chapter 14

Pediatric Advanced Life Support Essentials

Sharon E. Mace, MD, FACEP, FAAP

Objectives

1. Discuss the new developments in resuscitation science.
2. Review new 2010 American Heart Association Guidelines for cardiopulmonary resuscitation.
3. Discuss new pediatric basic life support changes.
4. Update pediatric advance life support guidelines.
5. Review use of medications in pediatric resuscitation.

Chapter Outline

CASE SCENARIO 1

You are called to your neighbor's apartment because she could not wake up her 3-month-old daughter. You find the infant in bed, unresponsive, and not breathing.

1. *What is your assessment of this infant?*
2. *What is the appropriate treatment?*

Introduction

During the past two decades, reported survival rates for in-hospital pediatric cardiac arrest have been 27% to 33%.[1,2] In one study, the rate of pediatric in-hospital survival from pulseless arrest was 33%, with the rate of survival to hospital discharge varying based on the underlying rhythm: 24% with asystole, 34% with ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT), and 38% with pulseless electrical activity (PEA).[1]

Survival from out-of-hospital cardiac arrest in infants and children remains poor.[1,2] Recent studies have documented survival rates for pediatric out-of-hospital cardiac arrest of only 4% for infants, 10% for children, and 13% for adolescents.[1] One reason cited for the lower survival rate is that many infants who have been "found down" have likely been dead for an extended period, often from sudden infant death syndrome.[1]

Rapid and effective bystander cardiopulmonary resuscitation (CPR) has been associated with the successful return of spontaneous circulation (ROSC) and with neurologically intact survival in children, as well as in adults, with out-of-hospital cardiac arrest. However, only approximately one-third to half of infants and children who experience cardiac arrest receive bystander CPR.[1] Therefore, most infants and children with both in-hospital and out-of-hospital cardiac arrest do not survive or, if they do survive, have severe neurologic impairment.

New Developments in Resuscitation Science

Emergency Cardiovascular Care Chain of Survival

The 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiac Care have five links in the chain of survival (**Figure 14.1**).[3] The five links are:

- Immediate recognition and activation of the emergency response system
- Early CPR with an emphasis on chest compressions
- Rapid defibrillation
- Effective advanced life support
- Integrated post–cardiac arrest care (Figure 14.1)

The first three links constitute basic life support (BLS). With the current 2010 guidelines, the fifth link, integrated post–cardiac arrest care, was added. One reason for adding the fifth link is the recognition of the importance of quality postresuscitation stabilization and post–cardiac arrest care.

Postresuscitation care has multiple goals: the preservation of neurologic function, the prevention of secondary organ injury, and the diagnosis and treatment of the underlying cause of the arrest. The overriding purpose is to allow the patient to arrive at a tertiary care facility in the best possible physiologic state, thereby allowing for the optimal chance of survival with intact neurologic function.[2] This fifth link emphasizes the importance of newer therapies such as therapeutic hypothermia.

The pediatric chain of survival (**Figure 14.2**) also has five links, which are:

- Prevention
- Early CPR
- Access to the emergency response system

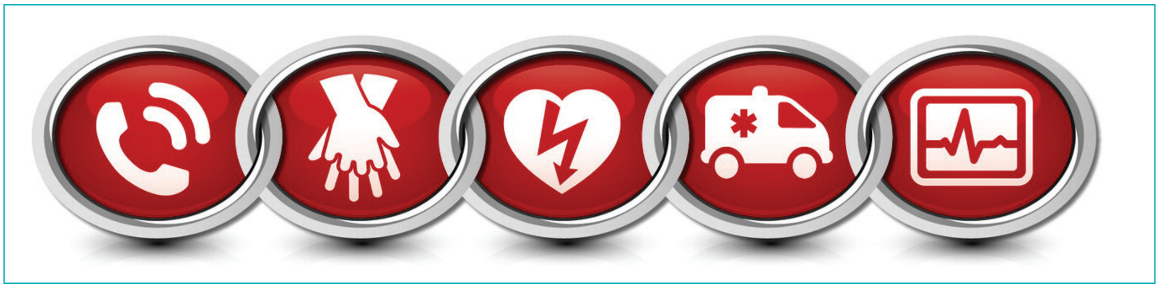

Figure 14.1 Adult chain of survival. Immediate recognition and activation of emergency response system, early cardiopulmonary resuscitation, rapid defibrillation, effective advanced life support, and integrated post-cardiac arrest care.

Travers AH, Rea TD, Bobrow BJ, et al. Part 4: CPR Overview. In: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* (Supplement) 2010; 122(18, suppl 3): S676–S684.

