



# PALS

Study  
Guide



January  
2008

510.849.4009 or  
Toll free: 1.800.637.7387



Dear PALS student:

**Please read this letter carefully!**

This letter is to confirm your registration in the Pediatric Advanced Life Support (PALS) course. *Please see the attached page with address and map to the location of your particular class.*

Please plan to be on time because it will be difficult for late students to catch up once we start. All classes start at 9:00 am sharp. If you are more than 15 minutes late, you may be turned away, as required by the American Heart Association. Students are expected to attend and participate in the entire course.

As you are probably aware, changes were made in The American Heart Association's Guidelines for CPR and Emergency Cardiovascular Care in Fall 2005. Implementation of these guidelines by Training Centers began July 1, 2006. **This new format requires all students to be fully prepared prior to coming to class.**

The PALS Course does not teach CPR, ECG rhythm identification, pharmacology, or PALS algorithms. If you do not review CPR, and if you do not learn and understand the ECG and pharmacology information in the Precourse Assessment, it is unlikely that you can successfully complete the PALS Course. This Precourse Assessment is included on the Student CD as well as in the Fast Response Study Guide.

**What we sent you**

Enclosed are this PALS Study Guide, and a *PALS Provider Manual* and *Course Guide* with Student CD.

**Precourse Requirements**

The PALS Course is designed to teach you the lifesaving skills required to be both a team member and a team leader in in-hospital and out-of-hospital settings. Because the PALS Course covers extensive material in a short time, **you will need to prepare for the course beforehand.** You should prepare for the course by doing the following:

1. Review the Study Guide, *PALS Provider Manual*, and *Course Guide*.
2. **Be prepared to pass the child 1-rescuer CPR/AED and infant 1- and 2-rescuer CPR skills tests.** You will not be taught how to do CPR or use an AED during the course; you must know this in advance. The scenarios require your BLS skills and knowledge to be current. Review and understand all BLS 2005 guidelines, especially as they relate to pediatric patients. You will find this information in this Study Guide or the *PALS Content Guide*, or in the 2005 ECC Handbook (which is not provided with this course). (Please note that we are not able to renew your BLS card based on this CPR test, which is a requirement of the PALS course itself.)
3. Review the Competency Checklists that will be used to evaluate you during the course (pages 16-17, 21-23, 42-44, 52-54, 64-67, 79-82 of the *PALS Course Guide*).

4. Review and understand the information in the *PALS Provider Manual*, the *PALS Course Guide*, and the student CD. Pay particular attention to the systematic approach to pediatric assessment, the **“Assess – Categorize – Decide – Act”** model, and the management of respiratory and circulatory abnormalities.
5. Be familiar with the PALS algorithms so that you can apply them to clinical scenarios. Note: the PALS course does not present the details of each algorithm.
6. Work through the practice cases located on the student CD to familiarize yourself with the **“Assess – Categorize – Decide – Act”** model taught in the course. As you read through each case, try to answer the questions. Check your answers to make sure you understand the concepts. Understanding and use of this model is critical to successful completion of the course.
7. Complete the Precourse Assessment included on the Student CD or in the Study Guide. This assessment consists of 3 sections: ECG Rhythm Identification, Pharmacology, and Practical Application. Use this assessment to identify areas where you need to increase your knowledge.

#### **What to Bring and What to Wear**

***It is essential that you bring your PALS Course Guide to class; you will need it during each lesson in the course. You must bring your completed Precourse Assessment to class.***

Please wear loose, comfortable clothing to class. You will be practicing skills that may require you to work on your hands and knees, and the course requires bending, standing, and lifting. If you have any physical condition that might prevent you from engaging in these activities, please tell an instructor so that they can adjust the equipment if you have back, knee, or hip problems.

Please be aware:

- There are no refunds for class fees
- You must call us at least 72 hours prior to the first day of your PALS Class to reschedule without penalty
- You will charged a \$25.00 rescheduling fee for calling fewer than 72 hours prior to the first day of class
- You will be charged a \$100.00 fee for calling us fewer than 24 hours prior to the first day of class
- If you do not attend and do not inform us, you will forfeit your entire class fee.

All renewal (1-day) participants must bring their current **American Heart Association-issued** PALS card to class. **There are no exceptions for expired cards.** PALS cards and Continuing Education Units (CEU's) will be issued at the end of class.

We look forward to welcoming you at the course. Please feel free to call with any questions. We at Fast Response hope you find the PALS Course interesting, fun, and educational!!

