

2025 Korean Guidelines for Cardiopulmonary Resuscitation: Part 7. Pediatric basic life support

Jisook Lee¹ , Do Kyun Kim² , Jin-Tae Kim³ , Jae Yoon Na⁴ ,
Bobae Park⁵ , Soo In Jeong⁶ , June Dong Park⁷ , Sung Phil Chung⁷ ,
Tae-Youn Kim⁸ , Youdong Sohn⁹ , Gyuhong Shim¹⁰ ,
Young Hwa Jung¹¹ , Yunhee Oh¹² , Chun Song Youn¹³ , Mi Jin Lee¹⁴ ,
Chang Hee Lee¹⁵ , Youngbin Jang⁷ , Yong Soo Jang⁹ ,
Gyu Chong Cho⁹ , Kyoung-Chul Cha¹⁶ , Ju Sun Heo¹¹ ,
Sung Oh Hwang¹⁶ 

Full list of author information is available at the end of the article (see [ARTICLE INFORMATION](#)).

Pediatric cardiac arrest primarily arises from asphyxia in infants and trauma in older children, contrasting with adult etiologies dominated by cardiac events. This underscores prevention as the cornerstone of pediatric basic life support, through injury mitigation like child restraint systems and water supervision, safe sleep practices including supine positioning on firm surfaces with caregiver smoking cessation to reduce sudden infant death syndrome, plus awareness of child abuse and adolescent suicide prevention. In hospitals, pediatric early warning systems (PEWS) enable early deterioration detection via vital sign scoring for timely intervention. Major updates in the 2025 pediatric basic life support guidelines reflect evidence-driven refinements. First, hospitals should implement PEWS to prompt rapid response teams for at-risk inpatients. Second, all rescuers (lay and healthcare providers) should employ the two-thumb encircling hands technique for infant chest compressions for optimal depth (about 4 cm), rate (100–120/min), and recoil; one-hand heel compression serves as backup if infeasible. Third, lay rescuers may apply automated external defibrillators for nontraumatic out-of-hospital cardiac arrest in children aged 1 year or older, prioritizing prompt attachment after initial cardiopulmonary resuscitation (CPR) cycles to address potential shockable rhythms. Fourth, for infant foreign body airway obstruction, alternate five back blows (over the spine between scapulae) with five chest thrusts (using heel-of-hand on sternum) until cleared or unresponsive, then transition to CPR. These updates aim to enhance bystander intervention, CPR quality, and survival with favorable neurologic outcomes in pediatric cardiac arrest.

Keywords Heart arrest; Resuscitation; Pediatrics

MAJOR CHANGES IN THE 2025 PEDIATRIC BASIC LIFE SUPPORT GUIDELINES

The major changes in the 2025 pediatric basic life support (PBLS) guideline are as follows:

- (1) It is suggested to implement pediatric early warning systems (PEWS) to facilitate early recognition of clinical deterioration in hospitalized children (weak recommendation, low certainty of evidence).

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Correspondence to:

Do Kyun Kim
(bird001@snu.ac.kr)



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- (2) For all rescuers (lay and healthcare providers), the two-thumb encircling hands technique is recommended for chest compressions in infants regardless of the number of rescuers (strong recommendation, very low certainty of evidence). One-hand compression may be considered when this technique cannot be performed, or when the infant's body habitus and weight are close to those of a 1-year-old, but it is not recommended as the first choice (expert consensus recommendation).
- (3) For nontraumatic out-of-hospital cardiac arrest (OHCA) in children aged 1 year or more, the use of automated external defibrillators (AEDs) by lay rescuers is suggested (weak recommendation, very low certainty of evidence). The evidence is insufficient to recommend or oppose the use of AEDs by lay rescuers for nontraumatic OHCA in less than 1-year-old infants.
- (4) Five back blows and five chest thrusts should be alternated to relieve foreign body airway obstruction in infants and repeated until the foreign body is expelled or the infant becomes unresponsive; chest thrusts should be delivered using the heel of one hand (expert consensus recommendation).

PEDIATRIC CHAIN OF SURVIVAL

BLS in pediatric cardiac arrest, which has the greatest impact on return of spontaneous circulation (ROSC) and survival, begins with cardiac arrest prevention. The pediatric chain of survival starts with cardiac arrest recognition and activation of emergency response. However, cardiac arrest prevention should be pursued before this to avoid progression to cardiac arrest through various institutional and environmental injury prevention and safety strategies in an out-of-hospital setting and through systems like PEWS in the hospital. The first three of the five links in the chain of survival correspond to BLS. As in adults, rapid and effective cardiopulmonary resuscitation (CPR) by lay rescuers contributes to successful ROSC and favorable neurological recovery in children. In pediatric patients, survival varies depending on age and the cause of cardiac arrest, and it generally improves with increasing age, while survival to hospital discharge can exceed 40% for in-hospital pediatric cardiac arrest [1].

Importance of prevention in pediatric cardiac arrest

To reduce overall mortality from cardiac arrest, it is important to recognize that both medical (prevention, treatment, and rehabilitation) and nonmedical (public awareness of cardiac arrest and CPR education) factors are associated with survival since cardiac

arrest is difficult to predict and can occur in various settings. Prevention is a key strategy for reducing deaths from cardiac arrest since cardiac arrest survival remains low, even with effective resuscitation.

