FLORIDA HEART CPR*

AMERICAN HEART ASSOCIATION BLS, ACLS, PALS TRAINING CENTER

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Pediatric Advanced Life Support

Student Supplement 2025

Assessing and treating an ill or injured child can be very stressful, both for the parents and clinical staff. Early recognition and aggressive treatment can be lifesaving. While you will learn to "code" a pediatric patient, this is not the most common situation. Many children suffer from respiratory events, shock, and even cardiovascular incidents.

Access to the textbook is important to review prior to the course. It is a valuable tool to complete the mandatory pre-course assessment and to look up critical components of the course. Prior to class you should study the chapters on shock, respiratory, cardiac as well as patient assessment. Those who prepare prior to class should easily pass if you study!

You can expect informative, expert instruction while enjoying non-stressful presentations of didactic and skill stations. We are positive you will enjoy the course. We are here to answer all of your questions both before and during the course.

This packet contains preparatory information and an incredibly useful study guide. Be sure to utilize this packet *BEFORE* the course. You will also need to access **elearning.heart.org/courses** to complete the mandatory pre-course assessment. If you need practice with EKGs, visit Skillstat.com.

If you have questions, feel free to contact our office at 772.388.5252. We look forward to having you in class!

See the next page for pre-course assessment instructions.

PALS Pre-course Letter to Participants

Dear PALS Course student: Class begins with registration at 8:45 a.m. Please be on time!

Students are expected to attend and participate in the entire course.

**ATTENTION: TO ACCESS THE PRE-COURSE ASSESSMENT: **

1. Visit elearning.heart.org/courses.

2. In the search bar find the course name (PALS Pre-course Assessment).

3. Choose the PALS Pre-course Self-Assessment and PALS pre-course work, then select Launch Course to begin.

4. Make sure you complete both the PALS Pre-course Assessment AND PALS Pre-course work exercises and videos. **PRINT BOTH CERTIFICATES AND BRING THEM TO CLASS**. Note: If you haven't already logged in, the system will ask you to do so. If you haven't visited the site before, you'll be prompted to set up an account. The PALS Provider Course is designed to teach you the lifesaving skills required to be both a team member and a team leader in either an in-hospital or out-of-hospital setting. Because the PALS Provider Course covers extensive material in a short time, you will need to prepare for the course beforehand.

You should prepare for the course as follows:

1. CPR competency: Be prepared to pass the child and infant one and two rescuer CPR/AED CPR skills test. You will not be taught how to do CPR or how to use an AED during the course. You must know this in advance. Review and understand all current BLS guidelines, especially as they relate to the pediatric patient. You may find this information in the BLS for Healthcare Providers manual or in other AHA guidelines publications (see www.americanheart.org/cpr).

2. Complete the self-assessment certificates and print your score of 70% or better; bring the completed scores to the PALS course. This test consists of 3 sections: ECG rhythm identification, pharmacology, and practical application. Use this assessment to identify areas where you need to increase your knowledge. Precourse Prep information is found on page 5 of your student manual.

3. PALS algorithms and flowcharts: Be familiar with the PALS algorithms and flowcharts so that you can apply them to clinical scenarios. Note that the PALS course does not present the details of each algorithm. We will review these in class, however.

4. Supplement your knowledge: Review and understand the information in the PALS Provider Manual. Pay particular attention to the systematic approach to pediatric assessment, the “evaluate, identify, intervene” treatment model, and the management of respiratory, cardiac, and circulatory abnormalities.

5. Complete the PALS Study Guide from the website and look up the answers in your textbook or supplemental material. This will help you prepare for the course immensely! We will go over this document in class.

What This Course Does Not Cover: The PALS Provider Course does not teach ECG or pharmacology information. If you do not review CPR and if you do not learn and understand the ECG and pharmacology information in the self-assessment computer-based test, you may have difficulty in the course. Students who do not complete the pre-course assessment will be rescheduled.

It is essential that you bring your PALS Provider Manual to class: The student text is an essential reference during class lessons, and during the written exam! You can access a textbook or purchase an online version of the textbook from www.ShopCPR.heart.org. We may also have books for rent for the course. Call the office for more information.

We look forward to training you. If you have any questions about the course, or are having difficulty accessing the student website, please call Florida Heart @ 388-5252 well in advance of the date of the course. Thanks! See you in class!