Lisa Dubnoff, MICP  
PALS Program Director



# PALS Course Agenda – Renewal

- 0900-0910 Welcome / Course Overview
- 0910-0920 Precourse Self-Assessment Review
- 0920-0940 Overview of PALS Science Video
- 0940-1030 1<sup>st</sup> Rotation of Respiratory Emergencies and 1- and 2- rescuer CPR Practice & Test
- 1030-1040 Break
- 1040-1130 2<sup>nd</sup> Rotation of Respiratory Emergencies and 1- and 2- rescuer CPR Practice & Test
- 1130-1140 Pediatric Assessment Video
- 1140-1200 Resuscitation Team Concept Video
- 1200-1300 Lunch
- 1300-1400 “Putting It All Together” Group Learning Stations
- 1400-1500 1<sup>st</sup> Rotation of Cardiac Cases Test and Respiratory / Shock Cases Test
- 1500-1600 2<sup>nd</sup> Rotation of Cardiac Cases Test and Respiratory / Shock Cases Test
- 1600-1615 PALS Jeopardy
- 1615-1645 Written Exam
- 1645-1700 Wrap-up

# PALS Course Agenda – Provider

## Day 1

- 0900-0910 Welcome / Course Overview
- 0910-0920 Precourse Self-Assessment Review
- 0920-0930 PALS Course Organization Video
- 0930-0950 Overview of PALS Science Video
- 0940-1030 1<sup>st</sup> Rotation of Respiratory Emergencies and 1- and 2- rescuer CPR Practice & Test
- 1030-1040 Break
- 1040-1130 2<sup>nd</sup> Rotation of Respiratory Emergencies and 1- and 2- rescuer CPR Practice & Test
- 1130-1150 Vascular Access / IO Video
- 1150-1210 1<sup>st</sup> Rotation of EKG / Electrical Therapy & Vascular Access
- 1210-1310 Lunch
- 1310-1330 2<sup>nd</sup> Rotation of EKG / Electrical Therapy & Vascular Access
- 1330-1345 Pediatric Assessment Video
- 1345-1405 Resuscitation Team Concept Video
- 1405-1415 Cardiac Cases Discussions Video
- 1415-1515 Cardiac Cases 1–4 Group Simulations

# **PALS Course Agenda – Provider**

## **Day 2**

**0900-0920 Respiratory & Shock Cases Discussions Video**

**0920-1020 Respiratory Cases 1–4 Group Simulations**

**1020-1120 Shock Cases 1–4 Group Simulations**

**1120-1220 Cardiac Cases Testing**

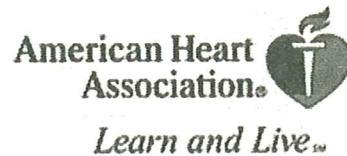
**1220-1320 Lunch**

**1320-1420 Respiratory / Shock Cases Testing**

**1420-1440 PALS Jeopardy**

**1440-1510 Written Exam**

**1510-1530 Wrap-up**



## American Heart Links

There are several resources available to you on the American Heart Association website at [www.americanheart.org](http://www.americanheart.org). Here are some helpful links:

- You can find statistics on cardiovascular diseases and risk factors at  
<http://www.americanheart.org/presenter.jhtml?identifier=2007>
- You can find out *your* risk for heart disease at  
<http://www.americanheart.org/presenter.jhtml?identifier=3003500>
- You can access information on the warning signs of heart attack and stroke at  
<http://www.americanheart.org/presenter.jhtml?identifier=3053>
- You can find out how to lead a healthy lifestyle at  
<http://www.americanheart.org/presenter.jhtml?identifier=1200009>
- You can also go to the Emergency Cardiovascular Care (ECC) website at  
<http://www.americanheart.org/presenter.jhtml?identifier=3011764>, where you can find out about other American Heart Association CPR or First Aid courses and even find a course in your area.
- To find any other topic, use the Heart and Stroke Encyclopedia at this link:  
<http://www.americanheart.org/presenter.jhtml?identifier=10000056>

# Pediatric Assessment

When treating a pediatric patient, you should use the “**Assess – Categorize – Decide – Act**” model: **Assess** the patient; **Categorize** the nature and severity of their illness; **Decide** on the appropriate actions; and **Act**. Once you have completed this process, begin again by reassessing the patient, always seeking additional information that will help in determining the nature of the illness or treatment of the patient. Your assessment process should include the following four stages:

**General Assessment:** This first assessment should be done quickly, within a minute or less. The Pediatric Assessment Triangle is used to rapidly evaluate the patient’s initial complaints and level of stability by assessing the patient’s **Appearance** (Activity/Level of Consciousness), **Work of Breathing**, and **Circulation** (Skin Signs) to categorize whether the patient’s problem is likely to be *cardiac, respiratory, or shock*.

**Primary Assessment:** This more extensive assessment evaluates the patient to better assess the nature of the illness: **Airway** (including breath sounds), **Breathing** (rate, effort), **Circulation** (pulse, blood pressure, etc.), **Disability** (Activity, Level Of Consciousness), and **Exposure** (temperature, injuries, rash, etc.).

**Secondary Assessment:** In addition to reassessing the patient’s ABCDEs, the provider should obtain a **SAMPLE History** and perform a Detailed **Physical Examination**.

**Tertiary Assessment:** These elements of the Therapeutic Endpoints can be performed at any stage of treatment, but should wait until the patient is stable. They include laboratory, X-Ray, and other tests to confirm diagnosis, seek for underlying causes or differential diagnosis, and aid in ongoing treatment.

