PALS

Pediatric Advanced Life Support

2020-2025 Guidelines and Standards

Provider Handbook

By Dr. Karl Disque

PALS

Pediatric Advanced Life Support

Provider Handbook

By Dr. Karl Disque

Satori Continuum Publishing
1810 E Sahara Ave. Suite
1507 Las Vegas, NV 89104

Printed in the United States of America

Educational Service Disclaimer

This Provider Handbook is an educational service provided by Satori Continuum Publishing. Use of this service is governed by the terms and conditions provided below. Please read the statements below carefully before accessing or using the service. By accessing or using this service, you agree to be bound by all of the terms and conditions herein.

The material contained in this Provider Handbook does not contain standards that are intended to be applied rigidly and explicitly followed in all cases. A health care professional's judgment must remain central to the selection of diagnostic tests and therapy options of a specific patient's medical condition. Ultimately, all liability associated with the utilization of any of the information presented here rests solely and completely with the health care provider utilizing the service.

Version 2025.01

TABLE *of* CONTENTS

TABLE *of* CONTENTS

CHAPTER 1

INTRODUCTION TO PALS

The goal of Pediatric Advanced Life Support (PALS) is to save a life. For a child or infant experiencing serious injury or illness, your action can be the difference between life and death. PALS is a series of protocols to guide responses to life-threatening clinical events. These responses are designed to be simple enough to be committed to memory and recalled under moments of stress. PALS guidelines have been developed from thorough review of available protocols, patient case studies, and clinical research; and they reflect the consensus opinion of experts in the field. The gold standard in the United States and many other countries is the course curriculum published by the International Liaison Committee on Resuscitation (ILCOR). Approximately every five years the ILCOR updates the guidelines for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiovascular Care (ECC). This handbook is based on the most recent ILCOR publication of PALS and will periodically compare the previous and the new recommendations for a more comprehensive review.

Any provider attempting to perform PALS is assumed to have developed and maintained competence with not only the materials presented in this handbook, but also certain physical skills, including Basic Life Support (BLS) interventions. Since PALS is performed on children and infants, PALS providers should be proficient in BLS for these age groups. While we review the basic concepts of pediatric CPR, providers are encouraged to keep their physical skills in practice and seek additional training if needed.

Proper utilization of PALS requires rapid and accurate assessment of the child or infant's clinical condition and selection and delivery of the appropriate intervention for the given situation. This not only applies to the provider's initial assessment of a child or an infant in distress, but also to the reassessment throughout the course of treatment utilizing PALS guidelines.

PALS protocols assume that the provider may not have all of the information needed from the child or the infant or all of the resources needed to properly use PALS in all cases. For example, if a provider is utilizing PALS on the side of the road, they will not have access to sophisticated devices to measure breathing or arterial blood pressure. Nevertheless, in such situations, PALS providers have the framework to provide the best possible care in the given circumstances. PALS algorithms are based on current understanding of best practice to deliver positive results in life-threatening cases and are intended to achieve the best possible outcome for the child or the infant during an emergency.

CHAPTER 2

THE RESUSCITATION TEAM

The ILCOR guidelines for PALS highlights the importance of effective team dynamics during resuscitation. In the community (outside a health care facility), the first rescuer on the scene may be performing CPR alone; however, a pediatric arrest event in a hospital may bring dozens of people to the patient's room. It is important to quickly and efficiently organize team members to effectively participate in PALS. The ILCOR supports a team structure with each provider assuming a specific role during the resuscitation. This consists of a team leader and several team members *(Table 1)*.

Clear communication between team leaders and team members is essential.

TEAM LEADER	TEAM MEMBER
• Organizes the group • Monitors performance • Able to perform all skills • Directs team members • Provides feedback on group performance after the resuscitation efforts	• Understand their role • Be willing, able, and skilled to perform the role • Understand the PALS sequence • Committed to the team's success

Table 1

It is important to know your own clinical limitations. Resuscitation is the time for implementing acquired skills, not trying new ones. Clearly state when you need help and call for help early in the care of the person. Resuscitation demands mutual respect, knowledge sharing, and constructive criticism. After each resuscitation case, providers should spend time reviewing the process and providing each other with helpful and constructive feedback. Ensuring an attitude of respect and support is crucial and aids in processing the inevitable stress that accompanies pediatric resuscitation *(Figure 1)*.

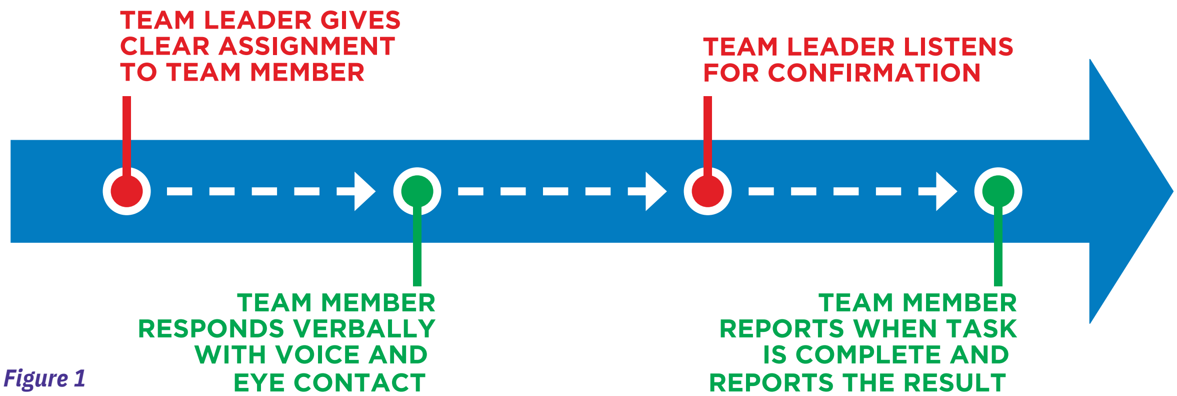


Figure 1
Closed-Loop Communication

CHAPTER 3

BASIC LIFE SUPPORT

This handbook covers PALS and only briefly describes BLS. All PALS providers are assumed to be able to perform BLS appropriately. It is essential that PALS providers be proficient in BLS first. High-quality BLS is the foundation of PALS.

Basic Life Support (BLS) utilizes CPR and cardiac defibrillation when an Automated External Defibrillator (AED) is available. BLS is the life support method used when there is limited access to advanced interventions such as medications and monitoring devices. In general, BLS is performed until the emergency medical services (EMS) arrives to provide a higher level of care. In every setting, high-quality CPR is the foundation of both BLS and PALS interventions. High-quality CPR gives the child or the infant the greatest chance of survival by providing circulation to the heart, brain, and other organs until return of spontaneous circulation (ROSC).

Differences in BLS for Infants and BLS for Children

INFANTS (0 to 12 months)	CHILDREN (1 year to puberty)
According to the 2020 CPR guidelines, for all ages of children, the ratio of compressions to ventilations should be 30:2 for one provider and 15:2 for two providers.	
Check for infant's pulse using the brachial artery on the inside of the upper arm between the infant's elbow and shoulder.	*Check for child's pulse using the carotid artery on the side of the neck or femoral pulse on the inner thigh in the crease between the leg and groin.*
Perform compressions on the infant using two fingers (if you are by yourself) or two thumbs with hands encircling the infant's chest (with two rescuers)	*Perform compressions on a child using one or two-handed chest compressions depending on the size of the child.*
Compression depth should be one-third of the chest depth; for most infants, this is about 1.5 inches (4 cm).	*Compression depth should be one-third of the chest depth; for most children, this is 2 inches (5 cm).*
If you are the only person at the scene and find an unresponsive infant or child, perform CPR for two minutes before you call EMS or go for an AED.	
If you witness a cardiac arrest in an infant or child, call EMS and get an AED before starting CPR.	

Table 2

BLS FOR CHILDREN (1 YEAR TO PUBERTY)

BLS for both children and infants is almost identical. For example, if two rescuers are available to perform CPR, the compression to breath ratio is 15:2 for both children and infants.

ONE-RESCUER BLS FOR CHILDREN

If you are alone with a child, do the following:

1. Tap their shoulder and talk loudly to the child to determine if they are responsive.
2. If the child does not respond and is not breathing (or is only gasping for breath), yell for help. If someone responds, send the second person to call 911 and to get an AED.
3. Assess if they are breathing while feeling for the child's carotid pulse (on the side of the neck) or femoral pulse (on the inner thigh in the crease between their leg and groin) for no more than 10 seconds.
4. If you cannot feel a pulse (or if you are unsure), begin CPR by doing 30 compressions followed by two breaths. If you can feel a pulse but the pulse rate is less than 60 beats per minute, you should begin CPR. This rate is too slow for a child.
5. After doing CPR for about two minutes (usually about five cycles of 30 compressions and two breaths) and if help has not arrived, call EMS while staying with the child. The ILCOR emphasizes that cell phones are available everywhere now and most have a built-in speakerphone. Get an AED if you know where one is.
6. Use and follow AED prompts when available while continuing CPR until EMS arrives or until the child's condition normalizes.

TWO-RESCUER BLS FOR CHILDREN

If you are not alone with a child, do the following:

1. Tap their shoulder and talk loudly to the child to determine if they are responsive.
2. If the child does not respond and is not breathing (or is only gasping for breath), send the second rescuer to call 911 and get an AED.
3. Assess if they are breathing while feeling for the child's carotid pulse (on the side of the neck) or femoral pulse (on the inner thigh in the crease between their leg and groin) for no more than 10 seconds.
4. If you cannot feel a pulse (or if you are unsure), begin CPR by doing 15 compressions followed by two breaths. If you can feel a pulse but the rate is less than 60 beats per minute, begin CPR. This rate is too slow for a child.
5. When the second rescuer returns, begin CPR by performing 15 compressions by one rescuer and two breaths by the second rescuer.
6. Use and follow AED prompts when available while continuing CPR until EMS arrives or until the child's condition normalizes.

BLS FOR INFANTS (0 TO 12 MONTHS)

BLS for both children and infants is almost identical. The main differences between BLS for children and BLS for infants are *(Table 2)*:

Figure 2

- Check the pulse in the infant using the brachial artery on the inside of the upper arm between the infant's elbow and shoulder.
- During CPR, compressions can be performed on an infant using two fingers (with one rescuer) or with two thumb-encircling hands (if there are two rescuers and rescuer's hands are big enough to go around the infant's chest) *(Figure 2)*.
- Compression depth should be one-third of the chest depth; for most infants, this is about 1.5 inches (4 cm).
- In infants, primary cardiac events are not common. Usually, cardiac arrest will be preceded by respiratory problems. Survival rates improve as you intervene with respiratory problems as early as possible. Keep in mind that prevention is the first step in the Pediatric Chain of Survival.

ONE-RESCUER BLS FOR INFANTS

If you are alone with an infant, do the following:

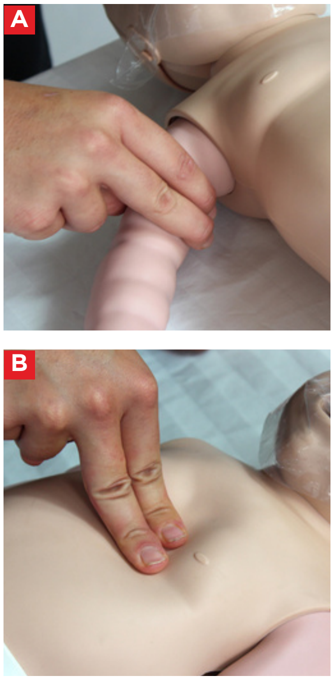


Figure 3

1. Tap the bottom of their foot and talk loudly to the infant to determine if they are responsive.
2. If the infant does not respond, and they are not breathing (or if they are only gasping), yell for help. If someone responds, send the second person to call EMS and to get an AED.
3. Assess if they are breathing while feeling for the infant's femoral or brachial pulse for no more than 10 seconds *(Figure 3a)*.
4. If you cannot feel a pulse (or if you are unsure), begin CPR by doing 30 compressions followed by two breaths. If you can feel a pulse but the rate is less than 60 beats per minute, begin CPR. This rate is too slow for an infant. To perform CPR on an infant do the following *(Figure 3b)*:
   a. Be sure the infant is face-up on a hard surface.
   b. Using two fingers, perform compressions in the center of the infant's chest; do not press on the end of the sternum as this can cause injury to the infant.
   c. Compression depth should be about 1.5 inches (4 cm) and a rate of 100 to 120 per minute.
5. After performing CPR for about two minutes (usually about five cycles of 30 compressions and two breaths) if help has not arrived, call EMS while staying with the infant. The ILCOR emphasizes that cell phones are available everywhere now and most have a built-in speakerphone. Get an AED if you know where one is.
6. Use and follow AED prompts when available while continuing CPR until EMS arrives or until the infant's condition normalizes.

TWO-RESCUER BLS FOR INFANTS

If you are not alone with the infant, do the following:

1. Tap the bottom of their foot and talk loudly at the infant to determine if they are responsive.
2. If the infant does not respond and is not breathing (or is only gasping), send the second rescuer to call 911 and get an AED.
3. Assess if they are breathing while simultaneously feeling for the infant's brachial pulse for 5 but no more than 10 seconds.
4. If you cannot feel a pulse (or if you are unsure), begin CPR by doing 15 compressions followed by two breaths. If you can feel a pulse but the rate is less than 60 beats per minute, begin CPR. This rate is too slow for an infant.
5. When the second rescuer returns, begin CPR by performing 15 compressions by one rescuer and two breaths by the second rescuer. If the second rescuer can fit their hands around the infant's chest, perform CPR using the two thumb-encircling hands method. Do not press on the bottom end of the sternum as this can cause injury to the infant.
6. Compressions should be approximately 1.5 inches (4 cm) deep and at a rate of 100 to 120 per minute.
7. Use and follow AED prompts when available while continuing CPR until EMS arrives or until the infant's condition normalizes.

Pediatric BLS Algorithm

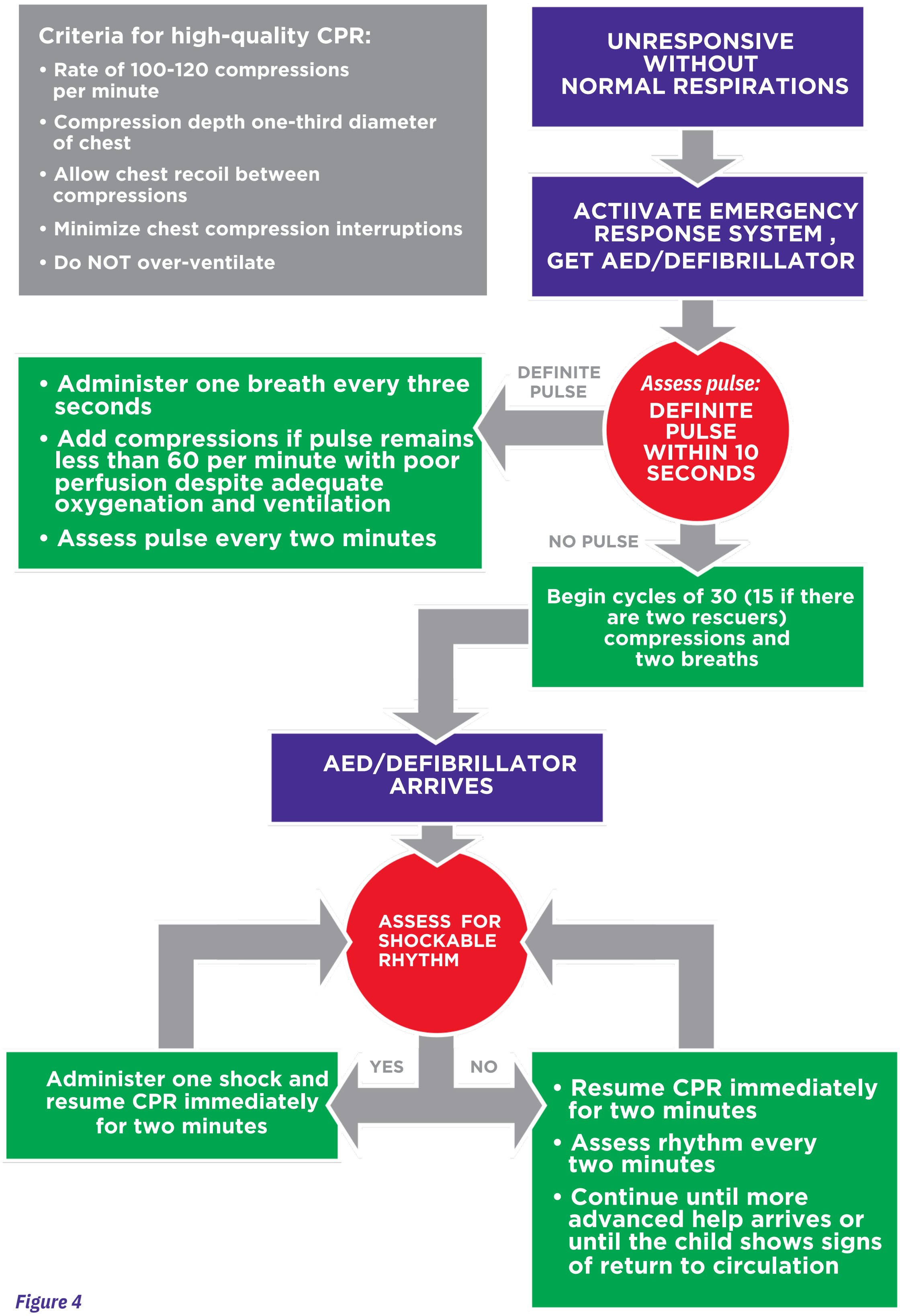


Figure 4

SELF-ASSESSMENT FOR BLS

1. You respond to a child or an infant that is found down. What is the next action after determining unresponsiveness?
    a. Apply AED.
    b. Tell a bystander to call 911.
    c. Look for a parent.
    d. Provide rescue breaths.
2. Which of the following describes the brachial pulse location?
    a. Wrist - thumb side
    b. Elbow - inside near forearm
    c. Upper arm - inside
    d. Neck - either side of the trachea
3. What is the two-rescuer CPR compression to breath ratio for children and infants?
    a. 30:2
    b. 15:2
    c. 30:5
    d. 15:5
4. Effective communication is key in all resuscitation attempts. Which of the following are components of effective team communication?
    a. Knowledge sharing
    b. Clear communication
    c. Mutual respect
    d. All of the above

ANSWERS

1. B

Early activation is key. Send any available bystanders to call 911. Many pediatric cardiac arrest situations are the result of a respiratory problem, and immediate intervention can be life-saving.

