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 required 2011 AHA PALS Textbook available for reference and study for more in depth content. There is a password on page ii of the textbook that will allow the student to access an AHA student website with extensive additional materials for study and reference. The 2015 ECC Handbook is also helpful to have readily available for review and as a reference.

Agenda
Welcome, Introduction, Overview
Overview of PALS Science
BLS Review, Practice & Testing
Rhythm/Algorithm Review/Electrical Therapy and Practice
Vascular Access
Resuscitation Team Concept
Overview of Pediatric Assessment
Overview/Learning Stations-Respiratory, Shock, and Cardiac
Putting it All Together
Skills Evaluation
Written Evaluation

Evidence Based Updates
Beginning with the 2015 Guidelines Updates, the AHA is going to a continuous update format of 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 are developed, documented, debated and then evaluated by scientific experts from outside the United States and outside the AHA. The guidelines are then classified as to the strength of evidence that supports the recommendation.

Objectives
Upon the successful completion of this PALS course the participant will be able to:

Cognitive
♥ Describe the timely recognition and interventions required to prevent respiratory and cardiac arrest in any pediatric patient
♥ Describe the systematic approach to pediatric assessment by using the initial impression, primary and secondary assessments, and diagnostic tests
♥ Describe priorities and specific interventions for infants and children with respiratory and/or circulatory emergencies
♥ Explain the importance of effective team dynamics, including individual roles and responsibilities, during a pediatric resuscitation
♥ Describe the key elements of post resuscitation management

Psychomotor
♥ Perform effective, high-quality cardiopulmonary resuscitation (CPR) when appropriate
♥ Perform effective respiratory management within scope of practice
♥ Select and apply appropriate cardiorespiratory monitoring
♥ Select and administer the appropriate medications and electrical therapies when presented with an arrhythmia scenario
♥ Demonstrate effective communication and team dynamics as a team member and a team leader
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. This repolarization 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 in the atria, 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 three ways 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 on the previous page. 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.
3. A third method is to count the number of large boxes between QRS complexes and divide 300 by that number. For example, in the picture above, there are just over 4 boxes between QRSs, so 300 divided by 4 is 75. The rate is approximately 75bpm.
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.

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

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 course VF. Course VF usually occurs immediately after a cardiac arrest and has a better prognosis with defibrillation. Fine VF, has waves that can be nearly flat and look similar asystole. Fine VF 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](image)

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.
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**

The possible causes are referred to as “H’s & T’s” and are the following:
- Hypovolemia
- Hypoxia
- Hydrogen ion imbalance
- Hypoglycemia
- Hypo-/hyperkalemia
- Hypothermia
- Toxins
- Tamponade, cardiac
- Tension pneumothorax
- Thrombosis, coronary
- Thrombosis, pulmonary

In order to treat a pulseless rhythm, bradycardia, or tachycardia, 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.
Bradycardia

Bradycardia occurs when the heart is beating too slowly—less than 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 through the AV node, 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 through the AV node following the delay.

Second-Degree AV Block Type I, (Mobitz I, Wenckebach)—Some P waves conducted through the AV node, 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 (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 through the AV node, 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.

Third Degree or Complete AV Block—No P waves conducted through the AV node

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.
Tachycardia

There are 3 basic groups of tachycardias: sinus tachycardia, supraventricular tachycardia (including atrial tachycardia), and ventricular tachycardia. The algorithm that is used depends upon if the child has ADEQUATE or POOR PERFUSION. Treatment will also be determined by a NARROW or 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, agitation, or other identifiable causes
- 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 = 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.

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.

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, may consider Adenosine
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, treat VT the same as VF.

![Monomorphic Tachycardia = same size & shape QRS](image1)

**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.

![Torsades de Pointes](image2)
Prevention of injury or arrest ♥ Early & Effective CPR ♥ Early EMS Activation ♥ Early Advanced Care

**BLS Review**
(Primary Survey Approach to ECC)

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

**Rescue Techniques – C-A-B and D**

**Unresponsiveness:** After determining that the scene is safe, check to see if victim is responsive and breathing normally. If the infant or child victim is unresponsive and NOT breathing normally, 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 C-A-B CPR and then phones 911 after 2 minutes of rescue support. The goal of “phone fast” approach is to deliver oxygen quickly 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, if you are alone, activate EMS immediately after verifying that victim is unresponsive.