After each assessment/reassessment, you should categorize the nature and (if possible) severity of the problem in one (or more) areas:

**Cardiac:** Either a life-threatening dysrhythmia or cardiac arrest (see page 13).

**Respiratory:** Either respiratory distress or respiratory failure (see page 14).

**Shock:** Either compensated shock or decompensated (hypotensive) shock (see page 18).

As you provide treatment, **you must frequently reassess your patient** (especially after initiating a therapy or intervention), then recategorize them based on the information available to you; what you first categorize (correctly) as respiratory distress may turn out to be the result of a life-threatening dysrhythmia, so you would need to recategorize the problem as cardiac once you identify the heart rhythm, then treat the patient appropriately.

As you continue to gather information and assess the patient, you should try to determine the underlying cause or specific nature of the problem. The PALS course identifies the following specific cardiac, respiratory, and shock types, although providers need to be aware that these are not exhaustive lists:

**Cardiac:** Common life-threatening dysrhythmias include Supraventricular Tachycardia or Bradycardia.

Patients in cardiac arrest may be in Ventricular Fibrillation, Pulseless Ventricular Tachycardia, Asystole, or Pulseless Electrical Activity (PEA), which includes all other heart rhythms that present without a pulse. In pediatric patients, severely symptomatic bradycardia may require CPR.

**Respiratory:** Respiratory problems can be broadly divided into Upper Airway Obstruction, Lower Airway Obstruction, Lung Tissue Disease, or Disordered Control of Breathing (which includes any ineffective respiratory rate, effort, or pattern).

**Shock:** Shock (widespread inadequate tissue perfusion) can be Hypovolemic, Obstructive, Distributive (Septic), or Cardiogenic in nature.

If a patient’s General Appearance indicates that they may be unconscious, you should check for responsiveness. If the patient is **Unresponsive**, get help (send someone to call 911 and bring back an AED, call a code, etc.). The BLS Algorithm should then be followed – open the *Airway*, check for *Breathing*, and assess *Circulation*. If the patient is apneic, rescue breathing should be started; if the patient is pulseless (or if a pediatric patient has a heart rate less than 60 with serious signs and symptoms), rescuers should begin CPR.

# PALS Algorithm Review

***Always start with the ABCD survey!***

## **BRADYCARDIA**

*Algorithm:* Bradycardia with a pulse (*Course Guide*, page 49)

*Remember:* Vegans Can Eat Tofu Dogs:

- Ventilations – provide assisted ventilations as needed – aggressive oxygenation is the highest priority for pediatric bradycardia.
- CPR – perform chest compressions if heart rate still < 60 with poor perfusion.
- Epinephrine 0.01 mg/kg (1:10,000 solution) IV/IO (if unresponsive to ventilations and CPR).
- consider Transcutaneous Pacing if patient unresponsive to ventilations, CPR, and epinephrine.
- Differential Diagnosis – consider the 6 H's and 5 T's (see next page).

*Note:* Atropine is indicated bradycardia secondary to vagal tone stimulation or 1° heart block only (dose is 0.02 mg/kg, with a minimum dose of 0.1 mg).

## **TACHYCARDIA**

*Algorithm:* Tachycardia with Pulses and Poor Perfusion (*Course Guide*, page 51)

*Remember:* The first-line treatment for any pediatric dysrhythmia is oxygenation and, if necessary, assisted ventilations. Otherwise:

- For **Regular Narrow Complex** Tachycardia (*rate < 180 for children, < 220 for infants*) – Probable *Sinus Tachycardia* (ST):
  1. Obtain 12-lead ECG (if appropriate).
  2. Seek for and treat underlying cause.
- For **Regular Narrow Complex** Tachycardia (*rate > 180 for children, > 220 for infants*) – Probable *Supraventricular Tachycardia* (SVT):
  1. Obtain 12-lead ECG; consider expert consultation.
  2. Attempt vagal maneuvers (if attempted without delays).
  3. Adenosine 0.1 mg/kg rapid IV push (maximum initial dose: 6 mg) if IV access readily available. If no conversion, may double the initial dose once (only).
  4. Synchronized Cardioversion (0.5 to 1 J/kg, increase to 2 J/kg if rhythm does not convert). Sedate if possible, but do not delay cardioversion.
  5. Seek for and treat underlying causes (6 H's and 5 T's; see next page).
- For **Wide Complex** Tachycardia (probable *Ventricular Tachycardia*):
  1. Immediate Synchronized Cardioversion (0.5 to 1 J/kg, increase to 2 J/kg if rhythm does not convert). Sedate if possible, but do not delay cardioversion.
  2. May attempt adenosine one time (0.1 mg/kg) *if it does not delay cardioversion*.
  3. Obtain 12-lead ECG; expert consultation advised.
  4. Convert rhythm using Amiodarone (5 mg/kg IV over 20-60 minutes) **OR**
  5. Procainamide (15 mg/kg IV over 30-60 minutes).
    - o Do not routinely administer amiodarone and procainamide together.
  6. Seek for and treat underlying causes (6 H's and 5 T's; see next page).

