PALS Study Guide

Course Overview
This Study Guide is an extensive outline of content that will be taught in the American Heart Association Accredited Pediatric Advanced Life Support (PALS) Course. It is intended to summarize important content, but since all PALS content cannot possibly be absorbed in a class given every two years, it is expected that the student will have the 2005 Updated AHA ECC Handbook readily available for review and as a reference. The student is also required to have the AHA PALS Textbook available for reference and study for more in depth content.

Agenda
- Welcome, Introduction, Overview
- Lethal Rhythms
- Rhythm Practice
- BLS Review
- Rapid Cardiopulmonary Assessment
- PALS Algorithms
- Scenarios
- Skills Stations
- Skills Evaluation
- Written Evaluation

Evidence Based Updates
Approximately every 5 years the AHA updates the guidelines for CPR and Emergency Cardiovascular Care. These updates are necessary to ensure that all AHA courses contain the best information and recommendations that can be supported by current scientific evidence. Evidence based guidelines were developed, documented, debated and then evaluated by scientific experts from outside the United States and outside the AHA. The guidelines were then classified as to the strength of evidence that supports the recommendation.

Objectives
Upon the completion of this PALS course the participant will be able to:
- Identify lethal rhythms
- Describe Rapid Cardiopulmonary Assessment and use it as a guide while working through scenarios
- Verbalize treatment algorithms for each of the following lethal rhythms:
  1. Pulseless arrest
  2. Bradycardia
  3. Tachycardia
- Verbalize steps to assess and treat shock
- Perform skills in 4 required skills stations:
  1. Bag-Mask Ventilation and Advanced Airway
  2. Arrhythmia Recognition and Management, Cardioversion and Defibrillation
  3. Vascular Access
  4. BLS
Normal Anatomy Review

In order to understand Pediatric Advanced Life Support, it is essential to understand normal cardiac function. By understanding the normal electrical pathways in the heart, it will be easier to understand abnormal function. When blood enters the atria of the heart, an electrical impulse is sent out from the SA node that conducts through the atria causing them to contract. The atrial contraction registers on an EKG strip as the P wave. This impulse then travels to the AV node that in turn sends out an electrical impulse that travels through the Bundle of His, bundle branches, and into the Purkinje fibers of the ventricles causing them to contract. The ventricular contraction registers on the EKG strip as the QRS complex. Following ventricular contraction, the ventricles rest and repolarize that is registered on the EKG strip as the T wave. The atria repolarize also, but this coincides with the QRS complex and therefore cannot be observed on the EKG strip. Together a P wave, QRS complex, and T wave indicate a Sinus Rhythm.
In general, narrow QRS complexes originate at the junction of the heart or near the AV node. Wide QRS complexes indicate that a rhythm is originating below the bundle of His or in the ventricles.

Typically, when looking at an EKG strip, a patient will be hooked up to a monitor or a printout will read the heart rate. However, this is not always the case. It is important to be able to determine a heart rate when the monitor or printout rate is not given. There are two ways that will be discussed to determine the heart rate.

1. The most common way to determine heart rate is to count the QRS complexes on a six second strip and then multiply by 10 to give a rate per minute.
2. The second way works especially well in patients without a 6 second strip and in tachycardia patients. In tachycardia patients, it can be time consuming to count the number of QRS complexes on a six second strip. A better method is to memorize the numbers 300 – 150 – 100 – 75 – 60 – 50, as is shown in the diagram above. One suggestion is to memorize them in triplets “300-150-100” “75-60-50.” It has a nice rhythm. Starting from a QRS complex that falls on a heavy line, count 300 on the next heavy line, then 150 on the next heavy line, and so on until the next QRS complex is reached. This will give a range as to the heart rate with accuracy enough to determine tachycardia or normal rhythm. For bradycardia, counting the QRS complexes on a six second strip will be faster.
**Cardiac Arrhythmias**

**Pulseless Rhythms**

**Ventricular Fibrillation**

Ventricular Fibrillation (V-Fib or VF) is the most common rhythm that occurs immediately after cardiac arrest. In this rhythm, the ventricles quiver and are unable to uniformly contract to pump blood. It is for this reason that early defibrillation is so imperative. A victim’s chance of survival diminishes rapidly over time once the heart goes into V-fib, therefore, each minute counts when initiating defibrillation.

\[\text{V-Fib} = \text{Defib.}\]

Defibrillation stops the heart, like rebooting a computer, and allows it to restart with a corrected rhythm (hopefully).

There are two types of VF, fine and coarse VF. Coarse VF usually occurs immediately after a cardiac arrest and has a better prognosis with defibrillation. Fine VF, in which the waves flatten and nearly look like asystole, often develops after more prolonged cardiac arrest and is much more difficult to correct. Caution: Sometimes artifact can look like VF, but we know to always check our patient.

![Coarse VF vs. Fine VF](image1)

**Ventricular Tachycardia**

1. Stable vs. Unstable
2. Pulse vs. No pulse

Since this section is about pulseless rhythms, we are looking at Ventricular Tachycardia (VT) without a pulse. Ventricular Tachycardia will be discussed in more detail later. When a VT is present and the victim has no pulse, the treatment is the same as with VF. High dose shocks for defibrillation will give the best chance for converting the patient out of pulseless VT.

![Polymorphic VT](image2)
Pulseless Electrical Activity

Pulseless Electrical Activity (PEA) occurs when the heart is beating and has a rhythm, it can be any rhythm, but the patient does not have a pulse. **Always treat the patient, not the rhythm strip.** The number one question in this situation is, “Why?”

- **P =** Possible causes
- **E =** Epinephrine 0.01 mg/kg IV/IO (1:10,000)
- **A**

![ECG Image]

The possible causes are referred to as “H’s & T’s” and are the following:

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

In order to treat pulseless rhythms, bradycardias, and tachycardias, identification of the possible underlying causes is essential. If a cause is not identified, all of the drugs in the world will not cure the problem. For example, if a patient is hypovolemic, unless he or she gets more fluids, it will be impossible to correct the problem.