Gayl Nye

ACLS/PALS Course Coordinator

Helpful study pages in textbook:

Pre-course Preparation	**p. 5**	**Disability/TICLS**	**p. 59**
BLS review	**p. 13**	**Managing Respiratory Emergencies**	**p. 141**
Evaluate-identify-intervene	**p. 44**	**Managing Shock Emergencies**	**p. 222**
Normal Respiratory rates	**p. 46**	**Algorithms Review-Part 12**	**p. 243**
Normal Heart rates	**p. 53**	**EKG Review**	**pp. 290-293**
Normal BP's	**p. 58**		

2025 PALS SCIENCE UPDATE

Major science changes in 2025

- High-quality CPR should focus on providing adequate chest compression rate and depth, minimizing interruptions in CPR, allowing complete chest recoil between compressions, and avoiding excess ventilation.
- Target a respiratory rate of 20-30 breaths per minute for infants and children who are receiving CPR with an advanced airway OR receiving rescue breathing and have a pulse.
- For patients with non-shockable rhythms, the earlier epi is administered after CPR initiation, the more likely the patient will survive.
- Using a cuffed ET tube decreases the need for ET tube changes.
- The routine use of cricoid pressure does not reduce the risk of regurgitation during BVM ventilation and may impede intubation success.
- For out of hospital cardiac arrest, BVM ventilation is reasonable compared with advanced airway interventions such as ET tube intubation.
- Resuscitation does not end with return of spontaneous circulation (ROSC). Excellent post-cardiac arrest care is critically important to achieving the best patient outcomes. For children who do not regain consciousness after ROSC, this care includes targeted temperature management and continuous ECG monitoring. For all children, the prevention and/or treatment of hypotension, hyperoxia or hypoxia, and hypercapnia or hypocapnia is important.
- In addition to standard BLS care, naloxone is recommended for all pediatric patients with respiratory arrest due to suspected opioid overdose.
- For septic shock, providers can administer either 10mL/kg or 20mL/kg of fluid with frequent reassessment for fluid overload. For fluid-refractory septic shock, use epi or nor-epi infusions.

Respiratory rate

Because of lack of pediatric studies, respiratory rates during pediatric CPR have previously been extrapolated from adult data. Studies show that higher ventilation rates (at least 30 breaths/minute in infants younger than one year and at least 25 breaths/minute in children 1 year and older) were associated with improved rates of ROSC and survival in cardiac arrest. When performing CPR in infants and children with an advanced airway in place, it may be reasonable to target a respiratory rate range of 1 breath every 2-3 seconds (20-30 breaths/min), accounting for age and clinical condition.

Cuffed Endotracheal Tubes

Intubation with a cuffed endotracheal tube can improve capnography and ventilation inpatients with poor pulmonary compliance and decrease the need for ET tube changes. Three systematic reviews of the literature show that cuffed tubes decrease the need for reintubation, improve

successful ventilation and the accuracy of capnography, and may decrease the risk of aspiration.

Cricoid Pressure

Although cricoid pressure may be useful in certain circumstances, studies show that its routine use reduces the rate of first-attempt intubation success because it can impede visualization during laryngoscopy and chest rise BVM ventilation. Therefore, its use is not recommended during ET intubation of pediatric patients.

Early Epinephrine

The goal of EPI administration during CPR is to optimize coronary perfusion pressure and maintain cerebral perfusion pressure. Earlier administration of EPI during CPR may increase survival to discharge rates. For pediatric patients in any setting, it is reasonable to administer the initial dose of epi within 5 minutes after the start of chest compressions.

Diastolic blood pressure to guide CPR.

For patients with continuous invasive arterial blood pressure monitoring in place at the time of cardiac arrest, it is reasonable for providers to use diastolic blood pressure to assess CPR quality. Although ideal blood pressure targets during CPR are not known, diastolic blood pressure is a marker of adequate blood flow during CPR and may be used if an arterial line is in place.

Seizures after Cardiac Arrest

Post-cardiac arrest seizures are common. Many are nonconvulsive, which can be detected only with ECG monitoring. When resources are available, continuous ECG monitoring is recommended for detecting seizures after cardiac arrest in patients with persistent encephalopathy. It is recommended to treat clinical seizures that follow cardiac arrest.