**Circulation:** Check for a Pulse for 5 to 10 seconds.*
♥ The best location for performing a pulse check for a child 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 when only 1 rescuer is doing CPR on a child or infant. With 2 healthcare rescuers, the compression to ventilation ratio changes to 15:2.*
♥ 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 at least 100 compressions per minute.

♥ Compressions on the child, two hands are placed in the center of the chest between the nipples on the lower half of the sternum.

♥ Compressions on an infant are performed by using the two finger technique (pressing two fingers along the sternum, just below the nipple line), or by the two thumbs encircling hands technique (both thumbs press on the sternum, just below the nipple line, and the fingers of the hand wrap around the back and press in with each compression).

♥ Compression depth is about 2 inches on a child and about 1 ½ inches on an infant.

♥ Rotation of 2-man CPR is every 2 minutes (5 cycles of 30:2) or after 5 cycles of 15:2 for two person CPR of infants and children.

♥ Minimizing interruptions in chest compressions will increase the victim’s chance of survival.

**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). This can be a difficult technique, so after two unsuccessful attempts, use the head tilt-chin lift.

**Breathing:** Give two breaths.

♥ To give breaths, 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 a 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.

♥ If there is a pulse, but no breathing or inadequate breathing, perform rescue breathing. Rescue breathing rates are 1 breath every 3 to 5 seconds (12 – 20 breaths per minute) for newborn up to age 8*. Over age 8, rescue breathing rates are 1 breath every 5 to 6 seconds (10 – 12 breaths per minute).

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

♥ Immediate CPR and defibrillation within no more than 3 to 5 minutes gives a person in sudden cardiac arrest the best chance of survival.*

♥ The AED is used on adults, children, and infants.

♥ Only use adult AED pads when performing defibrillation on an adult or child over the age of 8.

♥ Child or infant victim: Rescuer should use pediatric pads when available for infants and children up to 8 years of age. If pediatric pads are NOT available, adult pads may be used.*
Adult or Child victim: Place one pad on the victim’s upper right chest just below the collar bone and to the right of the sternum and the other pad on the left side and below the nipple, being careful that the pads do not touch. If the infant or child is small and the pads would touch, place the pads in an anterior/posterior position.

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. Resume CPR immediately after the shock.*

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.

Pediatric Assessment

A Systematic Approach to Pediatric Assessment starts first with an Initial Impression. If there are no immediate life threatening conditions, proceed with the Evaluate-Identify-Intervene model.

Initial Assessment: – Perform a rapid assessment of level of consciousness, work of breathing, and color, determine if this is a life-threatening emergency. If so, begin emergency treatment.

Evaluate: – Evaluation consists of a Primary Assessment, Secondary Assessment, and Diagnostic Tests

Primary Assessment Includes: A rapid, hands-on ABCDE approach to evaluate respiratory, cardiac and neurologic function. This step includes assessment of vital signs and pulse oximetry.

A = Airway – positioning, assess need for airway devices
B = Breathing – rate, effort, volume, sounds, O2 sat
C = Circulation – skin color & temperature, HR, pulses, capillary refill time, BP
D = Disability – AVPU, Glasgow Coma Scale
E = Exposure – remove clothing, temperature
Secondary Assessment Includes: A focused medical history using the SAMPLE mnemonic and a focused physical exam
S = Signs & Symptoms
A = Allergies
M = Medications
P = Past medical history
L = Last meal
E = Events leading to presentation

Diagnostic Tests: Laboratory, radiographic, and other advanced tests that help to establish the child’s physiologic condition and diagnosis. Check glucose early.*

Identify: – Based upon the assessment, identify if this is a Respiratory problem, Circulatory problem, or if both are involved. Also determine the severity.