Asystole

Asystole is when there is no detectable cardiac activity on EKG. It may occur immediately after cardiac arrest or may follow VF or PEA. Asystole may also follow a third degree heart block. **Treatment of asystole is the same as PEA.** The American Heart Association recommends that if a patient is in sustained Asystole for 15 minutes, it is reasonable to call the code, but involve the family in the decision if they are available.

![ECG Image]
Bradycardia

Bradycardia occurs when the heart is beating too slowly—less that 60 beats per minute. If symptomatic, provide oxygen and begin CPR. Epinephrine is the initial drug of choice in children.

Sinus Bradycardia

In sinus bradycardia, the SA node fires at a rate slower than normal for a person’s age. In children this is usually a result of hypoxia and oxygen is the first treatment. Once a child’s heart rate has decreased to 60 bpm or below, they usually deteriorate very rapidly. This is why CPR is started even though a child still has a pulse.

First-Degree AV Block—All P waves conducted but delayed

First-degree AV block = prolonged PR interval (> 0.20 seconds or 5 small boxes on the EKG strip)

In First-degree AV block, all of the components of the EKG strip are normal except the PR interval. What happens in this situation is that the impulse from the SA node is delayed at the AV node. All impulses are, however, conducted following the delay.

Second-Degree AV Block Type I, (Mobitz I, Wenckebach)—Some P waves conducted, others blocked

Second-degree AV block type I (Mobitz I, or Wenckebach) = progressive lengthening of the PR interval with dropped QRS complexes.

The delay in Second-degree AV block type I occurs at the AV node. The delay produces progressively lengthening PR intervals and then there will be a P wave that is not followed by a QRS complex. Following this event, the cycle starts over again with progressively lengthening PR intervals followed by a dropped QRS.
Each repeating Wenckebach series has a consistent P:QRS ratio like 3:2, 4:3, 5:4, etc. (one less QRS than P’s in the series).

AV block location differentiates Second degree AV Type I blocks from Type II blocks.

**Second-Degree AV Block Type II (Mobitz II)—Some P waves conducted, others blocked**
Second-degree AV block type II = PR interval stays the same, but there are dropped QRS complexes.

The delay in Second-degree AV blocks occurs below the AV node at the Bundle of His or bundle branches. They usually produce a series of cycles consisting of one normal P-QRS-T cycle preceded by a series of paced P waves that fail to conduct through the AV node resulting in no QRS. This is a much more serious rhythm than Wenckebach and transcutaneous pacing is usually recommended.

![ECG Image](image.png)

**Third Degree or Complete AV Block—No P waves conducted**
Third Degree or Complete AV Block = no communication in the heart between SA and AV nodes

In Third-degree or complete AV block, the impulse originating in the SA node is completely blocked. This block may occur at the AV node, bundle of His or bundle branches. In response to this situation, the heart may develop a secondary pacemaker (either junctional or ventricular) in order to stimulate the ventricles to contract. The location of this “escape pacemaker” will determine if the QRS complexes are wide or narrow. A junctional (narrow QRS complex) escape pacemaker rhythm may possibly be stable with a ventricular rate of more than 40 bpm. However, a ventricular (wide QRS complex) escape pacemaker rhythm is usually unstable with a heart rate of less than 40 bpm.

In children, a complete heart block is usually due to a congenital abnormality. In complete heart block characterized by poor perfusion, transcutaneous pacing is recommended.

![ECG Image](image.png)

**Tachycardia**

There are 3 basic groups of tachycardias: sinus tachycardia, supraventricular tachycardia (including atrial tachycardia), and ventricular tachycardia. Fortunately, there is only one algorithm to treat all of them. The key factors are: STABLE vs. UNSTABLE and PULSE vs. NO PULSE. Additional factors are NARROW QRS vs. WIDE QRS.
**Sinus Tachycardia**

Sinus tachycardia occurs when the SA node is firing at a rate that is faster than normal for a person’s age. The rate is usually:
- Infants: <220 bpm
- Children: <180 bpm

All components of a normal EKG are present, P waves, QRS complexes, and T waves.

Sinus tachycardia generally:
- Starts and stops gradually
- Is a heart rate that varies with activity
- May be caused by pain, fever, or agitation
- Treating the cause, should slow the heart rate

**Supraventricular Tachycardia**

Supraventricular Tachycardia (SVT) includes any rhythms that begin above the bundle branches. This includes rhythms that begin in the SA node, atrial tissue, or the AV junction. Since the rhythms arise from above the bundle branches, they are characterized by narrow QRS complexes. A supraventricular tachycardia is not the name of a specific arrhythmia. It is a term used to describe a category of regular arrhythmias that cannot be identified more accurately because they have indistinguishable P waves due to their very fast rate. The rate is usually:
- Infants: >220 bpm
- Children: >180 bpm

The P waves are often indistinguishable because they run into the preceding T waves. The most common SVT rhythms are Atrial Tachycardia and Junctional Tachycardia, although Sinus Tachycardia can sometimes also fit into this category with indistinguishable P waves.