2. C

The brachial pulse is located in the upper arm.

3. B

For children and infants, 15:2is the ratio for two rescuers, and 30:2 is the ratio for one rescuer.

4. D

Additional components include clear messages, knowing one's limitations, constructive intervention, reevaluation, and summarizing.

CHAPTER 4

PEDIATRIC ADVANCED LIFE SUPPORT

NORMAL HEART ANATOMY AND PHYSIOLOGY

Understanding normal cardiac anatomy and physiology is an important component of performing PALS. The heart is a hollow muscle comprised of four chambers surrounded by thick walls of tissue (septum). The atria are the two upper chambers, and the ventricles are the two lower chambers. The left and right halves of the heart work together to pump blood throughout the body. The right atrium (RA) and the right ventricle (RV) pump deoxygenated blood to the lungs where it becomes oxygenated. This oxygen-rich blood returns to the left atrium (LA) and then enters the left ventricle (LV). The LV is the main pump that delivers the newly oxygenated blood to the rest of the body.

Blood leaves the heart through a large vessel known as the aorta. Valves between each pair of connected chambers prevent the backflow of blood. The two atria contract simultaneously, as do the ventricles, making the contractions of the heart go from top to bottom.

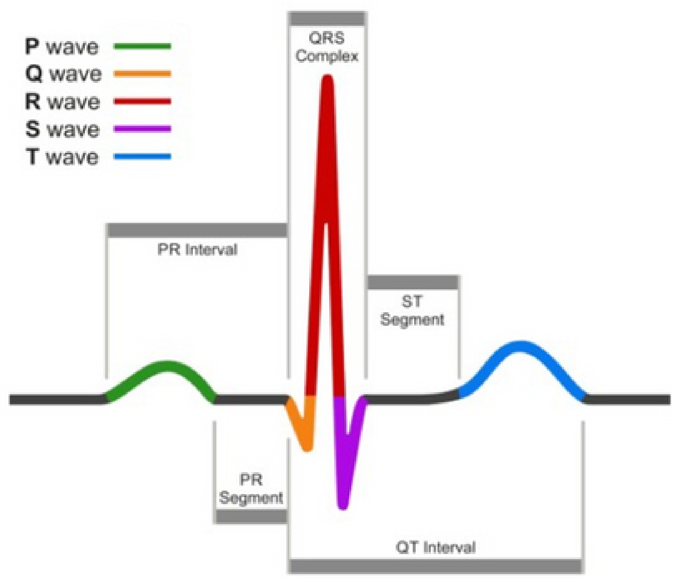


Figure 5

Each beat begins in the RA. The LV is the largest and thickest-walled of the four chambers, as it is responsible for pumping the newly oxygenated blood to the rest of the body. The sinoatrial (SA) node in the RA creates the electrical activity that acts as the heart's natural pacemaker. This electrical impulse then travels to the atrioventricular (AV) node, which lies between the atria and ventricles. After pausing there briefly, the electrical impulse moves on to the His–Purkinje system, which acts like wiring to conduct the electrical signal into the LV and RV. This electrical signal causes the heart muscle to contract and pump blood.

By understanding the normal electrical function of the heart, it will be easy to understand abnormal functions. When blood enters the atria of the heart, an electrical impulse that is sent out from the SA node conducts through the atria resulting in atrial contraction.

This atrial contraction registers on an electrocardiogram (ECG) strip as the P wave. This impulse then travels to the AV node, which in turn conducts the electrical impulse through the Bundle of His, bundle branches, and Purkinje fibers of the ventricles causing ventricular contraction. The time between the start of atrial contraction and the start of ventricular contraction registers on an ECG strip as the PR interval. The ventricular contraction registers on the ECG strip as the QRS complex. Following ventricular contraction, the ventricles rest and repolarize, which is registered on the ECG strip as the T wave. The atria also repolarize, but this coincides with the QRS complex, and therefore, cannot be observed on the ECG strip. Together a P wave, QRS complex, and T wave at proper intervals are indicative of normal sinus rhythm (NSR) (Figure 5). Abnormalities that are in the conduction system can cause delays in the transmission of the electrical impulse and are detected on the ECG. These deviations from normal conduction can result in dysrhythmias such as heart blocks, pauses, tachycardias and bradycardias, blocks, and dropped beats. These rhythm disturbances will be covered in more detail further in the handbook.

A SYSTEMATIC APPROACH

When you find an unresponsive child or infant, it is often not possible to immediately deduce the etiology. You will want to act quickly, decisively, and apply interventions that fit the needs of the individual at that moment. In order to achieve this, PALS was designed for providers to take a comprehensive approach.

While there are various causes for a child or an infant to become unresponsive, the central issues that need to be addressed include
keeping blood pumping through the vasculature (perfusion) and supplying oxygen to the lungs (oxygenation). When the child or infant is experiencing poor perfusion and oxygenation, CPR manually takes over for the heart and lungs. If they are still adequately maintaining perfusion and oxygenation but are unresponsive, then rapid diagnosis and treatment may be possible without CPR.

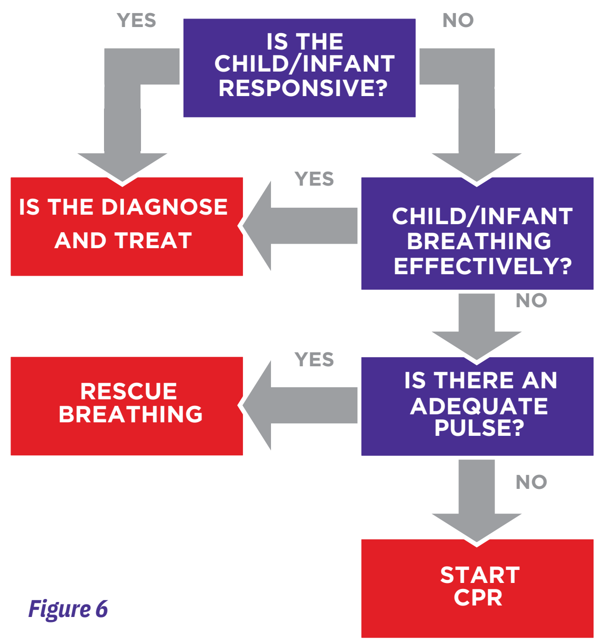


Figure 6

It is important to differentiate normal breathing from gasping (agonal breathing). Gasping is considered ineffective breathing.

Likewise, not all pulses are adequate. The rule of thumb is that at least 60 beats per minute is required to maintain adequate perfusion in a child or an infant.

The assessment must be carried out quickly. There is a low threshold for administering ventilation and/or compressions if there is evidence that the child or infant cannot do either effectively on their own.

If the problem is respiratory in nature (ineffective breathing with adequate pulses), then initiation of rescue breathing is warranted. If breathing is ineffective and pulses are inadequate, begin high-quality CPR immediately. It is important to understand that any case can change at any time, so you must reevaluate periodically and adjust the approach to treatment accordingly. Use CPR to support breathing and circulation until the cause has been identified and effectively treated.

INITIAL DIAGNOSIS AND TREATMENT

If you have reached the initial diagnosis and treatment phase of care, the child or infant is not in immediate danger of death. While this means that you likely have a brief period to find the cause of the problem and intervene with appropriate treatment, it does not mean that a life-threatening event is impossible. Always be vigilant for any indication to initiate high-quality CPR and look for life-threatening events such as respiratory distress, a change in consciousness, or cyanosis.

The ILCOR recommends following the ABCDE method when making an initial assessment *(Figure 7)*.

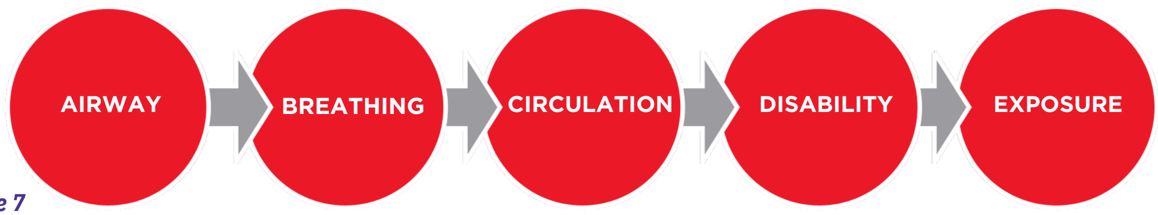


Figure 7

AIRWAY

Assess the airway and make a determination between one of three possibilities *(Table 3)*.

Once an airway has been established and maintained, move on to breathing.

Is the airway open?	• *This means open and unobstructed* • *If yes, proceed to Breathing*
Can the airway be kept open manually?	• *Jaw-Lift/Chin-Thrust* • *Nasopharyngeal or oropharyngeal airway*
Is an advanced airway required?	• *Endotracheal intubation* • *Cricothyrotomy, if necessary*

Table 3

BREATHING

If the child or infant is not breathing effectively, it is a life-threatening event and should be treated as respiratory arrest.

However, abnormal yet marginally effective breathing can be assessed and managed *(Table 4)*.

Is breathing too fast or too slow?	• *Tachypnea has an extensive differential diagnosis* • *Bradypnea can be a sign of impending respiratory arrest*
Is there increased respiratory effort?	• *Signs of increased respiratory effort include nasal flaring, rapid breathing, chest retractions, abdominal breathing, stridor, grunting, wheezing, and crackles*
Is an advanced airway required?	• *Endotracheal intubation* • *Cricothyrotomy, if necessary*

Table 4

CIRCULATION

Assessment of circulation in pediatrics involves more than checking the pulse and blood pressure. The color and temperature of the skin and mucous membranes can help to assess effective circulation. Pale or blue skin indicates poor tissue perfusion. Capillary refill time is also a useful assessment in pediatrics. Adequately, perfused skin will rapidly refill with blood after it is squeezed (e.g. by bending the tip of the finger at the nail bed). Inadequately perfused tissues will take longer than two seconds to respond. Abnormally, cool skin can also suggest poor circulation.

The normal heart rate and blood pressure in pediatrics are quite different than in adults and change with age. Likewise, heart rates are slower when children and infants are asleep. Most centers will have acceptable ranges that they use for normal and abnormal heart rates for a given age. While you should follow your local guidelines, approximate ranges are listed in *(Table 5)*.

AGE	NORMAL HEART RATE (AWAKE)	NORMAL HEART RATE (ASLEEP)	NORMAL BLOOD PRESSURE (SYSTOLIC)	NORMAL BLOOD PRESSURE (DIASTOLIC)	HYPOTENSION BLOOD PRESSURE (SYSTOLIC)
Neonate	*85-190*	*80-160*	*60-75*	*30-45*	*<60*
One Month	*85-190*	*80-160*	*70-95*	*35-55*	*<70*
Two Months	*85-190*	*80-160*	*70-95*	*40-60*	*<70*
Three Months	*100-190*	*75-160*	*80-100*	*45-65*	*<70*
Six Months	*100-190*	*75-160*	*85-105*	*45-70*	*<70*
One Year	*100-190*	*75-160*	*85-105*	*40-60*	*<72*
Two Years	*100-140*	*60-90*	*85-105*	*40-65*	*<74*
Child (2 to 10 years)	*60-140*	*60-90*	*95-115*	*55-75*	*<70 + (age x 2)*
Adolescent (over 10 years)	60-100	50-90	110-130	65-85	<90

Table 5

DISABILITY

In PALS, disability refers to performing a rapid neurological assessment. A great deal of information can be gained from determining the level of consciousness on a four-level scale. Pupillary response to light is also a fast and useful way to assess neurological function.

AWAKE	*May be sleepy, but still interactive*
RESPONDS TO VOICE	*Can only be aroused by talking or yelling*
RESPONDS TO PAIN	*Can only be aroused by inducing pain*
UNRESPONSIVE	*Cannot get the patient to respond*

Table 6

Neurologic assessments include the AVPU (alert, voice, pain, unresponsive) response scale and the Glasgow Coma Scale (GCS). A specially-modified GCS is used for children and infants and takes developmental differences into account *(Tables 6 and 7)*.

Glasgow Coma Scale for Children and Infants

AREA ASSESSED	INFANTS	CHILDREN	SCORE
Eye-opening	*Open spontaneously*	*Open spontaneously*	*4*
	Open in response to verbal stimuli	*Open in response to verbal stimuli*	*3*
	Open in response to pain only	*Open in response to pain only*	*2*
	No response	*No response*	*1*
Verbal response	*Coos and babbles*	*Oriented, appropriate*	*5*
	Irritable cries	*Confused*	*4*
	Cries in response to pain	*Inappropriate words*	*3*
	Moans in response to pain	*Incomprehensible words or nonspecific sounds*	*2*
	No response	*No response*	*1*
Motor response	*Moves spontaneously and purposelly*	*Obeys commands*	*6*
	Withdraws to touch	*Localizes painful stimulus*	*5*
	Withdraws in response to pain	*Withdraws in response to pain*	*4*
	Responds to pain with decorticate posturing (abnormal flexion)	*Responds to pain with flexion*	*3*
	Responds to pain with decerebrate posturing (abnormal extension)	*Responds to pain with extension*	*2*
	No response	*No response*	*1*

Table 7

>> Next: Exposure

EXPOSURE

Exposure is classically most important when you are responding to a child or infant who may have experienced trauma; however, it has a place in all PALS evaluations. Exposure reminds the provider to look for signs of trauma, burns, fractures, and any other obvious sign that might provide a clue as to the cause of the current problem. Skin temperature and color can provide information about the child or infant's cardiovascular system, tissue perfusion, and mechanism of injury. If time allows, the PALS provider can look for more subtle signs such as petechiae or bruising. Exposure also reminds the provider that children and infants lose core body temperature faster than adults do. Therefore, while it is important to evaluate the entire body, be sure to cover and warm the individual after the diagnostic survey.

SECONDARY DIAGNOSIS AND TREATMENT

After you have progressed through the ABCDE method and have discovered a treatable cause, and the child or infant has not deteriorated to a more severe clinical (life-threatening) situation, move on to performing a more thorough survey. This includes a focused history and physical examination involving the individual, family, and any witnesses as relevant. In terms of history, you could follow the acronym SPAM: Signs and symptoms, Past medical history, Allergies, and Medications (Table 8).

The focused examination will be guided by the answers to the focused history. For example, a report of difficult breathing will prompt a thorough airway and lung examination. It may also prompt a portable chest x-ray study in a hospital setting. Key point is that it is best to work from head to toe to complete a comprehensive survey. Make use of diagnostic tools when possible to augment the physical examination.

S: SIGNS & SYMPTOMS
• *Evaluate recent events related to current problem* *-Preceding illness, dangerous activity*
• *Examine patient from head to toe for the following:* *- Consciousness, delerium* *- Agitation, anxiety, depression* *- Fever* *- Breathing* *- Appetite* *- Nausea/vomiting* *- Diarrhea (bloody)*
P: PAST MEDICAL HISTORY
• *Complicated birth history*
• *Hospitalizations*
• *Surgeries*
A: ALLERGIES
• *Any drug or environmental allergies*
• *Any exposure to allergens or toxins*
M: MEDICATIONS
• *What medications is the child taking (prescribed and OTC)?*
• *Could child have taken any inappropriate medication or substance?*

Table 8

LIFE-THREATENING ISSUES

If at any time you determine that the child or infant is experiencing a life-threatening emergency, support breathing and cardiovascular function immediately. This usually means providing high-quality CPR. While it is important to recognize and respond to the particular cause of the problem, the time required to determine the problem should not interfere with perfusion and oxygenation for the child or the infant. As you maintain breathing and circulation for them, determine if they are primarily experiencing respiratory distress/arrest, bradycardia, tachycardia, shock, or cardiac arrest. Individual PALS protocols for each of these clinical situations are provided throughout this handbook.

