



American Heart Association

American Academy of Pediatrics

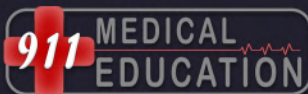


DEDICATED TO THE HEALTH OF ALL CHILDREN



ARRESTS

PEDIATRIC ADVANCED LIFE SUPPORT



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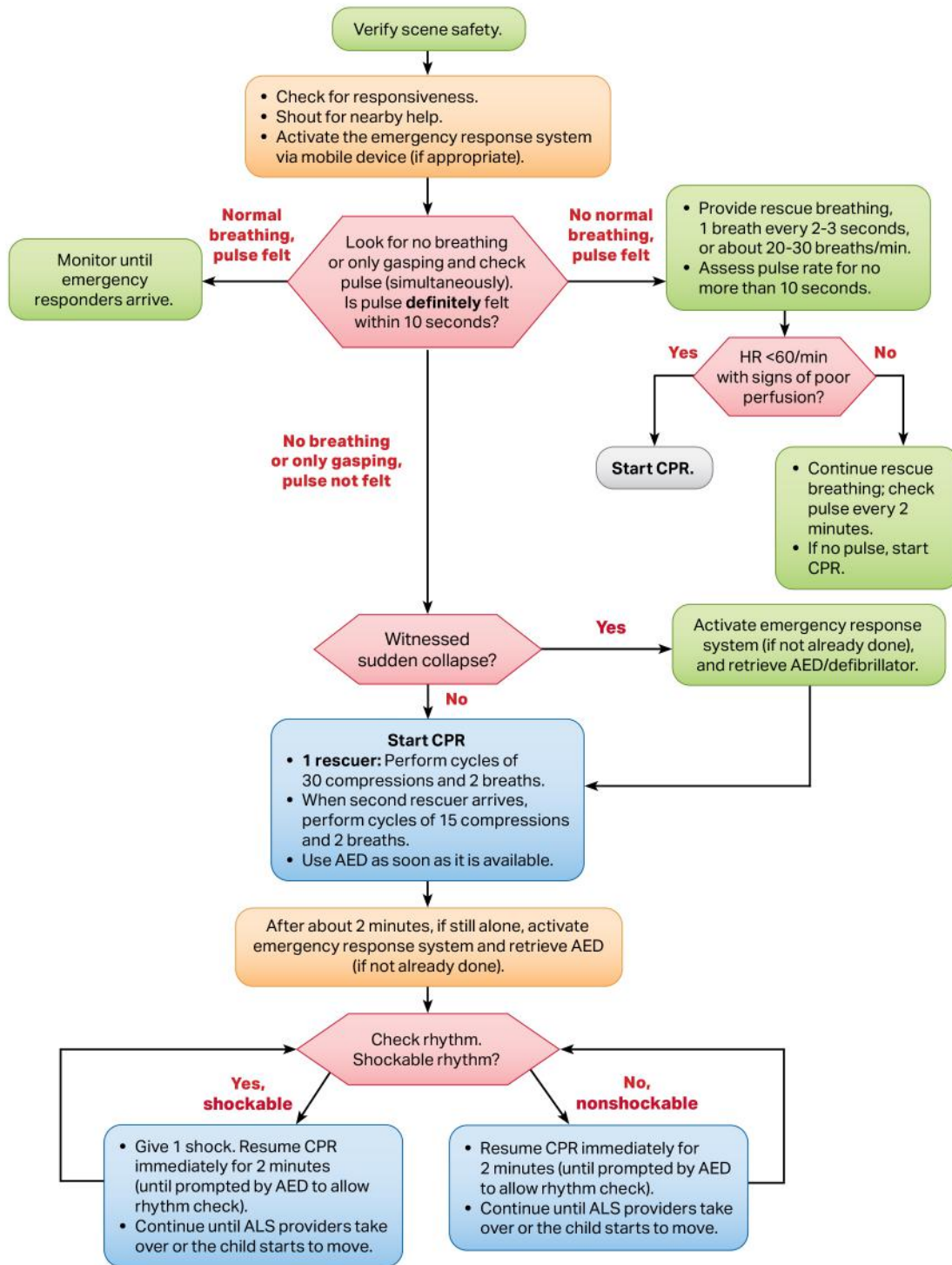