The main causes of cardiac arrest in infants include respiratory failure and sudden infant death syndrome (SIDS), whereas trauma is the most common cause in children older than 1 year. Thus, a substantial proportion of pediatric cardiac arrests can be prevented by appropriate environmental management and lifestyle modification, which is a major difference compared with adults. SIDS can be prevented by avoiding the prone sleeping position and placement on soft surfaces, as well as providing smoking cessation education to caregivers. Fatal injuries from traffic accidents can be prevented using seat belts and age-appropriate child restraint systems. Drowning is the second most common cause of unintentional death in children aged less than five years and the third most common cause of death in adolescents [2]. Most young children drown after falling into swimming pools without direct supervision, whereas adolescents often drown in lakes or rivers. Drowning can be prevented by ensuring that children and adolescents wear appropriate life jackets when swimming.

Recent national mortality statistics indicate that homicide is the third leading cause of death in 1- to 9-year-olds [3]. Efforts to prevent such deaths should include increasing awareness of child abuse and active reporting. Intentional self-harm (suicide) is the leading cause of death among adolescents aged ≥ 10 years, underscoring the need for emotional support and proactive intervention to reduce suicide risk [3].

Recognition of cardiac arrest, activation of emergency response, and bystander CPR

Once cardiac arrest is suspected or recognized, rapid initiation of CPR is as important as prompt activation of the emergency response system because asphyxial cardiac arrest is more common in children. However, considering the high penetration rate of mobile phones in Korea, as with adult BLS, rescuers who encounter a child with suspected cardiac arrest should immediately call the emergency number.

Domestic studies on pediatric OHCA have shown that a shorter time from collapse to CPR initiation is associated with higher ROSC rates [4]. Additionally, rapid and effective layperson CPR at the scene is associated with higher ROSC rates and survival to discharge with favorable neurological outcomes in pediatric OHCA [5,6].

PBLS FOR LAY RESCUERS

Age definitions in pediatric CPR are as follows:

- (1) Newborn: up to 4 weeks from birth
- (2) Infant: younger than 1 year of age
- (3) Child: aged between 1 year and less than 8 years
- (4) Adult: aged 8 years or more

Pediatric BLS is applied to infants and children aged less than 8 years, regardless of whether the rescuer is a layperson or health-care provider. The PBLS algorithm for lay rescuers is shown in Fig. 1 and Table 1. In cases with a high risk of infectious disease transmission, compression-only CPR should be performed instead of standard CPR. Ventilation is extremely important in pediatric resuscitation because asphyxial cardiac arrest is far more common than primary cardiac arrest in infants and children. However,

the CPR sequence begins with chest compressions followed by rescue breaths, even in infants and children with cardiac arrest, which is consistent with adult BLS for simplicity of education and training and to maintain continuity with the previous 2020 guidelines [7–9].

Rescuer and patient safety

Rescuers should always ensure scene safety before initiating CPR. Wearing a mask and adhering to personal protective measures is essential during infectious disease outbreaks, although the risk of infection transmission to rescuers during CPR is theoretically present but very low in practice.