Septic Shock

Previous AHA guidelines for managing septic shock included aggressive (20mL/kg) fluid boluses and lacked additional guidance. The 2020 AHA guidelines suggest a more tailored approach to fluid administration and provide recommendations for vasopressor use. In patients with septic shock, it is reasonable to administer fluid bolus in 10mL/kg or 20mL/kg aliquots with frequent reassessment. After each fluid bolus, providers should reassess for fluid responsiveness and for signs of volume overload. Either isotonic crystalloids or colloids can be effective as the initial fluid choice for resuscitation. In infants and children with fluid-refractory septic shock, it is reasonable to use either epinephrine or norepinephrine as an initial vasoactive infusion.

Opioid Overdose

Pediatric opioid overdose management is the same as it is for adults. *(End of 2020 update).*

SYSTEMATIC APPROACH

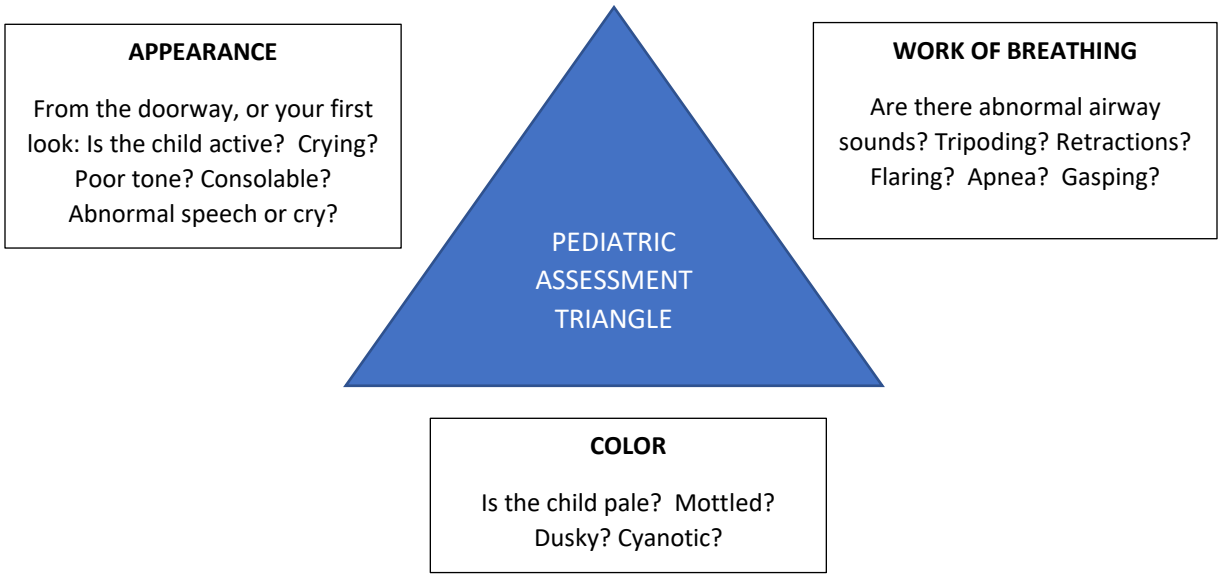
*See part **4** in your PALS textbook.*

- ✓ ***Children are unique*** when it comes to assessment and treatment. Remember that they are NOT little adults and must be assessed and treated accordingly. First, children may be fearful of rescuers and medical personnel. Approaching a child in an emergency situation may result in the child becoming upset, and that may change the dynamics of the situation, including the vital signs. This is a good time to involve the parents or caretakers during assessment. Consider the **Initial Assessment** of the child from a distance first. For example, when entering an exam room, keep your distance and observe the child as he interacts with his mother. This is also your **"doorway evaluation."** *This first glance at the child will determine if the patient needs IMMEDIATE intervention or not.* There is no need for the child to become frightened or apprehensive if you don't approach him right away. Consider washing your hands while you observe and speak quietly to the caretaker or parent as you begin to assess. What does the child look like? Is he awake? Interactive? Crying? Lethargic? Make a note of these observations.

This begins your **Initial Assessment** or

GENERAL IMPRESSION:

APPEARANCE-WORK OF BREATHING-COLOR



At any part of your initial exam if you discover a life-threatening emergency, correcting it takes precedent over baseline vitals. If the patient is unresponsive, not breathing, or only gasping, initiate the BLS Algorithm, including breathing and chest compressions if necessary!