SELF-ASSESSMENT FOR PALS

1. What is a simple mnemonic for aid in the assessment of mental status?
   a. AVPU
   b. SAMPLE
   c. ABCDE
   d. NRP
2. You are resuscitating a child and your partner suggests to follow SPAM. What is this acronym related to?
   a. Primary survey (Initial Diagnosis and Treatment)
   b. CPR technique
   c. Secondary survey (Secondary Diagnosis and Treatment)
   d. Medications to consider
3. True or False: The Glasgow Coma Scale (GSC) verbal component utilizes the exact same responses for infants and adults.

ANSWERS

1. A
   AVPU (alert, voice, pain, unresponsive) is a simple assessment tool to assess for adequate brain perfusion.
2. C
   SPAM stands for Signs and symptoms, Past medical history, Allergies, Medications. SPAM refers to the history component of the more comprehensive secondary survey (Secondary Diagnosis and Treatment).
3. False
   The GSC is modified for children and infants. The verbal abilities of an infant are much different from those of a child or adult.

CHAPTER 5

RESUSCITATION TOOLS

Understanding that resuscitation tools are available is an essential component of PALS. These adjuncts are broken down into two subcategories: medical devices and pharmacological tools.
A medical device is an instrument used to diagnose, treat, or facilitate care. Pharmacological tools are the medications used to treat the common challenges experienced during a pediatric emergency. It is important that thorough understanding is achieved to optimally care for a child or an infant that needs assistance.

Intraosseous access should not be attempted without training.

MEDICAL DEVICES

INTRAOSSEOUS ACCESS

The relative softness of bones in young children makes intraosseous access a quick, useful means to administer fluids and medications in emergency situations when intravenous access cannot be performed quickly or efficiently. Fortunately, any medication that can be given through a vein can be administered into the bone marrow without dose adjustment. Contraindications include bone fracture, history of bony malformation, and insertion site infection.

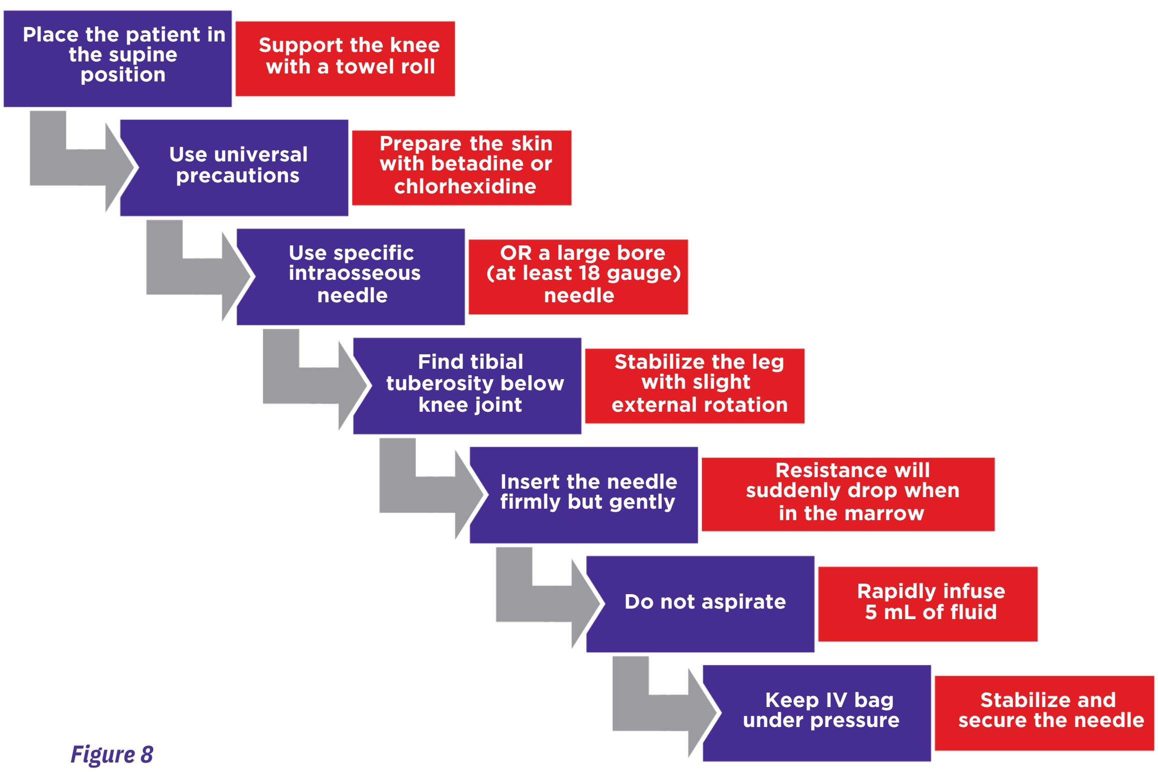


Figure 8

BAG-MASK VENTILATION

When performed appropriately, bag-mask ventilation is an important intervention in PALS. Proper use requires proper fit: the child or the infant's mouth and nose should be covered tightly, but not the eyes. When possible, use a clear mask since it will allow you to see the color of their lips and the presence of condensation in the mask indicating exhalation.

The two most common types of bag-masks are self-inflating and flow-inflating. While a self-inflating bag-mask should be the first choice in resuscitations, it should not be used in children or infants who are breathing spontaneously. Flow-inflating bag-masks, on the other hand, require more training and experience to operate properly as the provider must simultaneously manage gas flow, suitable mask seal, individual's neck position, and proper tidal volume. The minimum size bag should be 450 mL for infants and young and/or small children. Older children may require a 1000 mL volume bag. Proper ventilation is of utmost importance as insufficient ventilation leads to respiratory acidosis.

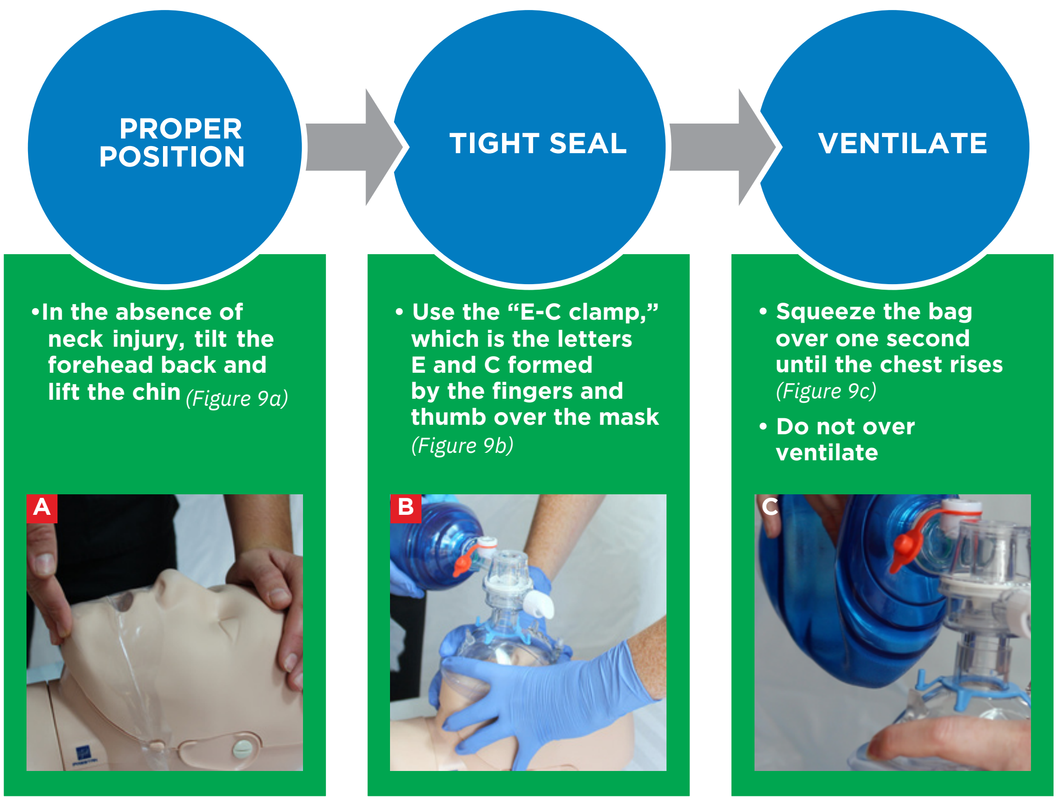


Figure 9

ENDOTRACHEAL INTUBATION

Endotracheal (ET) intubation is used when the airway cannot be maintained, when bag-mask ventilation is inadequate or ineffective, or when a definitive airway is necessary. ET intubation requires specialized training and a complete description is beyond the scope of this handbook.

BASIC AIRWAY ADJUNCTS

Oropharyngeal Airway

The oropharyngeal airway (OPA) is a J-shaped device that fits over the tongue to hold the soft hypopharyngeal structures and the tongue away from the posterior wall of the pharynx. OPA is used in persons who are at risk for developing airway obstruction from the tongue or from relaxed upper airway muscle.

If efforts to open the airway fail to provide and maintain a clear, unobstructed airway, then use the OPA in unconscious persons. An OPA should not be used in a conscious or semiconscious person because it can stimulate gagging and vomiting. The key assessment is to check whether the person has an intact cough and gag reflex. If so, do not use an OPA.

- *Only use an OPA in unresponsive persons with no cough or gag reflex. Otherwise, OPA can stimulate vomiting, aspiration, and laryngeal spasm.*
- *An NPA can be used in conscious persons with intact cough and gag reflex. However, use carefully in persons with facial trauma because of risk of displacement.*
- *Keep in mind that the person is not receiving 100% oxygen while suctioning. Interrupt suctioning and administer oxygen if any change in monitoring parameters is observed during suctioning.*

Nasopharyngeal Airway

The nasopharyngeal airway (NPA) is a soft rubber or plastic un-cuffed tube that provides a conduit for airflow between the nares and the pharynx. It is used as an alternative to an OPA in persons who need a basic airway management adjunct. Unlike the oral airway, NPAs may be used in conscious or semiconscious persons (persons with intact cough and gag reflex). The NPA is indicated when insertion of an OPA is technically difficult or dangerous. Use caution or avoid placing NPAs in a person with obvious facial fractures.

Suctioning

Suctioning is an essential component of maintaining a patent airway. Providers should suction the airway immediately if there are copious secretions, blood, or vomit. Attempts at suctioning should not exceed 10 seconds. To avoid hypoxemia, follow suctioning attempts with a short period of 100% oxygen administration. Monitor the person's heart rate, pulse oxygen saturation, and clinical appearance during suctioning. If a change in monitoring parameters is seen, interrupt suctioning and administer oxygen until the heart rate returns to normal and until clinical condition improves. Assist ventilation as warranted.

BASIC AIRWAY TECHNIQUE

Inserting an OPA

STEP 1: Clear the mouth of blood and secretions with suction if possible.

STEP 2: Select an airway device that is the correct size for the person.

- Too large of an airway device can damage the throat.
- Too small of an airway device can press the tongue into the airway.

STEP 3: Place the device at the side of the person's face. Choose the device that extends from the corner of the mouth to the earlobe.

STEP 4: Insert the device into the mouth so the point is toward the roof of the mouth or parallel to the teeth.

- Do not press the tongue back into the throat.

STEP 5: Once the device is almost fully inserted, turn it until the tongue is cupped by the interior curve of the device.

Inserting an NPA

STEP 1: Select an airway device that is the correct size for the person.

STEP 2: Place the device at the side of the person's face. Choose the device that extends from the tip of the nose to the earlobe. Use the largest diameter device that will fit.

STEP 3: Lubricate the airway with a water-soluble lubricant or anesthetic jelly.

STEP 4: Insert the device slowly, moving straight into the face (not toward the brain).

STEP 5: It should feel snug; do not force the device into the nostril. If it feels stuck, remove it and try the other nostril.

• OPAs too large or too small may obstruct the airway.

• NPAs sized incorrectly may enter the esophagus.

• Always check for spontaneous respirations after insertion of either device.

Tips on Suctioning

- When suctioning the oropharynx, do not insert the catheter too deeply. Extend the catheter to the maxi- mum safe depth and suction as you withdraw.
- When suctioning an ET tube, remember the tube is within the trachea and you may be suctioning near the bronchi/lung. Therefore, sterile technique should be used.
- Each suction attempt should be for no longer than 10 seconds. Remember the person will not get oxygen during suctioning.
- Monitor vital signs during suctioning and stop suctioning immediately if the person experiences hypoxemia (oxygen sats less than 94%), has a new arrhythmia or becomes cyanotic.

AUTOMATED EXTERNAL DEFIBRILLATOR

If you look around the public places you visit, you are likely to find an Automated External Defibrillator (AED). An AED is both sophisticated and easy to use, providing life-saving power in a user-friendly device. This makes the device useful for people who have no experience operating an AED and allows successful use in stressful scenarios. However, proper use of an AED is very important. The purpose of defibrillation is to reset the electrical systems of the heart, allowing a normal rhythm a chance to return.

Criteria for AED Use:

• No response after shaking and shouting.

• Not breathing or ineffective breathing.

• No carotid artery pulse detected.

AED Steps for Children and Infants

1. Retrieve the AED *(Figure 10a)*.
   a. Open the case.
   b. Turn on the AED.
2. Expose the infant or the child's chest *(Figure 10b)*.
   a. If wet, dry chest.
   b. Remove medication patches.
3. Open the pediatric AED pads *(Figure 10c)*. If pediatric pads are not available, use adult pads. Ensure that the pads do not touch.
   a. Peel off backing.
   b. Check for pacemaker or defibrillator; if present, do not apply patches over the device.
4. Apply the pads *(Figure 10d)*.
   a. Upper right chest above breast.
   b. Lower left chest below armpit.
   c. If pads will touch on the chest of an infant, apply one pad on the anterior chest and another pad on the posterior of the infant instead.

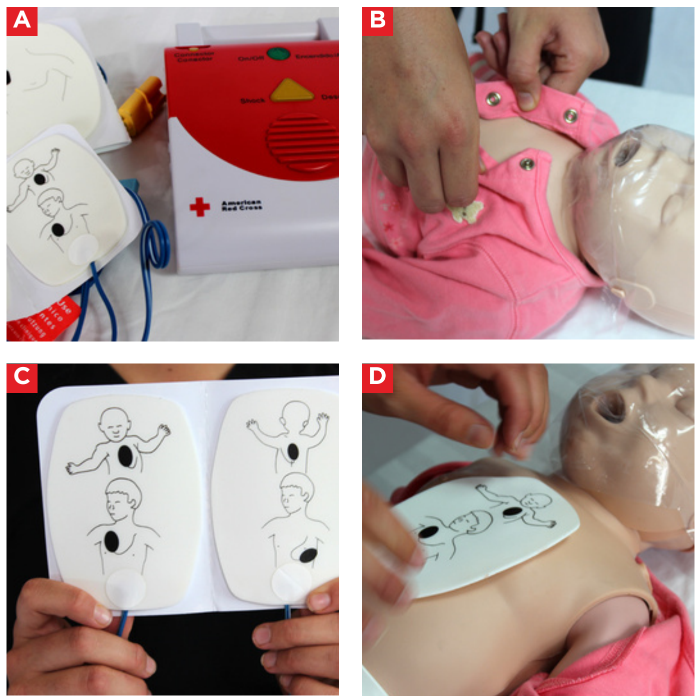


Figure 10

• If the AED is not working properly, continue giving CPR. Do not waste excessive time troubleshooting the AED. CPR always comes first; AEDs are supplemental.

• Do not use AED in water.