Figure 14.2 Pediatric chain of survival. Prevention, early cardiopulmonary resuscitation, access to the emergency response system, pediatric advanced life support, and post-cardiac arrest care.

Berg MD, Schexnayder SM, Chameides L, et al. Part 13: pediatric basic life support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2010;122(suppl 3):S862–S875.

- Pediatric advanced life support
- Post-cardiac arrest care[1]

High-Quality CPR and High-Quality Chest Compressions

Chest compressions form the cornerstone of CPR (Table 14-1). The emphasis in the new 2010 guidelines is on high-quality CPR. High-quality chest compressions during CPR are critical to generating blood flow to vital organs, especially the heart and the brain, and attaining ROSC. The evidence citing the importance of high-quality chest compressions comes from multiple adult CPR studies. It has been shown that in adults with VF cardiac arrest, chest compressions are more important than ventilations. Outcomes are improved when chest compressions are begun as early as possible, with minimal interruptions. Therefore, the consensus is that all rescuers should initiate chest compressions almost immediately.[4]

To maintain high-quality chest compressions, the individuals who are doing chest compressions should switch frequently before rescuer fatigue occurs because the quality (force and depth) of chest compressions declines with rescuer fatigue.

Compressions, Airway, Breathing

Starting with rescue breathing (ie, positioning the head and achieving a seal for mouth-to-mouth or bag-mask apparatus) takes time and has a net effect of delaying onset of chest compressions.[4] Unlike adults, asphyxial cardiac arrest occurs more frequently in children and infants than VF cardiac arrest. In a recent large pediatric study and in several animal studies of asphyxial cardiac arrest, the outcome is better with both ventilations and chest compressions.[1]

However, practically speaking, beginning CPR with 30 compressions followed by two ventilations would only postpone ventilation by approximately 18 seconds with a single rescuer and even less time when there are two rescuers. Therefore, extrapolating from the adult data, to simplify training and be consistent with adult recommendations, with the hope that this will encourage more bystander CPR, a C-A-B sequence is also recommended for pediatric patients.

This approach is a definite change from previous guidelines, which began with the A-B-C sequence. The new recommendation is to begin CPR with chest compressions and not ventilations.

Chest Compressions During CPR: "Push Hard, Push Fast"

Again, stressing the importance of chest compressions is the principle of "push hard and push fast." The foundation of CPR depends on effective chest compressions, which are essential to providing blood flow to essential organs during CPR. Critical to providing high-quality CPR is providing chest compressions at an adequate rate and depth (push hard), while allowing complete chest recoil after each compression, minimizing interruptions in compressions, and avoiding excessive ventilation. The new "push fast" guideline refers to providing chest compressions at an adequate rate (ie, at least 100/min), whereas the old recommendation was to provide chest compressions at approximately 100/min. It is believed that high-quality (push hard, push fast) compressions are necessary to generate the pressures required to perfuse the coronary and cerebral arteries.

To provide chest compressions of adequate depth, the new recommended compression depths are:

- Infants—at least one-third the depth of the chest (approximately 4 cm [1½ in])
- Children—at least one-third the depth of the chest (approximately 5 cm [2 in])
- Adults—at least 5 cm (2 in)

Pediatric Basic Life Support

The accepted age cutoffs for CPR (eg, foreign-body airway obstruction or BLS) are as follows: infant (<1 year of age), child (1 year to puberty), and adolescent and adult (puberty and older).[5] The general principles and goals of resuscitation—to perfuse vital organs during CPR—are similar no matter what the chronologic age.

Sequence for Pediatric BLS Resuscitation

The new sequence of steps in BLS resuscitation is as follows (Table 14-2 and Figure 14.3):

- Check the patient for responsiveness and breathing.

