

Educational material for the First aid class prepared by the Medical Education Center JFMED based on ERC guidelines

Paediatric CPR and other paediatric emergencies

The epidemiology, pathophysiology, and common aetiologies of paediatric cardiac arrest are distinct from adult and neonatal cardiac arrest. Cardiac arrest in infants and children does not usually result from a primary cardiac cause; rather, it is the result of progressive respiratory failure or shock. In these patients, cardiac arrest is preceded by a variable period of deterioration, which eventually results in cardiopulmonary failure, bradycardia, and cardiac arrest. In children with congenital heart disease, cardiac arrest is often due to a primary cardiac cause, although the aetiology is distinct from adults. In children between 1-15 years of age, cardiac arrest is usually secondary, because of asphyxia.

Neurological outcomes remain difficult to assess across the paediatric age spectrum, with variability in reporting metrics and follow-up time across OHCA (out-of-hospital cardiac arrest) and IHCA (in-hospital cardiac arrest) studies. Favourable neurological outcome has been reported in up to 47% of survivors discharged. Despite increases in survival from IHCA, there is more to be done to improve both survival and neurological outcomes.

The International Liaison Committee on Resuscitation (ILCOR) Formula for Survival emphasizes 3 essential components for good resuscitation outcomes:

1. Guidelines based on sound resuscitation science
2. Effective education of the lay public and resuscitation providers
3. Implementation of a well-functioning Chain of Survival

As survival rates from paediatric cardiac arrest increase, there has been a shift with more focus on neurodevelopmental, physical, and emotional outcomes of survivors. Recent studies demonstrate that a quarter of patients with favourable outcomes have global cognitive impairment and that 85% of older children who were reported to have favourable outcomes have selective neuropsychological deficits.

Historically, cardiac arrest care has largely focused on the management of the cardiac arrest itself, highlighting high-quality CPR, early defibrillation, and effective teamwork. However, there are aspects of pre-arrest and post-arrest care that are critical to improve outcomes. As paediatric cardiac arrest survival rates have plateaued, the prevention of cardiac arrest becomes even more important. In the out-of-hospital environment, **this includes safety initiatives (eg, bike helmet laws), sudden infant death syndrome prevention, lay rescuer CPR training, and early access to emergency care**. When OHCA occurs, **early bystander CPR is critical in improving outcomes**. In the in-hospital environment, cardiac arrest prevention

includes **early recognition and treatment of patients at risk for cardiac arrest, such as neonates undergoing cardiac surgical procedures, patients presenting with acute fulminant myocarditis, acute decompensated heart failure, or pulmonary hypertension.**

Following resuscitation from cardiac arrest, management of the post-cardiac arrest syndrome (which may include brain dysfunction, myocardial dysfunction with low cardiac output, and ischemia or reperfusion injury) is important to avoid known contributors to secondary injury, such as hypotension. Accurate neuroprognostication is important to guide caregiver discussions and decision-making. Finally, given the high risk of neurodevelopmental impairment in cardiac arrest survivors, early referral for rehabilitation assessment and intervention is key.

To highlight these different aspects of cardiac arrest management, the Paediatric Chain of Survival has been updated (Figure 1). A separate OHCA Chain of Survival has been created to distinguish the differences between OHCA and IHCA. In both the OHCA and IHCA chains, a sixth link has been added to **stress the importance of recovery, which focuses on short- and long-term treatment evaluation, and support for survivors and their families.** For both chains of survival, activating the emergency response is followed immediately by the initiation of high-quality CPR. If help is nearby or a cell phone is available, activating the emergency response and starting CPR can be nearly simultaneous. However, in the out-of-hospital setting, a single rescuer who does not have access to a cell phone should begin CPR (compressions-airway-breathing) for infants and children before calling for help because **respiratory arrest** is the most common cause of **cardiac arrest**, and help may not be nearby. In the event of sudden witnessed collapse, rescuers should use an available automatic external defibrillator (AED), **because early defibrillation can be lifesaving.**



Figure 1. Pediatric Chains of Survival for in-hospital (top) and out-of-hospital (bottom) cardiac arrest.