As you continuously assess the patient you will initiate and continuously **EVALUATE-IDENTIFY-INTERVENE.** This is a cyclic process that continues until the child is stable or you turn over your patient to another level of care. For example, is the initial Sa02 only 85%? That is your **EVALUTION**. You have **IDENTIFIED** that the child needs 02. You will now **INTERVENE** by applying oxygen, then circle around to the **EVALUATION** again, and see if your intervention was successful. Continue the **EVALUATE-IDENTIFY-INTERVENE** sequence until the child is stable,

After the ***General Impression***, it's time to move on to the **Primary Assessment**, or ***A-B-C-D-E.***

PRIMARY ASSESSMENT

AIRWAY: Is the airway patent? Are there noises coming from the airway such as stridor or wheezing? Look for chest movement and listen for breath sounds. *Maintain airway patency, position, airway adjunct (NPA, OPA), suction if needed.*

BREATHING: What is the respiratory rate, effort, and pattern? *Evaluate respiratory rate before your hands on assessment because anxiety and agitation commonly change the baseline rate.* What is the pulse oximetry? Maintain an oxygen saturation of 94-99%. Too fast or too slow? Are there retractions or nasal flaring? Is there head bobbing or grunting? If so, he or she is starting to tire from the effort, and this can indicate imminent respiratory failure. You must intervene! *High flow 02, BVM, advanced airway, avoid excessive ventilation.*

CIRCULATION: Heart rate, BP, cap refill, compare central and peripheral pulses. Skin color and temperature, level of consciousness. *Consider IV access and fluid resuscitation. An increase in urine output is a good indicator of positive responses to therapy. See table for normal heart rates and blood pressures by age.*

DISABILITY: Responsiveness, level of consciousness, pupillary response. AVPU, point of care glucose. *Spinal immobilization? Correct hypoglycemia, consider naloxone.* Sudden hypoxia may cause decreased LOC, seizures, pupil dilation, irritability, lethargy. Use standard evaluations such as Glascow Coma Scale, TICLS. Decreased LOC in kids can be caused by: Poor cerebral perfusion, severe shock, TBI, hypoglycemia, seizures, drugs, hypoxemia, encephalitis, hypercarbia, or meningitis.

EXPOSURE: Remove clothing and perform physical exam anterior/posterior looking for bleeding, burns, trauma, unusual markings, rashes, or medical alert jewelry. Assess temperature. *Maintain normothermia, control bleeding, immobilize injuries if necessary.*

- ✓ *Determine if the nature of the problem is respiratory, cardiac or shock.*
- ✓ *An important part of the assessment is the point of care BGL. In neonates it should be at least 45mg/dL, and infants and children at least 60mg/dL.*

Next: the Secondary Assessment, which consists of a focused history and detailed physical exam and ongoing responses to treatment.

SECONDARY ASSESSMENT

The focused history is designed to gather information about the patient and the incident. Use the mnemonic ***SAMPLE*** as a memory aid to obtain a focused history.

- **S**- signs and symptoms
- **A**-allergies
- **M**-medications
- **P**-past medical history
- **L**-last meal or oral intake
- **E**-events leading to current illness or injury

Signs and symptoms may present such as difficulty breathing, tachypnea, diaphoresis, decreased LOC, fever, diarrhea, vomiting, agitation, or anxiety.

Allergies to food, medications, latex, and environmental considerations

Medications the child is taking or has taken recently including vitamins, OTC medications, or other medications found in the child's environment. Record last dose and time of medications.

Past medical history, including premature birth, congenital conditions, and hospitalizations. Recent hospitalizations should be revealed. Underlying medical conditions such as diabetes, seizures, head injury or tumors and neuromuscular diseases, past surgeries, and immunizations.

Last meal including breast and bottle feeding, elapsed time between last meal and presentation of illness.

Events leading to current illness, gradual or acute onset. Any injuries?

If the child is lethargic you may want to consider obtaining a POC glucose level. Try to get lung sounds before the child wakes up and he starts crying. Don't forget to warm up that stethoscope!

As a result of this information the clinician may move ahead with an assessment of the patient and discover underlying conditions affecting the care of the child. At this time, you may consider x-rays, IV insertion, labs, breathing treatments, medications, cultures, pediatric consult for cardiology or surgery or calling respiratory therapy.

A head-to-toe physical exam, or if indicated, a focused exam should now be performed.

PHYSICAL EXAM

HEENT (HEAD, EYES, EARS, NOSE, THROAT) Check fontanelles in infants, integrity of head in all ages. Check eyes for mucous membrane color, discharge, pupil size and symmetry. Check ears and throat for possible infection or unusual discharge.