TABLE 14-1 Basic Life Support (BLS): Key Changes in 2010 Guidelines

CPR	New 2010 Guidelines	Previous 2005 Guidelines
"High-quality" CPR	Emphasis on chest compressions Minimize interruptions in chest compressions Two-minute periods of uninterrupted CPR	Airway opened Two rescue breaths before chest compressions
Sequence	Compressions first	Airway/breathing first
C-A-B vs A-B-C	C-A-B: chest compressions, airway, breathing	A-B-C: airway, breathing, chest compressions
Compressions	Start compressions within 10 seconds of recognition of arrest	Compressions after assessed airway, breathing, two rescue breaths
Compression rate	At least 100/min	Approximately 100/min
Compression cycle	Thirty compressions completed in ≤18 seconds	Thirty compressions completed ≤23 seconds
Compression depth	At least one-third depth of chest: Infant 4 cm (1½ in) Child 5 cm (2 in) Adult at least 5 cm (2 in)	Infant/child: one-third to half depth of chest Adult: 4 to 5 cm (1½ to 2 in)
BLS sequence	• Check responsiveness and breathing • Call for help, get AED • Check pulse (no pulse check if untrained lay provider) • Give 30 compressions (adult one or two rescuers; children one rescuer), 15 compressions (children with two health care provider rescuers) • Open airway, two rescue breaths • Resume compressions	• Check responsiveness • Call for help, get AED • Open airway • Check breathing (look, listen, feel) • Two rescue breaths • Pulse check • Compressions
Breathing assessment	Briefly check for breathing when checking for responsiveness, omit "look, listen, feel"	"Look, listen, feel for breathing" part of BLS sequence
Chain of survival	Fifth link added—"post–cardiac arrest care"	Four links
AED use in infants (<1 year)	Prefer manual defibrillator If none, use AED with pediatric dose attenuator If neither, use AED without dose attenuator	No recommendation for or against AED use in infant
Pulse check	No pulse check for untrained lay provider, deemphasize pulse check for health care professional (if no pulse in 10 seconds, begin chest compressions)	Pulse check in algorithm
Hands-only CPR (adult with sudden collapse)	Bystander not trained in CPR can do hands-only (compression only)	Not addressed
Check responsiveness (for lay rescuer)	If not breathing or only gasping, begin CPR When checking responsiveness, also briefly check for breathing	Breathing check, including "look, listen, feel," is separate step from checking responsiveness

Abbreviations: AED, automatic external defibrillator; CPR, cardiopulmonary resuscitation.

TABLE 14-2 Sequence for Pediatric BLS Resuscitation

No Pulse	Definite Pulse
• Begin cycles of chest compressions: – 30 compressions: two breaths (one rescuer) – 15 compressions: two breaths (two rescuers) • After 2 minutes, activate emergency response system and get AED or manual defibrillator if not already done • Use AED as soon as possible – If manual defibrillator, check rhythm	• Give one breath every 3 to 5 seconds • Add compressions if pulse <60/min with poor perfusion
Shockable Rhythm	**Not Shockable Rhythm**
• Give one shock • Resume CPR immediately for 2 minutes • Recheck rhythm	• Resume CPR immediately • Check rhythm every 2 minutes

Abbreviations: AED, automatic external defibrillator; CPR, cardiopulmonary resuscitation.

- Call for help and get the AED.
- Check the pulse (maximum 10 seconds and for health care professionals only).
- Follow Table 14-2 based on presence or absence of pulse.

Airway and Breathing

Previously, "look, listen, and feel for breathing" was used to assess breathing after the airway was opened. Currently, "look, listen, and feel for breathing" has been eliminated from the sequence for assessment of breathing after opening the airway. When checking responsiveness to detect signs of cardiac arrest, health care professionals should briefly check for breathing. A rescuer should not open the airway and deliver two breaths until after delivery of chest compressions. For a lone rescuer, the compression-to-ventilation ratio is 30:2 or 30 compressions then two breaths. For two health care providers, the compression-to-ventilation ratio is 15:2 or 15 compressions then two breaths. Chest compressions come before the two rescue breaths, using a C-A-B instead of the A-B-C sequence recommended in the past.[1]

Automatic External Defibrillation

According to the previous guidelines, AEDs were not recommended in infants (age <1 year). Now AEDs can be used in infants <1 year. A manual defibrillator is preferred, but if a manual defibrillator is not available, an AED with a pediatric dose attenuator can be used. If neither is available, then an AED without an attenuator can be used.[2]

Pediatric Advanced Life Support

Airway and Breathing

Cricoid Pressure

The new 2010 guidelines no longer routinely recommend cricoid pressure for use during endotracheal intubation[2] (Table 14-3). There is evidence that the use of cricoid pressure, also known as the Sellick maneuver, can actually impede endotracheal intubation and is frequently applied inconsistently and incorrectly by health care professionals in an emergency.[6] Cricoid pressure can still be used in an unresponsive person during bag-mask ventilation, but excessive cricoid pressure should be avoided so as not to obstruct the trachea.