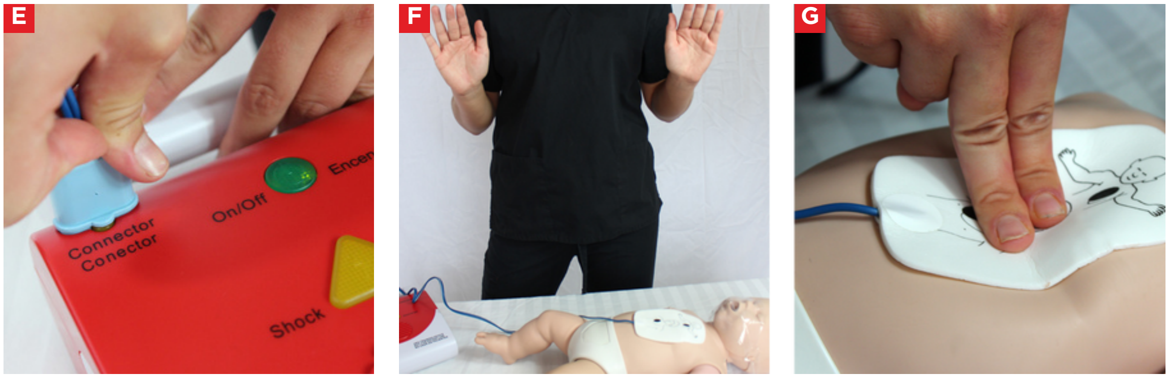


Figure 10

AED Steps for Children and Infants Continued

5. Ensure wires are attached to AED box *(Figure 10e)*.

6. Move away from the person *(Figure 10f)*.

    a. Stop CPR.
    b. Instruct others not to touch the person.

7. AED analyzes the rhythm.

8. If message reads "Check Electrodes," then:

    a. Ensure electrodes make good contact.
    b. If message reads "Shock," then shock.

9. Resume CPR for two minutes *(Figure 10g)*.

10. Repeat cycle.

PHARMACOLOGICAL TOOLS

Use of any of the medications listed in *Table 9* should be done within your scope of practice and after thorough study of the actions and side effects. This table provides only a brief reminder for those who are already knowledgeable in the use of these medications. Moreover, *Table 9* contains only pediatric doses, indications, and routes of administration (intravenous/intraosseous) for the most common PALS drugs. Although cited for reference, routine administration of drugs via an ET tube is discouraged. Rapid access and drug delivery through an IO are preferred to ET administration as drug absorption from the ET tube route is unpredictable.

DRUG	MAIN PALS USE	PEDIATRIC DOSE (IV/IO)	NOTES
Adenosine	*Supraventricular tachycardia*	*First dose: 0.1 mg/kg (MAX DOSE 6 mg)* *Second dose: 0.2 mg/kg (MAX DOSE 12 mg)*	*Rapid IV/IO bolus (no ET)* *Flush with saline* *Monitor ECG*
Amiodarone	*Tachyarrhythmia*	*5 mg/kg over 20 to 60 minutes*	*Very long half-life* *Monitor ECG & BP*
Atropine	*Bradycardia*	*0.02 mg/kg* *ET: 0.03 mg/kg* *Repeat once if needed* *(MAX single dose 0.5 mg)*	*Also used to treat specific toxins (e.g. organophosphate poisoning)*
Epinephrine	*Cardiac Arrest/ Shock*	*IV/IO: 0.01 mg/kg [1:10,000] (MAX DOSE 1 mg)* *ET: 0.1 mg/kg [1:1,000] (MAX DOSE 2.5 mg)*	*Multiple uses, multiple routes* *Repeat every 3 to 5 min if needed*
Glucose	*Hypoglycemia*	*0.5 to 1 g/kg*	*Newborn: 5 to 10 mL/kg D10W* *Infants/Children: 2 to 4 mL/kg D25W* *Adolescents: 1 to 2 mL/kg D50W*
Lidocaine	*Tachyarrhythmia*	*Initial: 1 mg/kg* *Infusion: 20 to 50 mcg/kg/min* *(MAX DOSE 100 mg)* *ET: 2 to 3 mg*	
Magnesium Sulfate	*Torsades de Pointes* *Refractory Asthma*	*20 to 50 mg/kg over 10 to 20 min* *(MAX DOSE 2 grams)*	*May run faster for Torsades*
Milrinone	*Cardiogenic Shock*	*Initial: 50 mcg/kg over 10 to 60 min* *Maintain: 0.5 to 0.75 mcg/kg/min*	*Longer infusion times and euvolemia will reduce risk of hypotension*
Naloxone	*Opioid Reversal*	*Less than 5 y/o OR under 20 kg: 0.1 mg/kg* *Over 5 y/o OR over 20 kg: 2 mg IV q 2 to 3 min prn*	*Decrease dose to reverse respiratory depression due to therapeutic opioid use (1 to 5 mcg/kg, titrate to effect)*
Procainamide	*Tachyarrhythmia*	*15 mg/kg over 30 to 60 minutes*	*Do NOT give with amiodarone* *Monitor ECG & BP*
Sodium Bicarbonate	*Metabolic Acidosis Hyperkalemia*	*1 mEq/kg slow bolus* *(MAX DOSE 50 mEq)*	*Monitor ABG & ECG* *After adequate ventilation*

Table 9

SELF-ASSESSMENT FOR RESUSCITATION TOOLS

1. What is the proper sequence for AED operation?
   a. Apply pads, turn on AED, deliver shock, and clear individual.
   b. Apply pads, clear individual, deliver shock, and analyze rhythm.
   c. Turn on AED, apply pads, deliver shock, and resume CPR.
   d. Turn on AED, analyze rhythm, CPR, and deliver shock.
2. You are treating a 10-year old with a rapid pulse. The monitor is showing supraventricular tachycardia (SVT). What drug do you consider to treat this person?
   a. Vasopressin
   b. Lidocaine
   c. Bretylium
   d. Adenosine
3. Which of the following explains why ET delivery of drugs is not the preferred route?
   a. Unpredictable absorption
   b. Allergic reaction
   c. Difficult administration
   d. High effectiveness

ANSWERS

1. C

AED devices are equipped with instructions and may also have voice prompts making these devices operable by everyone.

2. D

Adenosine is effective for the treatment of SVT. The first dose is 0.1 mg/kg up to a maximum of 6 mg. The second dose is 0.2 mg/kg up to a maximum of 12 mg.

3. A

Delivery of medications via the ET tube results in unpredictable absorption. The intravenous or intraosseous route is preferred.

RESPIRATORY DISTRESS/FAILURE

RECOGNIZING RESPIRATORY DISTRESS/FAILURE

In its simplest form, respiratory distress is a condition in which pulmonary activity is insufficient to bring oxygen to and to remove carbon dioxide from the blood. Challenge arises with the recognition of respiratory distress when the person appears to be breathing but is not actually breathing effectively. Proper rate and depth of breathing is important to assess when evaluating whether the person is effectively breathing. The two main actions involved in breathing are ventilation and oxygenation. Consider the signs and symptoms presented below.

VENTILATION			OXYGENATION		
Is the airway clear?	*Are the muscles of the chest functioning?*	*Is the rate of breathing sufficient?*	*Is oxygen available?*	*Is lung blood flow adequate?*	*Can gases cross the pulmonary vasculature?*
Ex. An obstructed airway prevents gas flow	*Ex. Chest muscle fatigue can occur*	*Ex. CNS depression can slow/stop breathing*	*Ex. High altitudes have low O2*	*Ex. Vascular shunts may not send blood to lungs*	*Ex. Pulmonary edema or pneumonia*

RESPIRATORY DISTRESS — RESPIRATORY FAILURE

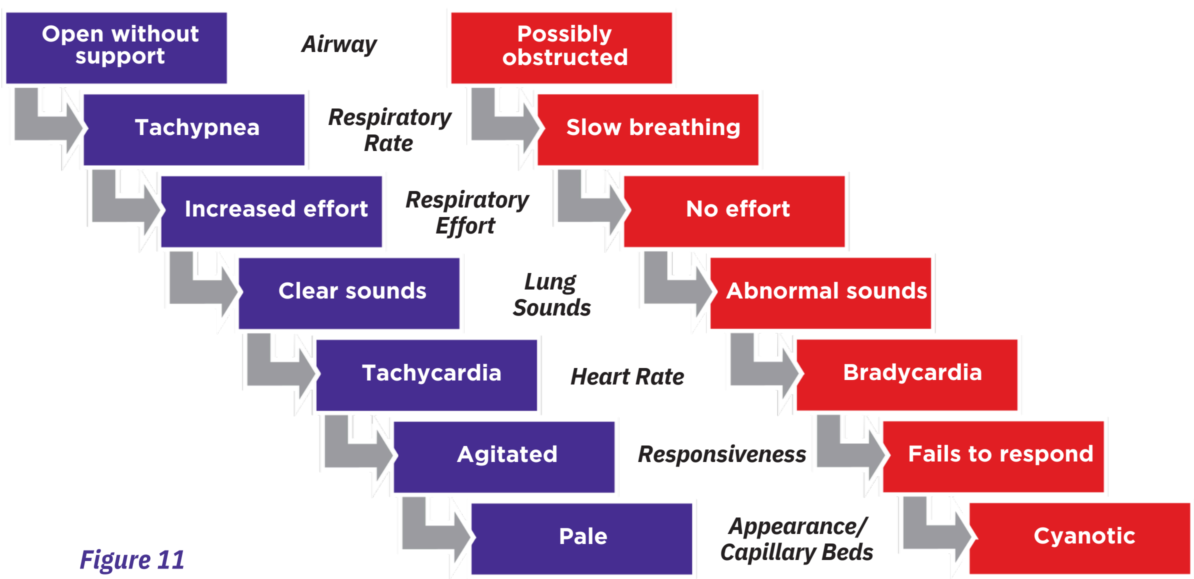


Figure 11

Abnormal breath sounds

STRIDOR	• *Upper airway obstruction (foreign body)*
GRUNTING	• *Upper airway obstruction (swollen airway)* • *Pneumonia (grunting to recruit alveoli)*
WHEEZING	• *Lower airway obstruction (asthma)*
CRACKLES	• *Fluid in lungs (wet)* • *Atelectasis (dry)*
ABSENT/DECREASED BREATH SOUNDS	• *Collapsed lung (air, blood)* • *Lung tissue disease (pneumonia)*

Table 11

CAUSES OF RESPIRATORY DISTRESS/FAILURE

Respiratory distress or failure generally falls into one of four broad categories *(Table 12)*: upper airway, lower airway, lung tissue disease, and central nervous system (CNS) issues. This list is not comprehensive, and specific conditions should be addressed with specific therapy, but these represent the most common causes of respiratory distress or failure in a pediatric population.

In some instances, breath sounds can provide information about the source of the breathing problem.

UPPER AIRWAY	LOWER AIRWAY	LUNG TISSUE DISEASE	CNS ISSUES
Croup (swelling)	*Bronchiolitis*	*Pneumonia*	*Overdose*
Foreign body	*Asthma*	*Pneumonitis*	*Head trauma*
Retropharyngeal abscess		*Pulmonary edema*	
Anaphylaxis			

Table 12

RESPONDING TO RESPIRATORY DISTRESS/FAILURE

INITIAL MANAGEMENT OF RESPIRATORY DISTRESS/FAILURE			
AIRWAY	*Open and support the airway*	*Suction*	*Consider advanced airway*
BREATHING	*Monitor O_2 sats*	*Supplemental O_2*	*Nebulizers*
CIRCULATION	*Monitor vitals*	*Establish vascular access*	

Table 13

- *As an example, croup management depends on the severity of the disease.*
- *Dexamethasone, a corticosteroid, can cause hypertension and reduce activation of lymphocytes.*

PALS management of respiratory distress/failure is adjusted based on the severity of the current condition. For example, mild asthma is treated with bronchodilator inhalers, but severe asthma (status asthmaticus) may require ET intubation. The provider must continually assess the person's current needs and adjust care accordingly.

Croup Management

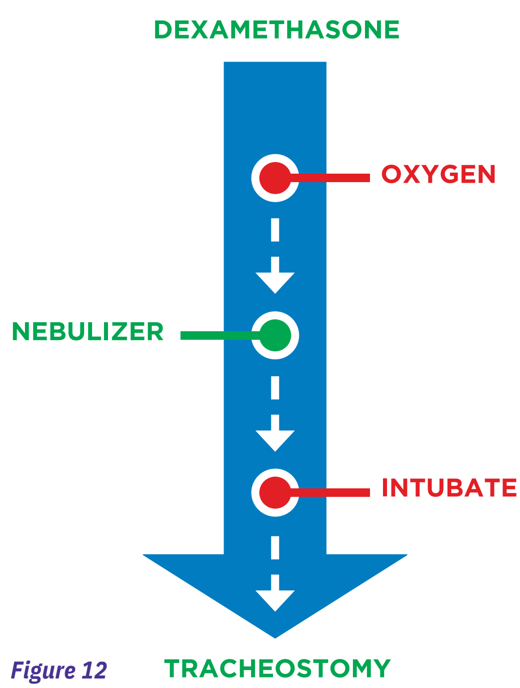


Figure 12

UPPER AIRWAY		LOWER AIRWAY		LUNG TISSUE DISEASE		CNS ISSUES	
Cause	*Treatment*	*Cause*	*Treatment*	*Cause*	*Treatment*	*Cause*	*Treatment*
CROUP	*Dexamethasone* *Oxygen (Heliox)* *Nebulizer (epinephrine)* *Intubate* *Tracheostomy*	*BRONCHIOLITIS*	*Suctioning* *Nebulizers*	*PNEUMONIA*	*Dexamethasone* *Oxygen (Heliox)* *Nebulizer (epinephrine)* *Tracheostomy* *Antibiotics (bacterial)*	*OVERDOSE*	*Naloxone (opioid reversal)* *Antidotes* *Support breathing*
FOREIGN BODY	*Dexamethasone* *Oxygen (Heliox)* *Nebulizer (epinephrine)* *Intubate* *Tracheostomy*	*ASTHMA*	*Oxygen (Heliox)* *Nebulizers (albuterol and ipratropium bromide)* *Cor ticosteroids* *Magnesium sulfate* *Epinephrine SQ* *Support breathing*	*PNEUMONITIS*	*Nebulizers* *Support* *breathing*	*TRAUMA*	*Neurosurgery* *Reduce intracranial pressure* *Support breathing*
ANAPHYLAXIS	*Epinephrine IM* *Nebulizer* *Diphenhydramine*			*PULMONARY EDEMA*	*Diuretics* *Inotrope* *Support breathing*		

Table 14

SELF-ASSESSMENT FOR RESPIRATORY DISTRESS/FAILURE

1. Which of the following sounds suggest an upper airway obstruction?
    a. Stridor
    b. Burping
    c. Rales
    d. Apnea

2. A five-year-old child is laughing and playing with his siblings. Moments later, the child was noted to be coughing with asymmetric chest rise. What is the most likely cause?
    a. Trauma
    b. Airway obstruction
    c. Stroke
    d. Pericardial tamponade

3. A four-month-old female infant is noted to be febrile and grunting. What underlying problem does grunting suggest?
    a. Behavior problem
    b. Upper airway obstruction
    c. Lung tissue disease
    d. Diabetes

ANSWERS

1. A
   Stridor suggests an upper airway source of obstruction.
2. B
   Asymmetric chest rise in this setting is most likely a foreign body obstructing the right mainstem bronchus. Other causes include pneumothorax, hemothorax, pleural effusion, and mucous plugging.
3. C
   Grunting is a sign of lung tissue abnormalities such as pneumonia or pulmonary contusion and acute respiratory distress, and may progress to respiratory failure.

CHAPTER 7

BRADYCARDIA

RECOGNIZING BRADYCARDIA

Bradycardia is defined as a heart rate that is slower than what is considered normal for a child's age. Bradycardia in children and infants should be evaluated, but not all bradycardia needs to be medically managed. Intervention is required when bradycardia is symptomatic and compromises cardiovascular function. This commonly means that the heart is beating too slowly to maintain blood pressure, thereby causing shock, poor tissue perfusion, and/or a change in mental status. Symptomatic bradycardia may cause a number of signs and symptoms including low blood pressure, pulmonary edema/congestion, abnormal rhythm, chest discomfort, shortness of breath, lightheadedness, confusion, and/or syncope. Bradycardia most commonly becomes symptomatic when it is of new onset for the person (acute slowing of the heart rate).

