# M06: Pediatrics - Cardiac Arrest

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## Introduction

Pediatric cardiac arrest is a rare event. Most pediatric cardiac arrests occur in children younger than one year of age, and 90% occur secondary to hypoxia due to respiratory failure. There are many rare causes of pediatric cardiac arrest including sudden infant death syndrome (SIDS), submersion or drowning, trauma, and sepsis. In contrast to cardiac arrest in adults, cardiopulmonary arrest in infants and children is rarely a sudden event, and does not often result from a primary cardiac cause. In cases of sudden collapse in older pediatric patients and patients with congenital heart disease, a primary cardiac cause should be considered.

## Essentials

- Prepare, in advance, any calculations that may be necessary to provide care for pediatric patients. A Broselow tape, the BCEHS Handbook, and many other tools are available that can simplify this process.
- Recognize that in the majority of cases, respiratory failure is the primary cause of cardiac dysfunction. Focus on adequate oxygenation and ventilation.
- Be aware that these are some of the most stressful types of prehospital events. Pre-arrival planning, and effective crew resource management, are essential for ensuring an organized approach and high quality CPR.
- High quality CPR, appropriate ventilation, timely vascular access, and a moderate scene time (10 to 35 minutes) are proven elements that improve survival from cardiac arrest with good outcomes.
- Resuscitation and cardiac emergencies for neonates (<28 days of age) differ in approach than that for older patients. See CPG M11 and CPG M13 for additional information.
- When an infant or child is found without a pulse, treatment should first be directed towards adequate ventilation and oxygenation, and maintenance of circulation by chest compression.
- Commotio cordis (cardiac concussion) refers to blunt, non-penetrating, precordial chest impact that causes arrhythmia or sudden death without evidence of cardiac injury. It is from low-impact trauma, and significant signs of trauma are usually not found.

## Additional Treatment Information

- Once oxygenation and high quality CPR have been established all infants and children in cardiac arrest should have a defibrillator attached to determine if a shockable rhythm is present. If there is a history of blunt trauma to the chest, electrocution, or the patient has a cardiac history, oxygen and CPR are still the priority, but paramedics should apply the AED with greater urgency as these patients may be more likely to demonstrate a shockable rhythm.
- If ventricular fibrillation is demonstrated, defibrillation should be attempted as soon as possible.
- Rhythm analysis and defibrillation are appropriate for all pediatric cardiac arrests regardless of age. A manual defibrillator is preferred for infants less than 1 year of age however if not available an AED with a pediatric attenuator is appropriate.
- An AED with a pediatric attenuator is preferred for children less than 8 years of age. If neither a manual defibrillator nor an AED with pediatric attenuator is available, an AED without a dose attenuator may be used for any pediatric cardiac arrest.
- AEDs that deliver relatively high energy doses have been used in infants with minimal myocardial damage and good neurological outcomes
- For pulseless ventricular tachycardia, or ventricular fibrillation, an initial dose of 2 J/kg is indicated when using manual defibrillators. If the initial shock fails and the patient is not hypothermic perform defibrillation at 4 J/kg.
- Drugs and advanced airways do not affect outcomes of pediatric cardiac arrest. While still indicated, time and priorities should focus on high quality CPR, ventilation and defibrillation if indicated. Do not stay on scene to justify intubating or providing drugs.
- For patients whose cardiac arrest is a result of traumatic injuries, rapid transport to a trauma center is the most important treatment. En route management and early notification to a receiving facility are the major prehospital

contributors to patient survival. In penetrating trauma, particularly penetrating chest trauma, a small percentage of patients can survive a cardiac arrest with early emergency thoracotomy. These are almost always patients who have demonstrated at least some signs of life in the prehospital setting.

- Needle decompression: in the setting of blunt traumatic cardiac arrest, bilateral needle decompression is appropriate any time the patient is in pulseless electrical activity.
  - Bilateral decompression is used because of the unreliable clinical examination in this patient subset
  - Assume a tension pneumothorax is present in all cases of cardiac arrest with penetrating chest trauma

## Referral Information

All pediatric cardiac arrest patients with ROSC require emergency transport to hospital. Pediatric patients with a prolonged pulseless condition should be discussed with CliniCall. Non-viable or futile cases should also be discussed with CliniCall.