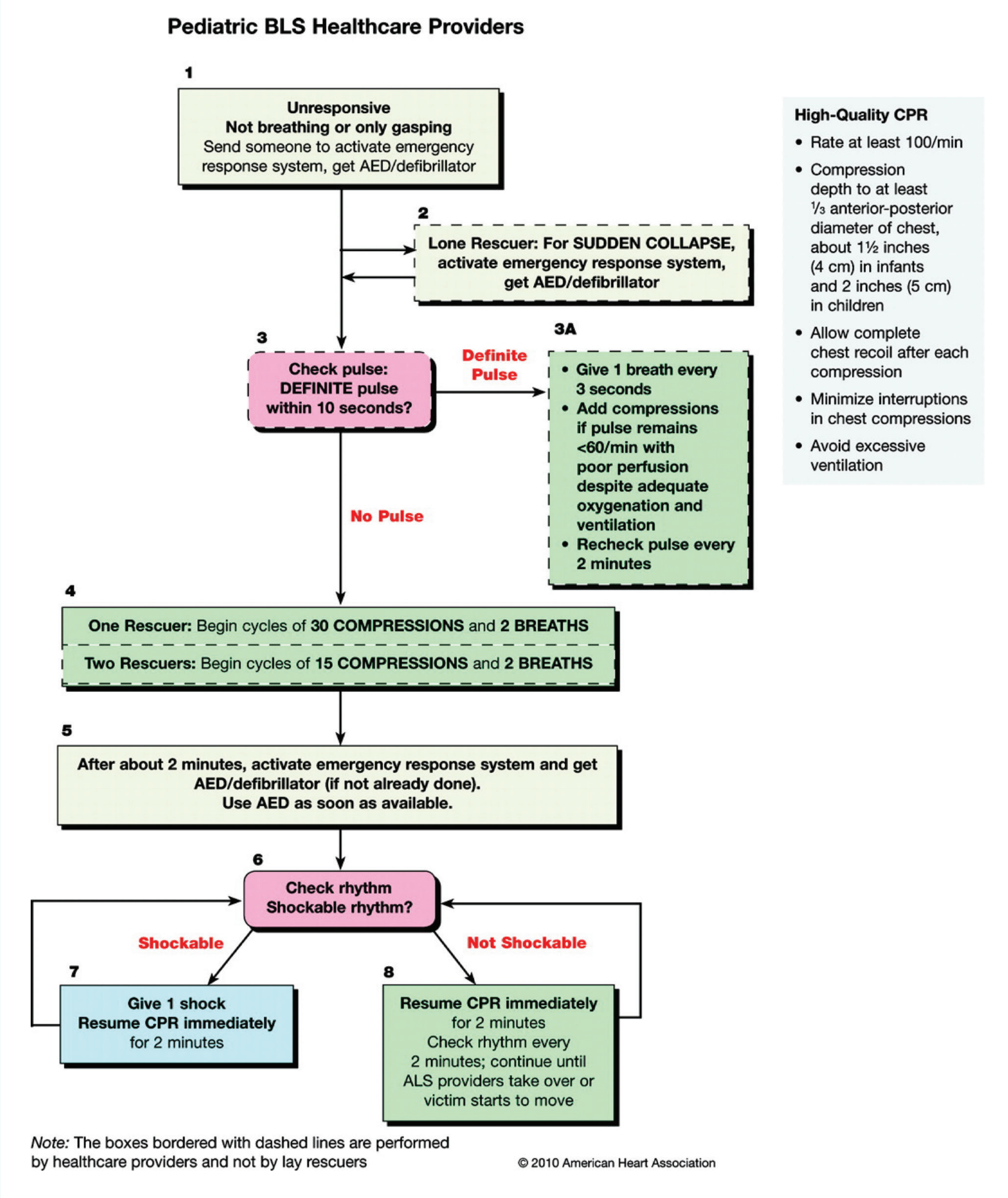

Figure 14.3 Pediatric basic life support algorithm for healthcare providers.

Berg MD, Schexnayder SM, Chameides L, et al. Part 13: pediatric basic life support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2010;122(suppl 3):S862–S875.

THE BOTTOM LINE

Pediatric BLS Algorithm and "High-Quality" Chest Compressions

- Rate: at least 100/min
- Depth:
  - Infant or child at least one-third depth of chest
    - Infant 4 cm (1½ in)
    - Child 5 cm (2 in)
  - Adult at least 5 cm (2 in)
- Compressions: begin within 10 seconds
- Set of 30 compressions for ≤18 seconds
- Minimal interruption in compressions
- Chest compressions, airway, breathing (C-A-B)
- Delete "look, listen, feel"
- Health care professionals briefly check for breathing when checking responsiveness
- Compressions before open airway
  - Lone rescuer: 30 compressions then open airway and give two breaths
  - Lone rescuer provides 2 minutes of CPR before activating emergency response system
  - Two rescuers: 15 compressions to two ventilations ratio
- Automatic external defibrillator (AED) can be used in infants
- Avoid hyperventilation