## VENTRICULAR FIBRILLATION / PULSELESS VENTRICULAR TACHYCARDIA

Algorithm: Pulseless Arrest – **Shockable** (Course Guide, page 39)

Remember: Good ACLS starts with good BLS:

- CPR – start immediately. Push hard and push fast.
- Shock – analyze rhythm, and shock if in VF/pulseless VT (2 J/kg).
- CPR – resume CPR immediately after shock delivery. Continue for 10 cycles / 2 minutes.
- Vasopressor – Epinephrine 0.01 mg/kg (1:10,000 solution) q 3-5 min IV/IO.  
Give as soon as possible after resuming CPR, circulate with chest compressions.
- Shock – analyze rhythm, and shock if in VF/pulseless VT (4 J/kg).
- CPR – resume CPR immediately after shock delivery. Continue for 10 cycles / 2 minutes.
- Antiarrhythmic – Amiodarone 5 mg/kg IV/IO or Lidocaine 1 mg/kg.  
Give as soon as possible after resuming CPR, circulate with chest compressions.
- Shock – analyze rhythm, and shock if in VF/pulseless VT (4 J/kg).
- CPR – resume CPR immediately after shock delivery. Continue for 10 cycles / 2 minutes.

Note: **Minimize interruptions to chest compressions – do not check a pulse or evaluate the heart rhythm after a shock.** After each shock, resume CPR immediately and continue for 10 cycles prior to rhythm analysis and possible pulse check. Although Epi can be given every 3-5 minutes (in practical terms, every 10 cycles/4 minutes), only one antiarrhythmic dose should be given to a pediatric patient.

## PULSELESS ELECTRICAL ACTIVITY

Algorithm: Pulseless Arrest – **Not Shockable** (Course Guide, page 39)

Remember: **PEA:**

- Possible causes (consider the 6 H's and 5 T's).
- Epinephrine 0.01 mg/kg IV/IO q 3-5 minutes.  
Give as soon as possible after resuming CPR, circulate with chest compressions.
- Aggressive oxygenation – use compression:ventilation ratio of 15:2, consider advanced airway.  
Avoid hyperventilation – do not ventilate too quickly, too often, or with too much volume.

Note: In PEA, the electrical system of the heart is functioning, but there is a problem with the *pump, pipes, or volume* – a mechanical part of the system is not working. You can use the **6 H's and 5 T's** to remember the most common reversible causes of PEA:

Hypovolemia	Hypoxia	Tamponade, cardiac	Toxins
Hypo-/Hyperkalemia	Hypoglycemia	Tension Pneumothorax	Trauma
Hydrogen Ion (acidosis)	Hypothermia	Thrombosis (coronary or pulmonary)	

## ASYSTOLE

Algorithm: Pulseless Arrest – **Not Shockable** (Course Guide, page 39)

Remember: **DEAD:**

- Determine whether to initiate resuscitative efforts.
- Epinephrine 0.01 mg/kg (1:10,000 solution) q 3-5 min IV/IO.  
Give as soon as possible after resuming CPR, circulate with chest compressions.
- Aggressive oxygenation – use compression:ventilation ratio of 15:2, consider advanced airway.  
Avoid hyperventilation – do not ventilate too often, too quickly, or with too much volume.
- Differential Diagnosis or Discontinue resuscitation – Are they still dead? Consider the 6 H's and 5 T's (see above) – check blood glucose; check core temperature; consider Naloxone; etc.

# Respiratory Compromise

When treating a child, providers should be vigilant for signs of respiratory compromise. Often, symptoms of shock or cardiac distress are treated without regard to respiratory status, but in many cases a cardiac dysrhythmia or compensated shock can be completely resolved by aggressive oxygenation. Whenever a pediatric patient's heart rate is too slow, or is slowing, the first and primary treatment is to give assisted ventilations if the child's airway is not maintained or their work of breathing is not effective.

For pediatric patients with any symptoms, always provide oxygen, the exact flow rate depending on patient needs. Stable patients with a cardiac dysrhythmia but no respiratory distress can receive low-flow oxygen (up to 4 L/min.) via nasal cannula. Unstable cardiac patients, patients in shock (compensated or hypovolemic), or patients with respiratory distress should receive high-flow oxygen via non-rebreather mask, if they tolerate it. Patients in respiratory failure should receive assisted ventilations via bag-mask valve. O<sub>2</sub> saturation monitoring is important, so pulse oximetry should be attached as soon as possible.

Respiratory Rate (breaths/min)	
Age	Rate
Infant	30 to 60
Toddler	24 to 40
Preschooler	22 to 34
School-age child	18 to 30
Adolescent	12 to 16

It is critical that students correctly categorize the degree of respiratory compromise (page 55 of the *PALS Course Guide*) and provide appropriate oxygenation.

In **Respiratory Distress**, the patient will have an increased respiratory rate and effort. Be alert for patient position, nasal flaring, retractions, and accessory muscle use. Skin color may be normal or pale, and the patient may exhibit the beginnings of an Altered Level of Consciousness (ALOC). Adventitious breath sounds may or may not be present. Any patient in respiratory distress should receive high-flow oxygen via non-rebreather mask, if they tolerate it.