## General Information

- Bystander CPR plus early defibrillation can more than double the rate of survival from out of hospital cardiac arrest. As such, paramedics should perform full resuscitation in settings where first responder or bystander CPR has been initiated unless obvious signs of death are present.
- Although survival from asystole or pulseless electrical activity is rare, patients who receive immediate, high quality CPR occasionally survive.
- Asystole in cardiac arrest is usually an ominous prognostic sign indicating prolonged hypoperfusion and myocardial ischemia with deterioration to asystole from more treatable dysrhythmias. Asystole must be confirmed in two or more leads.
- Pulseless electrical activity is evidence of organized electrical activity on the ECG without effective myocardial contraction. Patients with wide complex PEA rhythms usually have poor survival and there are often indications of severe malfunction of the myocardium or cardiac conduction system. There are numerous possible causes of PEA, some of which are amenable to pre-hospital treatment. Paramedics should follow a step-wise approach to identifying and treating reversible causes of PEA.
- Special consideration must be given to hypothermic patients without a pulse. As hypothermia progresses, the patient's respiratory and heart rate slow significantly. For this reason, breathing and pulse checks must be sufficiently long (60 seconds) to register very slow rates.
  - "Circum-rescue collapse" is a term that describes a death that occurs shortly before, during, or soon after rescue from exposure to a cold environment, usually cold water immersion. It often presents as an apparently stable, conscious patient who suffers ventricular fibrillation and cardiac arrest shortly thereafter.
  - A patient with a core body temperature below 30°C will most likely develop arrhythmias with progression to ventricular fibrillation.
  - Medications are more slowly metabolized in hypothermic patients; toxic levels of medications may accumulate if normal dosing regimens are used, therefore, prolong repeat times to twice the normal interval and limit vasopressors to a maximum of 3 doses.
- The most common causes of traumatic cardiac arrest include:
  - Hypoxemia from airway obstruction and hypoventilation
  - Obstructive shock resulting from cardiac tamponade or pneumothorax
  - Hemorrhagic shock, from any source of major hemorrhage
  - Myocardial contusions cause dysrhythmias, perforation, valve rupture
  - Electrical shock produces a fall; ventricular fibrillation may also be present

## Interventions

### First Responder

- Ensure high performance CPR and appropriate ventilation
  - → PR06: High Performance CPR
  - → B01: Airway Management
    - Most pediatric airways can be effectively managed with proper positioning and an OPA/NPA and BVM

and will not require further airway interventions. The gold standard for airway management is a self-maintained airway. Bag-valve mask is the preferred technique for airway management in pediatric resuscitation, and is reasonable compared with advanced airway interventions (endotracheal intubation or supraglottic airway) in the management of children during cardiac arrest in the out-of-hospital setting.

- → A07: Oxygen and Medication Administration

- Apply AED and follow prompts
- Communicate clinical scenario to follow-on personnel

**Emergency Medical Responder – All FR interventions, plus:**

- Investigate for precipitating cause
- Ensure scene time is no less than 10 minutes and no greater than 35 minutes
- Contact CliniCall for guidance
- Seek ACP/CCP assistance
- Low mechanism blunt trauma: CPR according to medical guidelines
- Penetrating trauma or high mechanism blunt trauma:
  - Immediately prepare for rapid transport and CPR
  - Control life threatening bleeding while facilitating transport
  - Direct pressure to sites of obvious ongoing blood loss
  - Rapid application of tight tourniquet for catastrophic extremity injury with ongoing large volume blood loss

**Primary Care Paramedic – All FR and EMR interventions, plus:**

- Consider vascular access for reversible causes
  - → D03: Vascular Access
    - All IV starts on a child < 12 years requires prior pediatric IV training and CliniCall consult

**Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:**

- Attach monitor and evaluate rhythm
- Establish vascular access
  - → PR12: Intraosseous Cannulation
- Ventricular fibrillation or ventricular tachycardia
  - Defibrillate 2 J/kg, repeat at 4 J/kg
  - EPINEPHrine
  - Amiodarone
  - Lidocaine
- Pulseless electrical activity or asystole:
  - EPINEPHrine
  - Consider treatable causes
- Bradycardia:
  - Bradycardia with poor cardiac output requires chest compressions if the heart rate is less than 60 and signs of poor perfusion are present. Signs of poor perfusion include cyanosis, mottling, decreased level of consciousness, and lethargy.
  - Consider normal saline bolus 20 mL/kg IV/IO
  - Consider EPINEPHrine
  - Consider pacing (Requires CliniCall consult)
    - → PR19: Transcutaneous Pacing
- Hyperkalemia, Torsades de Pointes, or suspected acidosis:
  - Sodium bicarbonate
  - Hypoglycemia
    - → E01: Hypoglycemia and Hyperglycemia
  - Narcotic overdose:

        - → J12: Opioids
    - Assess for pneumothorax
        - → PR21: Needle Thoracentesis

**Critical Care Paramedic – All FR, EMR, PCP, and ACP interventions, plus:**

- Aggressive fluid replacement including blood products for suspected hemorrhagic shock
- Aggressive re-warming if hypothermia present and suspected to be primary cause of presentation
- Ultranosonography to assess pneumothorax, tamponade and cardiac contractility
- Post-return of spontaneous circulation care:
    - Advanced airway
    - Crystalloid bolus 20 ml/kg IV/IO
    - EPINEPHrine infusion

## Evidence Based Practice

General Cardiac Arrest Care

PEA / Asystole

Post-Cardiac Arrest Care

VF/VT-Pulseless (Shock Advised)

## References

1. Alberta Health Services. AHS Medical Control Protocols. 2020. [Link]
2. Heart & Stroke. 2019 Focused Updates to AHA Guidelines for CPR and ECC: Frequently Asked Questions. 2019. [Link]
3. Tijssen JA, et al. Time on the scene and interventions are associated with improved survival in pediatric out-of-hospital cardiac arrest. 2015. [Link]