Recognition of cardiac arrest and response check

First, assess whether CPR is needed. An unresponsive child who is

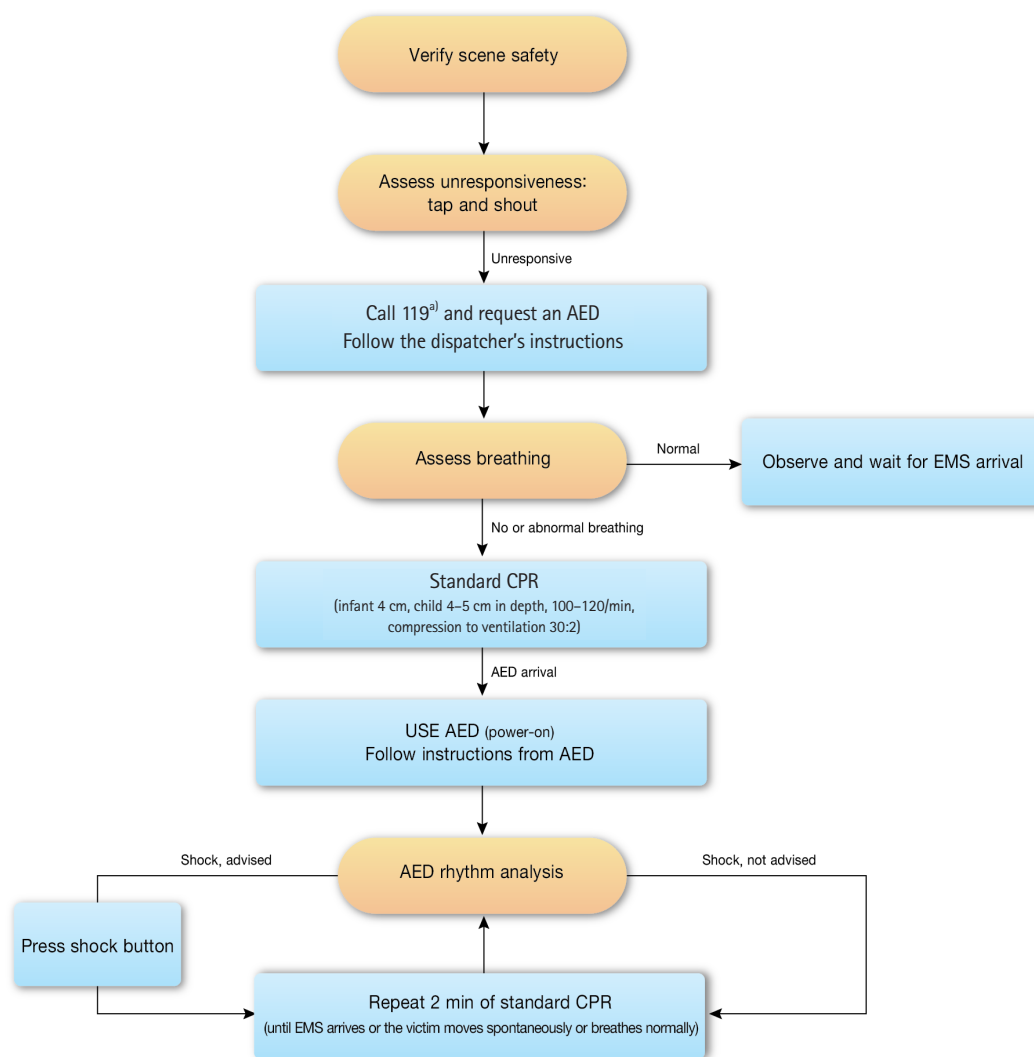


Fig. 1. Basic life support algorithm for pediatric out-of-hospital cardiac arrest (for lay rescuer). AED, automated external defibrillator; EMS, emergency medical services; CPR, cardiopulmonary resuscitation. ^{a)}EMS call number in Korea.

Table 1. Reference table of pediatric basic life support for lay rescuers

Management	Detail
Breathing that requires CPR	If there is no breathing or only gasping
Chest compression	
Location	Sternum just below the line connecting the nipples for infants, the lower half of the sternum for children
Depth	At least one-third of the anteroposterior diameter of chest (4 cm for infants and 4–5 cm for children)
Rate	100–120/min
Chest compression to ventilation ratio	Chest compression to ventilation ratio, 30:2 Rescuers who are unwilling or untrained to perform rescue breaths should perform compression-only CPR Perform compression-only CPR during pandemics
AED	Turn on and use the AED as soon as it is available
AED analyzes rhythm	Stop chest compression for rhythm analysis
CPR after shock	Resume chest compression immediately after delivering one shock

CPR, cardiopulmonary resuscitation; AED, automated external defibrillator.

gasping or not breathing normally is in cardiac arrest and requires CPR. Tap the child gently and shout, “Hey, are you okay?” or call the child by name if known. Quickly check for injuries or the need for medical intervention.

Activation of the emergency medical services

Shout for help if the child is unresponsive and alone. If bystanders are present, ask them to call 119 (emergency medical services [EMS] call number in Korea) and retrieve an AED. If no one is nearby, the lone rescuer should immediately call 119 (given the high mobile phone penetration in Korea) without leaving the child and inform the dispatcher of the child’s unresponsive state, request an AED, and follow the dispatcher’s instructions. If multiple rescuers are present, one should start CPR while the others activate the EMS and prepare the AED. If alone and without a phone, perform CPR for 2 minutes, then call EMS and retrieve an AED, returning to the child as quickly as possible to resume CPR.

Check the patient’s breathing

Remove the upper clothing to expose the chest and assess breathing. If normal breathing is present and no trauma is evident, place the child in the recovery position to maintain the airway and reduce aspiration risk, and then monitor breathing until EMS arrives. Allow children in respiratory distress to maintain comfortable postures because they often adopt positions that optimize their airway. Start CPR immediately if they are unresponsive and not breathing normally (or only gasping, i.e., agonal

breaths), since gasping can be mistaken for normal breathing and delay intervention.

Chest compression

Appropriate chest compression during cardiac arrest maintains vital organ perfusion and improves the chances of ROSC. Immediately perform 30 chest compressions (on a firm, flat surface) at a rate of 100–120/min to a depth of at least one-third of the anteroposterior chest diameter (approximately 4 cm for infants and 4–5 cm for children) if the infant or child is unresponsive and not breathing [10].

Use the two-thumb encircling hands technique for infants; encircle the chest with both hands and compress the sternum just below the nipple line with the thumbs side-by-side, avoiding the xiphoid process. The two-finger technique is no longer recommended because the two-thumb method better maintains coronary perfusion pressure, compression quality, and rescuer comfort [11,12]. One-hand heel compression may be considered if the two-thumb technique is not feasible or the infant’s size or weight approaches that of a 1-year-old, but it is not preferred (expert consensus).

For children, use the one- or two-hand heel technique on the lower half of the sternum, avoiding the xiphoid and ribs. Ensure complete chest recoil after each compression to allow venous return. With multiple rescuers, switch compressors every 2 minutes (ideally within 5 seconds) to prevent fatigue and maintain quality. Lay rescuers should continue cycles of 30 compressions and two breaths until EMS arrives or the child resumes breathing. Standard CPR with ventilation is preferred for asphyxial arrests, which are common in children [13,14]. If unwilling or untrained for breaths, perform compression-only CPR at a minimum.

Airway opening and ventilation

Use the head tilt–chin lift to open the airway because it may be obstructed by the tongue in unresponsive children. Use jaw thrust if trauma (especially cervical spine injury) is suspected. If inadequate, revert to head tilt–chin lift in life-threatening situations.

Use mouth-to-mouth or mouth-to-mouth-and-nose ventilation for infants and mouth-to-mouth for children. Deliver each 1-second breath sufficiently to cause chest rise. If no rise, reposition the head, seal tightly, and retry.

Chest compression to ventilation ratio

Immediately deliver two ventilations after 30 compressions. One-rescuer cycles of 30:2 take about 2 minutes for five cycles. With two rescuers, switch roles after five cycles while minimizing interruptions.

Compression-only CPR

Observational studies indicate that conventional CPR with ventilation yields better outcomes than compression-only CPR in infants and children [13–19]. Compression-only CPR in children is associated with better outcomes than no CPR at all. In infants, compression-only CPR shows similarly poor outcomes as no CPR, and conventional CPR with rescue breaths is associated with better outcomes. Overall, infants and children should receive conventional CPR with rescue breaths. If unable or unwilling to ventilate, initiate compression-only CPR and add breaths when feasible.

