PALS

American Heart Association®

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

# Pediatric Advanced Life Support

PROVIDER MANUAL

Professional

## Advanced Airway Management

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

- Avoid excessive ventilation during resuscitation.
  - Excessive ventilation can be harmful because it impedes venous return and decreases cardiac output.
  - Increased intrathoracic pressure from positive-pressure ventilation also elevates right atrial pressure and thus reduces coronary perfusion pressure.
  - When ventilating with a mask (in cycles of 15 compressions and 2 breaths), give each breath over 1 second and provide just enough volume to make the chest rise.
  - Excessive tidal volume or pressure during bag-mask ventilation may distend the stomach. Gastric distention impedes ventilation and increases the risk of aspiration.
- Avoid routine use of cricoid pressure if it interferes with intubation or ventilation.
- Use waveform capnography or capnometry to confirm and monitor ET tube placement.
- Colorimetric exhaled $CO_2$ devices may fail to detect the presence of exhaled $CO_2$ (ie, lack of a color change indicates no $CO_2$ detected) during cardiac arrest despite correct placement of the ET tube. Use direct laryngoscopy to confirm tube placement if exhaled $CO_2$ is not detected and there is evidence that the tube is in the trachea (eg, chest rise and bilateral breath sounds).
- When providing ventilations via an ET tube during CPR, provide 1 breath every 6 to 8 seconds (8 to 10 breaths/min) without pausing chest compressions. Chest compressions are delivered without interruption at a rate of at least 100/min. For more details see "Insertion of an Advanced Airway During CPR" later in this Part.

An advanced airway (eg, ET tube) can be placed during CPR. However, in a study of out-of-hospital cardiac arrest when emergency medical services (EMS) transport time was short and providers had limited ongoing experience in pediatric intubation, there was no demonstrated survival advantage of ET intubation over effective bag-mask ventilation. This study does not address ET intubation in the in-hospital setting but suggests that immediate intubation may not be necessary. For more details see Gausche et al, 2000 (full reference in the Suggested Reading List at the end of this Part).

## Pediatric Cardiac Arrest Algorithm

The Pediatric Cardiac Arrest Algorithm (Figure 7) outlines assessment and management steps for an infant or child in cardiac arrest who does not respond to BLS interventions. The Pediatric Cardiac Arrest Algorithm is based on expert consensus. It is designed to maximize uninterrupted periods of CPR while enabling efficient delivery of electrical therapy and medications as appropriate. Although the actions are listed sequentially, when several rescuers are involved, some actions will occur simultaneously.

Step numbers in the text below refer to the corresponding steps in the algorithm. The algorithm consists of 2 pathways, depending on the cardiac rhythm as seen on a monitor or interpreted by an AED:

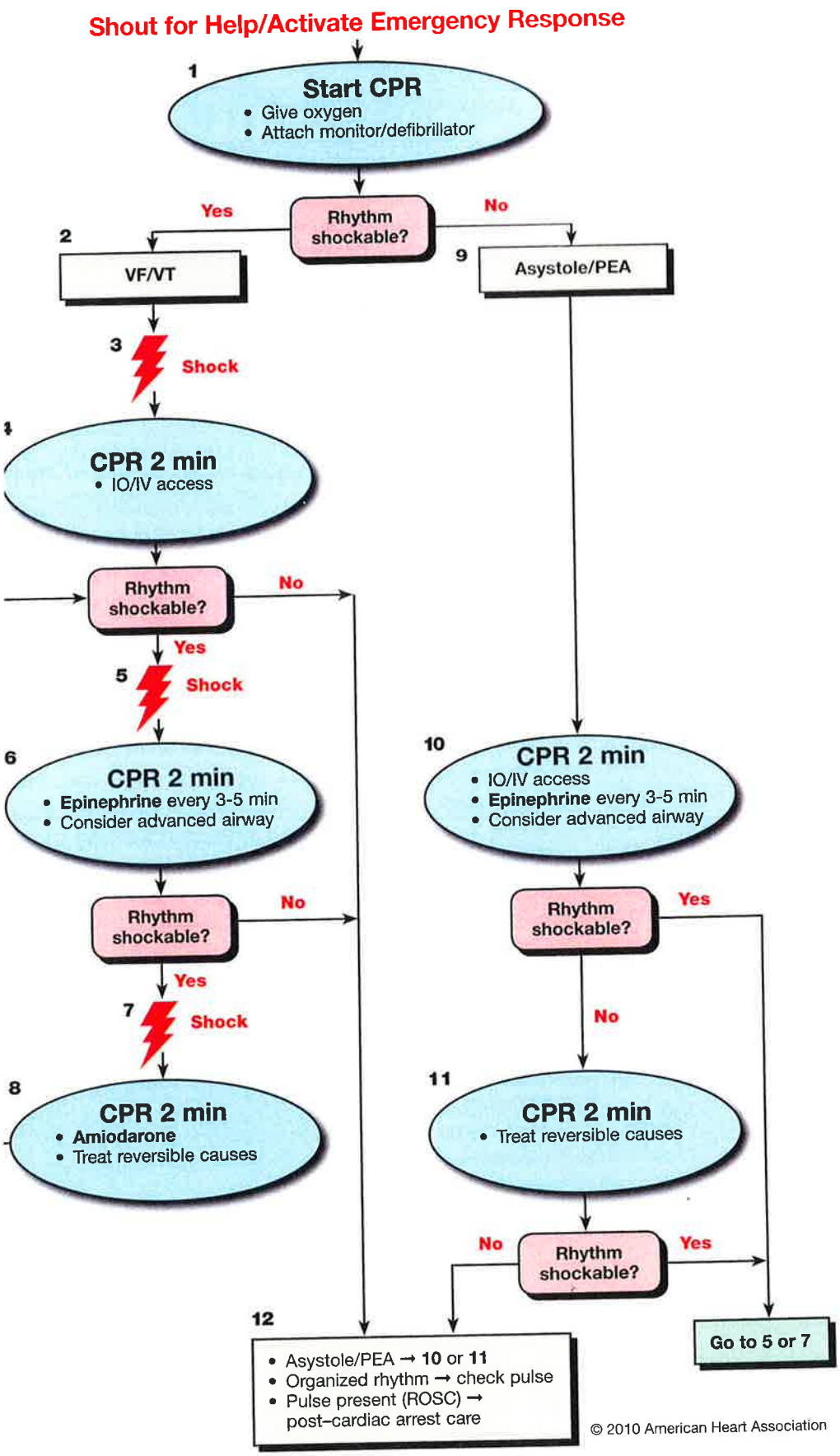
- A shockable rhythm (VF/VT) pathway is displayed on the left side of the algorithm.
- A nonshockable rhythm (asystole/PEA) pathway is displayed on the right side of the algorithm.