SVT generally:
- Is characterized by an abrupt rate change
- Is a heart rate that does not vary with activity

Treatment Question #1 = Pulse vs. No Pulse (If no pulse, go to Pulseless algorithm)
If Pulse, answer question #2
Treatment Question #2 = Stable vs. Unstable (Adequate Perfusion vs. Poor Perfusion)
If Stable = Vagal maneuvers & Adenosine
If Unstable = Cardiovert
**Atrial Tachycardia**
The SA node and AV nodes are the primary pacemakers of the heart. However, there are other “automaticity foci” (sometimes called “ectopic” foci) that are potential pacemakers capable of taking over the pacemaker function in emergency situations. In atrial tachycardia, a very irritable automaticity focus may begin firing leading to a very rapid heart rate. This often begins suddenly. A rhythm that starts suddenly is termed “Paroxysmal”. Therefore, when an Atrial Tachycardia arises suddenly from a very irritable automaticity focus, it is termed Paroxysmal Supraventricular Tachycardia (PSVT). The Atrial Tachycardia may be termed “ectopic” or “multifocal”, arising from one or more automaticity foci. Multifocal Atrial Tachycardia is a chaotic and irregular rhythm due to multiple foci, each with their own rates, stimulating the atria.

![EKG of atrial tachycardia](image)

**Junctional Tachycardia**
In Junctional Tachycardia, the AV junction becomes irritable and begins firing rapidly leading to a very rapid heart rate. If P waves are present (which they would not be in SVT), they would be inverted. The reason that P waves are inverted in junctional rhythms is because the impulse is being conducted backwards through the atria. This is more properly described as the atria being depolarized via retrograde conduction.

![EKG of junctional tachycardia](image)

**Ventricular Tachycardia**
Ventricular Tachycardia (VT) occurs when an irritable automaticity focus in either ventricle begins firing. This ventricular focus fires at a tachycardia rate and overrides the higher pacemaker sites and takes over control of the heart. It is basically a run of premature ventricular complexes (PVCs). In PVCs or in VT, the ventricles fire prematurely and in an abnormal manner. Because the rhythm is originating in the ventricles, the QRS complex is wide.

Treatment Question #1 = Pulse vs. No pulse (If no pulse, go to Pulseless algorithm)
If Pulse, answer question #2
Treatment Question #2 = Stable vs. Unstable (Adequate perfusion vs. Poor Perfusion)
If Stable = Amiodarone or Procainamide
If Unstable = Cardiovert
Monomorphic Ventricular Tachycardia

In monomorphic VT, the QRS complexes are of the same shape and amplitude. In PALS, we want to know if the patient is stable or unstable. If unstable, we want to know if there is a pulse or no pulse. If NO pulse, we treat monomorphic VT the same as VF.

Monomorphic Tachycardia = same size & shape QRS

Torsades de Pointes

In Torsades de Pointes VT, the QRS complexes are of different shape and amplitude. The name means “twisting of points”, and in fact, what differentiates this rhythm from others is that it looks like a twisting party streamer with upward-pointing and then downward-pointing QRS complexes in an alternating pattern. This rhythm can be caused by an electrolyte imbalance. PALS recommendations include treatment with Magnesium.

Pediatric Chain of Survival

Prevention of injury or arrest ♠ Early & Effective CPR ♠ Early EMS Activation ♠ Early Advanced Care
**BLS Review**  
(Primary Survey Approach to ECC)

Performing high quality CPR is the most critical component for successful resuscitation of a patient in cardiac arrest. The goal of intervention for a patient in respiratory or cardiac arrest is to restore effective oxygenation, ventilation and circulation.

- **A** = Airway
- **B** = Breathing
- **C** = Circulation
- **D** = Defibrillation

**Rescue Techniques – ABC and D**

**Unresponsiveness:** After determining that the scene is safe, check to see if victim is responsive. If the infant or child victim is unresponsive, send someone to activate the emergency response system (EMS) – phone 911 and get the AED.

**IF IN THE HOSPITAL, CALL THE CODE!**

If alone the rescuer calls out for “help” immediately for infants and children and begins the ABCs of CPR and then phones 911 after 2 minutes of rescue support. The goal of “phone fast” approach is to deliver oxygen immediately because the most common cause of cardiac arrest in infants and children is a severe airway breathing problem, respiratory arrest, or shock.

**EXCEPTION:** for sudden, witnessed collapse of child or infant, activate EMS immediately after verifying that victim is unresponsive.

**Airway:** Open the Airway.

- The head tilt-chin lift is the best way to open unresponsive victim’s airway when you do NOT suspect cervical spine injury.
- The jaw-thrust with cervical spine immobilization is used for opening airway without tilting the head or moving the neck if a neck injury is suspected (this includes drowning victims)—after two unsuccessful attempts, use head tilt-chin lift.

**Breathing:** Check for Breathing.

- Look, Listen, and Feel for breathing. Check for breathing by looking to see chest rise and fall when the victim breathes, listening and feeling for airflow through victim’s nose and mouth.
- Next, pinch the victim's nose closed, or for an infant place your mouth over the infant’s nose and mouth, and give 1 breath (blow for 1 second), watching for the chest to rise. If the chest does not rise, make a second attempt to open the airway with a head tilt-chin lift. Then give 1 breath (blow for 1 second) and watch for the chest to rise. Of course, if using a mask barrier device or bag mask ventilation, there is no need to pinch the nose. Only provide enough air to see the chest rise and fall. If using a bag mask, there is no need to compress the bag completely.
- Do not over-inflate the lungs. The positive pressure in the chest that is created by rescue breaths will decrease venous return to the heart. This limits the refilling of the heart, so it will reduce cardiac output created by subsequent chest compressions.
- Some victims may continue to demonstrate agonal or gasping breaths for several minutes after a cardiac arrest, but these breaths are too slow or too shallow and will not maintain oxygenation. Perform rescue breathing.

**Circulation:** Check for a Pulse.


- The best location for performing a pulse check for an adult is the carotid artery of the neck. On an infant up to the age of one year, check the brachial pulse.
You should start cycles of chest compressions and breaths when the victim is unresponsive, is not breathing adequately, and does not have a pulse.