Sinus Bradycardia

- Normal rhythm with slow rate

First Degree AV Block

- PR interval is longer than 0.20 seconds

Type I Second Degree AV Block (Mobitz I/Wenckebach)

- PR interval increases in length until QRS complex is dropped

Type II Second Degree AV Block (Mobitz II)

- PR interval is the same length with an intermittently dropped QRS complex

Third Degree AV Block (Complete)

- PR interval and QRS complex are not coordinated with each other

RESPONDING TO BRADYCARDIA

SYMPTOMATIC BRADYCARDIA	
CHECK HEART RATE	• *Confirm abnormally low heart rate or a significant rate drop from previous normal*
PALS SURVEY	*A: Airway* *B: Breathing (Check O_2 sats; administer O_2 as needed)* *C: Circulation (Check blood pressure and rate; 12-lead ECG; IV/IO access)* *D: Disability (Check Neuro status)* *E: Exposure (Check for signs of trauma, burns, fractures, etc.)*
CHECK FOR SIGNS/ SYMPTOMS	• *Are there symptoms of shock or acute change in mental status?* • *Are there symptoms being caused by the bradycardia?*
BRADYCARDIA SYMPTOMATIC AND SERIOUS	• *Do not delay CPR* • *Epinephrine 0.01 mg/kg IO/IV–Can be given every 3-5 minutes* • *Atropine 0.02 mg/kg IO/IV–Can be repeated once*
DRUGS UNSUCCESSFUL	• *Consider transthoracic/transvenous pacing (preferably with sedation) especially if bradycardia is the result of a complete heart block or an abnormal sinus node function* • *Seek expert consultation*

Table 15

- *The primary goal of symptomatic bradycardia treatment is to make sure the heart is adequately pumping blood to the body (adequate perfusion).*
- *Treatment is not necessarily aimed at increasing the heart rate. Treatment should continue until symptoms/signs resolve.*
- *If the person stops having a pulse, move to the Cardiac Arrest Protocol.*
- *Always consider the reversible causes of bradycardia in pediatrics and treat if possible.*
- *Atropine in doses less than 0.1 mg may worsen bradycardia (paradoxical bradycardia).*

PALS BRADYCARDIA ALGORITHM

Effective management of bradycardia in pediatric patients is crucial for emergency care professionals. Understanding the PALS bradycardia algorithm enables providers to quickly assess and treat life-threatening slow heart rhythms in children. This guide offers an overview of the key aspects of the PALS bradycardia algorithm, enhancing your ability to respond promptly during critical situations.

IMPORTANCE OF THE PALS BRADYCARDIA ALGORITHM

The PALS bradycardia algorithm is a systematic approach designed to assist clinicians in identifying and managing bradycardia in pediatric patients. It focuses on:

- **Early Recognition:** Promptly identifying signs of bradycardia to initiate immediate intervention.
- **Assessment of Hemodynamic Stability:** Determining the impact of bradycardia on circulation and organ perfusion.
- **Appropriate Intervention:** Implementing correct treatments based on the severity and underlying cause of the bradycardia.

By adhering to the PALS bradycardia algorithm, health care providers can improve patient outcomes and reduce the risk of progression to cardiac arrest.

Pediatric Bradycardia with Pulse/Poor Perfusional Algorithm

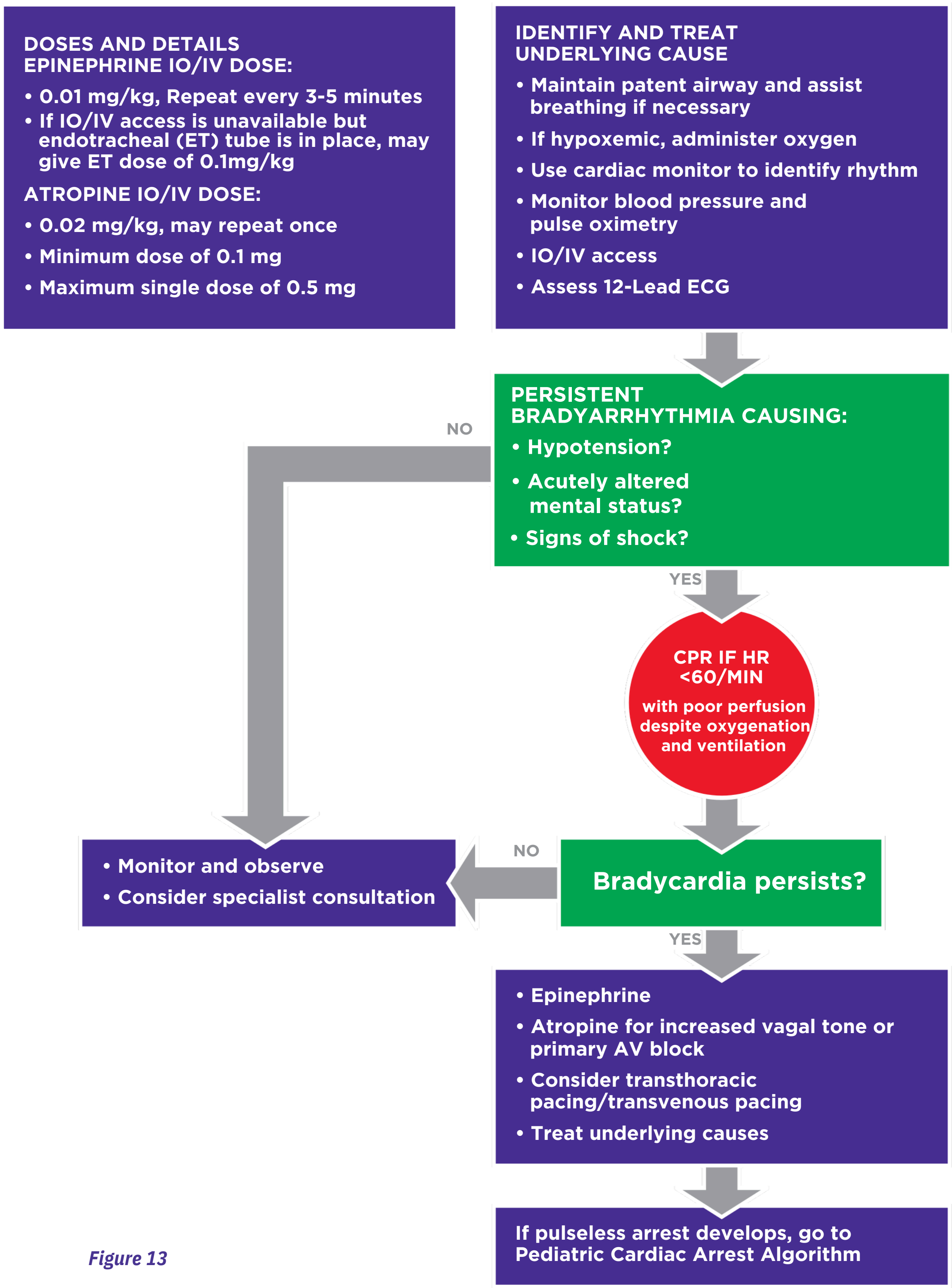


Figure 13

KEY CONSIDERATIONS IN THE PALS BRADYCARDIA ALGORITHM

1. Assess and Support ABCs

- **Airway:** Ensure the airway is open and clear; position the child appropriately.
- **Breathing:** Provide oxygen and support ventilation if necessary; monitor for adequate chest rise.
- **Circulation:** Check heart rate, pulse quality, skin color, and capillary refill time.

2. Identify Bradycardia

- **Definition:** A heart rate of less than 60 beats per minute in infants and children, especially when associated with poor perfusion.
- **Clinical Signs:** Weak pulses, hypotension, altered mental status, and signs of shock, such as pale or cool skin.

3. Evaluate for Underlying Causes

- **Hypoxia:** The most common cause of bradycardia in children; ensure adequate oxygenation.
- **Other Causes:** Consider hypothermia, acidosis, electrolyte imbalances, toxins, or increased intracranial pressure.

4. Initial Interventions

- **Oxygen Administration:** Provide high-flow oxygen to improve oxygen saturation.
- **Ventilatory Support:** Assist with bag-mask ventilation if the child is not breathing adequately.
- **Monitor Vital Signs:** Continuously observe heart rate, respiratory rate, and oxygen saturation.

5. Advanced Interventions

- **Epinephrine:** If bradycardia persists, administer 0.01 mg/kg of epinephrine intravenously or intraosseously every 3-5 minutes.
- **Atropine:** Consider 0.02 mg/kg of atropine for bradycardia due to increased vagal tone or primary atrioventricular block.
- **Transcutaneous Pacing:** If medication is ineffective and bradycardia persists, initiate pacing as per protocol.

SELF-ASSESSMENT FOR BRADYCARDIA

1. You are treating a child with a toxin ingestion, resulting in bradycardia. Atropine is advised by poison control. Why is the minimum dose 0.1 mg IV?
    a. Rebound tachycardia
    b. May worsen bradycardia
    c. Apnea
    d. Cardiac arrest
2. What is the drug of choice in managing symptomatic bradycardia?
    a. Adenosine
    b. Epinephrine
    c. Lidocaine
    d. Dopamine
3. Your team is treating a child with symptomatic bradycardia. His heart rate is 22 bpm, and you are having difficulty obtaining blood pressure. Epinephrine and atropine have had no effect. What would be the next most appropriate action?
    a. Faster CPR
    b. Transthoracic pacing
    c. High dose epinephrine
    d. Terminate resuscitation

ANSWERS

1. B
   A dose less than 0.1 mg may worsen the bradycardia. The maximum dose for a child is 0.5 mg.
2. B
   Epinephrine is a potent vasopressor and will also increase heart rate. The dose for bradycardia is 0.01 mg/kg IV or IO.
3. B
   Transthoracic pacing is an option for treatment of symptomatic bradycardia when drug therapy fails.

CHAPTER 8

TACHYCARDIA

RECOGNIZING TACHYCARDIA

Tachycardia is defined as a heart rate greater than what is considered normal for a child's age. Like bradycardia, tachycardia can be life-threatening if it compromises the heart's ability to perfuse effectively. When the heart beats too quickly, there is a shortened relaxation phase. This causes two main problems: the ventricles are unable to fill completely, so cardiac output is lowered; and the coronary arteries receive less blood, so supply to the heart is decreased.

There are several kinds of tachycardia, and they can be difficult to differentiate in children on ECG due to the elevated heart rate.

Signs and symptoms of tachycardia

- Respiratory distress/failure
- Poor tissue perfusion (e.g. low urine output)
- Altered mental state
- Pulmonary edema/congestion
- Weak, rapid pulse

Sinus tachycardia

- Normal rhythm with fast rate
- Likely non-dangerous
- Commonly occurring during stress or fever

Supraventricular tachycardia

- Rhythm starts above the ventricles

Atrial fibrillation

- Causes irregularly irregular heart rhythm

Atrial flutter

- Causes a sawtooth pattern on ECG

Ventricular tachycardia

- Rhythm starts in the ventricles

Pediatric tachyarrhythmias are first divided into narrow complex or wide complex tachycardia. Measure the QRS complex on a standard ECG to assess its width.

NARROW QRS COMPLEX (⩽ 0.09 s)	WIDE QRS COMPLEX (> 0.09 s)
Atrial fibrillation or Atrial flutter	*Ventricular tachycardia*
Sinus tachycardia	*Unusual SVT*
Supraventricular Tachycardia (SVT)	

Table 16

NARROW QRS COMPLEX

Atrial flutter is an uncommon rhythm distinguished on an ECG as a sawtooth pattern. It is caused by an abnormal pathway that causes the atria to beat very quickly and ineffectively. Atrial contractions may exceed 300 bpm but not all of these will reach the AV node and cause a ventricular contraction.

Most often, PALS providers will have to distinguish between two similar narrow QRS complex tachyarrhythmias: sinus tachycardia and supraventricular tachycardia (SVT). SVT is more commonly caused by accessory pathway reentry, AV node reentry, and ectopic atrial focus.

SINUS TACHYCARDIA	SUPRAVENTRICULAR TACHYCARDIA
Infant: < 220 bpm	*Infant: > 220 bpm*
Child: < 180 bpm	*Child: > 180 bpm*
Slow onset	*Abrupt start/stop*
Fever, hypovolemia	*Pulmonary edema*
Varies with stimulation	*Constant, fast rate*
Visible P waves	*Absent P waves*

Table 17

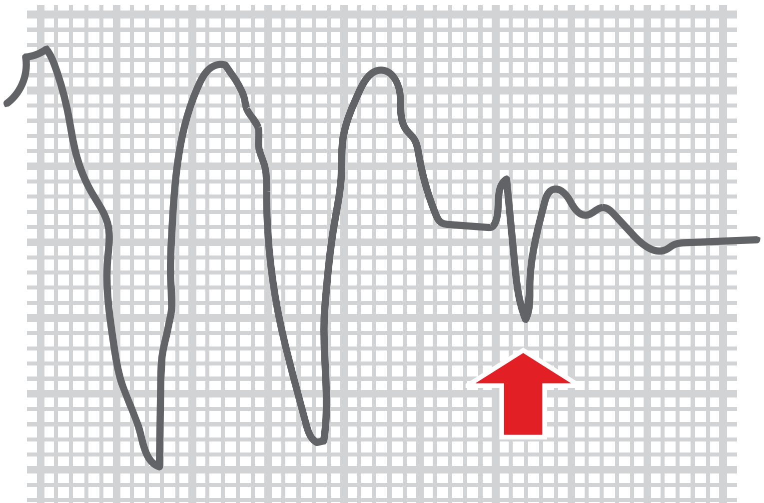


Figure 14

WIDE QRS COMPLEX

Ventricular tachycardia (VT) is uncommon in children but can be rapidly fatal. Unless the person has a documented wide complex tachyarrhythmia, an ECG with a QRS complex greater than 0.09 seconds is VT until proven otherwise. Polymorphic VT, Torsades de Pointes, and unusual SVT (SVT with wide complexes due to aberrant conduction) may be reversible, e.g. magnesium for Torsades, but do not delay treatment for VT. Any of these rhythms can devolve into ventricular fibrillation (VF). VT may not be particularly rapid (simply greater than 120 bpm) but is regular. Generally, P waves are lost during VT or become dissociated from the QRS complex. Fusion beats are a sign of VT and are produced when both a supraventricular and ventricular impulse combine to produce a hybrid appearing QRS (fusion beat) *(Figure 14)*.

PALS TACHYCARDIA ALGORITHM

Effective management of tachyarrhythmias in pediatric patients is crucial for emergency care professionals. Understanding the PALS tachycardia algorithm enables providers to quickly assess and treat life-threatening arrhythmias in children. This guide offers an overview of the key aspects of the PALS tachycardia algorithm, enhancing your ability to respond promptly during critical situations.

IMPORTANCE OF THE PALS TACHYCARDIA ALGORITHM

The PALS tachycardia algorithm is a systematic approach designed to assist clinicians in identifying and managing tachycardia in pediatric patients. It focuses on:

- **Early Recognition:** Identifying signs of tachyarrhythmias promptly.
- **Accurate Diagnosis:** Differentiating between sinus tachycardia, supraventricular tachycardia (SVT), and ventricular tachycardia (VT).
- **Appropriate Intervention:** Implementing the correct treatment based on the type of tachycardia and the patient's stability.

By adhering to the PALS tachycardia algorithm, health care providers can improve patient outcomes and reduce the risk of progression to cardiac arrest.

Responding to Tachycardia

The initial management of tachyarrhythmia is to assess pulse and perfusion.

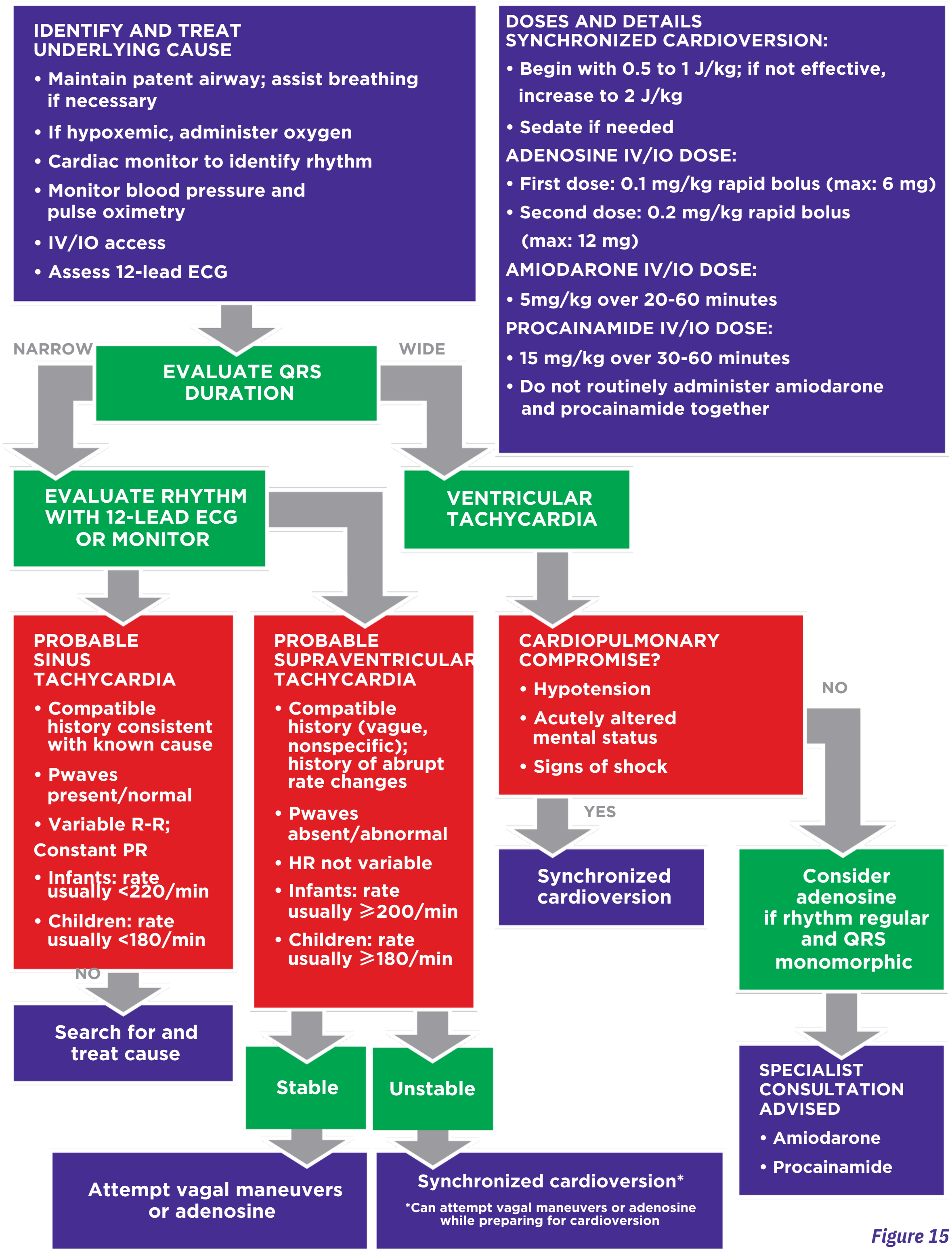


Figure 15

KEY STEPS OF THE PALS TACHYCARDIA ALGORITHM

1. Assess and Support ABCs

- **Airway:** Ensure it is open and protected.
- **Breathing:** Provide oxygen and support ventilation if necessary.
- **Circulation:** Monitor heart rate, blood pressure, and perfusion.