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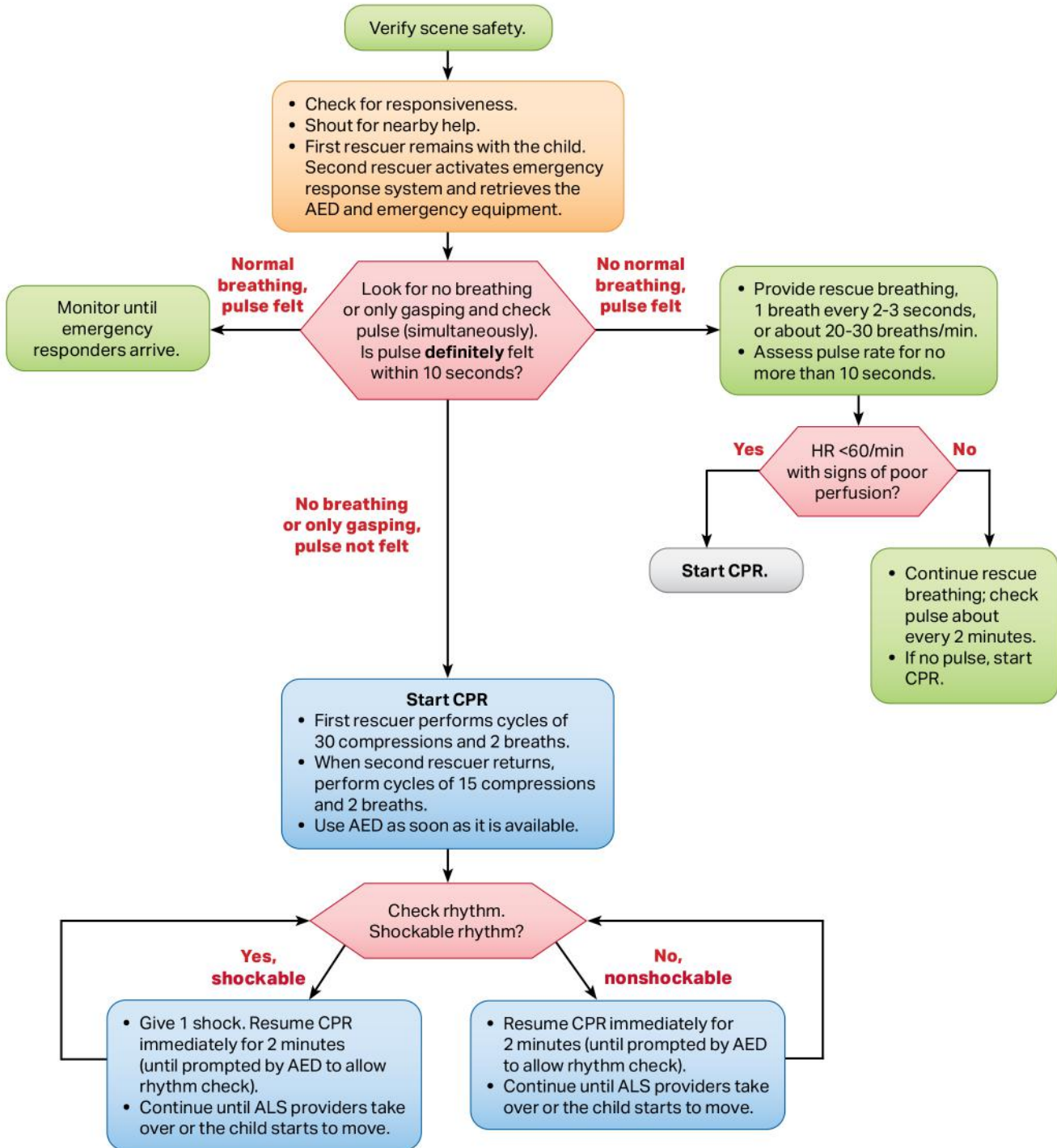
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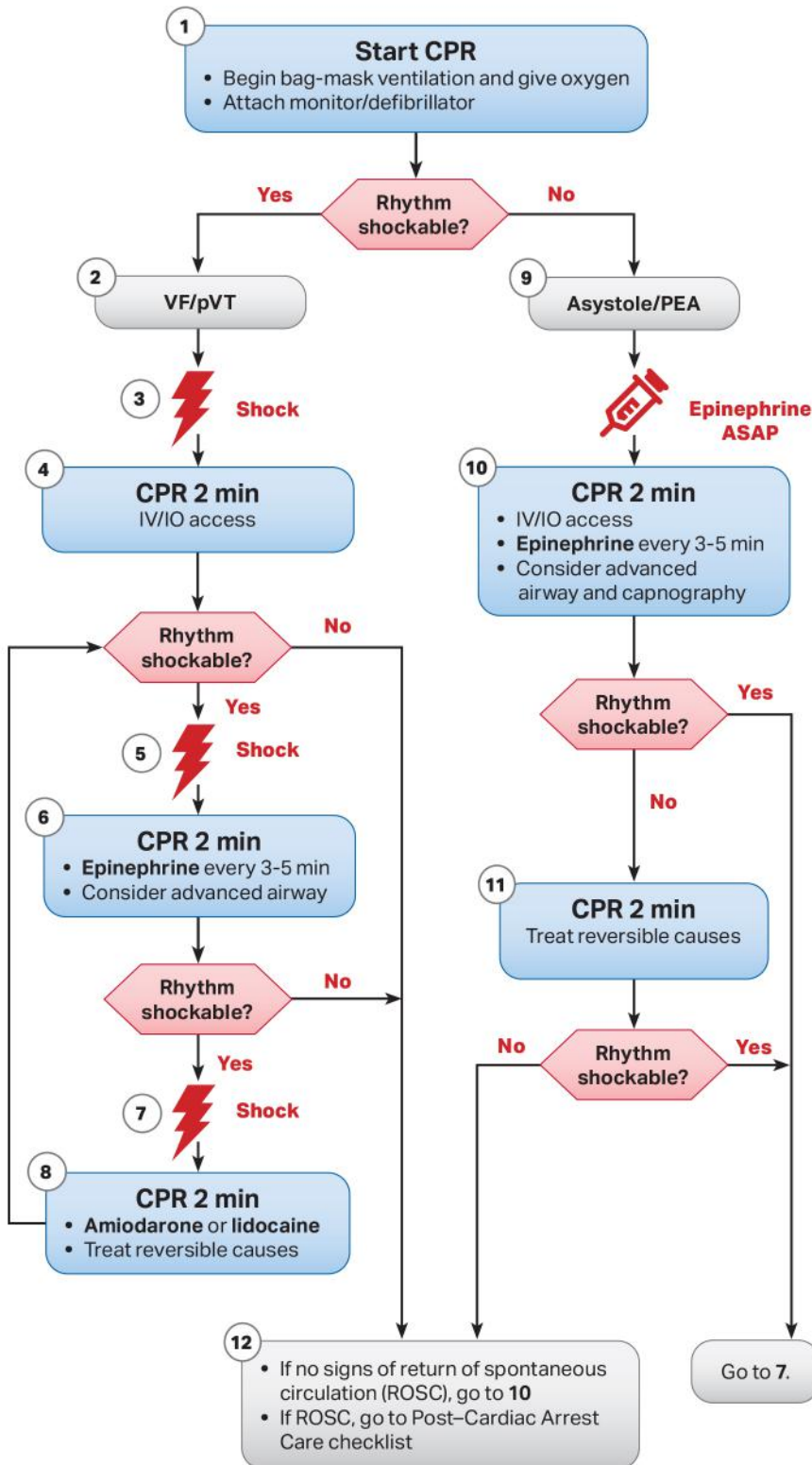
Pediatric Basic Life Support Algorithm for Healthcare Providers—Single Rescuer