- The compression to ventilation ratio is 30:2
- Proper compression technique requires the right rate and depth of compressions, as well as full chest recoil. Take your weight off your hands and allow the chest to come back to its normal position. Full chest recoil maximizes the return of blood to the heart after each compression.
- The rate of performing chest compressions for a victim of any age (adult, child and infant) is at a rate of 100 compressions per minute.
- Compressions on the adult, two hands are placed in the center of the chest between the nipples on the lower half of the sternum.
- Correct technique to perform chest compressions on a child use the heel of one (or two) hand(s) in the center of the chest between the nipples.
- Rotation of two-rescuer CPR is every 2 minutes (5 cycles of 30:2) or after 10 cycles of 15:2 for two-rescuer CPR of infants and children.
- Minimizing interruptions in chest compressions will increase the victim’s chance of survival.

**Defibrillation:** Attach the Automated External Defibrillator (AED).

- The probability of successful defibrillation diminishes rapidly over time. Immediate CPR and defibrillation within no more than 3 to 5 minutes gives an older child or adult in sudden cardiac arrest the best chance of survival.
- The AED is used on an adult victim and may be used on a child victim over the age of 1 yr.
- Only use adult AED pads when performing defibrillation on an adult.
- Child victim: Rescuer should use pediatric pads when available for children ages 1 to 8 yr. If not available use adult pads making sure that they do not touch each other.
- Adult or Child victim: Place one pad on the victim’s upper right chest just below the collar bone and right of the sternum and the other pad on the left side and below the nipple, being careful that the pads do not touch.
- Steps for defibrillation are: Power on the AED & attach pads, clear the victim and allow the AED to analyze the rhythm — make sure not to touch the victim during the analyze phase, clear the victim and deliver shock, if advised.
- Make sure to clear the victim before shocking so that you and others helping do not get shocked.
- If no shock is advised, leave the AED pads on the victim and continue CPR, beginning with compressions.
- CPR alone may not save the life of a sudden cardiac arrest victim. Early defibrillation is needed.

**Foreign Body Airway Obstruction - Choking**

- The best way to relieve severe choking in a responsive adult or child - Perform abdominal thrusts.
- The best action to relieve severe choking in a responsive infant – Begin cycles of 5 back slaps, followed by 5 chest thrusts.
- When a choking victim becomes unresponsive (adult, child, or infant) – Begin CPR. When you open the airway, look for and remove the object (if seen) before giving rescue breaths.

**BLS Skills Station**

In this skills station, participants should be able to:

- Demonstrate 1-rescuer CPR by the healthcare provider
- Demonstrate 2-rescuer CPR
- Demonstrate relief of a foreign-body airway obstruction in an infant and a child
- Demonstrate use of a barrier device to deliver ventilation
Rapid Cardiopulmonary Assessment
(Should take about 30 seconds)

1. Evaluation of General Appearance
2. Evaluation of Airway, Breathing, Circulation, and Disability
3. Classification of Physiologic Status
   - Classification of Respiratory Status
   - Classification of Circulatory Status
   - Classification of Cardiopulmonary Physiologic Status

Evaluation of General Appearance

APPEARANCE
- General color – “looks good vs. bad”
- Mental status, responsiveness
- Activity, movement, muscle tone
- Age-appropriate response (to parents, healthcare providers, painful procedures)

Evaluation of Airway, Breathing, Circulation, and Disability

AIRWAY
- Clear
- Maintainable with noninvasive assistance (positioning, suction, bag-mask ventilation)
- Not maintainable without invasive intervention/intubation
- Look for any signs of airway obstruction. Make sure that the airway is adequate and protected.

Secure the airway with:

- Nasopharyngeal Airway – semi-conscious
  1. Choose size based upon the diameter of the nostril (a 12F or 3-mm will generally fit a full-term infant)
  2. For proper length, measure from the nose to the ear
  3. A shortened E.T. tube may be used

- Oral pharyngeal Airway – unconscious
  1. Choose correct size by measuring from the corner of the mouth to the angle of the jaw.
  2. Insert while using a tongue depressor to hold the tongue on the floor of the mouth
  3. It is still necessary to keep the head and neck in the sniffing position after the oral pharyngeal airway is in place

- Laryngeal Mask Airway (LMA) – recommended if provider is inexperienced with E.T. tube

- Endotracheal Tube – usually the ideal airway in hospitalized patients
  1. The E.T. tube is placed using a laryngoscope, looking for the triangular vocal cords, and placing the E.T. tube through them.

      Determine proper uncuffed size by age ÷ 4 + 4
      Determine proper cuffed size by age ÷ 4 + 3

      (Note: cuffed tubes should not be inflated to a pressure of > 20 cm H2O)
  2. Cricoid pressure may be helpful during intubation. This is performed by pressing firmly on the cricoid cartilage.
  3. Attempts should be limited to 30 seconds.
  4. If bradycardia develops or the clinical condition of the child being intubated deteriorates, interrupt the intubation attempt to provide bag-mask ventilation with 100% oxygen.
• Insertion of an advanced airway may be deferred until several minutes into the attempted resuscitation, since airway insertion requires an interruption in chest compressions for many seconds.

**BREATHING (oxygen)**

Note: Young children cannot breathe and eat at the same time. If respiratory difficulty is present, keep the child NPO.

• Respiratory rate
  1. Infant normal rate = 30 – 60 bpm
  2. Toddler normal rate = 24 – 40 bpm
  3. Preschooler normal rate = 22 – 34 bpm
  4. School-age child normal rate = 18 – 30 bpm
  5. Adolescent normal rate = 12 – 16 bpm

• Respiratory effort and mechanics
  Note abnormal positions such as sniffing position, tripodding, head-bobbing, also note nasal flaring, grunting, or chest retractions.

**Classification of Respiratory Status:**

• **Respiratory distress**: increased effort/work of breathing
• **Respiratory failure**: inadequate gas exchange resulting in inadequate oxygenation and/or ventilation (may be present with or without respiratory distress). This usually occurs as a result of progressive hypoxia, hypercarbia and muscle fatigue.