**Critical Concept**

**Coordination of Team Members During Resuscitation**

Using the Pediatric Cardiac Arrest Algorithm, providers should structure assessments and interventions around 2-minute periods of uninterrupted high-quality CPR. This requires organization so that every member of the team knows his or her responsibilities. When all team members are familiar with the algorithm, they can anticipate and prepare for the next steps, getting equipment ready and drawing up the proper doses of medications. Chest compressors should rotate about every 2 minutes.

## Pediatric Cardiac Arrest




### 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-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**
- **H**ypovolemia
- **H**ypoxia
- **H**ydrogen ion (acidosis)
- **H**ypoglycemia
- **H**ypo-/hyperkalemia
- **H**ypothermia
- **T**ension pneumothorax
- **T**amponade, cardiac
- **T**oxins
- **T**hrombosis, pulmonary
- **T**hrombosis, coronary

**Figure 7.** Pediatric Cardiac Arrest Algorithm.

### Start CPR (Step 1)

As soon as the child is found to be unresponsive with no breathing (or only gasping), shout for help and activate emergency response, send for a defibrillator (manual or AED), check a pulse, and start CPR, beginning with chest compressions. Attach the ECG monitor or AED pads as soon as they are available. Throughout resuscitation, provide high-quality CPR (give chest compressions of adequate rate and depth, allow complete chest recoil after each compression, minimize interruptions in compressions, and avoid excessive ventilation). Use a compression-ventilation ratio of 30:2 for 1 rescuer and 15:2 for 2 rescuers. Administer $O_2$ with ventilations as soon as it is available.

Once the monitor/defibrillator is attached, check the rhythm. Determine whether the rhythm is shockable (VF/VT) or nonshockable (asystole/PEA). If the rhythm is shockable, follow the left side of the algorithm.

### Shockable Rhythm: VF/VT (Step 2)

If the rhythm is shockable, deliver 1 unsynchronized shock (Step 3). Perform CPR while the defibrillator is charging, if possible. The shorter the interval is between the last compression and shock delivery, the higher the potential shock success (elimination of VF) will be. Therefore, try to keep that interval as short as possible, ideally <10 seconds. Immediately after shock delivery, resume high-quality CPR, beginning with chest compressions. In a monitored setting this approach may be modified at the provider's discretion.

If the resuscitation takes place in a critical care setting and the child has intra-arterial monitoring in place, the presence of a waveform with an adequate arterial pressure can be useful in identifying ROSC. In other settings that determination will be made after about 2 minutes of CPR during the next rhythm check. A sharp increase in the exhaled $CO_2$ pressure ($P_{ETCO_2}$) can also indicate ROSC.

Defibrillation devices for children are the

- AED (able to distinguish pediatric shockable from nonshockable rhythms and ideally equipped with a pediatric dose attenuator)
- Manual cardioverter/defibrillator (capable of variable shock doses)

Institutions that care for children at risk for arrhythmias and cardiac arrest (eg, hospitals, emergency departments) ideally should have defibrillators available that are capable of energy adjustment appropriate for children.