Rapid recognition of cardiac arrest, immediate initiation of high-quality chest compressions, and delivery of effective ventilation are critical to improve outcomes from cardiac arrest. Lay rescuers should not delay starting CPR in a child with no “signs of life.” Healthcare providers may consider assessing the presence of a pulse as long as the initiation of CPR is not delayed more than 10 seconds. Palpation for the

presence or absence of a pulse is not reliable as the sole determinant of cardiac arrest and the need for chest compressions. In infants and children, asphyxial cardiac arrest is more common than cardiac arrest from a primary cardiac event; therefore, effective ventilation is important during resuscitation of children. When CPR is initiated, the sequence is compressions-airway-breathing.

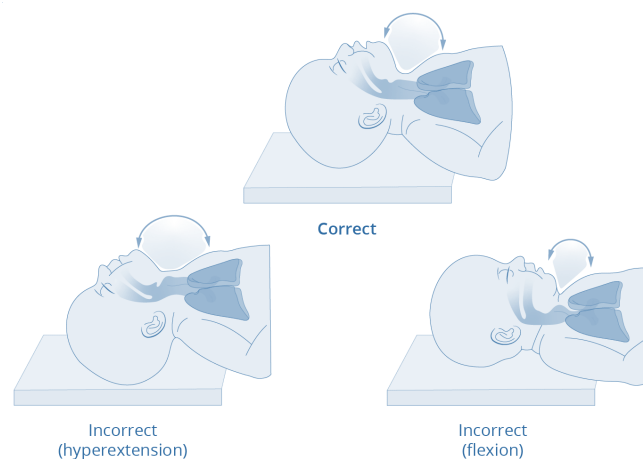
The sequence of steps is similar to the adult CPR; however, a slightly modified approach is used to recover respiration as soon as possible.

Basic Life Support of Babies and Children

It is preferable to modify adult BLS and perform five initial breaths followed by 1 min of CPR before going for help (see adult CPR). Advice for determining the landmarks for infant compression is now the same as for older children. Infant compression technique remains the same: two-finger compression for single rescuers and two-thumb, encircling technique for two or more rescuers, but for older children, there is no division between the one- or two-hand technique. The emphasis is on achieving an adequate depth of compression with minimal interruptions, using one or two hands according to rescuer preference.

The paediatric CPR algorithm 2021

1. Make sure you, the victim and any bystanders are safe.
2. Check the victim for response
3. Shout for help
4. Turn the victim onto his back
5. Open the airway. Unless a cervical spine injury is suspected, use a head tilt–chin lift maneuver to open the airway. For the trauma patient with suspected cervical spinal injury, use a jaw thrust without head tilt to open the airway. For the trauma patient with suspected cervical spinal injury, if the jaw thrust does not open the airway, use a head tilt–chin lift maneuver. Baby's head should be more in neutral position rather than extension – 90 °angle is preferable. Mind that both flexion and overextension of the neck change the anatomical situation and the rescue breaths would be problematic.

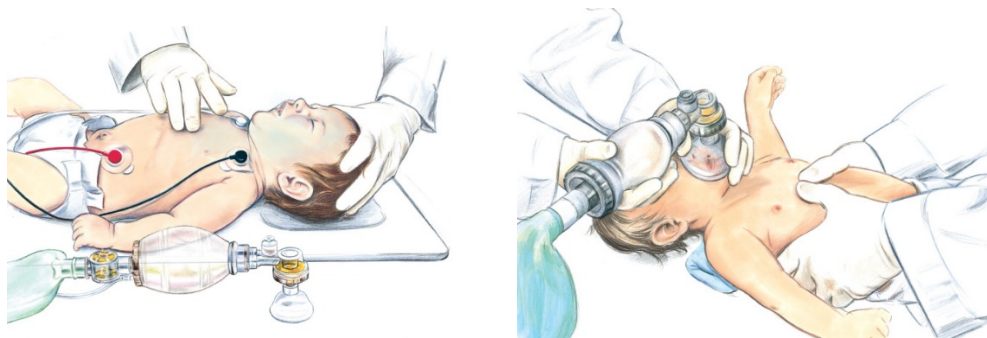


6. Check normal breathing.

7. If absent, start CPR. When more than one rescuer is available, one starts resuscitation while another rescuer goes for assistance. **Give 5 rescue breaths.** Take a breath and cover the mouth and nose of the infant with your mouth, making sure you have a good seal. If the nose and mouth cannot be covered in the older infant, the rescuer may attempt to seal only the infant's nose or mouth with his mouth (if the nose is used, close the lips to prevent air escape). Identify effectiveness by seeing that the child's chest has risen and fallen similarly to the movement produced by a normal breath.