**Breath sounds/air entry/tidal volume**

Evaluate by observing symmetric chest expansion and by listening for bilateral breath sounds. Breath sounds should be auscultated over the anterior and posterior chest wall and in the auxiliary areas. Listen for intensity and pitch of sounds.

**Upper airway obstruction:**
  1. Inspiratory stridor
  2. High pitched inspiratory sound
  3. Croup and foreign body airway obstruction are common causes
  4. Treatment = cool mist (humidified oxygen) and nebulized epinephrine

**Lower airway obstruction:**
  1. Expiratory wheeze
  2. Asthma and bronchiolitis are common causes.
  3. Treatment = nebulized bronchodilator (Albuterol) and epinephrine SQ

**Parenchymal lung disease:**
  1. Stiff lungs
  2. Grunting respirations
  3. Requires increased inspiratory and expiratory effort
  4. Tachypnea

**Abnormal control of ventilation:**
  1. Irregular breathing pattern (“funny breathing”)
  2. Results from brain injury or drug overdose

**Skin color**

Assess skin for pink, pale, dusky, or mottled skin tones
Methods of Oxygen delivery:
- Oxygen = #1 drug – give oxygen as soon as it is available
- Provide oxygen: Room air has 21% oxygen.
- Nasal Cannula (1 to 5 liters) = increases oxygen by 4% for each liter
- Face Mask without reservoirs = increases oxygen by 10% for each liter not recommended to give more than 40 – 60% without a reservoir
- Tents = 50% FIO2
- Hoods = 90% FIO2
- Face Mask with reservoir = ability to provide 100% oxygen

Bag Mask
1. Flow-Inflating Bags – requires compressed gas source, but can deliver free-flow oxygen at 100%
2. Self-Inflating – no compressed gas source is required, unable to deliver free-flow oxygen, needs a reservoir to deliver 100% oxygen
3. Use positive pressure ventilation with 100% oxygen for children with severe respiratory distress, including significant intercostal retractions.

Always monitor a patient with pulse oximetry.
1. Pulse oximetry evaluates oxygenation, but not effectiveness of ventilation (elimination of CO2)
2. Pulse oximetry may be inaccurate in the presence of shock when not enough peripheral blood volume is present.

Endotracheal (E.T.) Tube
- Confirm E.T. tube placement:
  1. Mist in the tube
  2. Auscultation of lungs for bilateral breath sounds
  3. Auscultation of the gastric area—no gurgling should be heard that would indicate intubation of the hypopharyngeal area
  4. Confirmation with CO2 Detector or Esophageal Detector (now one or the other is required for primary confirmation). Do NOT use esophageal detectors on children less than 20 kg.
- Secure the airway with a commercial device.

Once an advanced airway is in place, there is no need to pause chest compressions for ventilations. Provide 100 compressions per minute and 1 breath every 6 to 8 seconds.

If deterioration in respiratory status occurs in an intubated child, use the DOPE mnemonic:

D = Displacement – especially without cuffs, E.T. tubes in children can become displaced easily and should correct placement should be confirmed each time a child is moved

O = Obstruction – E.T. tubes in children can be very small and easily become occluded

P = Pneumothorax – If breath sounds are diminished on one side, there may be tracheal deviation, O2 saturation remains low, tachycardia and tachypnea are present, perform immediate needle decompression followed by chest/thoracostomy tube placement.

E = Equipment – always check to make sure that the equipment is functioning properly

CIRCULATION & DISABILITY
- Observe mental status
  Evaluation of responsiveness (AVPU scale)
  A – Awake
  V – responsive to Voice
  P – responsive to Pain
  U – Unresponsive
- Feel for heart rate, pulse quality, skin temperature, capillary refill
Heart rate: “Normal” heart rate decreases as a child ages. Increased heart rate or decreased heart rate may be a sign of distress.

**Capillary refill:** If prolonged (> 2 seconds) may indicate shock
Peripheral pulses: May be diminished, especially in shock
Skin perfusion: Temperature, color (pink, pale, blue, mottled)

- **Measure blood pressure early**
  Lower limits of systolic blood pressure in children 1 to 10 years of age: 70 mm Hg + (child's age in years x 2) mm Hg
  
  **Compensated shock:** signs of shock without hypotension
  ** Decompensated shock:** signs of shock with hypotension

- **Evaluate end-organ function/perfusion**
  Brain (mental status – see above)
  Skin (see above)
  Kidneys – urine output (measure after immediate crisis). Normal urine output is 1 to 2ml/kg per hour (will decrease when renal perfusion is compromised)

**Classification of Circulatory Status:**
- **Compensated shock (early):** tachycardia, poor systemic perfusion
- ** Decompensated shock (late):** weak central pulses, altered mental status, hypotension
- **Septic shock:** hypotension despite fluid administration and BP maintained only with drug support
  
  **Sepsis** may begin with subtle signs that are difficult to diagnose. Sepsis is defined as having 2 or more of the following: Fever or hypothermia, tachycardia, tachypnea with respiratory alkalosis, and a change in the white blood cell count (leukocytosis, leucopenia, or an increase in immature or band forms of white blood cells) plus the presence of suspected infection.
  **Severe sepsis** is when signs of sepsis are observed in association with evidence of inadequate organ perfusion and function.

- **Establish IV/Intraosseous (IO) access in order to:**
  give fluids as necessary, give medications, flush drugs in with a fluid bolus.
  E.T. administration of drugs is not preferred because there is an unknown amount of absorption, even though the following drugs can be administered via E.T. tube:
  LEAN = Lidocaine, epinephrine, atropine, and naloxone

  Especially in a child with shock and decreased peripheral blood flow, IV access may be difficult. If peripheral venous access cannot be established rapidly, initiate IO access. Video instruction is available to describe in detail the insertion technique. Access is confirmed when fluids flow freely and there is no soft tissue swelling at the infusion site.