CHEST-Is chest rise symmetrical? Do you see retractions in the suprasternal or intercostal areas? Any audible noises, such as wheezing or stridor?

ABDOMEN-Abdominal pain or rigidity? Has the child had diarrhea lately? Bruising?

PELVIC REGION-Rashes? Difficulty urinating? How many wet diapers per day?

LOWER EXTREMITIES-Look for rashes, injuries and check peripheral pulses. Look for mottling in one or both of the legs.

UPPER EXTREMITIES-Look for unusual flexing, check radial or brachial pulses.

V/S, Lung Sounds, Check temperature

Are there any critical interventions needed right now?? (nebulizer, Tylenol, 02). DO IT!

Evaluations of the patient should be ongoing and further treatments can be initiated enroute to the hospital, or in the hospital. Every attempt to prevent further decline of the patient should be a priority. If the patient appears unstable, vital signs should be taken more frequently. Typically the child should be with a parent or guardian the entire time.

Notes:

Respiratory Emergencies

Prompt recognition and aggressive treatment of respiratory emergencies are essential because they are a major cause of cardiac arrest in children. At times respiratory distress and respiratory can be difficult to differentiate because *failure can develop without significant distress*. Respiratory distress can progress rapidly to failure so careful examination and rapid treatment are paramount, or the child may start to decompensate and decline rapidly.

Respiratory distress and failure

Abnormal respiratory rates and patterns include irregular respiratory patterns, tachypnea, bradypnea or apnea. Neurological problems can cause irregular respiratory patterns, such as deep gasping followed by apnea. This is serious and requires urgent evaluation. Fast respiratory rates are often the first sign of respiratory distress. Respiratory distress or failure can be classified into one or more of the following types:

- Upper airway obstruction
- Lower airway obstruction
- Lung tissues disease
- Disordered control of breathing

Respiratory distress describes symptoms related to breathing problems. There can be many causes of respiratory distress in children. Usually it is caused by infections, chronic illness, or a blocked airway. A child who was premature at birth or has been in the hospital for respiratory problems, such as RSV, may be a greater risk. Respiratory distress may present with the following symptoms:

- Tachypnea/Tachycardia
- Anxiety/irritability/agitation
- Nasal flaring
- Supra-sternal or subcostal retractions
- Tripod positioning

Respiratory arrest is the absence of respirations with a pulse. Immediate treatment is important to prevent cardiac arrest. The updated guidelines are to give 1 breath every 2-3 seconds, delivering each breath over 1 second. Look for visible chest rise and check for a pulse every two minutes. Use oxygen as soon as it becomes available. Imminent or actual respiratory arrest may present with:

- Altered mental status/lethargy
- Head bobbing
- Grunting
- Cyanosis or pale skin
- Decreased Sa02
- Slow respirations/agonal breathing

Establish the type of respiratory problem. Upper or lower airway obstruction, disordered control of breathing, or lung tissue disease.

Respiratory arrest and failure/cardiopulmonary failure: poor respiratory effort = bradycardia

A respiratory rate of less than 10 or greater than 60 is abnormal and should be addressed immediately. Evaluate the respiratory rate before your hands on exam because the child may become anxious and agitated. This may alter their baseline rate. Keep in mind that fever or pain may alter the baseline rate as well.

*NORMAL RESPIRATORY RATES BY AGE**

AGE		*RATE (breaths per minute)*
Infant	*0-1 year*	*30-53*
Toddler	*1-3 years*	*22-37*
Pre-school	*3-5 years*	*20-28*
School age	*6-12 years*	*18-25*
Adolescent	*13 and up*	*12-20*

**These ranges may change in the presence of stress or fever. A consistent rate of less than 10 or more than 60 is often abnormal. This needs further assessment as it may be a potentially serious condition. Low respiratory rates may be caused by hypoxia, and high rates can cause exhaustion and respiratory failure.*

Initial management of respiratory distress and failure include the following:

A-Maintain airway patency, including using positioning. Use a head tilt chin lift or jaw thrust if needed. Suction as needed and remove foreign bodies. Use an NPA or OPA to maintain patency. Initiate "sniffing" position, apply oxygen by cannula, mask or blow by with parent's assistance.

B-Monitor Sa02, provide humidified 02 or if needed a non-rebreather for severe distress or possible failure. Considered inhaled medications such as albuterol or racemic epinephrine. Assist respirations with BVM if needed and prepare for endotracheal intubation if bag valve mask ventilations do not increase Sa02 within one minute or are not effective.

