

Pediatric advanced Life Support: 2025

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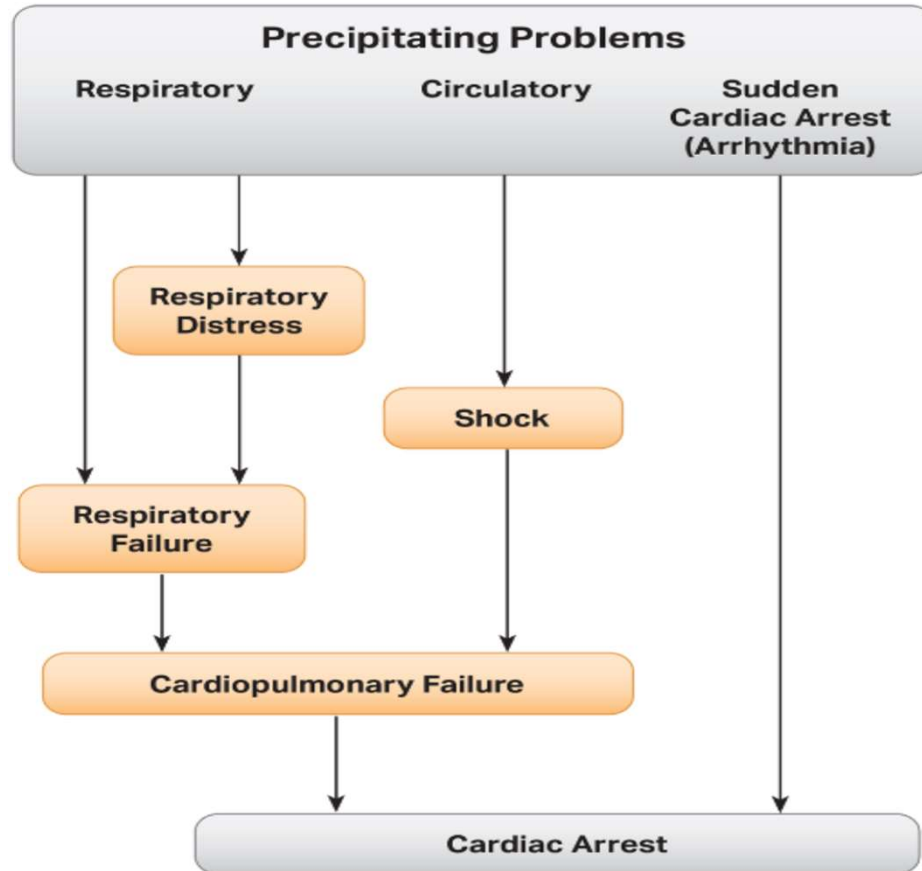
Pediatric intensivist



Figure 1. Cardiac arrest Chain of Survival.

CPR indicates cardiopulmonary resuscitation.

Recognizing and Managing Cardiac Arrest



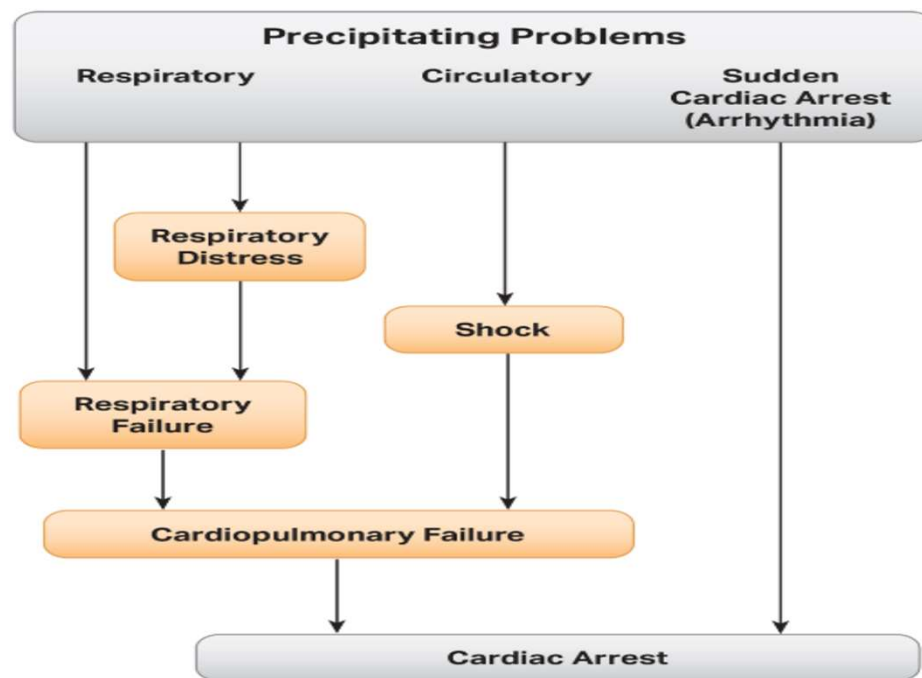
In infants and children:

- most cardiac arrests result from progressive respiratory failure, shock, or both.
- Less commonly, pediatric cardiac arrests can occur without warning (with sudden collapse) secondary to an arrhythmia (VF or VT).

About 5% to 15% of all pediatric in-hospital cardiac arrests (IHCAs) and out-of-hospital cardiac arrests (OHCAs). The incidence of cardiac arrest from VF/pVT increases with age and should be suspected in any patient with a sudden collapse.

shockable rhythm (VF or pVT) is the presenting rhythm in only about 14% up to 27% of pediatric in-hospital arrests.

Respiratory conditions may progress to respiratory failure with or without signs of respiratory distress when the child fails to maintain an open airway or adequate respiratory effort, typically because of a decreased level of consciousness.



- Once cardiac arrest occurs, even with optimal resuscitation efforts, the outcome is **generally poor** with significant neurologic impairment
- Cardiac arrest survival rates in the in-hospital setting are poor, and rates for the out-of-hospital setting are more dismal.
- The concepts in this course will help you identify signs of respiratory failure and shock and rapidly intervene to prevent progression to cardiac arrest.

Interventions

Activate the emergency response system as indicated in your practice setting and begin lifesaving interventions in the following circumstances:

- If the child has a life-threatening condition.
- If you are uncertain or “something feels wrong.”

Definition of Cardiac Arrest

- *Cardiac arrest* occurs when blood circulation ceases because of absent or ineffective cardiac mechanical activity.
- Clinically, the child is unresponsive and is not breathing or is only gasping, and you cannot detect a pulse.

Arrest rhythm may be noted on the cardiac monitor, but monitoring is not mandatory for recognizing cardiac arrest.

- Cerebral hypoxia causes the child to lose consciousness and stop breathing, although you may observe agonal gasps during the first minutes after sudden arrest.
- If a child is unresponsive and does not have normal breathing (or is only gasping), try to palpate a central pulse (brachial in an infant, carotid or femoral in a child). Because even health care professionals cannot always detect a pulse, take no more than 10 seconds to try to palpate the pulse. If there is no pulse felt or you are not sure if a pulse is present, start CPR, beginning with chest compressions.



Figure 4A. Pulse check. A, In an infant, feel for a brachial pulse.



Figure 4B. In a child, feel for a carotid pulse.



Figure 4C. Or, a femoral pulse.