**SPECIAL SITUATIONS**
- **Trauma**
  ABCs plus:
  Airway + cervical spine immobilization
  Breathing + pneumothorax management
  Circulation + control of bleeding
  Identify and treat life-threatening injuries

- **Toxicology**
  ABCs plus:
  Airway: reduced airway protective mechanisms
  Breathing: respiratory depression
  Circulation: arrhythmias, hypotension, coronary ischemia
  Identify and treat reversible complications
  Administer antidotes
Classification of Cardiopulmonary Physiologic Status:

- **Stable**
- **Respiratory distress**
- **Respiratory failure**
- **Shock (compensated vs. decompensated)**
- **Cardiopulmonary failure** – characterized by agonal respirations, bradycardia, cyanosis and poor perfusion can develop very quickly in children with respiratory arrest and has a very poor prognosis.

Rapid Cardiopulmonary Assessment Summary

- Evaluate general appearance
- Assess ABCs and Disability
- Classify physiologic status
  1. Respiratory distress
  2. Respiratory failure
  3. Compensated shock
  4. Decompensated shock
  5. Cardiopulmonary failure
- Begin management: Support ABCs

**Bag-Mask Ventilation and Advanced Airway Skills Station**

In this skills station, participants should be able to:

- Describe and demonstrate technique of bag-mask ventilation, including self-inflating and flow-inflating bags, and use of pulse oximetry
- Describe common oxygen delivery systems and their effectiveness in delivering oxygen to the infant or child
- Describe how to select and insert oropharyngeal and nasopharyngeal airways
- Describe and demonstrate (if appropriate to clinical practice) tracheal tube selection, size, and confirmation of placement
- Describe most common causes of acute deterioration in intubated patients using the DOPE pneumonic
- Discuss use of the laryngeal mask airway (LMA) in children

**Vascular Access Skills Station**

In this skills station, participants should be able to:

- Describe a sequential approach to establishment and use of IV/IO access during resuscitation
- Describe indications for placement of an IO needle and demonstrate the procedure
- List the signs of correct IO needle placement
- Discuss the risks and benefits of peripheral venous, central venous, and IO vascular access
Algorithms
In contrast to cardiac arrest in adults, cardiopulmonary arrest in infants and children is rarely sudden and is more often caused by progression of respiratory distress and failure or shock than by primary cardiac arrhythmias. Therefore, oxygen is the number one treatment for most pediatric conditions.

Most (not all) algorithms can be treated by following the ONE mnemonic – and then adding special considerations:

- **O** = oxygen
- **N** = normal saline
- **E** = epinephrine

Differential Diagnosis – **H’s and T’s**

“Thinking it Through” Unless the cause of an arrhythmia is correctly identified, it will be impossible to treat. A hypovolemic person in PEA will not be helped by all of the epinephrine in the world. H’s and T’s are essential to nearly every algorithm.

- **H**ypovolemia – give fluids
- **H**ypoxia – give oxygen, check E.T. tube
- **H**ydrogen ion (acidosis) – sodium bicarbonate
- **H**ypo-/Hyperkalemia – potassium or sodium bicarbonate
- **H**ypoglycemia – Glucose
- **T**oxins – Drug overdose = give Narcan
- **T**amponade, cardiac – pericardiocentesis
- **T**ension pneumothorax – needle decompression
- **T**hrombosis (coronary or pulmonary) – ? surgeon
- **T**rauma – assess & treat

Pulseless Arrest

Pulseless Arrest includes:
1. Ventricular Fibrillation and Pulseless Ventricular Tachycardia
2. Asystole and Pulseless Electrical Activity

V-Fib and Pulseless VT **ARE shockable**
Asystole and PEA **ARE NOT shockable**

IF SHOCKABLE (V-fib and Pulseless VT):

![Image of an ECG](image_url)

Defibrillation can be performed using either monophasic or biphasic technology. Biphasic, the newer technology uses about ½ the energy of a monophasic shock.

First shock is at 2 J/kg, subsequent shocks at 4 J/kg
Monophasic = maximum 360 J
Biphasic = maximum 150 J to 200 J

The first shock eliminates VF more than 85% of the time.

- Steps for defibrillation:
  1. When the AED or defibrillator arrives, turn it on
  2. Select energy level
  3. Position appropriate pads or electrodes (apply conductive paste if using paddles)
     - **Paddle size** = Infant size for <1 yr or <10 kg
     - Adult size for >1 yr or >10 kg
  4. Analyze the rhythm (do not touch the victim during this phase) if the rhythm is V-Fib or pulseless VT (or if the AED recommends a shock), prepare to shock
  5. Prepare to shock by selecting the appropriate # of Joules and selecting defibrillate mode
  6. Press the charge button—announce that you are doing this—continue CPR while charging
  7. Clear: I’m clear (you are not touching the patient or bed), You’re clear—includes making sure that the oxygen is away from the patient, Everybody’s clear (no one is touching patient, or bed)
  8. Press the shock button and wait for shock discharge

- Immediately following the shock, resume CPR starting with chest compressions.
- Perform CPR 5 cycles of 30:2 with one person or 2 minutes of CPR 15:2 with 2 people.
- After 2 minutes of CPR, stop compressions just long enough to check the rhythm and check for a pulse
- If another shock is needed, prepare to shock, but continue CPR while the defibrillator is charging.
- Repeat this sequence until the rhythm is not shockable

Reasons for CPR immediately after the shock:
- If the first shock fails, CPR will circulate the blood and bring more oxygen to the heart, making a subsequent shock more likely to be successful.
- Even when a shock eliminates VF, it often takes several minutes for a normal heart rhythm to return and more time for the heart to create blood flow. Chest compressions can deliver oxygen and sources of energy to the heart, increasing the likelihood that the heart will be able to effectively pump blood after the shock.