In **Respiratory Failure**, the patient may have an increase in respiratory effort with increased or decreased respiratory rate. Be alert for patient position, nasal flaring, retractions, and accessory muscle use. Head bobbing, decreased respiratory effort, "seesaw" respiratory pattern, shallow respirations, cyanosis, difficulty speaking, and poor air movement (diminished or absent breath sounds) are signs of respiratory failure.

For any child in respiratory failure or severe respiratory distress, you should consider the following interventions: *Assisted Ventilations* (provide ventilations via Bag-valve Mask); *Advanced Airway* (consider Endotracheal Intubation); or *Mechanical Ventilations* (such as CPAP or BiPAP). When providing assisted ventilations, students should remember that hyperventilation (ventilating too often, too rapidly, or with too much volume) **will diminish the effectiveness of circulation**.

After assessing the severity of respiratory compromise, you should determine the cause. Increased heart rate with no increased work of breathing is often a sign of shock (see page 18), but may be seen in the early stages of respiratory distress. Any increase in work of breathing, or any decrease in respiratory rate, indicates respiratory compromise. PALS divides respiratory problems into four types: *Upper Airway Obstruction*, *Lower Airway Obstruction*, *Lung Tissue Disease*, and *Disordered Control of Breathing*.

**Upper airway obstruction** can be caused by infection (e.g., croup); loss of consciousness; anaphylaxis; secretions; or foreign bodies. It is characterized by poor air movement; stridor or snoring may be heard. Airway management (such as head-tilt/chin-lift maneuver, airway adjuncts, suctioning, removal of foreign bodies) is critical.

**Lower airway obstruction** is commonly caused by asthma or bronchiolitis. It is characterized by poor air movement, and usually presents with coarse breath sounds or wheezing. Assisted ventilations at a relatively slow rate will often be necessary. Suctioning may also be required.

**Parenchymal (lung tissue) disease** involves inflammation of or fluid accumulation in the lungs, with causes including pulmonary edema and pneumonia. It is characterized by poor oxygenation even in the presence of good air movement; breath sounds often include crackles or grunting.

**Disordered control of breathing** is caused by an ineffective breathing pattern or markedly decreased respiratory rate. Management of the airway and providing assisted ventilations (as needed) are critical early actions. Many patients with respiratory compromise will degenerate to disordered control of breathing as their muscles weaken.

# Shock

When treating a child with respiratory distress, cardiac dysrhythmia, or circulatory compromise, providers should be vigilant for any signs of shock. Often, symptoms of compensated shock go unnoticed as providers concentrate on the child's primary complaint, but you should remember that children can decompensate very quickly. If primary interventions do not quickly resolve the patient's symptoms, assessment and treatment of shock may be necessary.

It is extremely important for students to correctly categorize the severity of shock (see page 74 of the PALS Course Guide) and to be able to recognize the *Therapeutic End Points of Shock*.

In **Compensated Shock**, the patient will have a Blood Pressure in the normal range but will show signs of compensation – increased heart rate and respiratory rate (often without an increase in respiratory effort); weak or absent distal pulses with delayed capillary refill; and pale, cool, or mottled extremities. The patient may or may not have a decreased Level of Consciousness.

In **Hypotensive (Decompensated) Shock**, the patient will have a decreased Blood Pressure and will show signs of a weakening of compensatory mechanisms – absent distal pulses with delayed or absent capillary refill; a pale, mottled, or cyanotic core; lethargy or unconsciousness; and possibly a decreased heart rate or respiratory rate. Central pulses may be normal or weak.

After you assess the severity of shock, you should determine the type. Although this is often done automatically, you should consciously consider the signs and symptoms, as the specific treatments for each type of shock differ, and ignoring signs may lead to incorrect or even dangerous treatments.

## Definition of Hypotension by Systolic Blood Pressure and Age

Age	Systolic Blood Pressure
Term neonates (0 to 28 days)	<60 mm Hg
Infants (1 to 12 months)	<70 mm Hg
Children 1 to 10 years (5th BP percentile)	<70 + (age in years × 2) mm Hg
Children >10 years	<90 mm Hg

PALS categorizes shock into four types: Hypovolemic, Obstructive, Distributive (Septic), and Cardiogenic.

**Hypovolemic shock** is caused by reduced circulating fluid volume. Common causes among children are dehydration and trauma. The primary treatment is to provide 20 ml/kg of fluids.

**Distributive shock** causes relative hypovolemia by an inappropriate distribution of blood volume. Distributive shock often shows signs of high cardiac output and low systemic vascular resistance (such as bounding pulses or warm extremities), the opposite of other types of shock. Infusion of 20 ml/kg of fluids is the initial treatment. If distributive shock is caused by sepsis, administer *antibiotics* as early as possible.

**Cardiogenic shock** is caused by a reduced ability of the heart to pump effectively. Central pulses may be weak; pulmonary edema may be present; and cyanosis and JVD may be noted. Fluid resuscitation should be conservative (limited to 5-10 ml/kg) to avoid overloading the heart. Early consideration of vasoactive drugs (like *Dopamine* or *Milrinone*) is important. Cardiac rhythm disturbances, if present, are a likely cause of cardiogenic shock, and should be treated rapidly.