Respiratory – Categorize by type and severity
Type:
1. Upper Airway Obstruction
2. Lower Airway Obstruction
3. Lung Tissue Disease
4. Disordered control of breathing
Severity:
Respiratory Distress or Respiratory Failure

Circulatory – Categorize by type and severity
Type:
1. Hypovolemic Shock
2. Distributive Shock
3. Cardiogenic Shock
4. Obstructive Shock
Severity:
Compensated Shock or Hypotensive Shock

Intervene: – Start treatment interventions appropriate for the clinical condition.

Evaluate-Identify-Intervene is an ongoing process in which the sequence is continuously repeated as new information is obtained.* If at any point you identify a life-threatening problem, start life-saving interventions immediately and get help by calling a code or activating EMS

Management of Respiratory Emergencies

Respiratory Problems can be Categorized into two categories based upon severity:
1. **Respiratory Distress:** tachypnea, increased respiratory effort, grunting, stridor, wheezing, seesawing or "abdominal" breathing, head bobbing, decreased oxygen saturation*
2. **Respiratory Failure:** bradypnea, periodic apnea, falling heart rate/bradycardia, diminished air movement, low oxyhemoglobin saturation, stupor, coma, poor muscle tone, cyanosis*
Respiratory Problems are Categorized into four categories based upon type:
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 axillary areas. Listen for intensity and pitch of sounds.

**Upper airway obstruction:**
- Croup, anaphylaxis and foreign body airway obstruction are common causes
- Inspiratory Stridor is a characteristic breath sound
- **Treatment = treat croup** with humidified oxygen and nebulized epinephrine, corticosteroids,* treat anaphylaxis with IM epinephrine or auto injector, albuterol, antihistamines, corticosteroids, treat **aspiration of a foreign body** by allowing position of comfort and specialty consultation

**Lower airway obstruction:**
- Asthma and bronchiolitis are common causes.
- Expiratory wheezes are generally heard and there is a prolonged expiratory phase*
- **Treatment = treat bronchiolitis** with nasal suctioning and bronchodilator, treat asthma with albuterol, corticosteroids, SQ epinephrine, magnesium sulfate, terbutaline

**Lung Tissue (Parenchymal) disease:**
- Pneumonia/Pneumonitis and pulmonary edema are common causes
- **Treatment = treat pneumonia/pneumonitis** with albuterol and antibiotics, treat pulmonary edema with ventilatory and vasoactive support, and consider a diuretic

**Disordered control of ventilation:**
- Increased ICP, Poisoning/Overdose, and Neuromuscular Disease are common causes, also can be present after seizures*
- Irregular breathing pattern (“funny breathing”)
- **Treatment = treat increased ICP** by avoiding hypoxemia, hypercarbia, and hyperthermia, treat poisoning/overdose with the antidote and call poison control center, treat neuromuscular disease with ventilatory support

**Airway Devices**

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

**Oral pharyngeal Airway** – unconscious, no gag reflex*
- Choose correct size by measuring from the corner of the mouth to the angle of the jaw.
- Insert while using a tongue depressor to hold the tongue on the floor of the mouth.
- It is still necessary to keep the head and neck in the sniffing position after the oral pharyngeal airway is in place.
- Do not suction for more than 10 seconds at a time

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

**Endotracheal Tube (ETT)** – usually the ideal airway in hospitalized patients
- The ETT is placed using a laryngoscope, looking for the triangular vocal cords, and placing the ETT through them.

**Determine proper uncuffed size by age ÷ 4 + 4**
**Determine proper cuffed size by age ÷ 4 + 3.5**
(Note: cuffed tubes should not be inflated to a pressure of > 20 cm H2O)
Intubation attempts should be limited to 30 seconds.

Preoxygenation should be done for at least 3 minutes prior to intubation

Confirm ETT placement by:

- Mist in the tube
- Auscultation of lungs for bilateral breath sounds
- Auscultation of the gastric area—no gurgling should be heard that would indicate intubation of the esophageal area
- Confirmation with CO2 Detector changing color after 6 ventilations or Esophageal Detector (now one or the other is required for primary confirmation). Do NOT use esophageal detectors on children less than 20 kg.