Pediatric Basic Life Support Algorithm for Healthcare Providers—2 or More Rescuers



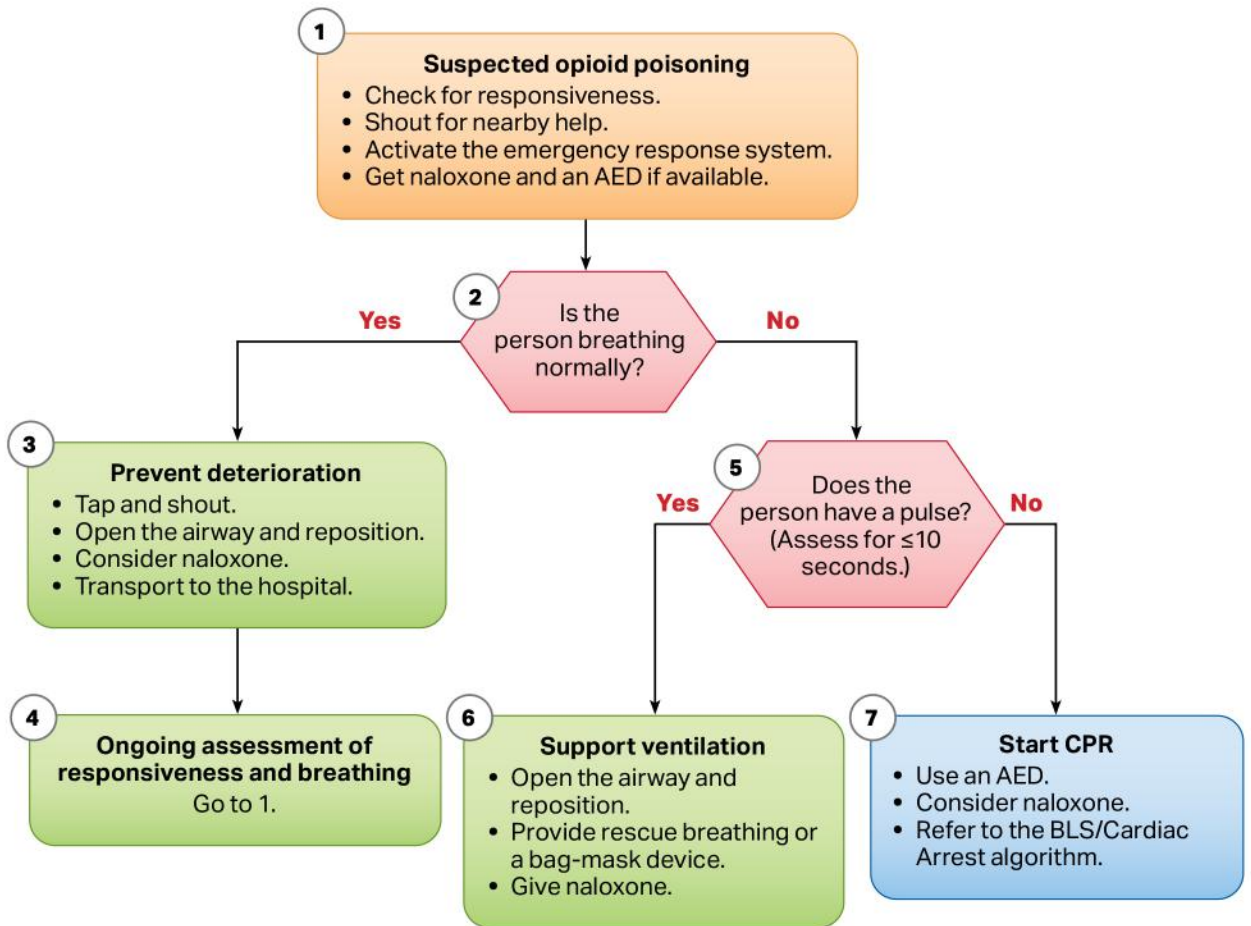
Pediatric Cardiac Arrest Algorithm



CPR Quality
<ul style="list-style-type: none"> • Push hard ($\geq\frac{1}{3}$ of anteroposterior diameter of chest) and fast (100-120/min) and allow complete chest recoil • Minimize interruptions in compressions • Change compressor every 2 minutes, or sooner if fatigued • If no advanced airway, 15:2 compression-ventilation ratio • If advanced airway, provide continuous compressions and give a breath every 2-3 seconds
Shock Energy for Defibrillation
<ul style="list-style-type: none"> • First shock 2 J/kg • Second shock 4 J/kg • Subsequent shocks ≥ 4 J/kg, maximum 10 J/kg or adult dose
Drug Therapy
<ul style="list-style-type: none"> • Epinephrine IV/IO dose: 0.01 mg/kg (0.1 mL/kg of the 0.1 mg/mL concentration). Max dose 1 mg. Repeat every 3-5 minutes. If no IV/IO access, may give endotracheal dose: 0.1 mg/kg (0.1 mL/kg of the 1 mg/mL concentration). • Amiodarone IV/IO dose: 5 mg/kg bolus during cardiac arrest. May repeat up to 3 total doses for refractory VF/pulseless VT or • Lidocaine IV/IO dose: Initial: 1 mg/kg loading dose
Advanced Airway
<ul style="list-style-type: none"> • Endotracheal intubation or supraglottic advanced airway • Waveform capnography or capnometry to confirm and monitor ET tube placement
Reversible Causes
<ul style="list-style-type: none"> • Hypovolemia • Hypoxia • Hydrogen ion (acidosis) • Hypoglycemia • Hypo-/hyperkalemia • Hypothermia • Tension pneumothorax • Tamponade, cardiac • Toxins • Thrombosis, pulmonary • Thrombosis, coronary

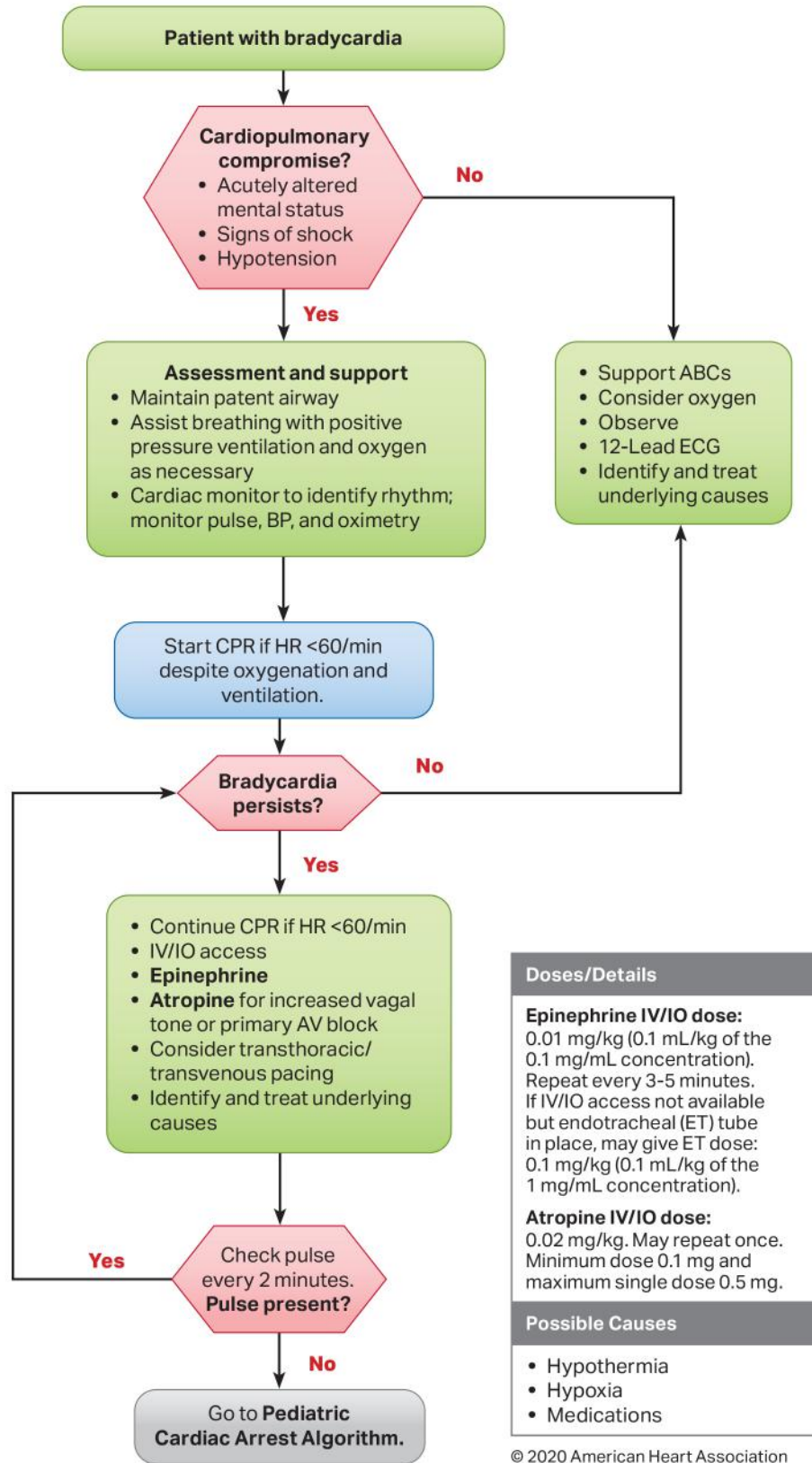
Components of Post-Cardiac Arrest Care	Check
Oxygenation and ventilation	
Measure oxygenation and target normoxemia 94%-99% (or child's normal/appropriate oxygen saturation).	<input type="checkbox"/>
Measure and target Paco ₂ appropriate to the patient's underlying condition and limit exposure to severe hypercapnia or hypocapnia.	<input type="checkbox"/>
Hemodynamic monitoring	
Set specific hemodynamic goals during post-cardiac arrest care and review daily.	<input type="checkbox"/>
Monitor with cardiac telemetry.	<input type="checkbox"/>
Monitor arterial blood pressure.	<input type="checkbox"/>
Monitor serum lactate, urine output, and central venous oxygen saturation to help guide therapies.	<input type="checkbox"/>
Use parenteral fluid bolus with or without inotropes or vasopressors to maintain a systolic blood pressure greater than the fifth percentile for age and sex.	<input type="checkbox"/>
Targeted temperature management (TTM)	
Measure and continuously monitor core temperature.	<input type="checkbox"/>
Prevent and treat fever immediately after arrest and during rewarming.	<input type="checkbox"/>
If patient is comatose apply TTM (32°C-34°C) followed by (36°C-37.5°C) or only TTM (36°C-37.5°C).	<input type="checkbox"/>
Prevent shivering.	<input type="checkbox"/>
Monitor blood pressure and treat hypotension during rewarming.	<input type="checkbox"/>
Neuromonitoring	
If patient has encephalopathy and resources are available, monitor with continuous electroencephalogram.	<input type="checkbox"/>
Treat seizures.	<input type="checkbox"/>
Consider early brain imaging to diagnose treatable causes of cardiac arrest.	<input type="checkbox"/>
Electrolytes and glucose	
Measure blood glucose and avoid hypoglycemia.	<input type="checkbox"/>
Maintain electrolytes within normal ranges to avoid possible life-threatening arrhythmias.	<input type="checkbox"/>
Sedation	
Treat with sedatives and anxiolytics.	<input type="checkbox"/>
Prognosis	
Always consider multiple modalities (clinical and other) over any single predictive factor.	<input type="checkbox"/>
Remember that assessments may be modified by TTM or induced hypothermia.	<input type="checkbox"/>
Consider electroencephalogram in conjunction with other factors within the first 7 days after cardiac arrest.	<input type="checkbox"/>
Consider neuroimaging such as magnetic resonance imaging during the first 7 days.	<input type="checkbox"/>