**Obstructive shock** is caused by a blockage of blood flow to or from the heart. Possible causes include *tension pneumothorax*, *cardiac tamponade*, *pulmonary embolism*, and *congenital heart lesions*. In the early stages, it is often indistinguishable from hypovolemic shock. Although rapid fluid administration is needed, the provider must identify and correct the cause of the obstruction.

## Therapeutic End Points of Shock

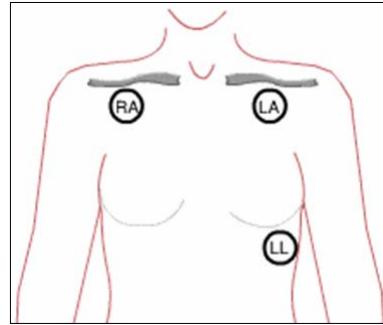
The *Therapeutic End Points of Shock* cannot be clearly defined. Although systolic Blood Pressure has traditionally been used to measure a return to adequate perfusion, it is often insufficient on its own, so providers should also assess some or all of the following: heart rate, respiratory rate, mental status, tissue perfusion [as indicated by strong peripheral pulses, normal capillary refill time, and good skin signs], urine output, venous oxygen saturation, and decreased serum lactate.

# EKG and Electrical Therapy Review

The EKG tracing represents electrical activity through the heart. The **P wave** represents depolarization of the atria; the **QRS complex** represents depolarization of the ventricles; and the **T wave** represents the latter stage of repolarization of the ventricles. The interval from the first deflection of the P wave to the beginning of the QRS complex is the P-R Interval (PRI), and should be between 0.12 and 0.20 seconds. A pediatric patient's QRS complex has a duration of 0.08 seconds or less; a longer duration (*wide QRS*) indicates delayed conduction through the ventricles, often as the result of a ventricular pacemaker focus.

The horizontal axis of the EKG strip measures time. Each large box represents 0.20 seconds; each small box represents 0.04 seconds.

To obtain a 3-lead EKG tracing, place the white (RA) electrode on the right chest just below the clavicle; the black electrode (LA) on the left chest just below the clavicle; and the Red electrode (LL) laterally on the lower left abdomen. Pacer and defibrillation pads generally go in the anterior/posterior positions, although on older children, defibrillation pads can go on the upper right chest and lower left abdomen.



## Rhythm Disturbances

**Treat the patient, not the dysrhythmia.** Always assess your patient for pulses, perfusion, and level of consciousness – is the patient *Stable*, *Unstable*, or *Pulseless*? Next, assess the rhythm: Is it fast or slow? Is it life-threatening? As you treat the patient, try to discover the cause of the dysrhythmia – for many patients, their only chance of survival is if you can identify and treat a **reversible cause**. There are many possible causes of rhythm disturbances, especially bradycardia or PEA. Some of the most common causes in children include hypoxia, drugs/toxins, hypovolemia, and intrinsic heart problems. Although lab draws can be useful, a history of the patient and the current event obtained from a parent or caregiver is often more useful.

## Defibrillation (Unsynchronized Shock)

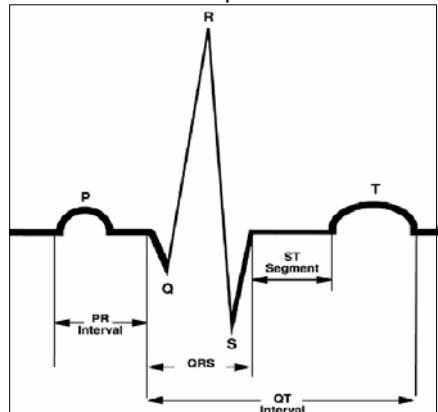
Fibrillation is a disorganized rhythm that, if present in the ventricles, is life-threatening. Immediate CPR combined with early defibrillation is critical to survival from sudden cardiac arrest. Defibrillation terminates all electrical activity in the pulseless heart in the hopes that it will resume beating in a coordinated fashion. A shock should be delivered about once every 2 minutes if the patient remains in Ventricular Fibrillation.

With either a monophasic or a biphasic manual defibrillator, the recommendation is to deliver the first shock at 2 Joules/kg. The second and subsequent defibrillation shocks are delivered at 4 J/kg.

## Synchronized Cardioversion

In pediatric patients, synchronized cardioversion is a secondary treatment. For patients with a narrow-complex tachycardia (i.e., SVT), attempt vagal maneuvers and adenosine first. For patients with a wide-complex tachycardia, expert consultation is advised if the patient is stable enough to withhold treatment.

If the patient is too unstable to attempt other treatments (or if other treatments are ineffective), consider synchronized cardioversion. The shock is timed by the monitor to be delivered in coordination with the QRS complex of the heart. If the patient is conscious, consider sedation prior to cardioversion; however, **synchronized cardioversion should not be delayed while waiting for sedation** in severely symptomatic patients. The initial shock is delivered at 0.5 to 1 J/kg regardless of the type of manual defibrillator used. If the initial shock fails to terminate the rhythm, with the second shock delivered at 2 J/kg.