NOTE: A single rescuer provides 5 rescue breaths; if no signs of life, 1 min consistent CPR is recommended before calling EMS. Oxygenation of the body is the highest priority.

8. If still unresponsive, start chest compressions. In infants, use a two-thumb encircling technique for chest compression or two-finger chest compression. To perform chest compression in children, compress the lower half of the sternum. Lift the fingers to ensure that pressure is not applied over the child's ribs. In larger children or for small rescuers, this is achieved most easily by using both hands with the fingers interlocked. Compress the sternum to depress it by approximately one-third of the depth of the chest. The frequency should be 100-120/min.



For infants, single rescuers (whether lay rescuers or healthcare providers) should compress the sternum with 2 fingers or 2 thumbs placed just below the intermammary line. The 2-thumb encircling hands technique is recommended when CPR is provided by 2 rescuers. If the rescuer cannot physically encircle the victim's chest, compress the chest with 2 fingers. For children, it may be reasonable to use either a 1- or 2-hand technique to perform chest compressions. For infants, if the rescuer is unable to achieve guideline-recommended depths (at least one third the anterior-posterior diameter of the chest), it may be reasonable to use the heel of 1 hand.

9. Combine chest compressions with rescue breathing. The ratio is 15:2
10. After 1 minute of basic life support (rescue breaths and chest compressions), go to find a phone and call emergency medical services (ambulance).
11. Continue with CPR until the AED arrives. Attach the AED and follow the instructions. For 1–8-year-olds, use paediatric electrodes and pads if available. If not, use an adult AED.

12. CPR is again fully continued until qualified help arrives and takes over or the child starts breathing normally, or the rescuer is exhausted.”

Paediatric emergencies

Many emergencies in children present as the same problems in adults. The main difference is a faster onset (children have lower physiological reserves and rapid worsening due to lower efficiency of compensating mechanisms). Some diseases are typical for the paediatric group: the most dangerous are presented in the chapter.

Suffocation

Definition: respiratory system insufficiency due to the airway occlusion/narrowing caused by heterogeneous processes.

Causes: depend on the site of disturbances. There may be an obstacle in the upper airways (epiglottitis, laryngitis, foreign body aspiration) or lower airways (asthma, bronchiolitis, pneumonia), less frequently pneumothorax, injury, etc.

Signs and symptoms:

- increased respiratory rate (in newborns and infants > 50/min, in children 1 – 6 y. >

25 min, older children > 20/min

- breathing through the open mouth
- abnormal sounds during breathing (stridor, wheezing, high-pitched noises, barking

cough)

- retraction of soft parts of the chest and throat, in small children, and movement of the nostrils during breathing
- typical position (sitting in epiglottitis, orthopnoea in asthma)
- cyanosis

REMEMBER: sudden calming or lethargy of a suffocating child is a warning sign of critical asphyxia with the risk of cardiac arrest

Suffocation can be caused by multiple pathological processes such as acute epiglottitis, acute subglottic laryngitis, foreign body aspiration or even allergic oedema of the upper airways.

Acute epiglottitis

Definition: Acute viral inflammation of the epiglottis and surrounding tissues, which may result in suffocation from larynx obstruction by swollen epiglottis.

Signs and symptoms: Usually in children aged 6 months – 5 years with fever up to 40 °C, sitting and refusing to lie down because they have problems breathing. Due to the pain during swallowing, they have excessive salivation, limited cough, anxiety, or lethargy. Bubbling sounds during inspiration.

First aid:

- Immediately call EMS
- Make sure the child is close to the mother (calming, decrease in ventilatory effort)
- Cold air (put in front of refrigerator or open window if it is a freezing day).

REMEMBER: never put the child in a supine position.

Subglottic acute laryngitis

Definition: Acute viral inflammation of the larynx, typically during October to May. Risk groups are children aged 6 months to 5 years, where inflammation can cause laryngeal oedema and asphyxia. Signs and symptoms: Onset usually at night, difficulties in breathing, stridor on inspiration, hoarse barking cough, mild fever, restlessness, no effect of the child's position. Worsening is signalled by moving of nostrils during breathing, strangulation in abdomen at the site of diaphragm, bluish discoloration of the skin or lips, sucking in of the chest, lethargy.