Drug delivery should not interrupt CPR. The timing of the drug is less important than minimizing interruptions in chest compressions.

- A drug may be administered
  1. During the CPR
  2. While the defibrillator is charging
  3. Immediately after the shock

**Medication Sequence:**
- Epinephrine 0.01 mg/kg IV/IO (0.1 ml/kg of 1:10,000) repeated every 3 to 5 minutes
- Amiodarone 5 mg/kg IV/IO bolus can repeat to total of 15 mg/kg IV per 24 hours
Note: The 2005 guidelines recommend Amiodarone. Lidocaine may be given instead of Amiodarone, but only if Amiodarone is not available.

One additional consideration is regarding a VF cardiac arrest that has been present for several minutes prior to CPR. The heart has probably used up most of the available oxygen needed to contract effectively. The VF is therefore, fine VF and defibrillation is not typically successful. If it is successful, the heart is unlikely to pump blood effectively for several seconds or even minutes after defibrillation. A period of CPR before shock delivery will provide some blood flow to the heart, delivering some oxygen and sources of energy to the heart muscle. This will make a shock more likely to eliminate the VF and will make the heart more likely to resume an effective rhythm and effective pumping function after shock delivery. It is therefore recommended that 2 minutes of CPR be performed prior to defibrillating a child.

IF NOT SHOCKABLE (Asystole and PEA):

![ECG Graph]

P = Possible causes = H’s & T’s, hypovolemia is most common and often easiest to treat
E = Epinephrine 0.01 mg/kg IV/IO every 3 to 5 minutes
A

Note: Asystole should not be called “flat line”. Flat line indicates a lead is off or the gain and sensitivity need to be adjusted.

If a patient is in sustained asystole for 15 minutes, it may be reasonable to consult the family and consider calling the code.

**Bradycardia**

![ECG Graph]

1. Oxygen first
2. CPR if HR is < 60 bpm
3. Epinephrine 0.01 mg/kg IV/IO (1:10,000; 0.1 ml/kg) is the first drug of choice for bradycardia in children.
4. Atropine 0.02 mg/kg IV/IO (Minimum dose: 0.1mg; maximum total dose for child: 1mg) may be given. Small doses of atropine may cause paradoxical bradycardia in small doses which is why epinephrine is generally used. However, atropine may be used if bradycardia is due to increased vagal tone or primary AV block.

If there is a high level heart block (usually due to a congenital condition), consider **transcutaneous pacing**
Steps for transcutaneous pacing:
1. Consider sedation
2. Attach pacing electrodes to the patient as shown on package (AP position preferred)
3. Turn pacer on
4. Set the pacing rate—typically 100 bpm
5. Look for electrical capture on the strip (turn up mA dial until capture is achieved—widening QRS & broad T waves)

6. Assess mechanical capture by assessing right arm or right femoral pulses
7. Once capture is achieved, set pacing at about 2 mA higher than the threshold of initial capture.
   Epinephrine or dopamine infusion may be considered while awaiting pacemaker or if pacing is ineffective.

Tachycardia with Pulses and Adequate or Poor Perfusion

#1 Question = STABLE vs. UNSTABLE

**STABLE = Vagal and/or Medication**

**Narrow QRS Regular Rhythm**
- Sinus Tachycardia – Treat the cause
- Supraventricular Tachycardia:

Wide QRS (VT with pulse)

- Amiodarone 5 mg/kg IV over 20 to 60 minutes
- Or Procainamide 15 mg/kg IV over 30 to 60 minutes
- May need synchronized cardioversion
Wide QRS (torsades de pointes)

![Wide QRS (torsades de pointes) wave form]

Magnesium load with 25 to 50 mg/kg over 10 minutes

UNSTABLE (WITH PULSE) = SYNCHRONIZED CARDIOVERSION

Prepare for IMMEDIATE cardioversion. While preparing, you may try an appropriate medication (Adenosine or Amiodarone) if there is time. Also, sedate the patient if possible.

Use 0.5 to 1 J/kg up to 2 J/kg monophasic, depending upon the acuity of the patient (or a clinically equivalent biphasic energy dose. Optimal biphasic doses have not yet been established with certainty.

- Steps for cardioversion:
  1. Consider sedation
  2. Turn on defibrillator
  3. Attach monitor leads to patient
  4. Press “SYNC” mode button
  5. Look for markers on R waves indicating sync mode
  6. Select appropriate energy level
  7. Position appropriate pads or paddles
  8. Press the charge button—announce that you are doing this
  9. Clear: I’m clear, You’re clear—includes making sure that the oxygen is away from the patient, Everybody’s clear
  10. Press the shock button and wait for shock discharge (this may take a few seconds while the machine looks for R waves and determines where to sync the shock)
  11. Analyze the rhythm again. If still in tachycardia, increase the joules and try again.

Note: Reset the sync mode after each synchronized cardioversion because most defibrillators default back to unsynchronized mode.
**Shock** = cardiac output is inadequate to meet metabolic demands resulting in inadequate tissue perfusion

**Classification of Shock** (Each classification may be compensated or decompensated which is determined by BP values)

1. **Hypovolemic**: inadequate intravascular volume relative to the vascular space. Most common type of shock occurring in children as a result of nausea, vomiting, diarrhea, and trauma.

   **Symptoms:**
   - Increased respiratory rate, normal effort, normal breath sounds.
   - **Normal level of consciousness**, unless severe—then may be lethargic
   - Increased heart rate, thready pulse
   - Normal to prolonged capillary refill, pink, cool skin

   **Treatment:**
   - **Fluids**: Crystalloid Isotonic Solution (Normal Saline, or Ringers Lactate) 20cc/kg over 10 to 20 minutes

2. **Cardiogenic**: myocardial dysfunction. Cardiogenic shock is present in all forms of prolonged shock regardless of etiology.