2. Evaluate the Patient's Condition

- **Identify Symptoms:** Look for signs of hemodynamic instability such as hypotension, altered mental status, signs of shock, or chest pain.
- **Determine Stability:** Assess whether the patient is stable or unstable.

3. Analyze the Rhythm

- **ECG Monitoring:** Obtain a 12-lead ECG if possible.
- **QRS Duration:**
  - Narrow QRS (<0.09 sec): Likely SVT or sinus tachycardia.
  - Wide QRS (≥0.09 sec): Possible VT or SVT with aberrancy.

4. Management Based on Rhythm and Stability

Stable Patients with Narrow QRS Tachycardia
- **Possible SVT:**
  - Attempt vagal maneuvers (e.g., ice to the face, Valsalva maneuver).
  - If vagal maneuvers are ineffective, administer adenosine.

Unstable Patients with Narrow QRS Tachycardia
- **Immediate Synchronized Cardioversion:**
  - Initial dose: 0.5 to 1 J/kg.
  - If not effective, increase to 2 J/kg.

Stable Patients with Wide QRS Tachycardia
- **Consider Expert Consultation:**
  - Adenosine may be administered if the rhythm is regular and monomorphic.
  - Antiarrhythmic Medications: Amiodarone or procainamide may be considered.

Unstable Patients with Wide QRS Tachycardia
- **Immediate Synchronized Cardioversion:**
  - Initial dose: 0.5 to 1 J/kg.
  - If not effective, increase to 2 J/kg.

5. Post-Intervention Care

- **Monitor Patient:** Continuously observe vital signs and cardiac rhythm.
- **Identify Underlying Causes:** Evaluate for potential triggers or underlying conditions.
- **Prepare for Transport:** If necessary, arrange for transfer to a facility with pediatric intensive care capabilities.

SELF-ASSESSMENT FOR TACHYCARDIA

1. Which of the following is not a life-threatening arrhythmia?
    a. Torsades de Pointes
    b. Ventricular fibrillation
    c. Ventricular tachycardia
    d. Sinus tachycardia
2. You are treating a 13-year-old male who has a history of congenital heart disease. The monitor shows a narrow complex rhythm with a heart rate of 175 bpm, and he has a palpable pulse. Which of the following is a possible diagnosis?
    a. SVT with aberrancy
    b. Sinus tachycardia
    c. Torsades de Pointes
    d. Ventricular tachycardia
3. You are treating a 10-year-old child who has SVT. What is the appropriate first dose for adenosine?
    a. 1 mg
    b. 6 mg
    c. 0.1 mg/kg with a maximum dose of 6 mg
    d. 12 mg

ANSWERS

1. D

Sinus tachycardia is often a response to an underlying condition such as fever, pain, or stress. Blood loss and hypovolemia can also result in sinus tachycardia, but the rhythm itself is not life-threatening.

2. B

Sinus tachycardia, atrial fibrillation or flutter, and supraventricular tachycardia are narrow complex rhythms.

3. C

Pediatric drug doses are based on weight. The maximum first dose is 6 mg for both adults and children.

CHAPTER 9

SHOCK

RECOGNIZING SHOCK

Shock is defined as a condition in which peripheral tissues and end organs do not receive adequate oxygen and nutrients. While it is sometimes used interchangeably with severe hypotension, shock does not only occur in the setting of severely low blood pressure. Importantly, the body will attempt to compensate for shock through various mechanisms, most commonly through increased heart rate. The heart rate will increase in an attempt to increase cardiac output (stroke volume x heart rate). Blood flow will be shunted from less vital organs such as the skin to more vital organs, such as the kidneys and the brain. In these cases, the child or the infant may be experiencing shock, but have high, normal, or low-normal blood pressure. This is called compensatory shock and may only persist for minutes to hours before progressing to frank uncompensated shock unless treatment is initiated. Without treatment, these compensatory systems can become overwhelmed and result in the child progressing quickly to critical hypotension and cardiac arrest. Therefore, the simple assessment of blood pressure is not a sufficient way to evaluate potential shock in pediatrics.

TYPES OF SHOCK	
HYPOVOLEMIC	*Low blood volume, often due to hemorrhage or fluid shifting out of vasculature*
DISTRIBUTIVE	*Blood vessel dilation (e.g. septic shock)*
CARDIOGENIC	*Heart is not pumping adequately*
OBSTRUCTIVE	*Physical block of the blood flow*

Table 18

HYPOVOLEMIC SHOCK

Hypovolemic shock is the most common type of shock and perhaps the easiest to understand.

Hypovolemic shock results from insufficient blood in the cardiovascular system. This can be due to hemorrhage externally, or into the peritoneum or into the gastrointestinal system. Hypovolemic shock in children can also occur from water loss, perspiration, diarrhea, vomiting, or when fluid moves into the tissues (third-spacing).

In hypovolemic shock, preload to the heart is decreased (less volume to fill the heart), though contractility is normal or increased. Likewise, afterload is increased since the vessels have constricted in an attempt to increase blood pressure.

SIGNS OF HYPOVOLEMIC SHOCK
Possible tachypnea
Tachycardia
Adequate or low blood pressure
Narrow pulse pressure
Slow capillary refill
Weak peripheral pulses
Normal central pulses
Possible decreased urine output
Decreased level of consciousness

Table 19

DISTRIBUTIVE SHOCK

Distributive shock is a condition in which the majority of blood is inappropriately distributed in the vasculature. A common way to conceptualize distributive shock is as a condition in which the vasculature has relaxed and dilated to the point of inadequacy. The arterial blood supply needs to maintain a certain tension in order to maintain blood pressure. Likewise, the venous system must maintain tension as well, so as not to retain too much of the total blood supply. In distributive shock, the blood is not being maintained in the required and needed useful blood vessels. Distributive shock is most commonly caused by sepsis, anaphylaxis, or a neurological problem, all of which cause vascular dilation or loss of blood vessel tone. In distributive shock, the preload, contractility, and afterload vary depending on the etiology.

SEPTIC SHOCK	ANAPHYLACTIC SHOCK	NEUROGENIC SHOCK
• *Decreased preload*	• *Decreased preload*	• *Decreased preload*
• *Normal/decreased contractility*	• *Contractility varies*	• *Normal contractility*
• *Afterload varies*	• *Afterload is low in left ventricle and high in right ventricle*	• *Afterload is decreased*

Table 20

Distributive shock is difficult to recognize because the signs and symptoms vary greatly depending on the etiology. Common symptoms include tachypnea, tachycardia, low to normal blood pressure, decreased urine output, and decreased level of consciousness.

Distributive shock is further categorized into warm and cold shock. If the person is experiencing warm shock, they commonly will have warm, erythematous peripheral skin and a wide pulse pressure in the setting of hypotension. If the person is experiencing cold shock, they commonly will have pale, vasoconstrictive skin and narrow pulse pressure hypotension. In each case, distributive shock is generally considered when the person is likely to have one of the three main causes: sepsis, anaphylaxis, or neurological problem.

CARDIOGENIC SHOCK

Cardiogenic shock is caused by inadequate contractility of the heart. One of the key differences between hypovolemic and cardiogenic shock is the work of breathing. In both cases, there will be tachypnea, but in hypovolemic shock the effort of breathing is only mildly increased. However, in cardiogenic shock, the work of breathing is often significantly increased as evidenced by grunts, nasal flaring, and the use of accessory thorax muscles. Also, since the heart is pumping ineffectively, blood remains in the pulmonary vasculature. This causes pulmonary congestion and edema, which can clinically be heard as crackles in the lungs and visualized as jugular vein distension. Pulses are often weak, capillary refill is slow, extremities are cool and cyanotic, and there may be a decrease in the level of consciousness.

OBSTRUCTIVE SHOCK

Obstructive shock is similar to cardiogenic shock in that the impaired heart function is the primary abnormality. In cardiogenic shock, the contractility is impaired; but in obstructive shock, the heart is prevented from contracting appropriately. Common causes of obstructive shock are cardiac tamponade, tension pneumothorax, congenital heart malformations, and pulmonary embolism. Obstructive and cardiogenic shock is most easily distinguished by the contractility of the heart. In obstructive shock, heart contractility is normal, although pumping function is not. Cardiac tamponade is associated with muffled heart sounds since blood is present in the pericardial space. Pulsus paradoxus (e.g. a drop in blood pressure on inspiration) may also be present. Tension pneumothorax is a clinical diagnosis. The trachea may have deviated away from the side of the lesion, and there are absent breath sounds over the affected side of the chest. Consider a pulmonary embolism when the person is cyanotic and/or hypotensive, experiences chest pain, and has respiratory distress without lung pathology or airway obstruction. Risk factors include obesity, hormone use, family history of abnormal clotting, and coagulation factor abnormalities.

RESPONDING TO SHOCK

The goal of shock management is to get oxygen to the tissues and to the organs. This requires having enough oxygen in the blood, getting the blood to the tissues, and keeping the blood within the vasculature. Thus, shock management is dedicated to achieving these three critical goals. In objective terms, this means returning the person to the correct blood pressure and heart rate for their age, restoring normal pulses, capillary refill, and mental status along with a urine output of at least 1 mL/kg an hour. Shock treatment varies according to etiology.

HYPOVOLEMIC SHOCK

The primary means of responding to hypovolemic shock is to provide additional volume. For children, an isotonic crystalloid such as normal saline or Lactated Ringer's is the preferred fluid for volume resuscitation. While volume repletion is somewhat straightforward in adults, great care must be taken when administering intravenous fluids to children and infants. Careful estimates should be made concerning the amount of volume lost (e.g. blood loss), the size of the person, and the degree of deficit. Current recommendations are to administer 20 mL/kg of fluid as a bolus over 5 to 10 minutes and repeat as needed.

In hypovolemic (or hemorrhagic) shock, administer 3 mL of fluid for every 1 mL of estimated blood lost—a 3:1 ratio. If fluid boluses do not improve the signs of hypovolemic, hemorrhagic shock, consider the administration of packed red blood cells without delay. Albumin can also be considered for additional intravenous volume for shock, trauma, and burns as a plasma expander.

If fluid boluses do not improve the signs of hypovolemic, hemorrhagic shock, re-evaluation of proper diagnosis and occult blood loss (e.g. into the GI tract) should be considered. The remaining interventions are aimed at restoring electrolyte imbalances (e.g. acid/base, glucose, etc.).

DISTRIBUTIVE SHOCK

The initial management of distributive shock is to increase intravascular volume. The intent is to provide enough volume to overcome the inappropriate redistribution of existing volume. As with hypovolemic shock, administer 20 mL/kg of fluid as a bolus over 5 to 10 minutes and repeat as needed. Beyond initial management, therapy is tailored to the cause of the distributive shock.

Septic Shock

In septic shock, aggressive fluid management is generally necessary. Broad-spectrum intravenous antibiotics are a key intervention and should be administered as soon as possible. In addition, a stress dose of hydrocortisone (especially with adrenal insufficiency) and vasopressors may be needed to support blood pressure. After fluid resuscitation, vasopressors are given if needed and according to the type of septic shock. Normotensive persons are usually given dopamine, warm shock is treated with norepinephrine, and cold shock is treated with epinephrine. Transfusing packed red blood cells to bring hemoglobin above 10 g/dL treats decreased oxygen-carrying capacity. As blood cultures return, focus antibiotic therapy to the particular microbe and its resistance patterns.

Anaphylactic Shock

Intramuscular epinephrine is the first and most important treatment for anaphylactic shock. In severe cases, a second dose of epinephrine may be needed or intravenous administration may be required. Crystalloid fluid can be administered judiciously. Remember that in anaphylactic shock, capillary permeability may increase considerably. Thus, while it is important to support blood pressure overall, there is significant likelihood that third spacing and pulmonary edema will occur. Antihistamines and corticosteroids can also blunt the anaphylactic response. If breathing challenges arise, consider albuterol use to achieve bronchodilation. In very severe cases of anaphylactic shock, a continuous epinephrine infusion in the Neonatal Intensive Care Unit (NICU) or Pediatric Intensive Care Unit (PICU) may be required.

Neurogenic Shock

Neurogenic shock is clinically challenging because often there is limited ability to correct the insult. Injury to the autonomic pathways in the spinal cord results in decreased systemic vascular resistance and hypotension. An inappropriately low pulse or bradycardia is a clinical sign of neurogenic shock. Therefore, treatment is focused on fluids first: 20 mL/kg bolus over 5 to 10 minutes; then reassess the person for a response. If hypotension does not respond to fluid resuscitation, vasopressors are needed. This resuscitation should be done in conjunction with a broader neurological evaluation and treatment plan.

CARDIOGENIC SHOCK

Since children in cardiogenic shock have a problem with cardiac contractility, the primary goal of therapy is to restore contractility. Unlike most other types of shock, fluid resuscitation is not a primary intervention in cardiogenic shock. Often medications to support contractility and reduce afterload are first-line treatments. In normotensive persons, this means vasodilators and diuretics (both decrease intravascular volume). Contractility is supported with inotropes. Milrinone is often used to decrease peripheral vascular resistance. When additional volume is needed, fluid can be administered slowly and cautiously: 5 to 10 mL/kg over 10 to 20 minutes. A pediatric cardiologist or critical care specialist should manage persons with cardiogenic shock.

OBSTRUCTIVE SHOCK

Causes of obstructive shock require rapid and definitive care since they are acutely life-threatening. Cardiac tamponade requires pericardial drainage. Tension pneumothorax requires needle decompression and subsequent placement of a chest tube (tube thoracotomy). Pediatric heart surgeons can address vascular abnormalities, and prostaglandin E1 analogs can be administered to maintain a patent ductus arteriosus in neonates with ductal-dependent lesions. Pulmonary embolism care is mostly supportive, though trained personnel can administer fibrinolytic and anticoagulant agents. Management of these complex etiologies is beyond the scope of this handbook.

SELF-ASSESSMENT FOR SHOCK

1. Aseven-year-old child is struck by a car and found to be hypotensive. What is the most likely cause of low blood pressure?
    a. Anaphylactic shock
    b. Hypovolemic shock
    c. Cardiogenic shock
    d. Obstructive shock

2. What type of shock results in bounding peripheral pulses and a wide pulse pressure?
    a. Septic
    b. Cardiogenic
    c. Traumatic
    d. Hemorrhagic

3. You are treating a pediatric person with low blood pressure. What amount of fluid is recommended for bolus therapy?
    a. 100 mL
    b. 1-liter
    c. 5 mL/kg
    d. 20 mL/kg

ANSWERS

1. B
   Trauma is a leading cause of blood loss and hypovolemic shock.
2. A
   Septic shock can result in a wide pulse pressure with low systemic resistance and normal or increased stroke volume.
3. D
   Consider boluses of 20 mL/kg of isotonic crystalloid (normal saline or lactated ringers).

CHAPTER 10

CARDIAC ARREST

RECOGNIZING CARDIAC ARREST

Unlike cardiac arrest in adults, which is very common due to acute coronary syndrome, cardiac arrest in pediatrics is more commonly the consequence of respiratory failure or shock. Thus, cardiac arrest can often be avoided if respiratory failure or shock is successfully managed. Less than 10% of the time, cardiac arrest is the consequence of ventricular arrhythmia and occurs suddenly.

It may be possible to identify a reversible cause of cardiac arrest and treat it quickly. The reversible causes are essentially the same in children and infants as they are in adults.

