5 min
   - Consider advanced airway

7. Shock

8. CPR 2 min
   - Amiodarone
   - Treat reversible causes

9. Doses/Details
   - CPR Quality
     - Push hard (≥1/3 of anterior-posterior diameter of chest) and fast (at least 100/min) and allow complete chest recoil
     - Minimize interruptions in compressions
     - Avoid excessive ventilation
     - Rotate compressor every 2 minutes
     - If no advanced airway, 15:2 compression-to-ventilation ratio. If advanced airway, 8-10 breaths per minute with continuous chest compressions

   - Shock Energy for Defibrillation
     - First shock 2 J/kg, second shock 4 J/kg, subsequent shocks ≥4 J/kg, maximum 10 J/kg or adult dose.

   - Drug Therapy
     - Epinephrine IO/IV Dose: 0.01 mg/kg (0.1 mL/kg of 1:10 000 concentration). Repeat every 3-5 minutes. If no IO/IV access, may give endotracheal dose: 0.1 mg/kg (0.1 mL/kg of 1:1000 concentration).
     - Amiodarone IO/IV Dose: 5 mg/kg bolus during cardiac arrest. May repeat up to 2 times for refractory VF/pulseless VT.

   - Advanced Airway
     - Endotracheal intubation or supraglottic advanced airway
     - Waveform capnography or capnometry to confirm and monitor ET tube placement
     - Once advanced airway in place give 1 breath every 6-8 seconds (8-10 breaths per minute)

   - Return of Spontaneous Circulation (ROSC)
     - Pulse and blood pressure
     - Spontaneous arterial pressure waves with intra-arterial monitoring

   - Reversible Causes
     - Hypovolemia
     - Hypoxia
     - Hydrogen ion (acidosis)
     - Hypoglycemia
     - Hypo-/hyperkalemia
     - Hypothermia
     - Tension pneumothorax
     - Tamponade, cardiac
     - Toxins
     - Thrombosis, pulmonary
     - Thrombosis, coronary

10. CPR 2 min
    - IO/IV access
    - Epinephrine every 3-5 min
    - Consider advanced airway

11. Rhythm shockable?
    - Yes
    - CPR 2 min
    - Treat reversible causes
    - No

12. Doses/Details
    - Asystole/PEA → 10 or 11
    - Organized rhythm → check pulse
    - Pulse present (ROSC) → post-cardiac arrest care

Go to 5 or 7
Pediatric Bradycardia
With a Pulse and Poor Perfusion Algorithm

Identify and treat underlying cause
- Maintain patent airway; assist breathing as necessary
- Oxygen
- Cardiac monitor to identify rhythm; monitor blood pressure and oximetry
- IO/IV access
- 12-Lead ECG if available; don’t delay therapy

No

Cardiopulmonary compromise continues?

Yes

CPR if HR <60/min with poor perfusion despite oxygenation and ventilation

No

Bradycardia persists?

Yes

- Epinephrine
- Atropine for increased vagal tone or primary AV block
- Consider transthoracic pacing/transvenous pacing
- Treat underlying causes

If pulseless arrest develops, go to Cardiac Arrest Algorithm

Cardiopulmonary Compromise
- Hypotension
- Acutely altered mental status
- Signs of shock

Doses/Details

Epinephrine IO/IV Dose:
0.01 mg/kg (0.1 mL/kg of 1:10 000 concentration), Repeat every 3-5 minutes. If IO/IV access not available but endotracheal (ET) tube in place, may give ET dose: 0.1 mg/kg (0.1 mL/kg of 1:1000).

Atropine IO/IV Dose:
0.02 mg/kg. May repeat once. Minimum dose 0.1 mg and maximum single dose 0.5 mg.
Pediatric Tachycardia With a Pulse and Adequate Perfusion Algorithm

**Pediatric Advanced Life Support**

**Identify and treat underlying cause**
- Maintain patent airway; assist breathing as necessary
- Oxygen
- Cardiac monitor to identify rhythm; monitor blood pressure and oximetry
- 12-Lead ECG if practical

**QRS normal (≤0.09 sec)**
- **Evaluate rhythm**

**QRS wide (>0.09 sec)**
- **Evaluate rhythm**

**Possible supraventricular tachycardia (with QRS aberrancy)**
- R-R interval regular
- Uniform QRS morphology

**Probable supraventricular tachycardia**
- Compatible history (vague, nonspecific; history of abrupt rate changes)
- P waves absent/abnormal
- HR not variable with activity
- Infants: rate usually ≥220/min
- Children: rate usually ≥180/min

**Probable ventricular tachycardia**

- Expert consultation strongly recommended
- Search for and treat reversible causes
- Obtain 12-lead ECG
- Consider pharmacologic conversion
  - Amiodarone 5 mg/kg IV over 20 to 60 minutes
  - Procainamide 15 mg/kg IV over 30 to 60 minutes
  - Do not routinely administer amiodarone and procainamide together
  - May attempt adenosine if not already administered
- Consider electrical conversion
  - Consult pediatric cardiologist
  - Attempt cardioversion with 0.5 to 1 J/kg (may increase to 2 J/kg if initial dose ineffective)
  - Sedate before cardioversion