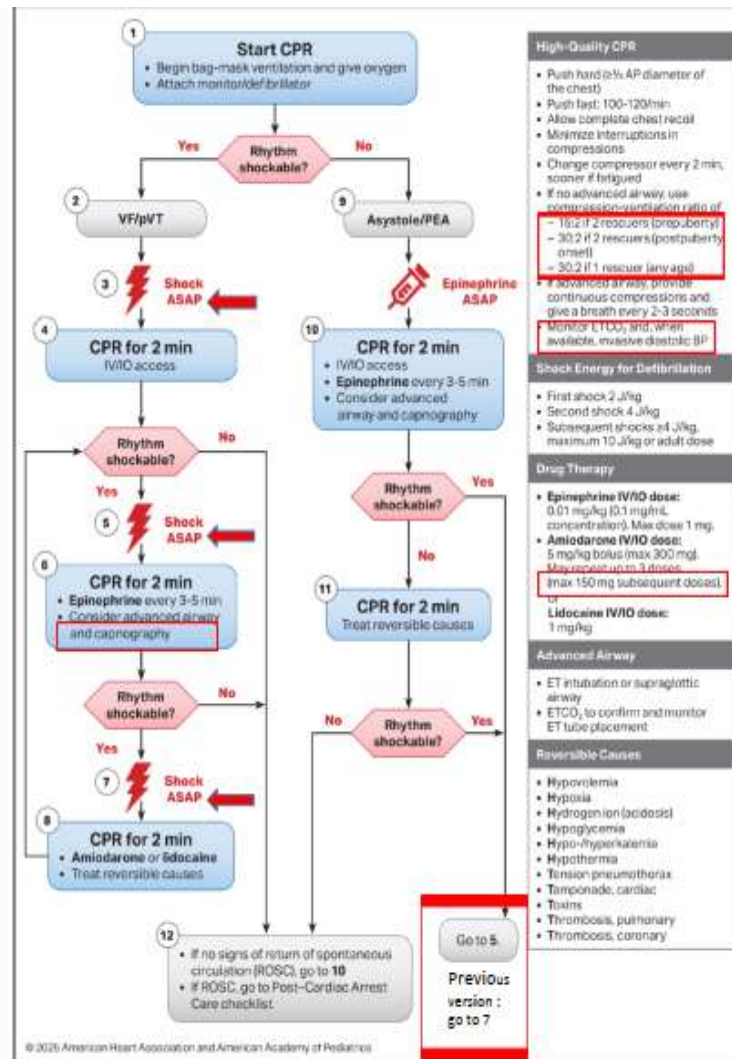


Figure 2. Pediatric Cardiac Arrest Algorithm.

Prioritize Airway and Breathing in Children in Cardiac Arrest

- In contrast to adults, infants and children usually arrest as the result of progression of respiratory failure or shock. As a result, the child's arterial oxygen content and oxygen delivery to the tissues are often low at the time of cardiac arrest.
- Although **C-A-B** sequence for CPR is used for **both adults and children**, establishing an adequate airway, along with adequate oxygenation and ventilation, should be a particularly high priority in children during CPR.

Arrest Rhythms

- Cardiac arrest is associated with one of the following rhythms, also known as *arrest rhythms* or *states*
- Asystole
- PEA
- VF
- pVT, including torsades de pointes

- Asystole and PEA are the most common initial rhythms seen in both pediatric IHCA and OHCA, especially in children younger than 12 years.
- Slow wide QRS complex rhythms that immediately precede asystole are often referred to as *agonal rhythms*
- VF and pVT are more likely terminal rhythms in older children with sudden collapse or in children with underlying cardiovascular conditions.