## Transcutaneous Pacing (TCP)

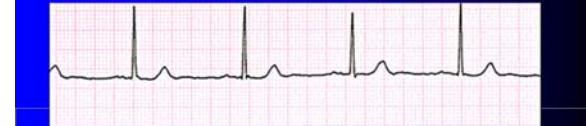
External cardiac pacing can be considered for pediatric bradycardia unresponsive to ventilation, oxygenation, CPR, and medications. Begin pacing at zero milliamps, slowly increasing until capture is achieved. Then, set the rate at 20 beats per minute above the monitored heart rate, with a minimum rate of 50 bpm.

### Normal Sinus Rhythm (NSR)



Rhythm	Regular
Rate	See Below
P waves	Normal in configuration & direction; one P wave precedes each QRS
PRI	Normal (0.12 - 0.20 seconds)
QRS	Normal (0.08 seconds or less)

### Sinus Bradycardia



Rhythm	Regular
Rate	< 60
P waves	Normal in configuration & direction; one P wave precedes each QRS
PRI	Normal (0.12 - 0.20 seconds)
QRS	Normal (0.08 seconds or less)

### Normal Sinus Rhythm

Age	Heart Rate
newborn to 3 mo.	80 - 205 bpm
3 months - 2 years	75 - 190 bpm
2 - 10 years	60 - 140 bpm
> 10 years	60 - 100 bpm

### Sinus Bradycardia

Age	Heart Rate
newborn to 3 mo.	< 100 bpm
3 months - 2 years	< 60 bpm
2 - 10 years	< 60 bpm
> 10 years	< 60 bpm

### Sinus Tachycardia (ST)



Rhythm	Regular
Rate	See Below
P waves	Normal in configuration & direction; one P wave precedes each QRS
PRI	Normal (0.12 - 0.20 seconds)
QRS	Normal (0.08 seconds or less)

### Supraventricular Tachycardia (SVT)



Rhythm	Regular; runs of SVT may be regular or irregular.
Rate	See Below
P waves	P waves in the runs of SVT usually abnormal (often pointed); usually hidden in preceding T wave.
PRI	Not measurable in the runs of SVT.
QRS	Normal (0.08 seconds or less).

### Sinus Tachycardia

Age	Heart Rate
newborn to 3 mo.	205 - 225 bpm
3 months - 2 years	190 - 225 bpm
2 - 10 years	140 - 180 bpm
> 10 years	100 - 150 bpm

### Supraventricular Tachycardia

Age	Heart Rate
newborn to 3 mo.	> 225 bpm
3 months - 2 years	> 225 bpm
2 - 10 years	> 180 bpm
> 10 years	> 150 bpm

## Sinus Arrhythmia



Rhythm	Irregular
Rate	Underlying rhythm usually normal, but may be slow (less than 60)
P waves	Normal in configuration & direction; one P wave precedes each QRS
PRI	Normal (0.12 - 0.20 seconds)
QRS	Normal (0.08 seconds or less)

## Asystole

(Hint: This is not a good sign)



Rhythm	Regular (or "None")
Rate	0 (or "None")
P Waves	Usually absent, but may be present.
PRI	N/A
QRS	Absent

## Sinus Arrhythmia

Age	Heart Rate
newborn to 3 mo.	
3 months - 2 years	usually normal for age; may be slow.
2 - 10 years	
> 10 years	

## Asystole

Age	Heart Rate
newborn to 3 mo.	
3 months - 2 years	0 (may occasionally show P waves only, at normal or slow rate)
2 - 10 years	
> 10 years	

## Ventricular Tachycardia

Rhythm	Usually regular
Rate	See Below
P waves	SA node often still beats; however, the P wave is usually hidden in the QRS
PRI	Not measurable
QRS	Wide (> 0.08 seconds) and/or bizarre in morphology

## Ventricular Fibrillation

Rhythm	Irregular; the baseline is totally chaotic.
Rate	Cannot be determined (since there are no discernible waves or complexes).
P Waves	There are no discernible P Waves.
PRI	N/A
QRS	There are no discernible QRS complexes.

## Ventricular Tachycardia

Age	Heart Rate
newborn to 3 mo.	
3 months - 2 years	usually > 140 bpm
2 - 10 years	
> 10 years	

## Ventricular Fibrillation

Age	Heart Rate
newborn to 3 mo.	
3 months - 2 years	
2 - 10 years	N/A (too fast to count)
> 10 years	

### First-Degree AV Block



Rhythm	Regular
Rate	Heart rate is that of the underlying rhythm (usually sinus); both atrial and ventricular rates will be the same
P waves	Normal in configuration & direction; one P wave precedes each QRS
PRI	Prolonged (> 0.20 seconds); remains constant
QRS	Normal (0.08 seconds or less)

### Second-Degree AV Block Type I



Rhythm	Irregular (may be Regularly Irregular)
Rate	Depends on the underlying rhythm; Ventricular rate is less than atrial rate
P waves	Normal in configuration & direction; one P wave precedes each QRS until a P wave occurs with no following QRS complex
PRI	Progressively lengthens until a QRS is dropped, then the cycle begins again
QRS	Normal (0.08 seconds or less)