### *AED*

AEDs are programmed to evaluate the child's ECG to determine if a shockable rhythm is present, charge to a predetermined dose, and prompt the rescuer to deliver a shock. The AED provides voice and visual prompts to assist the operator. Many, but not all, AED algorithms have been shown to be sensitive and specific for recognizing shockable arrhythmias in children. Many are equipped with pediatric pad-cable systems that attenuate the adult dose to deliver a smaller energy dose appropriate for children. These dose attenuators should be used for children <8 years of age and less than about 25 kg in weight.

| Weight/Age | AED Energy Dose |
|---|---|
| ≥25 kg (≥8 years) | • Standard "adult" AED with adult pad-cable system |
| <25 kg (≥1 year and <8 years) | • AED with attenuated dose if available<br>• AED with adult system if pediatric dose attenuator is not available |
| <1 year | • Manual defibrillator if available<br>• AED with pediatric dose attenuator if manual defibrillator not available<br>• AED with adult system if neither of the above is available |

### *Manual Defibrillator*

The optimal electrical energy dose for pediatric defibrillation is unknown. For manual defibrillation, an initial dose of 2 to 4 J/kg is acceptable, and for ease of teaching a 2 J/kg (biphasic or monophasic waveform) may be considered. If VF or pulseless VT persists at the next rhythm check, deliver a dose of 4 J/kg for the second shock. If VF persists after the second shock, use at least 4 J/kg or higher, not to exceed 10 J/kg or the maximum adult dose. Successful resuscitation using shock doses up to 9 J/kg have been reported in children.

You can use either self-adhesive electrode pads or paddles to deliver shocks with a manual defibrillator. Self-adhesive pads are preferred because they are easy to apply and reduce the risk of current arcing. They also can be used to monitor the heart rhythm. If you use paddles, apply a conducting gel, cream, paste, or an electrode pad between the paddle and the child's chest to reduce transthoracic impedance. Do not use saline-soaked gauze pads, sonographic gels, or alcohol pads. Alcohol pads may pose a fire hazard and cause chest burns.

See the Critical Concept box "Manual Defibrillation" later in this Part for the universal steps for operating a manual defibrillator.

### Paddles/Pads

Use the largest paddles or self-adhering electrode pads that will fit on the chest wall without contact between the pads. Recommended paddle sizes are based on the child's weight/age.

| Weight/Age | Paddle Size |
|---|---|
| >10 kg (approximately 1 year or older) | Large "adult" paddles (8 to 13 cm) |
| <10 kg (<1 year) | Small "infant" paddles (4.5 cm) |

*Note:* The selection of pediatric pads versus adult pads is manufacturer specific. Refer to package instructions to determine the appropriate size.

Place the paddles/electrode pads so that the heart is between them. Place one paddle/electrode pad on the upper right side of the victim's chest below the right clavicle and the other to the left of the left nipple in the anterior axillary line directly over the heart. Allow at least 3 cm between paddles; when pads are used, place them so they don't touch. When using paddles, apply firm pressure to create good contact with the skin.

Modifications may be required in special situations (eg, if the child has an implanted defibrillator).

### Clearing for Defibrillation

To ensure the safety of rescuers during defibrillation, perform a visual check of the child and the resuscitation team just before you deliver a shock. Make sure that high-flow $O_2$ is not directed across the child's chest. Warn others that you are about to deliver a shock and that everyone must stand clear. State a "warning chant" firmly and in a forceful voice before delivering each shock (this entire sequence should take <5 seconds). See the Critical Concept box "Manual Defibrillation."

### Resume CPR, Establish IV/IO Access (Step 4)

Immediately after the shock, resume CPR, beginning with chest compressions. Give about 2 minutes of CPR. (For 2 rescuers this will be about 10 cycles of 15 compressions followed by 2 ventilations.) While CPR is being performed, if vascular access (IO or IV) is not already present, another member of the resuscitation team should establish vascular access in anticipation of the need for medications.

Before the rhythm check the team leader should ensure that the team is prepared to do the following:

- Rotate compressors.
- Calculate appropriate shock dose to administer if VF/pulseless VT persists.
- Prepare drugs for administration if indicated.

### Check Rhythm

After 2 minutes of CPR, check the rhythm. *Try to limit interruptions in CPR to <10 seconds for a rhythm check.*

This rhythm check may indicate the following outcomes from the previous shock and CPR:

- Termination of VF/VT to a "nonshockable" rhythm (asystole, PEA, or an organized rhythm with a pulse)
- Persistence of a shockable rhythm (VF/VT)

**FYI**

**Anterior-Posterior Pad Placement**

Some defibrillator manufacturers recommend placement of self-adhesive electrode pads in an anterior-posterior position, with one over the victim's heart and the other over the back. Anterior-posterior placement may be necessary in an infant, particularly if only large electrode pads are available.

Place the electrode pads according to the recommendations of the defibrillator manufacturer. These are typically illustrated on the pads themselves.