Dispatcher-assisted CPR

Dispatcher-assisted CPR guidance by emergency medical dispatchers over the phone increases the likelihood of bystanders performing CPR and shortens the time to CPR initiation in pediatric patients with OHCA. Dispatchers should guide lay rescuers via telephone to recognize cardiac arrest and perform CPR, increasing bystander intervention and reducing time to CPR initiation in pediatric OHCA [20–23].

AED use

For witnessed collapse (e.g., during exercise), suspect shockable rhythms that require prompt CPR and defibrillation. Studies on bystander AED use in pediatric patients with cardiac arrest revealed that, despite disadvantages like pauses in chest compressions and CPR interruptions, the benefits of AED use outweigh the risks in children aged ≥ 1 year [17,24–26]. AED use by lay rescuers is suggested for nontraumatic OHCA in children aged ≥ 1 year (weak recommendation, very low certainty). Early AED application should be considered for infants aged < 1 year when feasible.

PBLS FOR HEALTHCARE PROVIDERS

Although PBLS for healthcare providers and lay rescuers are fundamentally similar, they differ in some aspects (Figs. 2, 3, Table 2) [27–29]. The sequence priority is relatively less emphasized for healthcare providers because they typically work in teams, allowing simultaneous task execution (e.g., chest compressions and ventilation preparation).

Rescuer and patient safety

As with lay rescuers, always ensure scene safety before initiating CPR. Appropriate personal protective equipment, including masks, should be worn during infectious disease outbreaks.

Check the response

Assess whether CPR is needed by tapping the child gently and shouting, “Hey, are you okay?” or calling by name if known. Quickly evaluate for injuries or required medical interventions.

Activation of the EMS

If unresponsive and not breathing normally (or only gasping), activate the EMS by requesting others to call 119 and retrieve an AED. Immediately call for help if in-hospital, and activate the hospital emergency system and obtain a defibrillator.

Check the pulse

Check the pulse within 10 seconds if the infant or child is unresponsive and breathing abnormally. Check the brachial artery in infants and the carotid or femoral artery in children. Start chest compressions if no pulse is palpable, or if uncertain, within 10 seconds.

Inadequate breathing with palpable pulse and good perfusion

Provide rescue breaths at 20–30/min (30/min for those aged < 1 year and 20–30/min for 1–8 years) until spontaneous breathing recovers if the heart rate is > 60 /min but breathing is inadequate. Recheck the pulse every 2 minutes (pulse check duration, < 10 seconds).

Bradycardia with poor perfusion

Start chest compressions if the heart rate is < 60 /min with poor perfusion despite oxygen and ventilation (e.g., pale, mottled, or cyanotic skin). Cardiac output depends heavily on the heart rate in infants and children; so bradycardia with poor perfusion signals the need for compressions. Initiate CPR before full arrest to improve survival, using < 60 /min with poor perfusion as a practical threshold for education.

Chest compression

Start chest compressions if there is no breathing/pulse (or if uncertain). Use the two-thumb encircling hands technique for infants; encircle the chest and compress the sternum just below the nipple line with thumbs. Compared with two-finger compression, which is no longer recommended, this method is superior at maintaining coronary perfusion pressure, compression depth/force, systolic/diastolic pressures, and rescuer comfort [11,12]. Consider the one-hand heel technique if this is not feasible or if the infant nears the 1-year size or weight, but not as the first choice (expert consensus). For children, use the heel of one or two hands on the lower sternum. Use the 30:2 and 15:2 ratios for one and two rescuers, respectively.