TABLE 14-3 Pediatric Advanced Life Support: Key Changes in 2010 Guidelines

	New 2010 Guidelines	Previous 2005 Guidelines
Defibrillations: energy dose	Initial: 2-4 J/kg (monophasic, biphasic) Subsequent: ≥4 J/kg up to 10 J/kg or maximum adult dose (can use higher doses)	Initial 2 J/kg Subsequent 4 J/kg
Rhythm: definition of wide-complex tachycardia	Present if QRS width >0.09 seconds	Present if QRS width >0.08 seconds
Airway: cricoid pressure	Routine use not recommended for endotracheal intubation	Recommended.
Airway: ETTs	Can use cuffed or uncuffed tubes	Not addressed.
Airway: capnography (periarrest period)	Quantitative waveform capnography or colorimetric CO_2 detector to confirm ETT placement, monitor CPR quality, detect ROSC (based on $ETCO_2$)	Colorimetric or quantitative capnography to confirm ETT placement.
Titrate arterial oxygen saturation	After ROSC, titrate inspired oxygen to avoid hyperoxemia (maintain oxygen saturation ≥94% but <100%)	No recommendation for titration
Post–cardiac arrest care	Consider therapeutic hypothermia	
Sudden cardiac death	New diagnostic considerations Do a past medical and family history, unrestricted complete autopsy, genetic analysis to identify channelopathy	Not addressed
Congenital heart disease	New section	Not addressed
Neonatal cardiac arrest	Usually asphyxial Continue A-B-C sequence with 3:1 compressions-to-ventilation ratio except when obvious cardiac origin	A-B-C sequence

Abbreviations: CPR, cardiopulmonary resuscitation; ETT, endotracheal tube; $ETCO_2$, end-tidal carbon dioxide pressure; ROSC, return of spontaneous circulation.

Endotracheal Tubes

Cuffed or uncuffed endotracheal tubes (ETTs) are acceptable for intubating infants and children (Table 14-4). A new formula for determining the appropriate size cuffed ETT is:

$$3.5 + \frac{\text{Age in years}}{4}$$

The formula for an uncuffed ETT remains the same[2]:

$$4 + \frac{\text{Age in years}}{4}$$

or

$$\frac{16 + \text{Age in years}}{4}$$

TABLE 14-4 Endotracheal Tube Sizes

Age, yr	Uncuffed, mm	Cuffed, mm
<1	3.5	3.0
1–2	4.0	3.5
>2	$4 + \frac{\text{age}}{4}$	$3.5 + \frac{\text{age}}{4}$

Capnography

Under the previous guidelines, an exhaled carbon dioxide detector (colorimetry/capnometer) or an esophageal detector device was recommended to confirm ETT placement. Since then, it has been recognized that the most reliable technique for the monitoring of ETT placement is with continuous waveform capnography. Therefore, current 2010 guidelines recommend when available, the use of exhaled carbon dioxide detection by colorimetry or capnography for confirming intubation and ongoing monitoring of intubated patients. If capnography is not available, an esophageal detector device can be considered to confirm ETT placement in children weighing more than 20 kg with a perfusing rhythm.[2]

Monitoring the Arterial Oxyhemoglobin Saturation

Ventilation with 100% oxygen during CPR is reasonable. However, recent data suggest that hyperoxia can be harmful after ROSC. Therefore, according to the new guidelines, the arterial oxyhemoglobin saturation should be monitored in the post–cardiac arrest period. When possible, oxygen administration should be titrated to maintain an oxyhemoglobin saturation of 94% or higher in the post–cardiac arrest period. After ROSC is attained, the fraction of inspired oxygen should be adjusted to the minimum concentration necessary for maintaining an arterial oxyhemoglobin saturation of at least 94% while avoiding hyperoxia (ie, 100% saturation, where a PaO_2 can range from 80 to 500 mm Hg). Furthermore, supplemental oxygen might not be necessary for patients without evidence of respiratory distress or an arterial oxyhemoglobin saturation of 94% or higher on room air.

Family Presence During Resuscitation

Dealing with the death of a child can be devastating for the family. Allowing family members to be present during the resuscitation of a child or infant and providing family-centered care and support for grieving families greatly help families deal with their grief after the death of a child. Thus, whenever possible, family members should have the option of being present during the resuscitation of an infant or child.[7,8]

Electrical Therapy

Cardioversion

In pediatric patients, cardioversion should be started with 0.5 to 1.0 J/kg and, if unsuccessful, increased to 2 J/kg.