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 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

- 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.

Methods of Oxygen delivery:

Oxygen = #1 drug – give oxygen as soon as it is available
Provide oxygen: Room air has 21% oxygen.

Low flow Oxygen (< 10L/min) patient inspiratory flow exceeds O2 flow
Nasal Cannula (1 to 4 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

High flow Oxygen (> 10L/min) O2 flow exceeds patient inspiratory flow
Face Mask with reservoir = ability to provide 100% oxygen Bag Mask
- Flow-Inflating Bag – requires compressed gas source, but can deliver free-flow oxygen at 100%
- Self-Inflating – no compressed gas source is required, unable to deliver free-flow oxygen, needs a reservoir to deliver 100% oxygen

Use positive pressure ventilation with 100% oxygen for children with severe respiratory distress, including significant intercostal retractions.
Rescue breathing rates are 1 breath every 3 to 5 seconds (12 – 20 breaths per minute) for up to age 8*. Over age 8, rescue breathing rates are 1 breath every 5 to 6 seconds (10 – 12 breaths per minute).

♥ Always monitor a patient with pulse oximetry, but remember this can be unreliable. The most important thing is to evaluate the child.*
♥ When possible, monitor with capnography.
♥ Maintain the arterial oxyhemoglobin saturation to 94% to 99% range. An Oxyhemoglobin saturation of 100% is generally an indication to wean the FiO₂.
♥ Pulse oximetry evaluates oxygenation, but not effectiveness of ventilation (elimination of CO₂).
♥ Determine effectiveness of bag-mask ventilations by observing for visible chest rise.
♥ Endotracheal Tube (ETT)
**Management of Shock**

Key Points: Capillary refill, if prolonged (> 2 seconds), may indicate shock, measure blood pressure. Shock is defined as inadequate delivery of oxygen and nutrients to the tissues relative to tissue metabolic demand.

Shock can be categorized into two categories based upon severity:

1. **Compensated Shock**: Normal systolic BP, decreased level of consciousness, cool extremities with delayed capillary refill, and faint or non-palpable distal pulses
2. **Hypotensive Shock**: Hypotension (based upon age) with signs of shock*
   - For children ages 1 to 10 years of age, hypotension is defined as systolic BP < 70 mm Hg + (child’s age in years x 2) mm Hg*

Shock is categorized into four categories based upon type:

**Hypovolemic Shock**: (Most common)
- Non-hemorrhagic vs. Hemorrhagic
- 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, pale, cool skin
- Treatment: Fluids: Crystalloid Isotonic Solution (Normal Saline, or Ringers Lactate)
  20mL/kg over 5 to 10 minutes*

**Distributive Shock**::
- Septic vs. Anaphylactic vs. Neurogenic
- 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
- High fever may indicate septic shock*
- Treatment = treat septic shock with the septic shock algorithm (Fluids: Crystalloid Isotonic Solution 20mL/kg over 5 to 10 minutes,* Antibiotics, Support BP: Norepinephrine, Epinephrine and additional therapies), treat anaphylactic shock with IM epinephrine first,* then consider antihistamines, corticosteroids, epinephrine infusion, albuterol, treat neurogenic shock with 20 mL/kg NS/LR boluses and a vasopressor

**Cardiogenic Shock**::
- Bradyarrhythmia/Tachyarrhythmia vs. Other (e.g., CHD, Myocarditis, Cardiomyopathy, Poisoning)
- 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 = treat arrhythmias, give fluids 5 to 10 mL/kg NS/LR bolus over 10 to 20 minutes, vasoactive infusion, expert consultation
Obstructive Shock:
- Ductal-Dependent vs. Tension Pneumothorax, vs. Cardiac Tamponade vs. Pulmonary Embolism
- Similar symptoms to cardiogenic shock
- **Treatment** = treat ductal dependent with Prostaglandin E and expert consultation, treat tension pneumothorax with needle decompression (midclavicular line, 2nd intercostal space) and tube thoracostomy,* treat cardiac tamponade with pericardiocentesis and 20 ml/kg NS/LR bolus, treat pulmonary embolism with 20 mL/kg NS/LR, thrombolitics, anticoagulants, and expert consultation

Vascular Access

Especially in a child with shock and decreased peripheral blood flow, IV access may be difficult. If peripheral venous access cannot be established rapidly (after 2 attempts), initiate IO access.* Access is confirmed when fluids flow freely and there is no soft tissue swelling at the infusion site.