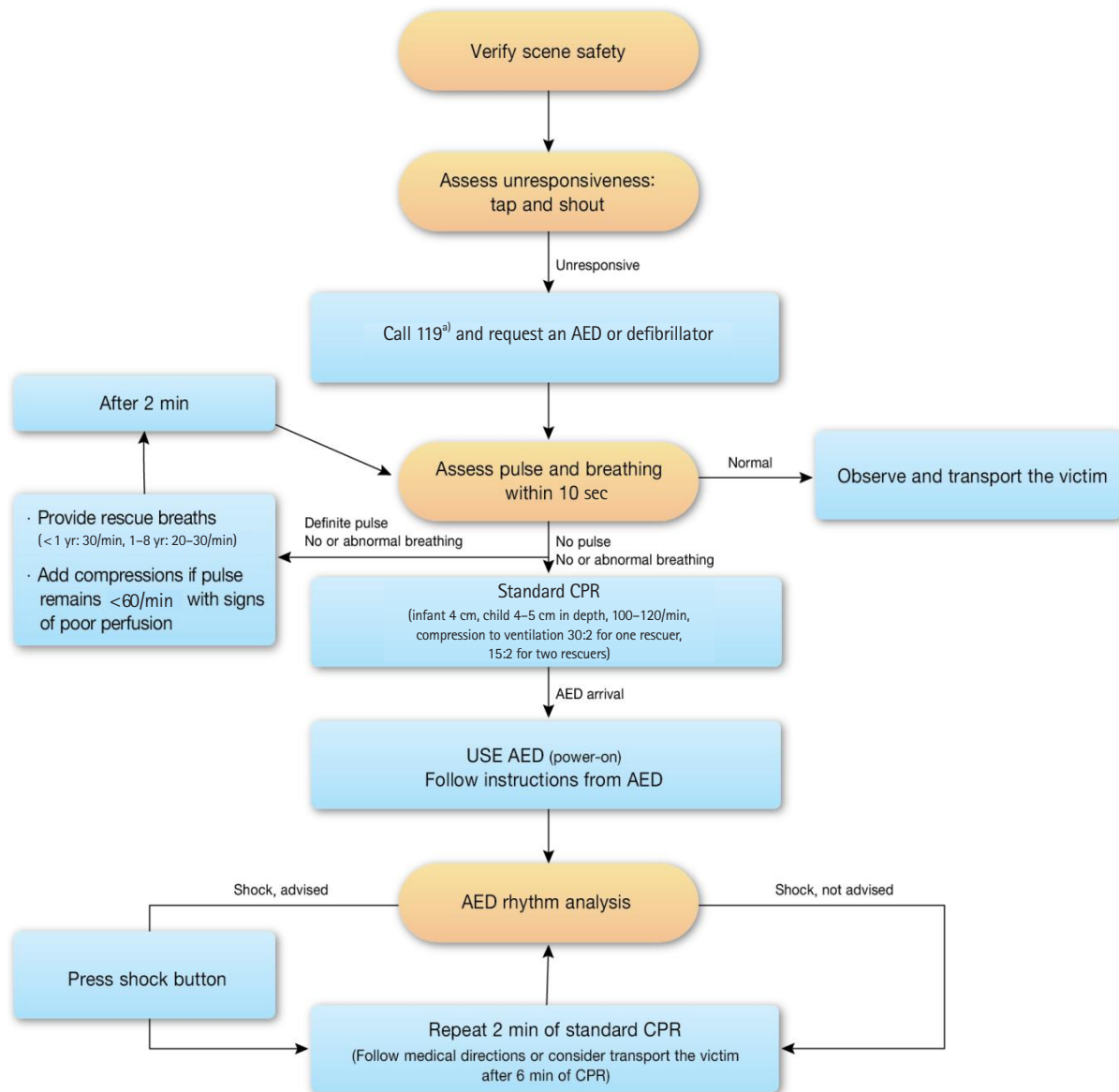


Fig. 2. Basic life support algorithm for pediatric out-of-hospital cardiac arrest (for healthcare provider). AED, automated external defibrillator; CPR, cardiopulmonary resuscitation. ^{a)}Emergency medical services call number in Korea.

Airway opening and ventilation

Open the airway with the head tilt–chin lift and deliver two breaths after 30 compressions (or 15 for two rescuers). Use jaw thrust if spinal injury is suspected, or the head tilt–chin lift if this is inadequate in life-threatening cases. For infants, mouth-to-mouth or mouth-to-nose ventilation can be performed if it is difficult to simultaneously cover the mouth and nose during rescue breaths.

Equipment and methods related to ventilation

Protective equipment

Use if preferred, but do not delay ventilation. Although it reduces infection risk, it does not eliminate it, and it adds airflow resistance.

Bag-mask ventilation

Although most pediatric cardiac arrest patients can achieve adequate ventilation with bag-mask ventilation, it has disadvantages when compared with advanced airway (endotracheal intubation or supraglottic airway), such as more frequent interruptions in