Defibrillation

Currently, there is insufficient information regarding the lowest effective energy dose or the maximum safe dose for defibrillation in pediatric patients. However, there are data in both children and animal models that doses greater than 4 J/kg are effective and safe for defibrillation in children without significant adverse events.[2] Therefore, the first defibrillation dose should be 2 to 4 J/kg, with a subsequent dose of 4 J/kg. If further defibrillation is needed, the next doses should be at least 4 J/kg, but not greater than 10 J/kg or the maximum adult dose. The appropriate paddle or self-adhesive pad size for children weighing more than 10 kg (or approximately 1 year old) is an adult size of 8 to 10 cm and for infants

THE BOTTOM LINE

Pediatric Advanced Life Support

- Optimal defibrillation energy dose is unknown
  - Initial dose of 2 to 4 J/kg
  - Subsequent dose of 4 J/kg or higher
- After ROSC: titrate oxygen to limit hyperoxemia while maintaining arterial oxyhemoglobin saturation of 94% or higher
- Family presence in resuscitations should be encouraged
- Therapeutic hypothermia can be beneficial
- For pediatric sudden death: obtain past medical and family history, complete autopsy, and genetic analysis looking for channelopathy

(<10 kg) is an infant size.[2] Use the largest size paddles or pads that will fit on a child's chest, leaving approximately 3 cm between paddles or pads.[2] (Using an "infant" pad size on a child >10 kg risks an ineffective shock.)

Pharmacology

Adenosine

Adenosine is still useful for pharmacologic conversion of supraventricular tachycardia. Studies have shown that adenosine is safe and can be effective in the initial assessment and treatment of undifferentiated, monomorphic, wide-complex tachycardia when the rhythm is regular. With the new 2010 recommendations, in addition to its traditional use in narrow-complex supraventricular tachycardia, adenosine can be used for stable, undifferentiated, regular, monomorphic, wide-complex tachycardia but NOT if the rhythm is irregular.

Amiodarone

Amiodarone is given as a rapid bolus for VF and pulseless VT. If a perfusing rhythm is present, it is administered slowly for 20 minutes with a suggested cardiologist consultation.

Atropine

Studies have failed to document any benefit from the routine use of atropine during PEA or asystole, so the new guidelines no longer recommend atropine's routine use in the PEA or asystole algorithm. It is also no longer used in the cardiac arrest algorithm.

Calcium

Calcium is not recommended in cardiac arrest unless hypocalcemia, hyperkalemia, hypermagnesemia, or calcium channel blocker overdose is present.

Etomidate

Etomidate facilitates endotracheal intubation with minimal hemodynamic effect but should not be used routinely in infants and children with septic shock. Etomidate causes adrenal suppression and has been associated with higher mortality rates in children and adults with septic shock.[2]

Lidocaine (Lignocaine)

Lidocaine (lignocaine) is not as effective as amiodarone for improving ROSC or survival to hospital admission in adults with refractory VF. (However, neither amiodarone nor lidocaine [lignocaine] has been proven to improve survival to hospital discharge.) Therefore, lidocaine (lignocaine) is not routinely recommended for VF or VT. In the pediatric cardiac arrest algorithm with a shockable rhythm (ie, VF or pulseless VT), the two drugs that can be given are epinephrine (adrenaline) and amiodarone.

Magnesium

Magnesium is indicated when hypomagnesemia or torsades de pointe (polymorphic VT with long QT) is present. There is insufficient evidence to recommend routine magnesium use during cardiac arrest.

Sodium Bicarbonate

Routine administration of sodium bicarbonate is not recommended in cardiac arrest. However, sodium bicarbonate can be useful in the setting of hyperkalemia and sodium channel blocker toxicity (such as tricyclic antidepressant overdose).

Vasopressin

Data is insufficient to recommend for or against the routine use of vasopressin during cardiac arrest. Although some pediatric and adult data have suggested that vasopressin (or its long-acting analog terlipressin) can be effective in refractory cardiac arrest when standard therapy fails, a large pediatric case series found that lower ROSC, 24-hour survival, and discharge survival were associated with the use of vasopressin.

Table 14-5 summarizes drugs used in the algorithms.

Summary

Basic Life Support

The current focus of the guidelines for CPR is on high-quality CPR, especially high-quality chest compressions. The sequence has changed from A-B-C to C-A-B. Chest compressions should be started as soon as possible and before ventilations with minimal interruptions. For an adult arrest, if there is an untrained lay rescuer, then "hands-only" (compressions-only) CPR is acceptable. However, for pediatric arrest, both compressions and ventilations are still recommended, although the sequence for delivery has now changed to C-A-B. The recommended rate and depth of compressions have also changed to a rate of at least 100/min with time allowed for sufficient recoil and depth of 4 cm in infants, 5 cm in children, and least 5 cm in adults. Interruptions in chest compressions should be minimized.

Pediatric Advanced Life Support: Nonpharmacologic Considerations

The optimal energy dose for the defibrillation of children is unknown. Higher doses might be more successful. The initial dose is 2 to 4 J/kg, and subsequent doses are 4 J/kg or greater. After ROSC, temperature control is important, and supplemental oxygen should be titrated to limit hyperoxemia, while maintaining an arterial oxyhemoglobin saturation of 94% or higher. Therapeutic hypothermia also can be beneficial in the post–cardiac arrest period.