Opioid-Associated Emergency for Healthcare Providers Algorithm

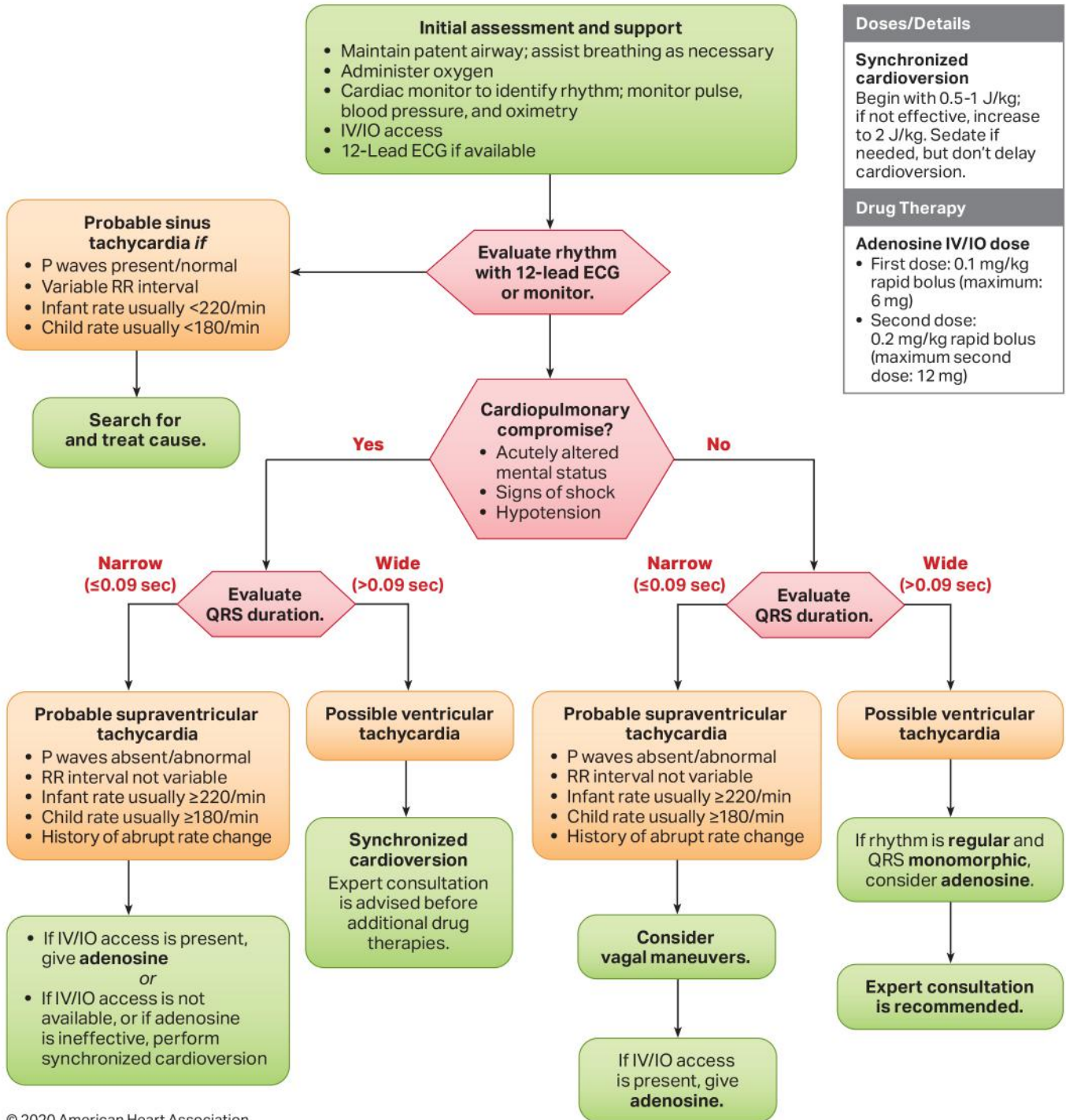


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Pediatric Bradycardia With a Pulse Algorithm



Pediatric Tachycardia With a Pulse Algorithm



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Vital Signs in Children

Normal Heart Rates* (beats/min)

Age	Awake Rate	Sleeping Rate
Neonate	100-205	90-160
Infant	100-180	90-160
Toddler	98-140	80-120
Preschooler	80-120	65-100
School-aged child	75-118	58-90
Adolescent	60-100	50-90

Normal Respiratory Rates (breaths/min)

Age	Rate
Infant	30-53
Toddler	22-37
Preschooler	20-28
School-aged child	18-25
Adolescent	12-20

Normal Blood Pressures

Age	Systolic Pressure (mm Hg) [†]	Diastolic Pressure (mm Hg) [†]	Mean Arterial Pressure (mm Hg) [‡]
Birth (12 h, <1000 g)	39-59	16-36	28-42 [§]
Birth (12 h, 3 kg)	60-76	31-45	48-57
Neonate (96 h)	67-84	35-53	45-60
Infant (1-12 mo)	72-104	37-56	50-62
Toddler (1-2 y)	86-106	42-63	49-62
Preschooler (3-5 y)	89-112	46-72	58-69
School-aged child (6-7 y)	97-115	57-76	66-72
Preadolescent (10-12 y)	102-120	61-80	71-79
Adolescent (12-15 y)	110-131	64-83	73-84

*Always consider the patient's normal range and clinical condition. Heart rate will normally increase with fever or stress.