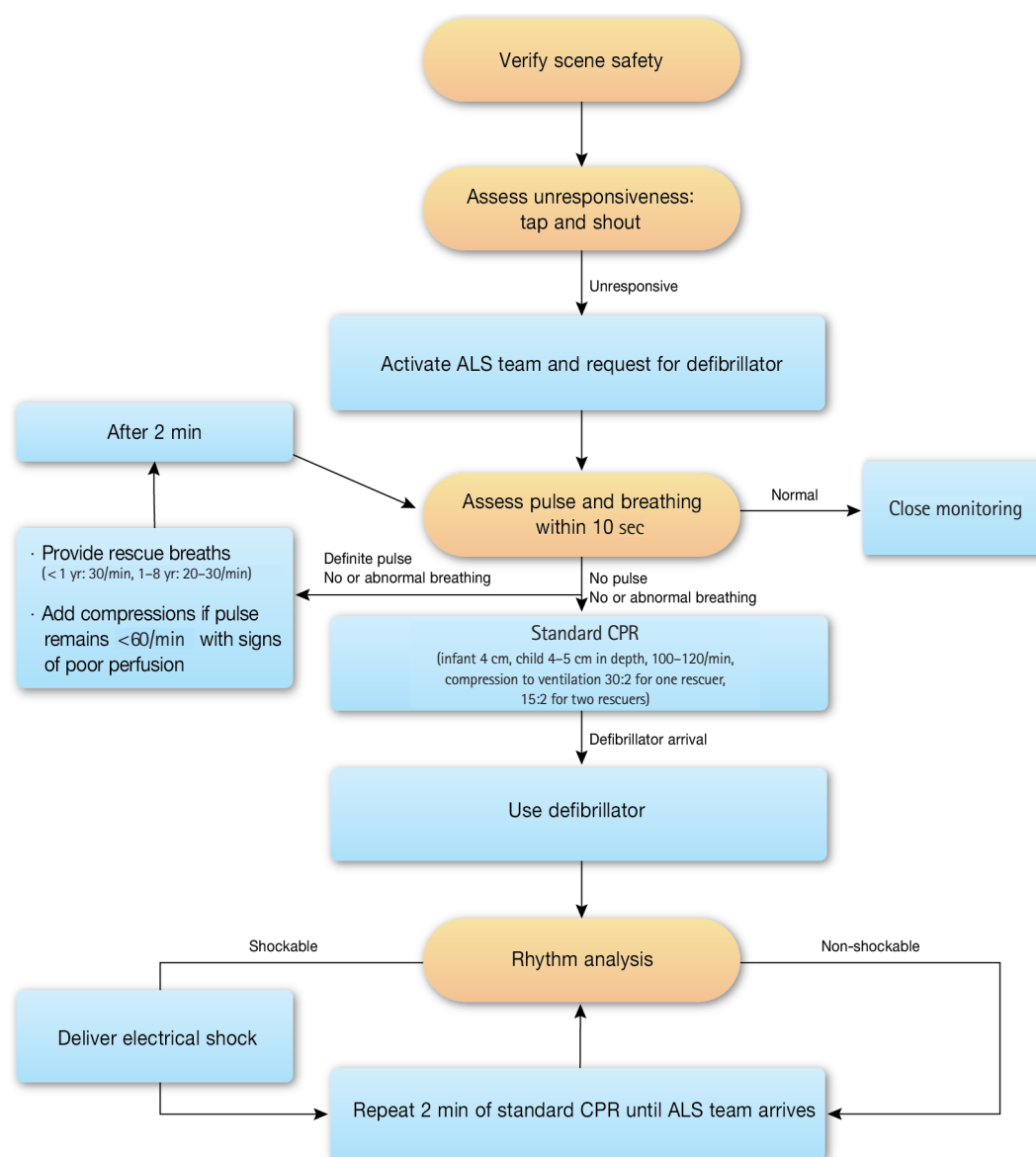


Fig. 3. Basic life support algorithm for pediatric in-hospital cardiac arrest (for healthcare provider). ALS, advanced life support; CPR, cardiopulmonary resuscitation.

chest compressions and a higher risk of aspiration. However, compared with bag-mask ventilation, endotracheal intubation or supraglottic airway insertion requires more training time, and intubation failures and complications are higher in pediatric patients with OHCA. Current studies indicate that compared to bag-mask ventilation, advanced airway insertion has no significant difference in survival to discharge or favorable neurological outcomes, or may even have worse results. Thus, bag-mask ventilation is more reasonable for ventilation in pediatric patients with OHCA (weak recommendation, very low certainty) [30-32]. Effective bag-mask ventilation requires a mastery of techniques like

appropriate mask size selection, airway opening, ensuring mask-to-face sealing, and appropriate pressure application.

Ventilation bag

Self-inflating bags provide at least 450 to 500 mL, and smaller capacity bags may not deliver adequate tidal volume to term newborns and infants. Adult self-inflating bags (1,000 mL) should be used for larger children or adolescents. Connect an oxygen reservoir to the bag for higher concentrations (60%-95%) and ventilate with room air only if oxygen is unavailable.

Table 2. Reference table of pediatric basic life support for healthcare providers

Management	Detail
Breathing that requires CPR	If there is no breathing or only gasping
Check pulse and breathing	Check pulse and look for no breathing or abnormal breathing simultaneously within 10 sec
Chest compression method	
Infant	Two thumbs encircling chest compression
Child	Heel of one or two hands chest compression
Chest compression	
Location	Sternum just below the line connecting the nipples for infants, the lower half of the sternum for children
Depth	At least one-third of the anteroposterior diameter of chest (4 cm for infants and 4–5 cm for children)
Rate	100–120/min
Chest compression to ventilation ratio	
One rescuer	30:2
Two or more rescuers	15:2
Ventilation after ROSC	Provide age-appropriate breaths (< 1 yr: 30/min; 1–8 yr: 20–30/min) if the pulse rate > 60/min and the perfusion condition is good
After insertion of advanced airway	Provide ventilation independent of chest compressions (< 1 yr: 30/min; 1–8 yr: 20–30/min)
Rhythm analysis	Stop chest compression for rhythm analysis
CPR after defibrillation	Resume chest compression immediately after defibrillation

CPR, cardiopulmonary resuscitation; ROSC, return of spontaneous circulation.

Method to prevent hyperventilation

Hyperventilation should be avoided because it reduces circulating blood volume. Perform two breaths (using mouth-to-mouth or bag-mask ventilation) after 30 chest compressions (single rescuer) or 15 compressions (two rescuers/healthcare providers) before advanced airway placement. Provide breaths only at 20–30/min (30/min for < 1 year and 20–30/min for ≥ 1 year) if spontaneous circulation returns without breathing. Excessive ventilation during CPR decreases venous return, reducing cardiac output and cerebral blood flow, and increases intrathoracic pressure, impairing coronary perfusion. Rescuers must adhere to the specified breath rate per minute.

Two-rescuer bag-mask ventilation

Two-person bag-mask ventilation can be effective in cases of severe airway obstruction, poor lung compliance, or difficulty achieving a tight mask-to-face seal, with one rescuer using both hands to maintain the airway and secure the mask firmly to the patient's face, while the other squeezes the ventilation bag. Both rescuers must confirm visible chest rise.

Gastric distention and cricoid pressure

Gastric distension should be avoided as it impairs effective ventilation and may induce vomiting. To minimize gastric distension because of excessive inspiratory pressure, deliver each breath over 1 second or consider cricoid pressure. However, routine cricoid pressure is not recommended and should only be considered with caution when the patient is unconscious, and additional healthcare providers are available, since excessive pressure may

paradoxically occlude the trachea.

Oxygen

Although animal studies suggest 100% oxygen is harmful, no postneonatal human studies have demonstrated detrimental effects from high oxygen concentrations. Thus, 100% oxygen should be used during CPR. Oxygen should be titrated once the patient has stabilized. Humidified oxygen prevents mucosal drying and lessens the thickening of pulmonary secretions.

Administer oxygen via mask or nasal cannula based on breathing status. Simple masks deliver 30% to 50% oxygen with spontaneous breathing, while reservoir masks, at 15 L/min, provide high concentrations. Size-appropriate nasal cannulas are preferred for infants or children (≤ 0.5–1, 1–2, 4, and 6 L/min for neonates, infants, preschoolers, and school-age children, respectively). The oxygen concentration is adjusted to the child's size, respiratory rate, and breathing effort.