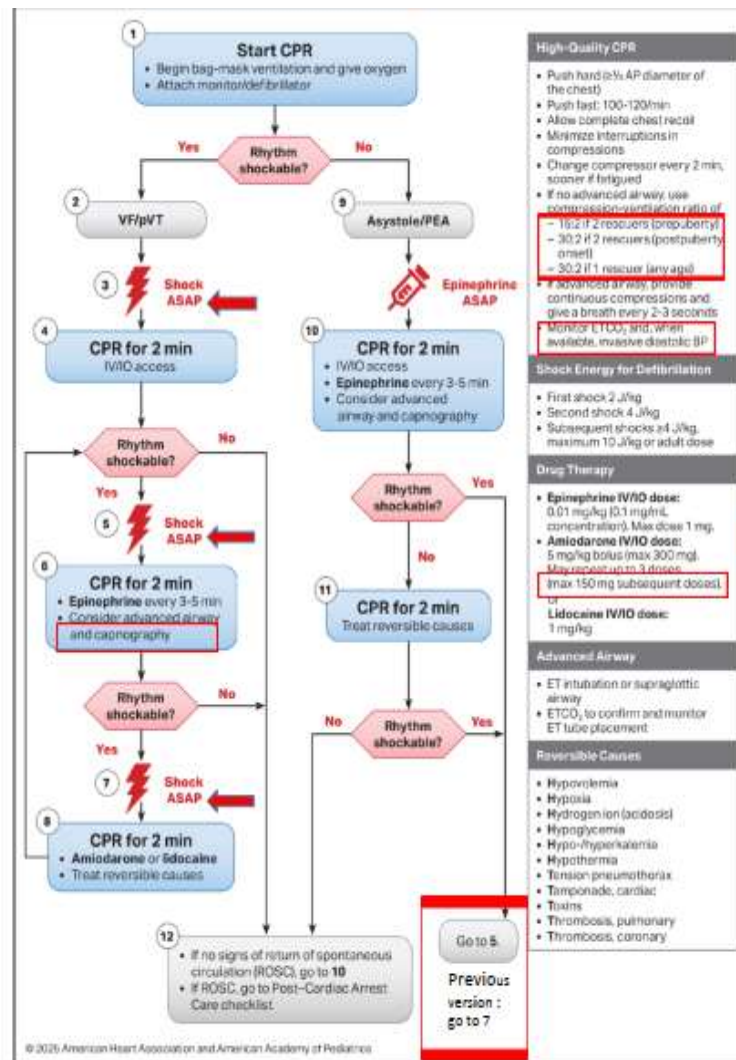


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Defibrillation

- A defibrillation shock “stuns” the heart by depolarizing a critical mass of the myocardium. If a shock is successful, it terminates VF/VT, which allows the heart’s natural pacemaker cells to resume an organized rhythm.
- When attempting defibrillation, provide compressions until the defibrillator is charged, deliver 1 shock, and immediately resume CPR, starting with chest compressions. Chest compressions are needed to maintain blood flow to the heart (the coronary circulation) and brain until effective cardiac contractility resumes.
- No evidence indicates that performing chest compressions in a child with spontaneous cardiac activity is harmful. When the rhythm has reverted to normal sinus rhythm, many patients have very poor contractility for the first 1 to 2 minutes following shock, requiring a minimum of 2 minutes of CPR.

Chest Compression Technique

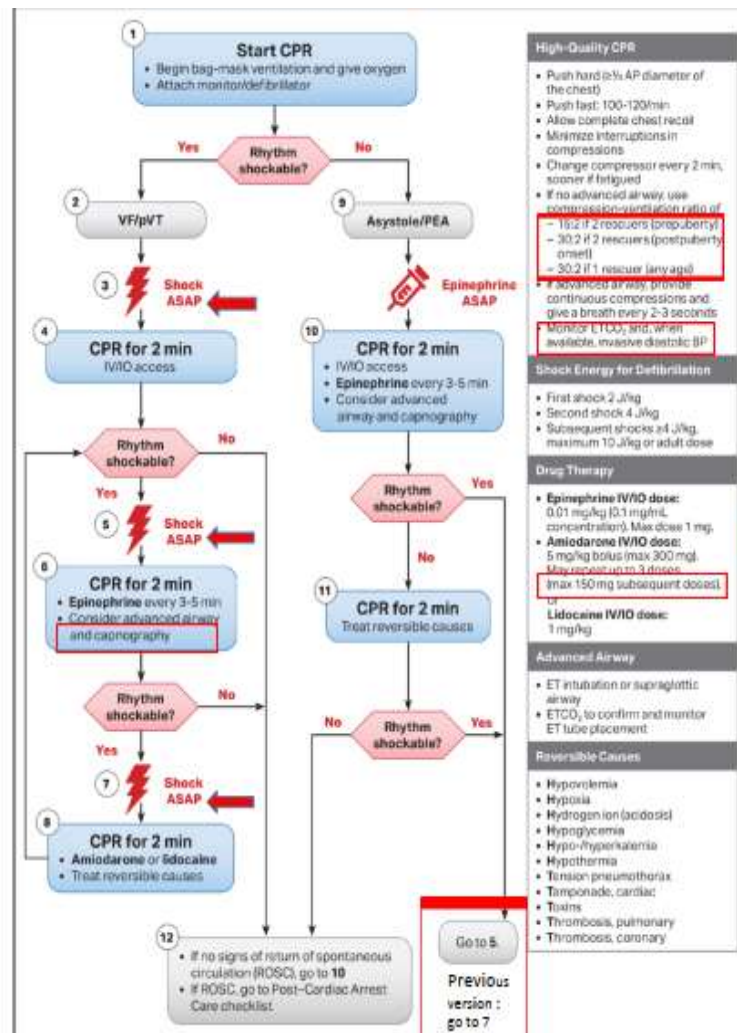
- For infants, rescuers should compress the sternum with the heel of 1 hand or by using the 2 thumb–encircling hands technique. If the rescuer cannot physically encircle the chest, it is recommended to compress the chest with the heel of 1 hand.
- For children, use either 1 or 2 hands to compress the chest, whichever technique allows the rescuer to achieve the desired compression depth