Pediatric Advanced Life Support: Drug Therapy

Some changes in drug therapy have been made. Atropine is not recommended for routine use in the management of PEA or asystole. Lidocaine (lignocaine) and magnesium are no longer routinely recommended for use in the VF or pulseless VT algorithm. The routine use of either sodium bicarbonate or calcium is not recommended either. However, sodium bicarbonate can be used in certain clinical scenarios, such as hyperkalemia and in the treatment of specific toxidromes. Similarly, calcium is indicated in some situations, including hyperkalemia, hypermagnesemia, calcium channel blocker overdose, or hypocalcemia. Adenosine is now regarded as safe and effective for the initial diagnosis and treatment of undifferentiated, regular, monomorphic, wide-complex tachycardia. There are insufficient data to recommend for or against the routine use of vasopressin during cardiac arrest.

TABLE 14-5 Pediatric Advanced Life Support: Drugs Used in Algorithms and Key Changes in 2010 Guidelines

Pharmacology	New 2010 Guidelines	Previous 2005 Guidelines
Adenosine	Effective for SVT and can be effective for undifferentiated, regular, monomorphic, wide-complex, tachycardia	Given for narrow complex tachycardia (SVT)
Amiodarone: unstable dysrhythmia	Can be used for unstable atrial/ ventricular dysrhythmias, including SVT, VT, VF, atrial/ junctional tachycardias	
Amiodarone or procainamide: stable dysrhythmia	Seek consultation if possible when using in stable patient	
Atropine	Not recommended for routine use in PEA or asystole Used in bradycardia algorithm	
Calcium	Routine use is NOT recommended except in hypocalcemia, hyperkalemia, hypermagnesemia, calcium channel blocker overdose	Routine calcium use does not improve outcome
Epinephrine (adrenaline)	Used in bradycardia, pulseless arrest algorithms	
Etomidate	Not recommended for routine use in septic shock	Not addressed.
Lidocaine (lignocaine)	NOT recommended for routine use in VF or pulseless VT	Can be used for VF or pulseless VT
Magnesium	NOT recommended for routine use for VF or pulseless VT Can be used for torsades de pointes with prolonged QT interval	Can be used for VF or pulseless VT
Sodium bicarbonate	Not used routinely in cardiac arrest Used in hyperkalemia, sodium channel blocker toxicity	

Abbreviations: PEA, pulseless electrical activity; SVT, supraventricular tachycardia; VF, ventricular fibrillation; VT, ventricular tachycardia.

CHAPTER REVIEW

Check Your Knowledge

1. Which of the following is correct regarding cardiac arrest in infants and children?
   - **A.** Survival rates for out-of-hospital arrest have increased and more than doubled during the past few decades.
   - **B.** Survival rates for out-of-hospital cardiac arrest are approximately 30%.
   - **C.** Survival rates for out-of-hospital cardiac arrest are less than 10%.
   - **D.** Survival rates for in-hospital cardiac arrests are approximately 60%.
   - **E.** Survival rates for in-hospital cardiac arrests vary depending on the underlying rhythm, with asystole having the best survival rate of approximately 40%.
2. The fifth link in the pediatric chain of survival is:
   - **A.** prevention.
   - **B.** early cardiopulmonary resuscitation (CPR).
   - **C.** access to the emergency response system.
   - **D.** pediatric advanced life support.
   - **E.** post-cardiac arrest care.
3. The 2010 American Heart Association guidelines recommend which of the following?
   - **A.** The CPR sequence is airway, breathing, chest compressions (A-B-C).
   - **B.** The initial steps in CPR are as follows: first open the airway, give two rescue breaths, check a pulse, then begin chest compressions.
   - **C.** The CPR sequence is chest compressions, airway, breathing (C-A-B).
   - **D.** After opening the airway, the rescuer should "look, listen, and feel" for breathing.
   - **E.** The untrained lay provider should do a pulse check.
4. Which of the following is a correct recommendation for chest compressions?
   - **A.** Depth of compressions in infants should be at least 2 cm.
   - **B.** Depth of compressions in children should be at least 3 cm.
   - **C.** Depth of compressions in adults is 3.8 to 5 cm (1½ to 2 in).
   - **D.** Provide chest compression at a rate of at least 100/min.
   - **E.** Provide chest compression at a rate of approximately 100/min.
5. Which of the following is correct regarding the resuscitation guidelines?
   - **A.** Begin CPR with ventilations not chest compressions.
   - **B.** Cricoid pressure is still routinely recommended during endotracheal intubation.
   - **C.** Chest compression cycles should take 23 seconds or less.
   - **D.** There is no recommendation regarding automatic external defibrillation (AEDs) in infants.
   - **E.** AEDs can be used in infants (<1 year old).