- 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

Contraindications for IO placement include: Fracture in extremity, infection in bone, previous insertion attempt at the same site

Resuscitation Team Concept

8 Elements of Effective Team Dynamics
1. Closed-loop communication
2. Clear messages
3. Clear roles and responsibilities*
4. Knowing one’s limitations
5. Knowledge sharing
6. Constructive intervention*
7. Reevaluation and summarizing
8. Mutual respect

6 Resuscitation Team Roles
1. Team Leader
2. Airway
3. IV/IO
4. Compressor
5. Monitor/defibrillator
6. Observer/recorder
**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.

- ♥ Hypovolemia – give fluids
- ♥ Hypoxia – give oxygen, check E.T. tube
- ♥ Hydrogen ion (acidosis) – sodium bicarbonate
- ♥ Hypo-/Hyperkalemia – potassium or sodium bicarb
- ♥ Hypoglycemia – Glucose
- ♥ Toxins – Drug overdose = give Narcan
- ♥ Tamponade, cardiac – pericardiocentesis
- ♥ Tension pneumothorax – needle decompression
- ♥ Thrombosis, coronary
- ♥ Thrombosis, pulmonary

**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):**

![Electrocardiogram](image)

Defibrillation can be performed using either monophasic or biphasic technology. Biphasic, the newer technology uses about \(\frac{1}{2}\) the energy of a monophasic shock.
First shock is at 2 J/kg, subsequent shocks at 4 J/kg or greater, max 10J/kg*
Biphasic = maximum 200 J
Note: 1st shock may be 2 – 4 J/kg, 2nd shock 4J/kg, may continue to increase to a maximum of 10J/kg or maximum adult dose

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 for the size of the child
   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 for 2 minutes.
♥ 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:
• During the CPR
• While the defibrillator is charging
• 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 15mg/kg IV per 24 hours or Lidocaine 1mg/kg

In 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):**

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**

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.

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:

1. Try Vagal maneuvers. Ask older children to cough or bear down. For infants, apply ice to the face.*
2. Adenosine 0.1mg/kg (maximum doses 6 mg, 2nd dose 12 mg)* RAPID IVP (2 syringe technique)
   Note: A brief period of asystole may follow the injection
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)

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 for first dose and increase to 2 J/kg if the initial dose is ineffective.∗

Steps for cardioversion:
1. Consider sedation
2. Turn on defibrillator
3. Attach appropriate electrode pads to patient
4. Press “SYNC” mode button
5. Look for markers on R waves indicating sync mode
6. Select appropriate energy level
7. Press the charge button—announce that you are doing this
8. Clear: I’m clear, You’re clear—includes making sure that the oxygen is away from the patient, Everybody’s clear
9. 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)
10. 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.
Post-Resuscitation Care

Patients display a wide spectrum of responses to resuscitation. Following return of spontaneous circulation (ROSC), 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 oxygen with mechanical ventilation and monitor with oxygen saturation levels and blood gas analyses. When feasible, titrate FIO₂ to minimum necessary to achieve SpO₂ ≥94% and <100%.* If mechanical ventilation is required, paralysis and sedation are often necessary.

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. Administer fluids.
- 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. A key component of this is to continuously monitor temperature and aggressively treat any fever.

- Hypothermia—for comatose children post resuscitation, either 5 days of normothermia (36°C to 37.5°C) or 2 days of initial continuous hypothermia (32°C to 34°C) followed by 3 days of normothermia.
“*” Used throughout the course outline indicates that there is a test question related to the noted material.

Credits:


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