Figure 6. Two thumb–encircling hands technique for an infant.



Figure 5. Heel-of-1-hand chest compression technique for an infant.



Endotracheal route is not recommended

Vascular Access

- Priorities for medication delivery routes during PALS are (in order of preference)
 1. Intravenous
 2. Intraosseous
 3. Endotracheal

IV Route

- central venous access is not needed during the resuscitation attempts, and its placement requires interruptions in chest compressions. Trying to place the central catheter during chest compressions may cause vascular lacerations, hematomas, pneumothorax, and bleeding.

If a central venous catheter is already in place, it may be used, however the resistance makes pushing volumes more difficult. A **short large-bore IV** for volume administration may be preferable.

- Establishing peripheral venous access does not require interrupting CPR, but it may delay medication delivery to the central circulation. To improve medication delivery, do the following when administering medications into a peripheral IV catheter infusion system:
 - Give the medication by bolus injection if appropriate.
 - Give the medication while chest compressions are being performed; not during pulse checks.
 - Follow with a 5-mL flush of normal saline to move the medication from the peripheral to the central circulation.

IO Route

- If IV access is not available, medications and fluids can be delivered safely and effectively via the IO route. In fact, the IO route is useful as the initial route of vascular access in cases of cardiac arrest. Important points about IO access are
 - IO access can be established in all age groups
 - IO access can often be achieved in 30 to 60 seconds
 - The IO route is preferred over the ET route
 - Any medication or fluid that can be administered IV can be administered IO

ET Rout

- lipid-soluble medications can be given by the ET route. These include naloxone, atropine, vasopressin, epinephrine, and lidocaine (**NAVEL**).
- However, there are limited human studies about ET vasopressin administration and limited studies to provide dosing guidelines for most medications given by the ET route.
- When considering medication administration via the ET route during CPR, keep these concepts in mind:
 - Medication absorption from the tracheobronchial tree is unpredictable, so medication concentrations and medication effects will be unpredictable.
 - The optimal medication dose given by the ET route is unknown.

Medication administration into the trachea results in lower blood concentrations than the same dose given via IV or IO routes.

Animal data suggest that the lower epinephrine concentrations achieved when the medication is delivered by the ET route may produce transient but detrimental β -adrenergic-mediated vasodilation.

- Recommended medication doses administered by the ET route are higher than for the IV/IO route.
The recommended ET dose of epinephrine is 10 times the IV/IO dose.
Use epinephrine 0.1 mg/kg (1 mg/mL concentration).
The typical ET dose of other medications is 2 to 3 times the IV/IO dose.

- To give a medication by the ET route, administer it as follows:
 - Instill the medication into the ET tube (briefly pause compressions during instillation).
 - Follow with a minimum of 5 mL normal saline flush; a smaller volume may be used in neonates.
 - Provide 5 rapid positive-pressure breaths after the medication is instilled.