REVERSIBLE CAUSES OF CARDIAC ARREST	
THE H'S	**THE T'S**
Hypovolemia	*Tension pneumothorax*
Hypoxia	*Tamponade*
H+ (acidosis)	*Toxins*
Hypo/Hyperkalemia	*Thrombosis (coronary)*
Hypoglycemia	*Thrombosis (pulmonary)*
Hypothermia	*Trauma (unrecognized)*

Table 21

RECOGNIZE CARDIOPULMONARY FAILURE	
AIRWAY	• *May or may not be patent*
BREATHING	• *Slow breathing* • *Ineffective breathing*
CIRCULATION	• *Bradycardia and hypotension* • *Slow capillary refill* • *Weak central pulses (carotid)* • *No peripheral pulses (radial)* • *Skin mottling/cyanosis/ coolness*
DISABILITY	• *Decreased level of consciousness*
EXPOSURE	• *Bleeding?* • *Hypothermia?* • *Trauma?*

Table 22

RECOGNIZE ARREST RHYTHMS
ASYSTOLE
PULSELESS ELECTRICAL ACTIVITY (PEA)
VENTRICULAR FIBRILLATION (V FiB)
PULSELESS VENTRICULAR TACHYCARDIA (VTach)

Table 23

PULSELESS ELECTRICAL ACTIVITY AND ASYSTOLE

Pulseless electrical activity (PEA) and asystole are related cardiac rhythms in that they are both life-threatening and unshockable. Asystole is the absence of electrical or mechanical cardiac activity and is represented by a flat-line ECG. There may be subtle movement away from baseline (drifting flat-line), but there is no perceptible cardiac electrical activity. Make sure that a reading of asystole is not a technical error. Ensure that the cardiac leads are connected, gain is set appropriately, and the power is on. Check two different leads to confirm. PEA is one of any number of ECG waveforms (even sinus rhythm) but without a detectable pulse. PEA may include any pulseless waveform except VF, VT, or asystole. Asystole may be preceded by an agonal rhythm. An agonal rhythm is a waveform that is roughly similar to a normal waveform but occurs intermittently, slowly, and without a pulse.

PEA and asystole are unshockable rhythms.

VENTRICULAR FIBRILLATION AND PULSELESS VENTRICULAR TACHYCARDIA

Ventricular fibrillation (VF) and pulseless ventricular tachycardia (VT) are life-threatening cardiac rhythms that result in ineffective ventricular contractions. VF is a rapid quivering of the ventricles instead of a forceful contraction. The ventricular motion of VF is not synchronized with atrial contractions. Pulseless VT occurs when the rapidly contracting ventricles are not pumping blood sufficiently to create a palpable pulse. In both VF and pulseless VT, victims are not receiving adequate perfusion. VF and pulseless VT are shockable rhythms.

VF and pulseless VT are shockable rhythms.

PALS CARDIAC ARREST ALGORITHM

Understanding and effectively implementing the PALS cardiac arrest algorithm is crucial for health care professionals who manage pediatric emergencies. This algorithm provides a structured approach to treating cardiac arrest in infants and children, enhancing the chances of survival and favorable neurological outcomes. In this guide, we will explore the algorithm's importance, common challenges, and best practices for optimizing patient care.

IMPORTANCE OF THE PALS CARDIAC ARREST ALGORITHM

The PALS cardiac arrest algorithm is designed to guide health care providers through the critical steps required during a pediatric cardiac arrest. It emphasizes:

- **Early Recognition:** Identifying cardiac arrest promptly to initiate immediate intervention.
- **High-Quality CPR:** Delivering effective chest compressions and ventilations to maintain vital organ perfusion.
- **Rapid Defibrillation:** Using appropriate energy doses for defibrillation when ventricular fibrillation or pulseless ventricular tachycardia is present.
- **Medication Administration:** Administering drugs like epinephrine and amiodarone at the correct dosages and intervals.
- **Advanced Airway Management:** Securing the airway to ensure adequate oxygenation and ventilation.

Adhering to the PALS cardiac arrest algorithm allows providers to make systematic decisions under pressure, improving the likelihood of a successful resuscitation.

RESPONDING TO CARDIAC ARREST

The first management step in cardiac arrest is to begin high-quality CPR. (See BLS section of this handbook for details.)

Pediatric Cardiac Arrest Algorithm

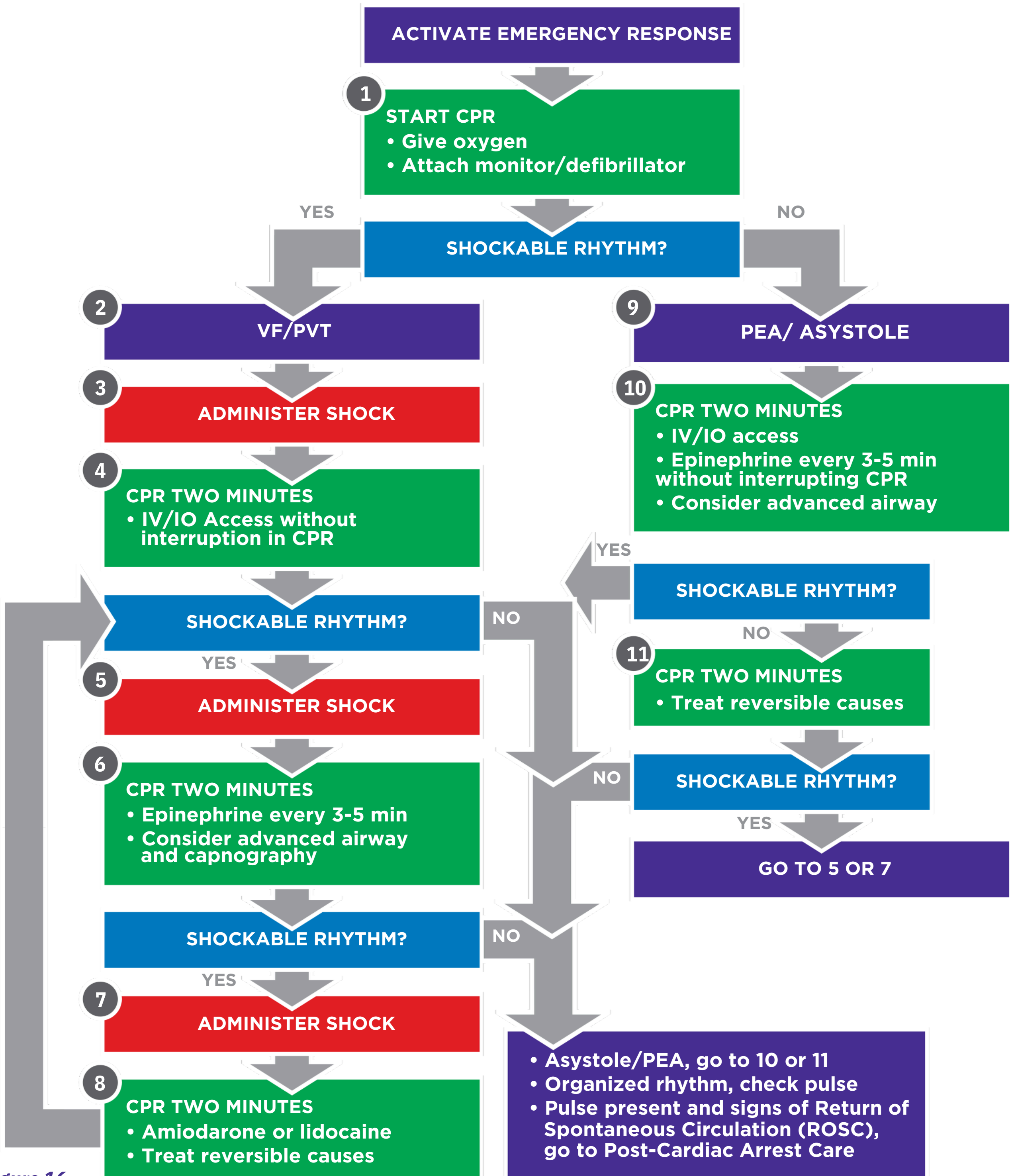


Figure 16

HIGH-QUALITY CPR: THE CORNERSTONE OF THE ALGORITHM

High-quality CPR is a critical component of the PALS cardiac arrest algorithm. It involves:

- **Correct Compression Rate and Depth:** 100 to 120 compressions per minute at a depth of one-third the chest diameter (about 1.5 inches/ 4 cm in infants and 2 inches/ 5 cm in children).
- **Full Chest Recoil:** Allowing the chest to return fully between compressions.
- **Minimizing Interruptions:** Keeping pauses in compressions under 10 seconds.
- **Proper Ventilation:** Providing breaths without causing gastric inflation.

Consistent delivery of high-quality CPR improves oxygenation and perfusion to vital organs, which is crucial during cardiac arrest.

DEFIBRILLATION AND RHYTHM MANAGEMENT

For shockable rhythms like ventricular fibrillation (VF) and pulseless ventricular tachycardia (VT), the PALS cardiac arrest algorithm recommends:

- **Shock Energy Levels:**
  - First shock: 2 Joules/kg
  - Second shock: 4 Joules/kg
  - Subsequent shocks: ≥4 Joules/kg (maximum 10 Joules/kg or adult dose)
- **Immediate CPR** after each shock, without delaying to reassess the rhythm.

Timely defibrillation can terminate arrhythmias and restore a perfusing rhythm.

Medication Protocols in the Algorithm

Medications are administered according to the PALS cardiac arrest algorithm to support resuscitation efforts:

- **Epinephrine:**
  - IV/IO dose: 0.01 mg/kg (0.1 mL/kg of 1:10,000 concentration)
  - Repeat every 3 to 5 minutes
  - If IV/IO access is not available, an endotracheal dose of 0.1 mg/kg may be given
- **Amiodarone:**
  - IV/IO dose: 5 mg/kg bolus during cardiac arrest
  - May repeat up to two times for refractory VF/pulseless VT

Accurate dosing and timely administration are vital for the effectiveness of these medications.

Addressing Reversible Causes

The PALS cardiac arrest algorithm highlights the importance of identifying and treating reversible causes, known as the "H's and T's":

- H's:
  - Hypovolemia
  - Hypoxia
  - Hydrogen ion (acidosis)
  - Hypothermia
  - Hypo-/hyperkalemia
  - Hypoglycemia
- T's:
  - Tamponade, cardiac
  - Toxins
  - Tension pneumothorax
  - Thrombosis (pulmonary or coronary)
  - Trauma

By promptly addressing these factors, health care providers can correct underlying issues contributing to cardiac arrest.

CPR Quality

- Rate of 100 to 120 compressions per minute
- Compression depth: one-third diameter of chest (1.5 inches (4 cm) in infants and 2 inches (5 cm) in children)
- Minimize interruptions
- Do not over ventilate
- Rotate compressor every two minutes
- If no advanced airway, 30:2 compression ventilation ratio for one provider and 15:2 compression ventilation ratio for two providers
- If advanced airway, 10 to 15 breaths per minute for one provider or 20 to 30 breaths per minute for two providers with continuous chest compressions

Shock Energy

- First shock: 2 J/kg
- Second shock: 4 J/kg
- Subsequent shocks: ≥ 4 J/kg
- Maximum dose of the shock: 10 J/kg or adult dose

Return of Spontaneous Circulation

- Return of pulse and blood pressure
- Spontaneous arterial pressure waves with intra-arterial monitoring

Advanced Airway

- Supraglottic advanced airway or ET intubation • Waveform capnography to confirm and monitor ET tube placement • Once advanced airway in place, give one breath every 2 to 3 seconds (20 to 30 breaths per minute)

Drug Therapy

- Epinephrine IV/IO dose: 0.01 mg/kg (Repeat every 3 to 5 minutes; if no IO/IV access, may give an endotracheal dose of 0.1 mg/kg.)
- Amiodarone IV/IO dose: 5 mg/kg bolus during cardiac arrest (May repeat up to two times for refractory VF/pulseless VT.)

Reversible Causes

- Hypovolemia
- Hypoxia
- H+ (acidosis)
- Hypothermia
- Hypo-/hyperkalemia
- Hypoglycemia
- Tamponade, cardiac
- Toxins
- Tension pneumothorax
- Thrombosis, pulmonary
- Thrombosis, coronary
- Trauma

SELF-ASSESSMENT FOR CARDIAC ARREST

1. Your team responds to a car accident where a 14-year-old is found in cardiac arrest. Which is a potentially reversible cause?
    a. Aortic dissection
    b. Traumatic brain injury
    c. Tension pneumothorax
    d. Spinal cord rupture

2. Which of the following are reversible causes of cardiac arrest?
    a. Hyperthermia
    b. Hypoxia
    c. Tetanus
    d. Theophylline overdose

ANSWERS

1. C
   Remember the H's & T's when evaluating cardiac arrest individuals. A tension pneumothorax can be initially treated with needle decompression and subsequent chest tube placement. The other injuries are not reversible.

2. B
   Hypoxia is a common precipitating factor for pediatric cardiac arrest scenarios. Hypothermia, toxins, trauma, and tamponade are additional causes.

CHAPTER 11

POST-RESUSCITATION CARE

If a person has a return of spontaneous circulation (ROSC), start post-resuscitation care immediately. The initial PALS process is intended to stabilize a child or an infant during a life-threatening event. Post- resuscitation care is meant to optimize ventilation and circulation, preserve organ/tissue function, and maintain recommended blood glucose levels.

Below, find a systematic approach followed by a post-resuscitation care algorithm to guide you in your treatment.

RESPIRATORY SYSTEM

- Chest x-ray to verify ET tube placement
- Arterial blood gas (ABG) and correct acid/base disturbance
- Pulse oximetry (continuously monitor)
- Heart rate and rhythm (continuously monitor)
- End-tidal CO2 (if the person is intubated)
- Maintain adequate oxygenation (saturation between 94% and 99%)
- Maintain adequate ventilation to achieve PCO2 between 35 to 45 mm Hg unless otherwise indicated
- Intubate if:
  - Oxygen and other interventions do not achieve adequate oxygenation
  - Need to maintain a patent airway in the child with a decreased level of consciousness
  - Ventilation is not possible through non-invasive means, e.g., continuous positive airway pressure (CPAP)
- Control pain with analgesics and anxiety with sedatives (e.g. benzodiazepines)

CARDIOVASCULAR SYSTEM

- Arterial blood gas (ABG) and correct acid/base disturbances
- Hemoglobin and hematocrit (transfuse or support as needed)
- Heart rate and rhythm (continuously monitor)
- Blood pressure (continuously monitor with arterial line)
- Central venous pressure (CVP)
- Urine output
- Chest x-ray
- 12 lead ECG
- Consider echocardiography
- Maintain appropriate intravascular volume
- Treat hypotension (use vasopressors if needed and titrate blood pressure)
- Pulse oximetry (continuously monitor)
- Maintain adequate oxygenation (saturation between 94% and 99%)
- Correct metabolic abnormalities (chemistry panel)

NEUROLOGICAL SYSTEM

- Elevate head of bed if blood pressure can sustain cerebral perfusion
- Temperature
    - Avoid hyperthermia and treat fever aggressively
    - Do not re-warm hypothermic cardiac arrest victim unless hypothermia is interfering with cardiovascular function
    - Treat hypothermia complications as they arise
- Blood glucose
    - Treat hypo/hyperglycemia (hypoglycemia defined as less than or equal to 60 mg/dL)
- Monitor and treat seizures
    - Seizure medications
    - Remove metabolic/toxic causes
- Blood pressure (continuously monitor with arterial line)
- Maintain cardiac output and cerebral perfusion
- Normoventilation unless temporizing due to intracranial swelling
- Frequent neurological exams
- Consider CT and/or EEG (electroencephalogram)
- Dilated unresponsive pupils, hypertension, bradycardia, respiratory irregularities, or apnea may indicate cerebral herniation

RENAL SYSTEM

- Monitor urine output
    - Infants and small children: > 1 mL/kg an hour
    - Larger children: > 30 mL an hour
    - Exceedingly high urine output could indicate neurological or renal problem (diabetes insipidus)
- Routine blood chemistries
- Arterial blood gas (ABG) and correct acid/base disturbances
- Urinalysis (when indicated)
- Maintain cardiac output and renal perfusion
- Consider the effect of medications on renal tissue (nephrotoxicity)
- Consider urine output in the context of fluid resuscitation
- Toxins can sometimes be removed with urgent/emergent hemodialysis when antidotes fail or are not available

GASTROINTESTINAL SYSTEM

- Monitor nasogastric (NG)/orogastric (OG) tube for patency and residuals
- Perform a thorough abdominal exam
    - Tense abdomen may indicate bowel perforation or hemorrhage
- Consider abdominal ultrasound and/or abdominal CT
- Routine blood chemistries including liver panel
- Arterial blood gas (ABG) and correct acid/base disturbances
- Be vigilant for bleeding into the bowel, especially after hemorrhagic shock

HEMATOLOGICAL SYSTEM

- Monitor complete blood count and coagulation panel
- Transfuse (as needed)
    - Correct thrombocytopenia
    - Fresh frozen plasma is to replenish clotting factors
    - Consider calcium chloride or gluconate if massive transfusion required
- Correct metabolic abnormalities (chemistry panel), especially after transfusion

PALS POST RESUSCITATION CARE ALGORITHM

Effective management of pediatric patients doesn't end with the return of spontaneous circulation (ROSC). Understanding and applying the PALS Post-Resuscitation Care Algorithm is crucial for healthcare professionals to ensure optimal recovery and reduce the risk of subsequent complications. This guide provides an overview of the key components of the PALS Post-Resuscitation Care Algorithm, emphasizing the importance of continuous monitoring and supportive care in pediatric patients following cardiac arrest.