[†]Systolic and diastolic blood pressure ranges assume 50th percentile for height for children 1 year and older.

[‡]Mean arterial pressures (diastolic pressure + [difference between systolic and diastolic pressure/3]) for 1 year and older, assuming 50th percentile for height.

[§]Approximately equal to postconception age in weeks (may add 5 mm Hg).

Reproduced from Hazinski MF. Children are different. In: Hazinski MF, ed. *Nursing Care of the Critically Ill Child*. 3rd ed. St Louis, MO: Mosby; 2013:1-18, copyright Elsevier. Data from Gemelli M, Manganaro R, Mami C, De Luca F. Longitudinal study of blood pressure during the 1st year of life. *Eur J Pediatr*. 1990;149(5):318-320; Versmold HT, Kitterman JA, Phibbs RH, Gregory GA, Tooley WH. Aortic blood pressure during the first 12 hours of life in infants with birth weight 610 to 4,220 grams. *Pediatrics*. 1981;67(5):607-613; Haque IU, Zaritsky AL. Analysis of the evidence for the lower limit of systolic and mean arterial pressure in children. *Pediatr Crit Care Med*. 2007;8(2):138-144; and National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. *The Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents*. Bethesda, MD: National Heart, Lung, and Blood Institute; 2005. NIH publication 05-5267.

Secondary Assessment A focused medical history (SAMPLE) and a focused physical exam

Diagnostic Tests Laboratory, radiographic, and other advanced tests that help to identify the child's physiologic condition and diagnosis

Identify Identify the child's problem as respiratory, circulatory, or both. Determine the type and severity of the problem(s). The table below lists common clinical signs that typically correlate with a specific type of problem and its severity.

Type	Severity
Respiratory <ul style="list-style-type: none"> • Upper airway obstruction • Lower airway obstruction • Lung tissue disease • Disordered control of breathing 	<ul style="list-style-type: none"> • Respiratory distress • Respiratory failure
Circulatory <ul style="list-style-type: none"> • Hypovolemic shock • Distributive (eg, septic, anaphylactic) shock • Obstructive shock • Cardiogenic shock 	<ul style="list-style-type: none"> • Compensated shock • Hypotensive shock
Cardiac Arrest	

Respiratory		
Signs	Type of Problem	Severity
<ul style="list-style-type: none"> • Increased respiratory rate and effort (eg, retractions, nasal flaring) • Decreased air movement • Stridor (typically inspiratory) • Barking cough • Snoring or gurgling • Hoarseness 	Upper airway obstruction	Respiratory distress <ul style="list-style-type: none"> • Some abnormal signs but no signs of respiratory failure Respiratory failure <i>One or more of the following:</i> <ul style="list-style-type: none"> • Very rapid or inadequate respiratory rate • Significant or inadequate respiratory effort • Low oxygen saturation despite high-flow oxygen • Bradycardia (ominous) • Cyanosis • Decreased level of consciousness
<ul style="list-style-type: none"> • Increased respiratory rate and effort (eg, retractions, nasal flaring) • Decreased air movement • Prolonged expiration • Wheezing 	Lower airway obstruction	
<ul style="list-style-type: none"> • Increased respiratory rate and effort • Decreased air movement • Grunting • Crackles 	Lung tissue disease	
<ul style="list-style-type: none"> • Irregular respiratory pattern • Inadequate or irregular respiratory depth and effort • Normal or decreased air movement • Signs of upper airway obstruction (see above) 	Disordered control of breathing	

Circulatory		
<ul style="list-style-type: none"> • Tachycardia • Weak peripheral pulses • Delayed capillary refill time • Changes in skin color (pallor, mottling, cyanosis) 	<ul style="list-style-type: none"> • Cool skin • Changes in level of consciousness • Decreased urine output 	Signs of poor perfusion

Signs	Type of Problem	Severity
<ul style="list-style-type: none"> • Signs of poor perfusion (see above) 	Hypovolemic shock Obstructive shock	Compensated shock <ul style="list-style-type: none"> • Signs of poor perfusion and normal blood pressure
<ul style="list-style-type: none"> • Possible signs of poor perfusion (see above) or • Warm, flushed skin with brisk capillary refill (warm shock) • Peripheral pulses may be bounding • Possible crackles • Possible petechial or purpuric rash (septic shock) 	Distributive shock	Hypotensive shock <ul style="list-style-type: none"> • Signs of poor perfusion and low blood pressure
<ul style="list-style-type: none"> • Signs of poor perfusion (see above) • Signs of heart failure 	Cardiogenic shock	

Intervene On the basis of your identification of the problem, intervene with appropriate actions. Your actions will be determined by your scope of practice and local protocol.

PALS Systematic Approach Summary

Initial Impression

Your first quick (in a few seconds) "from the doorway" observation

Appearance	Including level of consciousness (eg, unresponsive, irritable, alert and ability to interact)
Breathing	Increased work of breathing, absent or decreased respiratory effort, or abnormal sounds heard without auscultation
Circulation (color)	Abnormal skin color, such as cyanosis, pallor, or mottling
<i>The purpose is to quickly identify a life-threatening problem.</i>	

Is the child unresponsive with no breathing or only gasping?

If YES:

- Shout for help.
- Activate emergency response as appropriate for setting.
- Check for a pulse.
- Begin lifesaving interventions as needed.

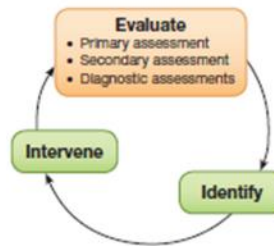
If NO:

- Continue the evaluate-identify-intervene sequence.

Use the **evaluate-identify-intervene** sequence when caring for a seriously ill or injured child.

- Evaluate the child to gather information about the child's condition or status.
- Identify any problem by type and severity.
- Intervene with appropriate actions to treat the problem.

Then repeat the sequence; this process is ongoing.



If at any time you identify a life-threatening problem, immediately begin appropriate interventions. Activate emergency response as indicated in your practice setting.

Evaluate

"Evaluate" consists of the primary assessment (ABCDE), secondary assessment, and diagnostic tests.