   **Symptoms:**
   - Very increased respiratory rate, increased effort, **abnormal breath sounds** (rales or grunting).
   - Lethargic to coma
   - Very increased heart rate, thready pulse
   - Prolonged capillary refill, mottled gray or blue, cool or cold skin

   **Treatment:**
   - **ABCs**
   - **Fluids**: Crystalloid Isotonic Solution (Normal Saline, or Ringers Lactate) 10cc/kg over 10 to 20 minutes
   - **Antibiotics**
   - **Support BP**: Dopamine, Norepinephrine, Epinephrine and additional therapies

3. **Distributive (Septic)**: inappropriate distribution of blood flow. Distributive shock is characteristic of sepsis and anaphylaxis.

   **Symptoms:**
   - Increased to very increased respiratory rate, normal to increased effort, normal breath sounds (may have crackles)
   - Lethargic or confused/agitated, coma occurs late
   - Increased to very increased heart rate, **early = bounding pulse, late = thready pulse**
   - Normal to prolonged capillary refill, pink, often warm skin in early shock

   **Treatment:**
   - **ABCs**
   - **Fluids**: Crystalloid Isotonic Solution (Normal Saline, or Ringers Lactate) 20cc/kg over 10 to 20 minutes
   - **Antibiotics**
   - **Support BP**: Dopamine, Norepinephrine, Epinephrine and additional therapies

**Trauma**

Trauma is the leading cause of death in children worldwide. Prevention is the key to reducing death and disability from trauma.

In a trauma situation, follow these guidelines:

1. **Scene survey** – Do a quick assessment to determine the safety of the scene.
2. **General appearance** – Do a quick visual assessment of appearance (looks good vs. looks bad).
3. **Primary survey** – Rapid evaluation and stabilization of airway, breathing, circulation, disability (neurologic function), and exposure.

4. **Secondary survey** – A complete “head-to-toe” physical examination. The detailed physical examination includes a focused history. Use the AMPLE mnemonic:
   - **A** = Allergies
   - **M** = Medications
   - **P** = Past medical history
   - **L** = Last meal
   - **E** = Events leading up to the current injury

**Post-Resuscitation Care**

Patients display a wide spectrum of responses to resuscitation. Following return of spontaneous circulation, patients may respond by becoming awake and alert with adequate spontaneous respirations and hemodynamic stability. Others will remain comatose with an unstable circulation and no spontaneous breathing. Many will require 24 to 48 hours of invasive hemodynamic monitoring for optimal management after resuscitation.

Your immediate goal is to provide cardio-respiratory support to optimize oxygenation and perfusion, particularly to the brain. This is accomplished by assessing and treating the primary and secondary ABCD surveys:

- **A** **Airway** = Secure the airway and confirm tracheal tube with primary assessments and secondary assessment which must include a chest x-ray.
- **B** **Breathing** = Administer 100% oxygen with mechanical ventilation and monitor with oxygen saturation levels and blood gas analyses. Mechanical ventilation often requires paralysis and sedation.
- **C** **Circulation** = Administer normal saline IV and monitor urine output to reflect tissue perfusion. Insert nasogastric tube and initiate an infusion of an antiarrhythmic for secondary prophylaxis.
- **D** **Differential Diagnosis** = Search for specific cause for the arrest. Review the chest x-ray, 12-lead ECG, history, and serum electrolytes.

**Other Actions:**
- Change IV lines placed without proper sterile technique.
- Replace deficient electrolytes
- Transport to higher level of care.

The following problems may develop:
- Hostile environment for the brain – control seizures that increase cerebral oxygen requirements. Elevate the head 30 degrees to decrease intracranial pressure.
- Hypotension – even mild hypotension can impair recovery of cerebral function.
- Recurrent VF/Pulseless VT – consider administration of an infusion of the antiarrhythmic used during resuscitation.
- Post-resuscitation of tachycardia – rapid SVTs that may develop in the immediate post-resuscitation period are best treated by leaving them alone.
- Post-resuscitation bradycardia – poor ventilation and oxygenation play a major role in post-resuscitation bradycardia.
- Post-resuscitation PVCs – improved oxygenation over time may eliminate the ectopic beats.
Post-resuscitation care includes support of the myocardial function with anticipation that myocardial “stunning” may be present, requiring vasoactive support. A healthy brain is the primary goal of cerebral and cardiopulmonary resuscitation. This may be accomplished by allowing moderate hypothermia.

- **Hypothermia**—The 2005 guidelines emphasize the importance of avoiding hyperthermia and the possible benefits of induced hypothermia (32°C to 34°C) for 12 to 24 hours for patients who remain comatose after resuscitation from cardiac arrest. Providers should monitor temperature and treat fever aggressively.
- **Maintaining strict glucose control**—Additional studies are needed to determine the precise blood glucose concentration that requires insulin therapy and the target range of blood glucose concentration. The 2005 guidelines recommend lowering of blood glucose in patients with acute ischemic stroke when serum glucose level is greater than 200 mg/dl.

### Arrhythmia Recognition and Management Skills Station

In this skills station, participants should be able to:

- Recognize and manage the following rhythms: bradycardia, wide- and narrow-complex tachycardia with poor perfusion, asystole, PEA, VF, and VT.
- Recognize unstable conditions resulting from arrhythmias requiring urgent intervention.
- Differentiate between SVT and Sinus Tachycardia and give appropriate treatments for each rhythm.
- Deliver electrical shocks safely and appropriately with a manual defibrillator and AED.
- Identify potentially reversible causes of unstable rhythms.

**Credits:**


Use of American Heart Association materials in an educational course does not represent course sponsorship by the American Heart Association. Any fees charged for such a course, except for a portion of fees needed for AHA course materials, do not represent income to the Association.