Defibrillation

Ventricular fibrillation and pulseless ventricular tachycardia, which are classified as "shockable rhythms" because they respond to defibrillation, may cause sudden cardiac arrest or occur during resuscitation. Sudden collapse in a witnessed pediatric case (e.g., a child collapsing during exercise) may indicate a shockable rhythm, necessitating immediate CPR and rapid defibrillation.

Manual defibrillation is preferable in infants if a trained healthcare provider identifies a shockable rhythm (initial energy, 2 J/kg; subsequent, ≥ 4 J/kg [not exceeding adult maximum]) [33]. Use an AED with a pediatric dose attenuator for infants and children

aged less than 8 years if a manual defibrillator is not available. An adult AED (no attenuation) is acceptable for infants if neither is available.

RESUSCITATION IN SPECIAL CIRCUMSTANCES

Airway obstruction (choking) by foreign bodies

Note that >90% of deaths caused by foreign body aspiration occur in children aged <5 years, and of these, 65% occur in infants. The clinical symptoms of airway obstruction by a foreign body include sudden shortness of breath, coughing, nausea, grunting, and wheezing. It occurs suddenly without previous fever or respiratory symptoms, which distinguishes it from other respiratory difficulties. Airway obstruction caused by foreign bodies can range from mild to severe. The child may cough or make a sound if airway obstruction is mild. Symptoms suspected of complete obstruction include no speech, no sound when coughing, inability to breathe, cyanosis, or loss of consciousness, and they require immediate treatment [34,35].

If severe airway obstruction is recognized in children aged >1 year, alternate five back blows with five abdominal thrusts until the foreign body is expelled or the child becomes unresponsive [36]. For infants, perform back blows and chest thrusts five times each until a foreign body comes out or consciousness disappears repeatedly [37,38]. Chest thrusts are delivered using the heel-of-one-hand technique (expert consensus recommendation) (Fig. 4) [39]. Abdominal thrust is not performed in infants because of the high risk of internal organ damage, since the liver is relatively large and their ribs do not sufficiently protect the epigastric organs [38].

Start CPR, regardless of the presence or absence of a pulse, if the patient does not respond or their reaction disappears during the foreign body removal procedure [40]. Use your fingers to remove the foreign body only if you can see it in the patient's mouth before breathing after chest compression, since performing blind finger sweeps may push the foreign body deeper into the pharynx or damage the pharynx [41,42]. Perform chest compression and ventilation repeatedly after two ventilations, until the foreign body is removed. There are limited high-quality studies that can help determine guidelines for airway obstruction by foreign bodies. Although most airway obstructions by a foreign body resolve by letting the patient cough, severe cases may need help from a rescuer.

Trauma

Unintentional trauma can be a leading cause of death in children



Fig. 4. Infant chest thrust.

and adolescents. Cardiac arrest because of major blunt and penetrating injuries has a very high mortality rate in children [2,43,44]. Tension pneumothorax, hemothorax, lung injury, and cardiac tamponade can interfere with hemodynamics, oxygenation, and ventilation. Therefore, severe chest injury should always be suspected in patients with chest-abdominal trauma. Early treatment for reversible causes after cardiac arrest because of penetrating trauma can increase survival [45,46]. It is recommended to control bleeding, recover circulating blood volume, secure airways, and treat tension pneumothorax for cardiac arrest caused by trauma. These procedures should be concurrently performed with standard CPR.

The principles of basic CPR for injured children and children with common diseases are the same, with certain emphases. Improperly performed CPR can increase preventable mortality. Errors in opening and maintaining the airways and errors caused by not recognizing internal bleeding are common when resuscitating children. The following points should be noted when performing CPR in pediatric trauma patients [2]:

- (1) Cardiac arrest in pediatric trauma patients often occurs because breathing is not adequately maintained due to hypovolemia caused by trauma. Therefore, it must be checked whether the airway and ventilation are maintained even in trauma patients.
- (2) Use a suction device if there is a possibility of airway obstruction because of broken teeth or blood.
- (3) If there is external bleeding, press to stop it. You should remove the patient's clothes and check their entire body to

determine the bleeding points, and then cover them with a warm cloth to prevent hypothermia.

- (4) Minimize cervical spine movement and do not pull or move the head and neck if there is the possibility of spinal injury, judging from the mechanism of the injury. Open the airway by lifting the patient's jaw and do not tilt the head. If the airway is not maintained by lifting the jaw, secure it by tilting the head and lifting the chin. If there are two rescuers, one should open the airway while the other prevents cervical spine movement. At least the thighs, pelvis, and shoulders should be fixed together on the spinal board. The occipital part should be placed in a slightly recessed position than the torso because infants and toddlers have relatively large heads, or the torso should be laid in a slightly elevated position and fixed to the spinal correction board to prevent cervical flexure [47].
- (5) Transfer children with multiple organ trauma to a trauma center with a pediatric specialist if possible.
- (6) Open thoracotomy could be considered for children with penetrating injuries and no pulse [48-52]. However, evidence is insufficient to recommend emergency thoracotomy in children and infants without a pulse because of blunt trauma [50,53].

Drowning

Drowning time is an important predictor of prognosis. Age, promptness of first aid, water type (freshwater or seawater), water temperature, and the presence of witnesses are not reliable prognostic factors [54]. Resuscitation efforts may be prolonged in drowning victims with hypothermia, particularly after submersion in icy water, there is a possibility of survival even when the drowning time is long [55,56]. Initiate CPR immediately after removing drowned children from water. Rescuers with special training should initiate rescue breathing while still in the water, but chest compressions should not be performed in the water because they are ineffective [57].