Primary Assessment

A rapid, hands-on ABCDE approach to evaluate respiratory, cardiac, and neurologic function; this step includes assessment of vital signs and pulse oximetry

Airway

Clear	Maintainable	Not maintainable
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Breathing

Respiratory Rate and Pattern	Respiratory Effort	Chest Expansion and Air Movement	Abnormal Lung and Airway Sounds	Oxygen Saturation by Pulse Oximetry
Normal Irregular Fast Slow Apnea	Normal Increased • Nasal flaring • Retractions • Head bobbing • Seesaw respirations Inadequate • Apnea • Weak cry or cough	Normal Decreased Unequal Prolonged expiration	Stridor Snoring Barking cough Hoarseness Grunting Gurgling Wheezing Crackles Unequal	Normal oxygen saturation (>94%) Hypoxemia (<94%)

Circulation

Heart Rate and Rhythm	Pulses		Capillary Refill Time	Skin Color and Temperature	Blood Pressure
Normal Fast (tachycardia) Slow (bradycardia)	Central Normal Weak Absent	Peripheral Normal Weak Absent	Normal: ≤2 seconds Delayed: >2 seconds	Pallor Mottling Cyanosis Warm skin Cool skin	Normal Hypotensive

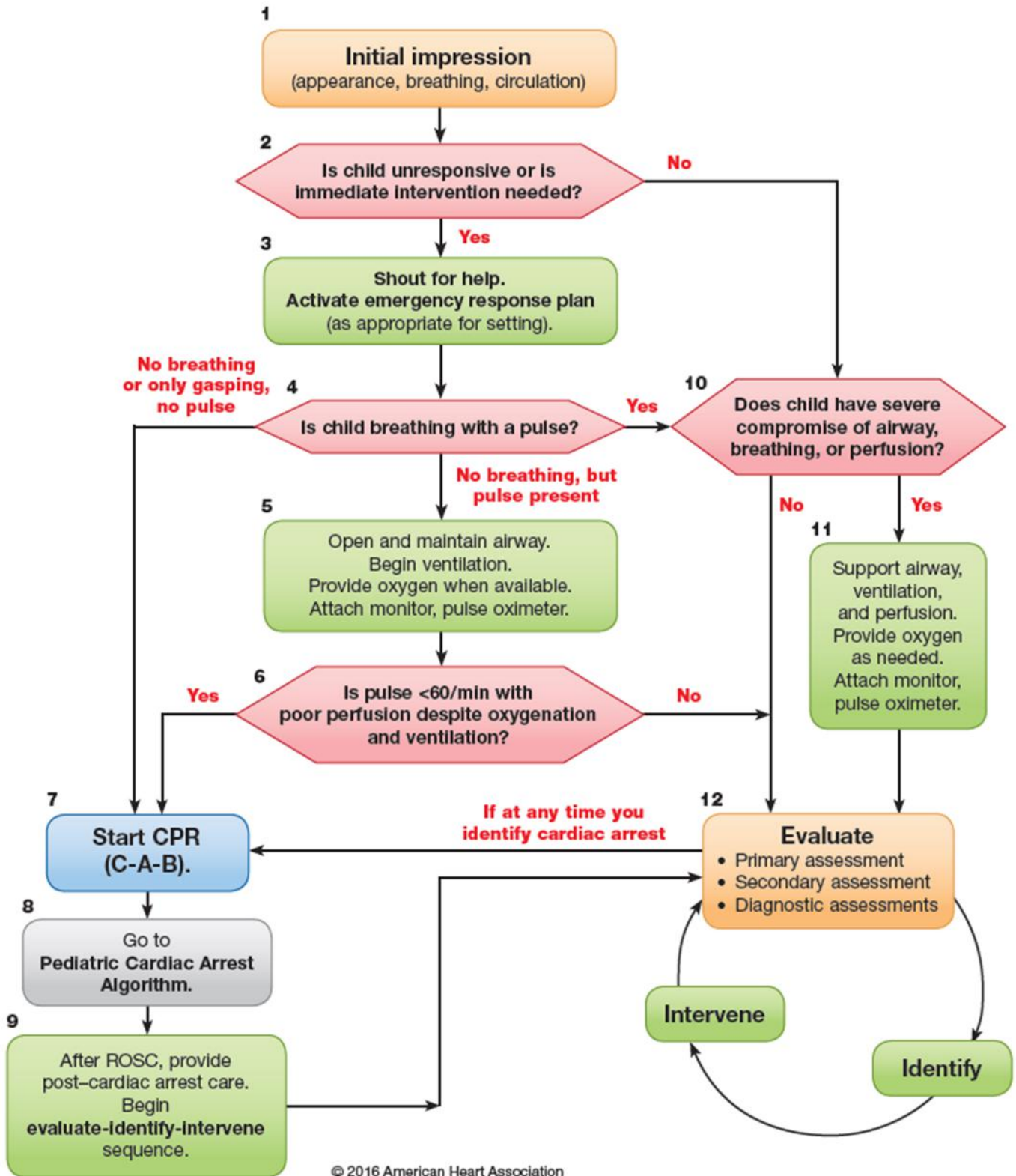
Disability

AVPU Pediatric Response Scale				Pupil Size Reaction to Light		Blood Glucose	
Alert	Responds to Voice	Responds to Pain	Unresponsive	Normal	Abnormal	Normal	Low

Exposure

Temperature			Skin	
Normal	High	Low	Rash (eg, purpura)	Trauma (eg, injury, bleeding)

PALS Systematic Approach Algorithm



Recognition of Respiratory Problems Flowchart

Pediatric Advanced Life Support Signs of Respiratory Problems				
Clinical Signs	Upper Airway Obstruction	Lower Airway Obstruction	Lung Tissue Disease	Disordered Control of Breathing
A Patency	Airway open and maintainable/not maintainable			
B Respiratory Rate/Effort	Increased			Variable
B Breath Sounds	Stridor (typically inspiratory) Barking cough Hoarseness	Wheezing (typically expiratory) Prolonged expiratory phase	Grunting Crackles Decreased breath sounds	Normal
B Air Movement	Decreased			Variable
C Heart Rate	Tachycardia (early)		Bradycardia (late)	
C Skin	Pallor, cool skin (early)		Cyanosis (late)	
D Level of Consciousness	Anxiety, agitation (early) Lethargy, unresponsiveness (late)			
E Temperature	Variable			

Pediatric Advanced Life Support Identification of Respiratory Problems by Severity	
Respiratory Distress	Respiratory Failure
Open and maintainable	Not maintainable
Tachypnea	Bradypnea to apnea
Work of breathing (nasal flaring/retractions) Increased effort	Decreased effort Apnea
Good air movement	Poor to absent air movement
Tachycardia	Bradycardia
Pallor	Cyanosis
Anxiety, agitation	Lethargy to unresponsiveness
Variable temperature	

Management of Respiratory Emergencies Flowchart

The Management of Respiratory Emergencies Flowchart summarizes general management of respiratory emergencies and specific management by etiology. Note that this chart does not include all respiratory emergencies; it provides key management strategies for a limited number of diseases.