**Search for and treat cause**

**Consider vagal maneuvers**
- Establish vascular access
- Consider adenosine 0.1 mg/kg IV (maximum first dose 6 mg)
  - May give second dose of 0.2 mg/kg IV (maximum second dose 12 mg)
  - Use rapid bolus technique
Pediatric Tachycardia
With a Pulse and Poor Perfusion Algorithm

Identify and treat underlying cause
- Maintain patent airway; assist breathing as necessary
- Oxygen
- Cardiac monitor to identify rhythm; monitor blood pressure and oximetry
- IO/IV access
- 12-Lead ECG if available; don’t delay therapy

Narrow (≤0.09 sec) Evaluate QRS duration Wide (>0.09 sec)
Evaluate rhythm with 12-lead ECG or monitor

Probable sinus tachycardia
- Compatible history consistent with known cause
- P waves present/normal
- Variable R-R; constant PR
- Infants: rate usually <220/min
- Children: rate usually <180/min

Probable supraventricular tachycardia
- Compatible history (vague, nonspecific); history of abrupt rate changes
- P waves absent/abnormal
- HR not variable
- Infants: rate usually ≥220/min
- Children: rate usually ≥180/min

Possible ventricular tachycardia

Cardiopulmonary compromise?
- Hypotension
- Acutely altered mental status
- Signs of shock

Yes
Consider adenosine if rhythm regular and QRS monomorphic
- Expert consultation advised
  - Amiodarone
  - Procainamide

No
Search for and treat cause

Consider vagal maneuvers (No delays)

Synchronized cardioversion
- If IO/IV access present, give adenosine OR
- If IO/IV access not available, or if adenosine ineffective, synchronized cardioversion

Doses/Details
Synchronized Cardioversion:
- Begin with 0.5-1 J/kg; if not effective, increase to 2 J/kg. Sedate if needed, but don’t delay cardioversion.

Adenosine
IO/IV Dose:
- First dose: 0.1 mg/kg rapid bolus (maximum: 6 mg).
- Second dose: 0.2 mg/kg rapid bolus (maximum second dose 12 mg).

Amiodarone
IO/IV Dose:
- 5 mg/kg over 20-60 minutes

Procainamide
IO/IV Dose:
- 15 mg/kg over 30-60 minutes

Do not routinely administer amiodarone and procainamide together.
Management of Shock After ROSC

**Optimize Ventilation and Oxygenation**
- Titrate FiO₂ to maintain oxyhemoglobin saturation 94%-99%; if possible, wean FiO₂ if saturation is 100%
- Consider advanced airway placement and waveform capnography

**Assess for and Treat Persistent Shock**
- Identify, treat contributing factors.*
- Consider 20 mL/kg IV/IO boluses of isotonic crystalloid. Consider smaller boluses (eg, 10 mL/kg) if poor cardiac function suspected.
- Consider the need for inotropic and/or vasopressor support for fluid-refractory shock.

*Possible Contributing Factors
- Hypovolemia
- Hypoxia
- Hydrogen ion (acidosis)
- Hypoglycemia
- Hypo-/hyperkalemia
- Hypothermia
- Tension pneumothorax
- Tamponade, cardiac
- Toxins
- Thrombosis, pulmonary
- Thrombosis, coronary
- Trauma

**Hypotensive Shock**
- Epinephrine
- Dopamine
- Norepinephrine

**Normotensive Shock**
- Dobutamine
- Dopamine
- Epinephrine
- Milrinone

- Monitor for and treat agitation and seizures
- Monitor for and treat hypoglycemia
- Assess blood gas, serum electrolytes, calcium
- If patient remains comatose after resuscitation from cardiac arrest, consider therapeutic hypothermia (32°C-34°C)
- Consider consultation and patient transport to tertiary care center

Estimation of Maintenance Fluid Requirements

- **Infants <10 kg**: 4 mL/kg per hour
  *Example*: For an 8-kg infant, estimated maintenance fluid rate
  = 4 mL/kg per hour × 8 kg
  = 32 mL per hour

- **Children 10-20 kg**: 4 mL/kg per hour for the first 10 kg + 2 mL/kg per hour for each kg above 10 kg
  *Example*: For a 15-kg child, estimated maintenance fluid rate
  = (4 mL/kg per hour × 10 kg) + (2 mL/kg per hour × 5 kg)
  = 40 mL/hour + 10 mL/hour
  = 50 mL/hour

- **Children >20 kg**: 4 mL/kg per hour for the first 10 kg + 2 mL/kg per hour for kg 11-20 + 1 mL/kg per hour for each kg above 20 kg.
  *Example*: For a 28-kg child, estimated maintenance fluid rate
  = (4 mL/kg per hour × 10 kg) + (2 mL/kg per hour × 10 kg) + (1 mL/kg per hour × 8 kg)
  = 40 mL/hour + 20 mL/hour + 8 mL per hour
  = 68 mL per hour

Following initial stabilization, adjust the rate and composition of intravenous fluids based on the patient's clinical condition and state of hydration. In general, provide a continuous infusion of a dextrose-containing solution for infants. Avoid hypotonic solutions in critically ill children; for most patients use isotonic fluid such as normal saline (0.9% NaCl) or lactated Ringer's solution with or without dextrose, based on the child's clinical status.