IMPORTANCE OF THE PALS POST RESUSCITATION CARE ALGORITHM

The PALS Post Resuscitation Care Algorithm outlines the necessary steps to stabilize pediatric patients after ROSC. It focuses on maintaining adequate oxygenation and perfusion, controlling blood pressure and heart rate, managing glucose levels, and identifying and treating the underlying cause of cardiac arrest. By following the PALS Post Resuscitation Care Algorithm, health care providers can improve neurological outcomes and increase the chances of survival for pediatric patients.

Pediatric Cardiac Arrest Algorithm

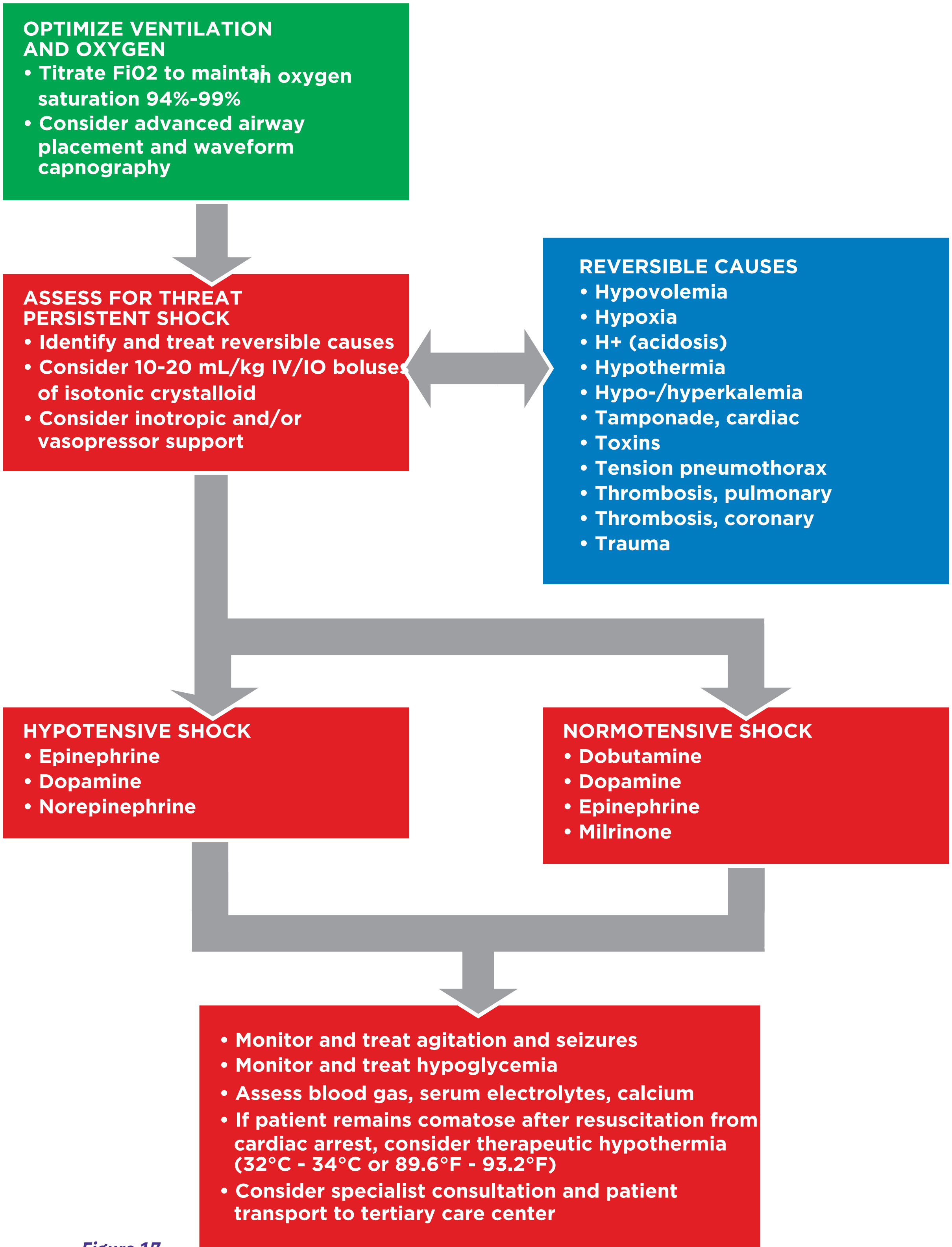


Figure 17

KEY COMPONENTS OF THE PALS POST RESUSCITATION CARE ALGORITHM

1. Optimize Oxygenation and Ventilation

- **Airway Management:** Ensure the airway is open and secured. Consider advanced airway placement if necessary.
- **Oxygenation:** Provide 100% oxygen initially, then titrate to maintain oxygen saturation between 94% and 99%.
- **Ventilation:** Adjust ventilation rates to achieve normal carbon dioxide levels. Avoid hyperventilation to prevent decreased cerebral blood flow.

2. Maintain Adequate Circulation

- **Blood Pressure Support:** Monitor blood pressure closely. Use fluid boluses and vasoactive medications as needed to maintain age-appropriate blood pressure levels.
- **Heart Rate and Rhythm:** Continuously monitor ECG. Treat arrhythmias according to PALS guidelines.

3. Neurological Monitoring and Support

- **Glucose Management:** Monitor blood glucose levels. Avoid hypoglycemia and hyperglycemia, both of which can negatively affect neurological outcomes.
- **Temperature Control:** Maintain normothermia. Avoid hyperthermia to reduce metabolic demand and prevent further neurological injury.
- **Neurological Assessment:** Perform regular neurological evaluations to detect changes in the patient's condition.

4. Identify and Treat Underlying Causes

- **Diagnostic Testing:** Order appropriate labs and imaging studies to identify reversible causes of the cardiac arrest.
- **Targeted Therapies:** Administer treatments specific to the identified cause, such as antibiotics for infections or surgical interventions for structural abnormalities.

5. Provide Family Support and Communication

- **Involve Family:** Keep the family informed about the patient's condition and involve them in care decisions when appropriate.
- **Emotional Support:** Provide resources and support to help the family cope with the stressful situation.

SELF-ASSESSMENT FOR PEDIATRIC POST RESUSCITATION CARE

1. Which of the following are useful to determine end-organ perfusion?
   a. Urine output
   b. Mental status
   c. Skin color
   d. All of the above

2. You have resuscitated a critically ill child. What is the goal for oxygen saturation?
   a. 100%
   b. 94% to 99%
   c. 90% to 94%
   d. Greater than 88%

ANSWERS

1. D
   All are useful clinical tools to assess for perfusion. Inadequate perfusion results in decreased or absent urine output, confusion, and cool or mottled skin.

2. B
   Optimize oxygenation and ventilation and titrate supplementary oxygen to obtain an oxygen saturation of 94% to 99%.

CHAPTER 12

PALS ESSENTIALS

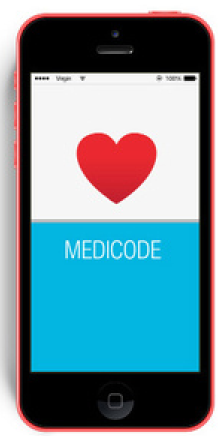
- Prevention does not require advanced skills, and early intervention can positively impact an emergency situation.
- Keep in mind that the child and infant's family and their response is influenced by a variety of factors and coping skills.
- Mentally prepare for treating the child or the infant as you approach the scene.
- Assess the appearance, work of breathing, and skin color as you approach any child or infant.
- Achild or infant's general appearance provides an important clue to the severity of illness, alert and interactive children or infants are rarely seriously ill.
- Head bobbing is a sign of respiratory distress in infants.
- A normal pulse oximetry reading does not exclude respiratory distress.
- Infants and young children may become agitated when attempting to apply supplemental oxygen.
- Slowing of normal respiratory rate after a period of respiratory distress can herald respiratory arrest.
- Bradycardia in children is most often due to hypoxia.
- Sudden infant death syndrome (SIDS) is the leading cause of death for infants of one month to one year of age.
- The unexpected death of a child or infant is extremely stressful for the rescuer/provider.
- If a foreign body is suspected, look inside the mouth and airway before suctioning.
- Nasopharyngeal airways are useful for persons having a seizure.
- Do not blindly sweep the airway to avoid pushing a foreign body in further.
- Pull the jaw up into the mask; do not push the mask onto the face when using bag-valve-mask.
- Deliver breaths slowly over one second to avoid gastric distention.

CHAPTER 13

ADDITIONAL TOOLS

MEDICODE

With MediCode, you no longer will have to carry a set of expandable cards with you at all times while at work. You will never have to waste valuable time in an emergency situation searching through multiple algorithms until you find the right one. All of the algorithms are now accessible from the palm of your hand, and you will be selecting your desired algorithm by memory in no time. Choose between multiple viewing options and easily share algorithms with co-workers and friends through email and social media.

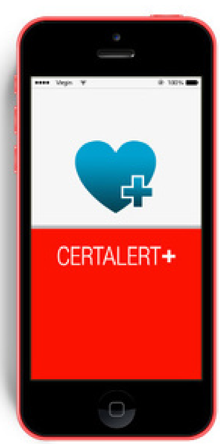


To improve functionality and speed in obtaining your desired algorithm as quickly as possible in an emergency, they have been divided between BLS, ACLS, PALS, and CPR. All are accessible from the home screen.
The individual algorithms included in this app are:

- Basic Life Support (BLS)
- Advanced Cardiac Life Support (ACLS)
- Pediatric Advanced Life Support (PALS)
- Cardiopulmonary Resuscitation (CPR) AED, and First Aid

CERTALERT+

CertAlert+ is the perfect app to minimize a potential area of stress and distraction in your life. With CertAlert+, you will have all your licenses and certifications in one place anytime you need them. We will keep track and remind you when your expiration date approaches, and we will help you with your registration whenever possible.



With CertAlert+, you can:

- Compile all required licenses and certifications in one location.
- Take photos (front and back) of certification cards and licenses for simple reference.
- Record all expiration dates and store with ease.
- Choose when you want to be reminded of your approaching expiration dates.
- Send all license or certification information directly to your email after exporting from the app.
- Quick access to easily register for online certification and recertification courses.

CHAPTER 14

PALS REVIEW QUESTIONS

1. Children have _________ metabolic rates compared to adults.

    a. Lower
    b. Higher
    c. Equal
    d. Unpredictable

2. The primary assessment includes all of the following assessments *except*:

    a. Airway
    b. Breathing
    c. Choking
    d. Exposure

3. Which of the following is a sign of upper airway obstruction?

    a. Fever
    b. Stridor
    c. Nasal flaring
    d. Itching

4. The following is an indication of poor ventilation:

    a. Hypertension
    b. Hyperthyroidism
    c. Hypercarbia
    d. None of the above

5. The following cause sinus tachycardia *except*:

    a. Metabolic stress
    b. Mobitz type II block
    c. Fever
    d. Acute blood loss

6. Common causes of acute community-acquired pneumonia include which of the following?

    a. Streptococcus pneumonia
    b. Mycoplasma pneumonia
    c. Chlamydia pneumonia
    d. All of the above

7. Hypoxemia is defined as a room air SpO2 reading less than _____ in a child.

    a. 98%
    b. 94%
    c. 90%
    d. 96%

8. Common causes of upper airway obstruction include all of the following *except*:
    a. Aspirated foreign body
    b. Asthma
    c. Allergic reactions
    d. Peritonsillar abscess

9. The following may be used in the treatment of croup:
    a. Dexamethasone
    b. Nebulized epinephrine
    c. Oxygen
    d. All of the above

10. Which statement concerning asystole is not correct?
    a. Asystole is a state of no myocardial contractions and no cardiac output or blood flow.
    b. An asystolic person has no detectable electrical activity.
    c. A flat line on an ECG always indicates asystole.
    d. Asystole is one of the rhythms associated with cardiac arrest.

11. Types of shock include all of the following except:
    a. Anaphylactic shock
    b. Hypovolemic shock
    c. Cardiogenic shock
    d. Hypothermic shock

12. When providing fluid resuscitation in children, how should intravenous fluid boluses be given?
    a. 15 mL/kg bolus over 5 to 20 minutes
    b. 20 mL/kg bolus over 5 to 20 minutes
    c. 25 mL/kg bolus over 5 to 20 minutes
    d. 30 mL/kg bolus over 5 to 20 minutes

13. Effectiveness of fluid resuscitation and medication therapy should be frequently monitored by which of the following?
    a. Heart rate
    b. Blood pressure
    c. Mental status
    d. All of the above

14. Common signs and symptoms of compensated shock include:
    a. Excessive sweating
    b. Increased heart rate
    c. Wide pulse pressure
    d. Hypertension

15. When should vasopressors be administered during the management of septic shock?
    a. When the person is responding to fluid resuscitation
    b. When the person is severely hypotensive despite proper fluid management
    c. Always indicated as soon as IV access is obtained
    d. Vasopressors are never used for septic shock

16. For fluid resuscitation in hypovolemic shock, give about _____ of crystalloid for every _____ of blood lost.

   a. 1 mL, 2 mL
   b. 3 mL, 2 mL
   c. 3 mL, 1 mL
   d. 2 mL, 3 mL

17. Hypoglycemia is defined as _____ in infants, children, and adolescents.

   a. Greater than or equal to 40 mg/dL
   b. Greater than or equal to 50 mg/dL
   c. Less than or equal to 60 mg/dL
   d. Less than or equal to 70 mg/dL

18. The gold standard treatment for anaphylactic shock is:

   a. Milrinone
   b. Epinephrine
   c. Dopamine
   d. Dobutamine

19. The preferred order of drug delivery routes are:

   a. IV route, IO route, ET route
   b. ET route, IV route, IO route
   c. IO route, ET route, IV route
   d. IV route, ET route, IO route

20. Which rhythm should be shocked?

   a. Ventricular fibrillation
   b. Pulseless ventricular tachycardia
   c. Pulseless electrical activity
   d. Both A and B

ANSWERS

1. B
   Higher
2. C
   Choking
3. B
   Stridor
4. C
   Hypercarbia
5. B
   Mobitz type II block
6. D
   All of the above
7. B
   94%
8. B
   Asthma
9. D
   All of the above
10. C
    A flat line on an ECG
11. D
    Hypothermic shock
12. B
    20 mL/kg bolus over 5 to 20 minutes
13. D
    All of the above
14. B
    Increased heart rate
15. B
    When the person is severely hypotensive despite proper fluid management
16. C
    3 mL, 1 mL
17. C
    Less than or equal to 60 mg/dL
18. B
    Epinephrine
19. A
    IV route, IO route, ET route
20. D
    Both A and B

Who is the **Disque** Foundation?

The Disque Foundation was created for the sole purpose of empowering others to save lives! We do this by providing advanced healthcare education to underserved populations of the U.S. and the world through technology.

To fulfill this mission, we have created the Save a Life Initiative. We offer the world's first free life support training courses online through our partnership with SaveaLife.com (Save a Life Certifications by NHCPS). Saving lives means giving others the chance to make a difference in the world. Our goal is to empower 10 million people with the ability to save a life by 2025.

How can I help?

Through the help of committed supporters like yourself, the Disque Foundation will have the ability to grow and expand our cause across the globe. Please help us by making a tax-deductible gift to the Disque Foundation. A donation of any size will help support our mission and your generous contribution will go directly to strengthening our efforts to empower others to save lives.

Donations can be made at **DisqueFoundation.org** or by mailing a check to:

Disque Foundation Donations Department

1609 W 100 S.
Brownstown, IN 47220
For more information, contact us at **info@disquefoundation.org**.

DISQUE™ FOUNDATION

Learn more at
DisqueFoundation.org

SaveaLife INITIATIVE™

The idea behind the Save a Life Initiative is simple – take the same advanced life-saving training we developed for health care providers, and give it to the underserved, at home and abroad. We work in conjunction with SaveaLife.com to fulfill its mission of advancing health care education to the underserved through advanced technology. When we put the knowledge, skills, and ability to perform CPR and other proven techniques in people's hands around the world, the power to save lives is possible.

Presented by the:

Save a Life INITIATIVE™