Do not waste time trying to drain water from the patient's lungs because there is no evidence that water acts as a foreign body causing airway obstruction [58]. Open the airway, perform rescue breathing twice, and start CPR with chest compressions. If there is one rescuer, perform chest compressions and ventilations five times cyclically at the ratio of 30:2, call EMS, and ask for an AED. If there are two rescuers, the first rescuer should continue CPR while the second reports to the EMS and prepares an AED [59].

Children requiring special medical assistance

Children requiring special medical assistance because of chronic disease complications (e.g., blockage of tracheostomy), problems with auxiliary medical devices (e.g., ventilator malfunction), and exacerbation of the existing disease need appropriate management for their conditions. You may have difficulty performing treatment if there is no information on an existing disease, treatment plans, and current medications. Parents or caregivers should copy the child's medical information and place it at home, school, or care facility in advance. If a child is discharged from the hospital with a chronic or fatal illness, a parent, school nurse, and home care provider should be aware of the reason for hospitalization, the condition during the hospitalization, and any symptoms that may worsen, as well as receive training for CPR in special circumstances [60].

Children with previous medical directions

Medical personnel should specify CPR-related limitations in detailed prescribing instructions if a decision has been made to limit or abandon CPR. The doctor should separately specify the prescribing instructions for situations outside the hospital. Care facilities and school nurses should maintain a copy of the medical order for children with documented decisions to withhold resuscitation. Parents, school nurses, and home-visit health care providers should receive sufficient information about the CPR guide and contact information in case of an emergency [60].

Ventilation through tracheostomy or tracheostomy window

The caregivers (parent, school nurse, and home health care provider) of a child who received a tracheostomy should know how to maintain the child's airways, how to remove airway secretions, and how to perform CPR through artificial airways. They should perform assisted ventilation through a tracheostomy window and verify airway maintenance. Suspect tracheostomy tube malposition and recheck airway management if ventilation through the tracheostomy window is ineffective after suctioning. Attempt mouth-to-stoma ventilation for patients with tracheostomy or bag-mask ventilation via nose/mouth when the stoma is occluded if the patient's breathing is inadequate [60].

Prevention of in-hospital pediatric cardiac arrest

PEWS and rapid response team

Rapid response teams (RRTs; or early warning systems) are implemented in many medical institutions to detect physiological changes early in hospitalized patients, prevent cardiac arrest, and reduce unplanned intensive care unit (ICU) admissions [61]. This

compensates for delays in clinician activation because of clinical deterioration by scoring vital signs, such as blood pressure, pulse, respiratory rate, temperature, oxygen saturation, and consciousness level for early warning [62].

Evidence for PEWS is lower in quality and quantity when compared with adults. However, they significantly reduce unplanned alerts for deterioration and unplanned pediatric ICU transfers [63–65]. Given these benefits, implementation of PEWS is suggested to detect clinical deterioration early in hospitalized children (weak recommendation, low certainty).

Pediatric RRT

RRTs (or medical emergency teams) composed of specialized providers monitor deteriorating inpatients and provide rapid intervention for respiratory, cardiovascular, or consciousness changes. Composition and activation vary by hospital resources, and teams should include skilled personnel for efficient critical care [64,66].

Although evidence is insufficient that pediatric RRTs improve ROSC or reduce mortality in in-hospital pediatric cardiac arrest, studies have reported reduced in-hospital cardiac arrest incidences, particularly outside the ICU [67–70]. One cohort study showed reduced CPR needs via early RRT intervention in unplanned ICU transfers [71]. Therefore, medical institutions with trained professional staff may consider establishing and operating a pediatric RRT to prevent cardiac arrest.

ARTICLE INFORMATION

Author details

¹Department of Emergency Medicine, Ajou University School of Medicine, Suwon, Korea

²Department of Emergency Medicine, Seoul National University College of Medicine, Seoul, Korea

³Department of Anesthesiology and Pain Medicine, Seoul National University College of Medicine, Seoul, Korea

⁴Department of Pediatrics, Hanyang University College of Medicine, Seoul, Korea

⁵Advanced Practice Provider Team Unit, Seoul National University Hospital, Seoul, Korea

⁶Department of Pediatrics, Ajou University School of Medicine, Suwon, Korea

⁷Department of Emergency Medicine, Yonsei University College of Medicine, Seoul, Korea

⁸Department of Emergency Medicine, Inha University College of Medicine, Incheon, Korea

⁹Department of Emergency Medicine, Hallym University College of Medicine, Chuncheon, Korea

¹⁰Department of Pediatrics, Inje University Sanggye Paik Hospital, Seoul, Korea

¹¹Department of Pediatrics, Seoul National University College of Medicine, Seoul, Korea

¹²Design and Contents Team, Asan Medical Center, Seoul, Korea

¹³Department of Emergency Medicine, College of Medicine, The Catholic University of Korea, Seoul, Korea

¹⁴Department of Emergency Medicine, St. Vincent's Hospital, College of Medicine, The Catholic University of Korea, Suwon, Korea

¹⁵Department of Paramedicine, Namseoul University, Cheonan, Korea

¹⁶Department of Emergency Medicine, Yonsei University Wonju College of Medicine, Wonju, Korea

Author contributions

Conceptualization: SOH; Funding acquisition: SPC; Investigation: all authors; Project administration: SPC; Writing—original draft: DKK, JL; Writing—review & editing: all authors. All authors read and approved the final manuscript.

Conflicts of interest

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Data availability

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