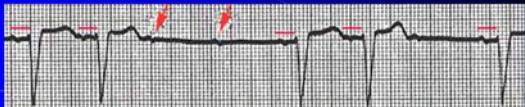
### 1<sup>st</sup> Degree Heart Block

Age	Heart Rate
newborn to 3 mo.	
3 months - 2 years	Usually normal for age; may be slow.
2 - 10 years	
> 10 years	

### 2<sup>nd</sup> Degree Heart Block Type I

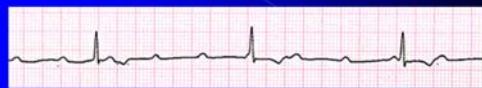
Age	Heart Rate
newborn to 3 mo.	
3 months - 2 years	May be normal for age or slow (if many QRS complexes dropped).
2 - 10 years	
> 10 years	

### Second-Degree AV Block Type II



Rhythm	Irregular (may be Regularly Irregular depending on the location and severity of the block)
Rate	Atrial: Rate of underlying rhythm Ventricular: Rate depends on conduction through AV node; less than the atrial rate.
P waves	Normal in configuration & direction; some P waves not followed by QRS complexes
PRI	May be normal or prolonged; remains constant
QRS	Can be Normal (< 0.08) or Wide (depending on location of block)

### Third-Degree AV Block



Rhythm	Irregular (atrial and ventricular rhythms are each regular, but are disassociated)
Rate	Atrial: varies (often normal for age) Ventricular: varies (usually slow)
P waves	Usually normal in configuration & direction; P waves and QRS complexes have no relationship
PRI	N/A (because QRS complexes and P waves are completely disassociated)
QRS	Can be normal but are often wide (>0.08 seconds)

### 2<sup>nd</sup> Degree Heart Block Type II

Age	Heart Rate
newborn to 3 mo.	
3 months - 2 years	Usually slow for age, especially with dropped QRS complexes.
2 - 10 years	
> 10 years	

### 3<sup>rd</sup> Degree Heart Block

Age	Heart Rate
newborn to 3 mo.	Atrial rate may be slow or normal for age; ventricular rate usually 20 - 30 bpm.
3 months - 2 years	
2 - 10 years	
> 10 years	

## MEDICATIONS FOR PEDIATRIC RESUSCITATION AND ARRHYTHMIAS

Medication	Dose	Remarks
Adenosine	0.1 mg/kg (maximum 6 mg) Repeat: 0.2 mg/kg (maximum 12 mg)	Monitor ECG Rapid IV/IO bolus
Amiodarone	5 mg/kg IV/IO; repeat up to 15 mg/kg Maximum: 300 mg	Monitor ECG and blood pressure Adjust administration rate to urgency (give more slowly when perfusing rhythm present) Use caution when administering with other drugs that prolong QT (consider expert consultation)
Atropine	0.02 mg/kg IV/IO 0.03 mg/kg ET* Repeat once if needed Minimum dose: 0.1 mg Maximum single dose: Child 0.5 mg Adolescent 1 mg	Higher doses may be used with organophosphate poisoning
Calcium chloride (10%)	20 mg/kg IV/IO (0.2 mL/kg)	Slowly
Epinephrine	0.01 mg/kg (0.1 mL/kg 1:10 000) IV/IO 0.1 mg/kg (0.1 mL/kg 1:1000) ET* Maximum dose: 1 mg IV/IO; 10 mg ET	Adult dose: 5–10 mL May repeat q 3–5 min
Glucose	0.5–1 g/kg IV/IO	D <sub>10</sub> W: 5–10 mL/kg D <sub>25</sub> W: 2–4 mL/kg D <sub>50</sub> W: 1–2 mL/kg
Lidocaine	Bolus: 1 mg/kg IV/IO Maximum dose: 100 mg Infusion: 20–50 µg/kg per minute ET*: 2–3 mg	
Magnesium sulfate	25–50 mg/kg IV/IO over 10–20 min; faster in torsades Maximum dose: 2g	
Milrinone	50 to 75 mcg/kg loading dose over 10 to 60 minutes, then .5 to .75 mcg/kg/minute IV/IO	Longer infusion times reduce risk of hypotension.
Naloxone	<5 y or ≤ 20 kg: 0.1 mg/kg IV/IO/ET* ≥ 5 y or >20 kg: 2 mg IV/IO/ET*	Use lower doses to reverse respiratory depression associated with therapeutic opioid use (1–15 µg/kg)
Procainamide	15 mg/kg IV/IO over 30–60 min Adult dose: 20 mg/min IV infusion up to total maximum dose 17 mg/kg	Monitor ECG and blood pressure Use caution when administering with other drugs that prolong QT (consider expert consultation)
Sodium bicarbonate	1 mEq/kg per dose IV/IO slowly	After adequate ventilation

IV indicates intravenous; IO, intraosseous; and ET, via endotracheal tube.

\*Flush with 5 mL of normal saline and follow with 5 ventilations.