First aid: Immediately call EMS, keep close to the mother (calming, decrease in ventilator effort), cold air (put in front of refrigerator or open window if it is a freezing day) – cold will reduce the swelling, and the air may flow in both inspiratory and expiratory direction

Foreign body aspiration (choking)

Definition: Semi-complete or complete obstruction of the airway by a foreign body. The most critical part of the airway is the larynx (between vocal cords in adults and just behind them in babies).

Signs and symptoms: cyanosis, panic, either a sudden cough (better) or an inability to breathe and cough, choking, the child may clutch his neck

First aid: In incomplete obstruction (ability to speak, breathe, and cough), only encourage coughing. In complete obstruction: back blows, chest thrusts, and abdominal thrusts – Heimlich manoeuvre (should not be performed in babies and small children) all increase intrathoracic pressure and can expel foreign bodies from the airway. If the victim is already unconscious, try to give 5 breaths and start resuscitation. Call EMS immediately

Allergic oedema of upper airways

Definition: Rapid onset of the swelling of the tongue, hypopharynx, and larynx caused by severe allergic reaction.

Signs and symptoms: History of allergy (REMEMBER, this may be the first allergic reaction!), visible insect bite, local disturbances of sensations (numbness or pinching), swelling, difficulty speaking and breathing, redness of the skin, swelling skin reaction, generalised signs of allergy.

First aid: Call EMS immediately. Before arrival, monitor the patient and reassure them. Oedema can be reduced by cold dressing or sucking ice cube. Some people have already been equipped with an autoinjector with adrenaline (e.g. EpiPen, Anapen), which must be applied as soon as possible to the outer upper third of the thigh. Act according to the pictures on the device. Following medical first aid consists of administration of adrenaline (s.c., i.m., i.v.), corticosteroids, infusions, etc. If treatment starts early, the prognosis is good.

REMEMBER: Even after successful EpiPen administration, the patient must be admitted to a hospital for 24 hours, and anaphylaxis may reappear after several hours.

Asthma attack

Definition: Asthma is a chronic inflammatory disease of the airways characterized by variable and recurring symptoms, reversible airflow obstruction, and bronchospasm. Common symptoms include wheezing, coughing, chest tightness, and shortness of breath. Asthmatic attack is a sudden worsening of a previous state with severe airway narrowing.

Causes: usually allergy, infection, sometimes psychogenic causes may trigger severe bronchoconstriction as they cause disturbance in the autonomic nervous system

Signs and symptoms: anything from mild worsening to life-threatening situation. Typically severe wheezing when breathing both in and out, coughing, tachypnoea, chest tightness or pressure, difficulty talking, feelings of anxiety or panic, sweating, blue lips or fingernails. REMEMBER: sudden silence, decreased respiratory rate, and bradycardia are signs of imminent cardiac arrest.

First aid: call EMS, help during drug administration (maintain prescribed doses)

Febrile seizures

Definition: convulsions brought on by a fever in infants or small children, usually between 3 – 5 years.

Signs and symptoms: fever over 39 °C, unconsciousness, and convulsions on both sides of the body. Less commonly, the child becomes rigid or has twitches in only a portion of the body, such as an arm or a leg, or on the right or the left side only. Most febrile seizures last a minute or two, although some can be as brief as a few seconds while others last for more than 15 minutes.

First aid: To prevent accidental injury, the child should be placed on a protected surface such as the floor or ground. The child should not be held or restrained during a convulsion. To prevent choking, the child should be placed on their side. When possible, gently remove any objects from the child's mouth. Never place anything in the child's mouth during a convulsion. Decrease body temperature (rectal paracetamol, ibuprofen) or cold dressing – especially over the head – cool the head first. Look at your watch when the seizure starts. If the seizure lasts 10 minutes, the child should be taken immediately to the nearest medical facility. Once the seizure has ended, the child should be taken to

the paediatrician to check for the source of the fever. This is especially urgent if the child shows symptoms of stiff neck, extreme lethargy, or abundant vomiting. Children especially prone to febrile seizures may be treated with the drug diazepam orally or rectally whenever they have a fever. Rectal diazepam is provided by a doctor as a preventive measure.

REMEMBER: acetylsalicylic acid (like Acylpyrin, Aspirin etc.) must never be given to babies and children, it can trigger a toxic reaction called Ray's syndrome. Use other antipyretics instead.

NOTICE: The vast majority of febrile seizures are short and harmless. During a seizure, there is a small chance that the child may be injured by falling or may choke on food or saliva in the mouth. There is no connection between febrile seizures and epilepsy.