6. Which of the following applies to post–cardiac arrest care?
   A. Hyperoxia is not harmful after return of spontaneous circulation.
   B. Oxygen saturation should be titrated to maintain arterial oxygen saturation of 90% or higher.
   C. Continuous waveform capnography is recommended for intubated patients.
   D. Hyperoxemia decreases the oxidative injury after ischemia reperfusion.
   E. There is no need to verify endotracheal tube position, patency, and security.
7. Drug therapy for resuscitation includes which of the following?
   A. Sodium bicarbonate is routinely recommended for cardiac arrest.
   B. Calcium is routinely recommended for cardiac arrest.
   C. Lidocaine (lignocaine) is recommended for use during ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT).
   D. Amiodarone and procainamide can be given together.
   E. Amiodarone is recommended for use during VF or pulseless VT.
8. Drug therapy for resuscitation in the current guidelines includes which of the following?
   A. Lidocaine (lignocaine) improves survival to hospital admission so it is recommended for VF.
   B. Amiodarone improves survival to hospital discharge in VF.
   C. Calcium can be used for calcium channel blocker overdose, hypermagnesemia, hyperkalemia, and hypocalcemia.
   D. Magnesium is routinely recommended for cardiac arrest.
   E. Atropine is still recommended for routine use in pulseless electrical activity or asystole.

References

1. Berg MD, Schexnayder SM, Chameides L, et al. Part 13: Pediatric Basic Life: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation.* 2010;122(18 suppl 3):S862–S875.
2. Kleinman ME, Chameides L, Schexnayder SM, et al. Part 14: Pediatric Advanced Life Support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation.* 2010;122(18 suppl 3):S876–S908.
3. Travers AH, Rea TD, Bobrow BJ, et al. Part 4: CPR Overview: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation.* 2010;122(18 suppl 3):S676–S684.
4. Berg RA, Hemphill R, Abella BS, et al. Part 5: Adult Basic Life Support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation.* 2010;122(18 suppl 3):S685–S705.
5. Hazinski MF, Samson R, Schexnayder S, eds. *2010 Handbook of Emergency Cardiovascular Care for Healthcare Providers.* Dallas, TX: American Heart Association; 2010:4.
6. Mace SE. Challenges and advances in intubation: airway evaluation and controversies with intubation. *Emerg Med Clin North Am.* 2008;26:977–1000.
7. Knazik S, Dietrich A, Gold C, Gausche-Hill M, Johnson R, Mace SE, Socher M. Death of a child in the emergency department. *Ann Emerg Med.* 2003;42:519-529.
8. Brown K, Mace SE, Dietrich AM, Knazik S, Schamban NE. Patient family-centered care for the pediatric patient in the emergency department. *CJEM.* 2008;10:38–43.

CHAPTER REVIEW

CASE SUMMARY 1

You are called to your neighbor's apartment because she could not wake up her 3-month-old daughter. You find the infant in bed, unresponsive, and not breathing.

1. *What is your assessment of this infant?*
2. *What is the appropriate treatment?*

The infant is in cardiopulmonary arrest. The pediatric basic life support algorithm (Figure 14.3), which focuses on high-quality CPR, high-quality chest compressions, should be followed for this infant. You arrive to find that the infant is unresponsive and not breathing. You tell the mother to call 911 and to bring the AED that is in the hallway entrance of the apartment building. Because you are not a healthxcare professional, you do not do a pulse check, but after establishing unresponsiveness and absence of breathing, you begin high-quality CPR at a rate of at least 100/min and a compression depth of at least one-third the anterior-posterior diameter of the chest (approximately 4 cm or 1½ in), allowing for complete chest recoil after each compression, minimizing interruptions in compressions, and beginning cycles of 30 compressions to two breaths. Emergency medical service rescuers arrive with the AED, which advises a "shockable" rhythm, so the AED is charged and one shock is given. CPR is immediately resumed for 2 minutes. The new cycle is now 15:2 because there are now two rescuers. The basic life support rescuer administers ventilatory support, being careful to avoid any interruptions in compressions and avoiding excessive ventilation. The infant is transported with CPR in progress to the emergency department.

Photo Credits

Opener © Stockbyte/ThinkStock

Unless otherwise indicated, all photographs and illustrations are under copyright of Jones & Bartlett Learning, courtesy of Maryland Institute for Emergency Medical Services Systems, or the American Academy of Pediatrics.

Some images in this book feature models. These models do not necessarily endorse, represent, or participate in the activities represented in the images.