High-Quality CPR

- Push hard ($\geq \frac{1}{3}$ AP diameter of the chest)
- Push fast: 100-120/min
- Allow complete chest recoil
- Minimize interruptions in compressions
- Change compressor every 2 min, sooner if fatigued
- If no advanced airway, use compression-ventilation ratio of
 - 15:2 if 2 rescuers (prepuberty)
 - 30:2 if 2 rescuers (postpuberty onset)
 - 30:2 if 1 rescuer (any age)
- If advanced airway, provide continuous compressions and give a breath every 2-3 seconds
- Monitor ETCO_2 and, when available, invasive diastolic BP

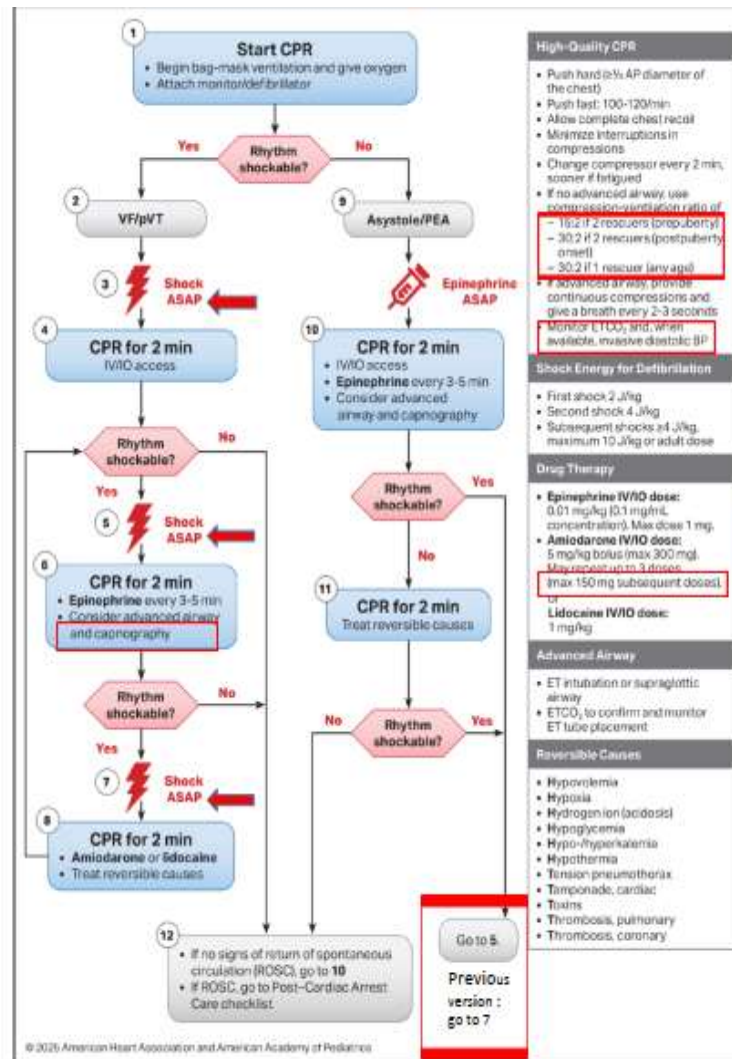


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Medication Therapy

The objectives for medication administration during cardiac arrest are to

- Increase coronary and cerebral perfusion pressures and blood flow
- Stimulate spontaneous or more forceful myocardial contractility
- Accelerate heart rate
- Correct and treat the possible cause of cardiac arrest
- Suppress or treat arrhythmias

Medications that may be used while treating pediatric cardiac arrest

- Epinephrine
- Atropine
- Lidocaine
- Amiodarone
- Magnesium sulfate
- Calcium
- Sodium bicarbonate