Management of Respiratory Emergencies Flowchart		
<ul style="list-style-type: none"> • Airway positioning • Suction as needed • Oxygen • Pulse oximetry • ECG monitor (as indicated) • BLS as indicated 		
Upper Airway Obstruction Specific Management for Selected Conditions		
Croup	Anaphylaxis	Aspiration Foreign Body
<ul style="list-style-type: none"> • Nebulized epinephrine • Corticosteroids 	<ul style="list-style-type: none"> • IM epinephrine (or autoinjector) • Albuterol • Antihistamines • Corticosteroids 	<ul style="list-style-type: none"> • Allow position of comfort • Specialty consultation
Lower Airway Obstruction Specific Management for Selected Conditions		
Bronchiolitis	Asthma	
<ul style="list-style-type: none"> • Nasal suctioning • Bronchodilator trial 	<ul style="list-style-type: none"> • Albuterol ± ipratropium • Corticosteroids • Subcutaneous epinephrine • Magnesium sulfate • Terbutaline 	
Lung Tissue Disease Specific Management for Selected Conditions		
Pneumonia/Pneumonitis Infectious Chemical Aspiration		Pulmonary Edema Cardiogenic or Noncardiogenic (ARDS)
<ul style="list-style-type: none"> • Albuterol • Antibiotics (as indicated) • Consider CPAP 		<ul style="list-style-type: none"> • Consider noninvasive or invasive ventilatory support with PEEP • Consider vasoactive support • Consider diuretic
Disordered Control of Breathing Specific Management for Selected Conditions		
Increased ICP	Poisoning/Overdose	Neuromuscular Disease
<ul style="list-style-type: none"> • Avoid hypoxemia • Avoid hypercarbia • Avoid hyperthermia 	<ul style="list-style-type: none"> • Antidote (if available) • Contact poison control 	<ul style="list-style-type: none"> • Consider noninvasive or invasive ventilatory support

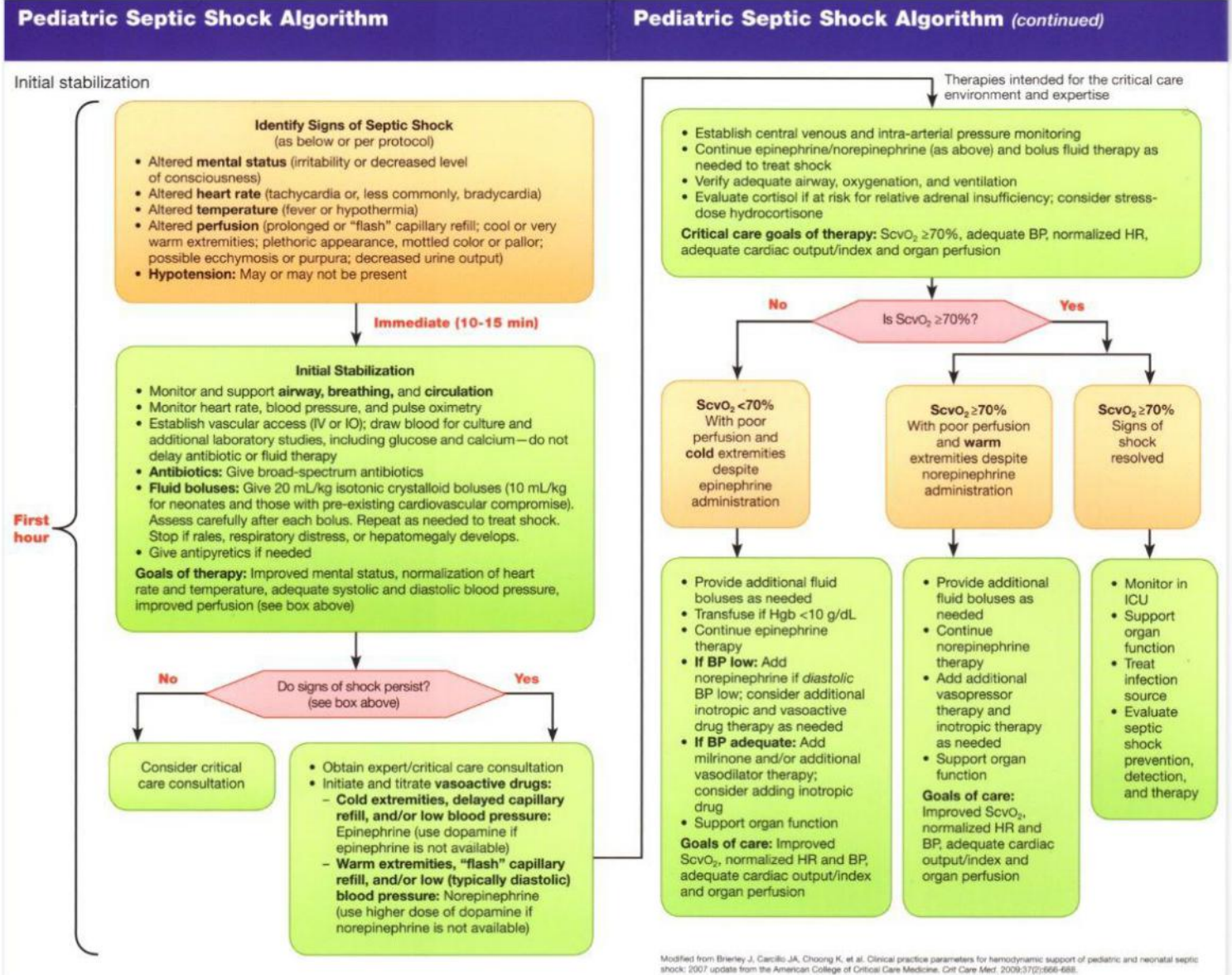
Recognition of Shock Flowchart

Clinical Signs		Hypovolemic Shock	Distributive Shock	Cardiogenic Shock	Obstructive Shock
A	Patency	Airway open and maintainable/not maintainable			
	Respiratory rate	Increased			
B	Respiratory effort	Normal to increased		Labored	
	Breath sounds	Normal	Normal (± crackles)	Crackles, grunting	
C	Systolic blood pressure	Compensated Shock → Hypotensive Shock			
	Pulse pressure	Narrow	Variable	Narrow	
	Heart rate	Increased			
	Peripheral pulse quality	Weak	Bounding or weak	Weak	
	Skin	Pale, cool	Warm or cool	Pale, cool	
	Capillary refill	Delayed	Variable	Delayed	
	Urine output	Decreased			
D	Level of consciousness	Irritable early Lethargic late			
E	Temperature	Variable			