Other Agents			
Atropine	Indicated to treat bradycardia, especially if it results from excessive vagal tone, cholinergic medication toxicity (eg, organophosphates), or complete μAV block	Increases heart rate	- No published studies suggesting efficacy for treating cardiac arrest in pediatric patients - Refer to complete discussion in Part 10: Managing Arrhythmias
Calcium	- Routine use in cardiac arrest is not recommended - Indicated for documented ionized hypocalcemia (relatively common in critically ill children, particularly during sepsis or after cardiopulmonary bypass) and hyperkalemia, particularly in children with hemodynamic compromise - May also be considered for hypermagnesemia or calcium channel blocker overdose	- Restores calcium - Helps maintain the cell membrane action potential threshold - Helps maintain the gradient between intracellular potassium and extracellular sodium	Does not improve survival in cardiac arrest and may be harmful
Sodium bicarbonate	- Routine administration in cardiac arrest is not recommended - Recommended for symptomatic patients with hyperkalemia, tricyclic antidepressant overdose, diphenhydramine, or an overdose of other sodium channel blocking agents	- Helpful in treating arrhythmias due to sodium channel blockers such as tricyclic or diphenhydramine overdose - Rapidly reduces potassium concentrations in hyperkalemia	Does not improve survival in cardiac arrest

reversible condition

Cardiac arrest in children may be associated with a reversible condition.

If you don't think about reversible causes or complicating factors, you are likely to miss them.

H's

- Hypovolemia
- Hypoxia
- Hydrogen ion (acidosis)
- Hypoglycemia
- Hypo-/hyperkalemia
- Hypothermia

T's

- Tension pneumothorax
- Tamponade (cardiac)
- Toxins
- Thrombosis, pulmonary or coronary