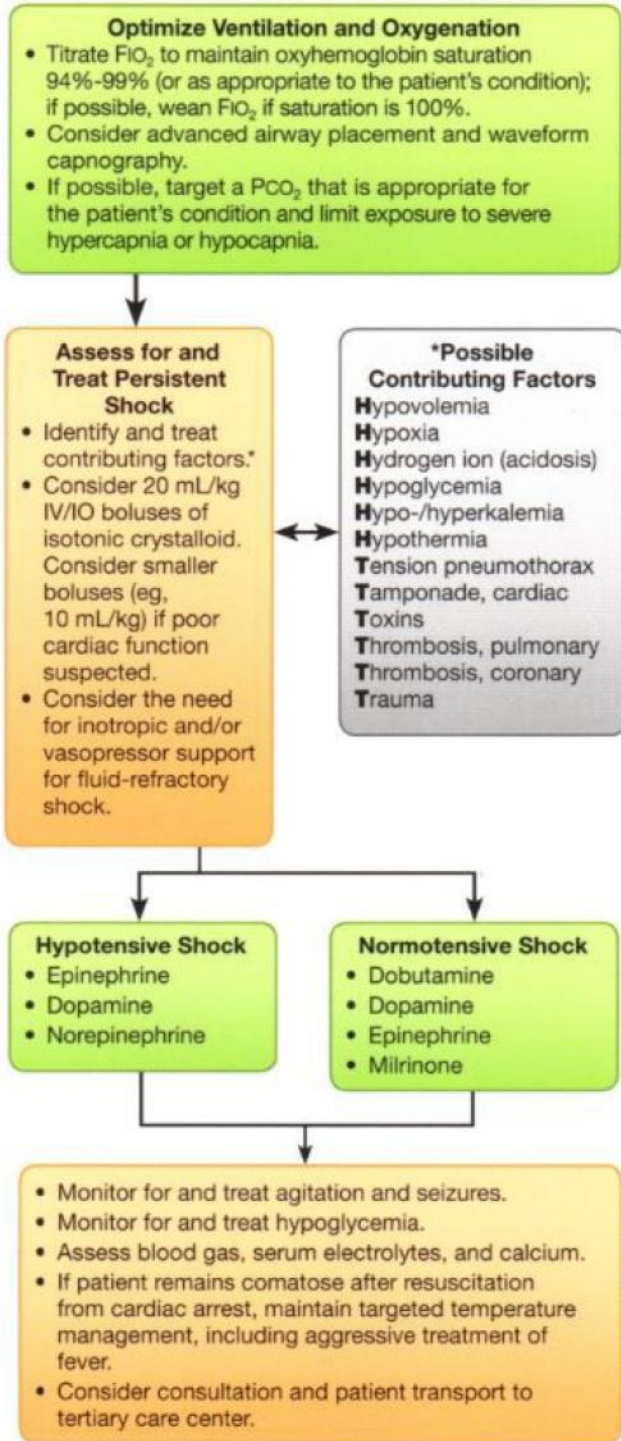
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Management of Shock Flowchart

Management of Shock Flowchart			
<ul style="list-style-type: none"> • Oxygen • Pulse oximetry • ECG monitor 		<ul style="list-style-type: none"> • IV/IO access • BLS as indicated • Point-of-care glucose testing 	
Hypovolemic Shock Specific Management for Selected Conditions			
Nonhemorrhagic		Hemorrhagic	
<ul style="list-style-type: none"> • 20 mL/kg NS/LR bolus, repeat as needed • Consider colloid 		<ul style="list-style-type: none"> • Control external bleeding • 20 mL/kg NS/LR bolus, repeat 2 or 3x as needed • Transfuse PRBCs as indicated 	
Distributive Shock Specific Management for Selected Conditions			
Septic	Anaphylactic	Neurogenic	
Management Algorithm: <ul style="list-style-type: none"> • Septic Shock 	<ul style="list-style-type: none"> • IM epinephrine (or autoinjector) • Fluid boluses (20 mL/kg NS/LR) • Albuterol • Antihistamines, corticosteroids • Epinephrine infusion 	<ul style="list-style-type: none"> • 20 mL/kg NS/LR bolus, repeat PRN • Vasopressor 	
Cardiogenic Shock Specific Management for Selected Conditions			
Bradyarrhythmia/Tachyarrhythmia		Other (eg, CHD, Myocarditis, Cardiomyopathy, Poisoning)	
Management Algorithms: <ul style="list-style-type: none"> • Bradycardia • Tachycardia With Poor Perfusion 		<ul style="list-style-type: none"> • 5 to 10 mL/kg NS/LR bolus, repeat PRN • Vasoactive infusion • Consider expert consultation 	
Obstructive Shock Specific Management for Selected Conditions			
Ductal-Dependent (LV Outflow Obstruction)	Tension Pneumothorax	Cardiac Tamponade	Pulmonary Embolism
<ul style="list-style-type: none"> • Prostaglandin E₁ • Expert consultation 	<ul style="list-style-type: none"> • Needle decompression • Tube thoracostomy 	<ul style="list-style-type: none"> • Pericardiocentesis • 20 mL/kg NS/LR bolus 	<ul style="list-style-type: none"> • 20 mL/kg NS/LR bolus, repeat PRN • Consider thrombolytics, anticoagulants • Expert consultation



PALS Management of Shock After ROSC Algorithm



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:**
40 mL per hour + 2 mL/kg per hour for each kg above 10 kg
Example: For a 15-kg child, estimated maintenance fluid rate
40 mL per hour
+ (2 mL/kg per hour × 5 kg)
= 50 mL per hour
- **Children >20 kg:** 60 mL per hour + 1 mL/kg per hour for each kg above 20 kg
Example: For a 28-kg child, estimated maintenance fluid rate
60 mL per hour
+ (1 mL/kg per hour × 8 kg)
= 68 mL per hour

After 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.

2020 American Heart Association Guidelines for CPR and ECC:
Pediatric Basic and Advanced Life Support

Just the Facts: Recap



High-quality CPR is the foundation of resuscitation.

- Make sure you have adequate compression rate and depth.
- Allow for full chest recoil.
- Minimize interruptions.



Give early epinephrine for patients in nonshockable rhythms.

- Early epinephrine in patients with nonshockable rhythms improves the likelihood of survival.



Use naloxone in opioid overdose.

- Naloxone will reverse only respiratory arrest due to opioid overdose.
- There is no evidence for use in cardiac arrest.

Airway Management



1. Aim for a rate of 20 to 30 breaths per minute.

Why? New guidelines suggest that this is the ideal rate for all infants and children receiving CPR with advanced airway in place or rescue breathing.



2. Do not underestimate bag-mask ventilation.

Why? For out-of-hospital cardiac arrest, bag-mask ventilation results in the same resuscitation outcomes as advanced airway interventions such as endotracheal intubation.



3. Consider a cuffed endotracheal tube.

Why? A cuffed endotracheal tube decreases the need for endotracheal tube changes.



4. Do not routinely use cricoid pressure.

Why? The routine use of cricoid pressure does not reduce the risk of regurgitation during bag-mask ventilation and may impede intubation success.

Post-Cardiac Arrest Care

Resuscitation does not end with ROSC.

For all, ensure prevention and treatment of



Hypotension



Hypercapnia and hypocapnia



Hyperoxia and hypoxia

For children who do not regain consciousness, consider



Targeted temperature management



Continuous EEG monitoring



Delaying prognosis decisions until at least 72 hours after return to normal temperature

After cardiac arrest, survivors can have physical, cognitive, and emotional challenges and may need ongoing therapies and interventions.



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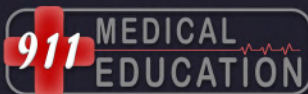


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