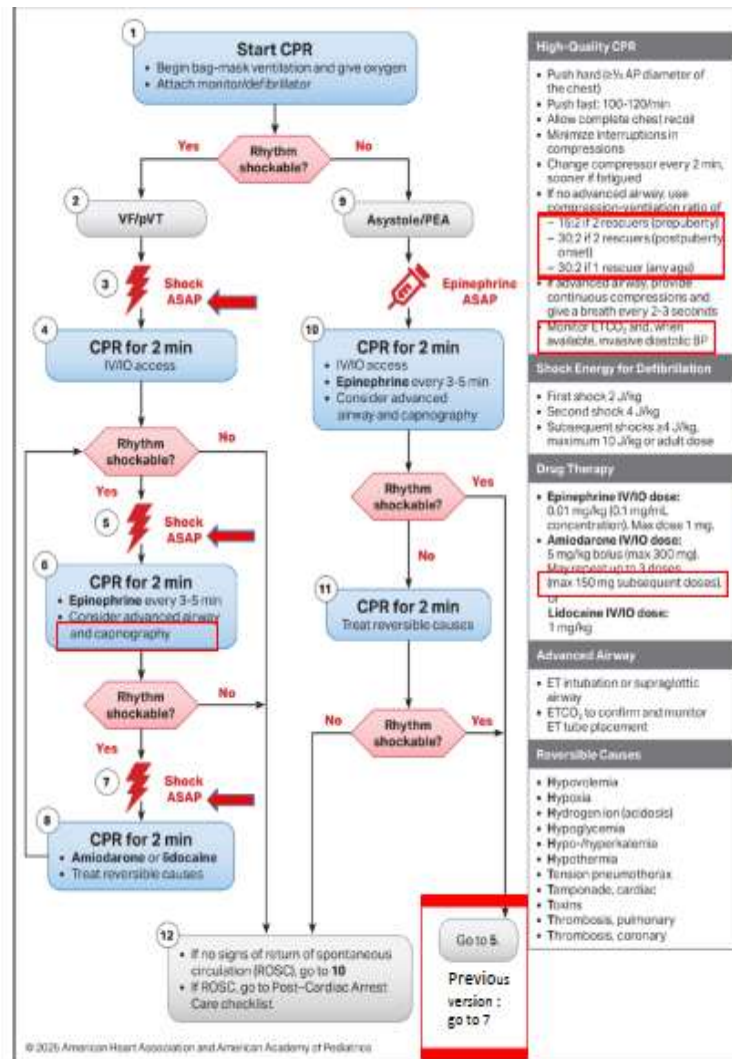


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Advanced Airway Management

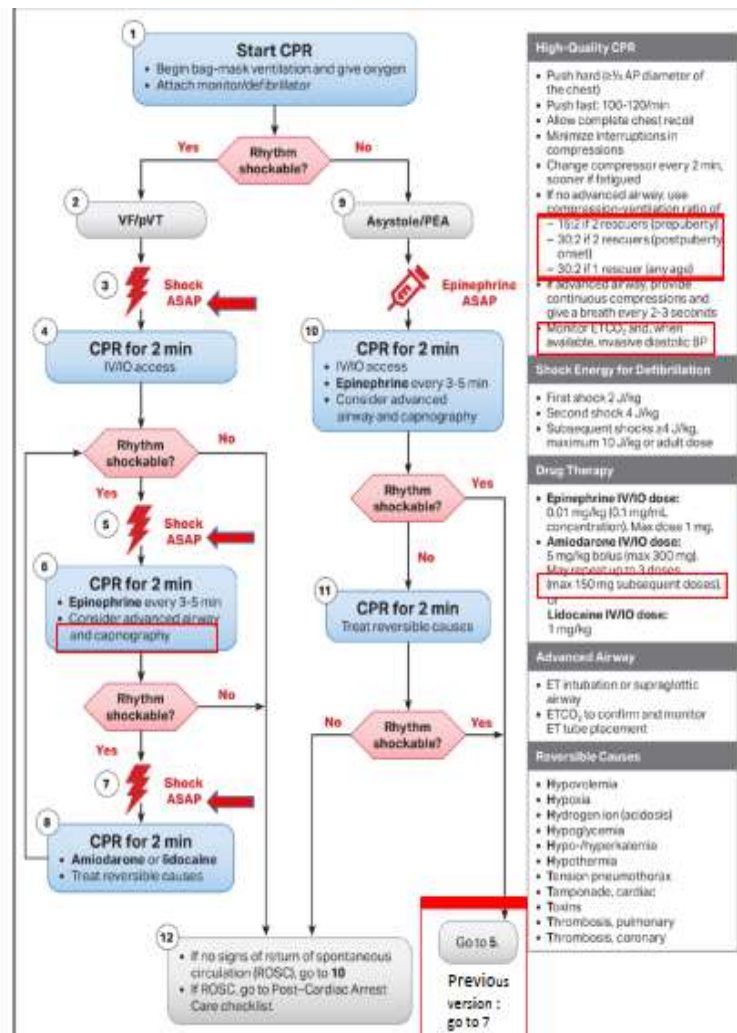
- An advanced airway (ET tube, SGA) can be placed during CPR. However, in a study of OHCA, ET intubation demonstrated no survival advantage over effective **bag-mask ventilation** when emergency medical services transport time was short, and health care professionals had **limited ongoing experience in pediatric intubation**. This study does not address ET intubation in the in-hospital setting but suggests that immediate intubation may not be necessary.

managing the airway and ventilation in pediatric patients of cardiac arrest, consider the following:

- Avoid excessive ventilation during resuscitation.

Excessive ventilation can be harmful because it impedes cerebral perfusion, venous return and decreases cardiac output and coronary perfusion pressure, gastric distention and increases the risk of regurgitation and aspiration

- When providing ventilation with a bag and mask (in cycles of 15 compressions and 2 breaths for 2 rescuers), give each breath over 1 second and provide just enough volume to make the chest rise.
- When providing ventilation via an advanced airway during CPR, provide 1 breath every 2 to 3 seconds (20-30 breaths/min) without pausing chest compressions. Chest compressions are delivered without interruption at a rate of 100 to 120/min.



Endotracheal route is not recommended

Return of Spontaneous Circulation

- The immediate goal of therapeutic interventions for cardiac arrest is **ROSC**, which occurs when an organized cardiac electrical rhythm on the monitor and palpable central pulses resume. Corresponding clinical evidence of perfusion will also be apparent(eg, sudden increase in end-tidal CO₂ [PETCO₂], measurable blood pressure, improved color).

Post-Cardiac Arrest Care