C-Monitor heart rate, rhythm, and blood pressure. Establish IV or IO to administer fluid or medications.

An advanced airway may be needed if the child is in profound shock, respiratory arrest, or bradycardia despite adequate ventilation or the child is tachypneic with poor tidal volume.

If an advanced airway is needed, consider a clinician who is skilled in pediatric intubation. Repeated unsuccessful attempts to intubate may result in unnecessary and dangerous laryngeal edema and trauma to soft tissue. Either cuffed or uncuffed is acceptable.

If an intubated patient suddenly deteriorates think "*D.O.P.E.*"

DISPLACEMENT OF TUBE: Did the tube migrate or become displaced during?

OBSTRUCTED TUBE: Is the tube kinked or obstructed with vomit or mucous?

PNEUMOTHORAX: Are ventilation pressures too high?

EQUIPMENT FAILURE: Ventilator failure or 02 bottle low or disconnected?

Other indicators of respiratory distress or failure:

- Abnormal Respiratory rate or pattern
- Apnea or agonal breaths
- Increased respiratory effort
- Nasal flaring
- Retractions
- Snoring
- Stridor
- Grunting
- Gurgling
- Wheezing
- Crackles

A child's normal oxygen saturation should be between 94-99%. Remember that 02 saturation does not provide information about effectiveness of ventilation (C02 elimination). Errors in pulse oximetry can occur if the probe is not placed over an area of pulsatile blood flow. Diminished pulses and slow cap refill can affect Sa02 measurement. Focus also on how the patient LOOKS. Signs of probable respiratory failure: rapid respiratory rate that begins to slow, extreme tachycardia or bradycardia, low Sa02 despite high flow oxygen delivery, decreased level of consciousness, cyanosis, grunting, cyanosis, or head bobbing.

Consider the relationship between the heart rate and the respiratory rate. In healthy children the heart rate may fluctuate with the respiratory cycle. The heart rate increases as the breathing increases and slows on expiration. This is called "sinus arrhythmia" and should not be of great concern to the clinician.

Notes:

Initial management of respiratory emergencies:

Support an open airway, allow child to be in a position of comfort, consider suction and airway adjuncts if necessary (NPA, OPA).

Monitor Sa02, provide supplemental oxygen, cool mist, or nebulized medications, assist ventilations with a BVM or consider intubation if necessary.

Monitor heart rate, rhythm, and BP. Establish IV or IO access for fluid or meds.

This table shows the S/S and treatments for respiratory emergencies:

Condition	S/S	Causes	Treatment
Upper airway obstruction: Croup, Stridor (croup is most common 6mos-3yrs)	Stridor, drooling, tripod position, changes in voice	Anaphylaxis, traumatic swelling of airway, foreign body airway obstruction	Humidified oxygen, nebulized epi, removal of FBAO, position of comfort, corticosteroids
Lower airway obstruction: Bronchiolitis, Asthma	Prolonged expiratory phase, coughing, wheezing, ↓ air movement	Bronchiolitis, Asthma	Albuterol + ipratropium, corticosteroids, mag sulfate, terbutaline
Lung tissue disease: Pneumonia, Pulmonary Edema	Grunting, crackles, hypoxia (despite 02 administration), cyanosis, pulmonary edema	Heart failure, pneumonia, respiratory syncytial virus (RSV), toxins, genetics, aspiration	High flow 02, bag mask ventilation, C-pap, Intubation, antibiotics for poss. Pneumonia, diuretic
Disordered control of breathing	Irregular pattern and rate of breathing	Post seizure, central apnea, head injury, intracranial pressure, neuromuscular disease, overdose	Avoid hypercarbia, supplemental 02, antidote, ventilatory support, intubation. Antidote for poisonings. Consider BiPap or CPAP.

See p. 141 for Management of Respiratory Emergencies Flowchart

Anaphylaxis is an additional airway emergency that may warrant immediate intervention. For mild allergies, treatments include removing the agent (such as bee stinger, antibiotic, or another allergen). Ask about allergies and consider an oral dose of antihistamine.

For moderate to severe reactions consider an IM injection of epi; more if needed. Treat bronchospasm with nebulized medicines.

Severe reactions should be treated with additional doses of Benadryl or steroids. Maintain BP with fluids if needed.

SHOCK: Recognition and Treatment

Part 9 in 2020 PALS Manual

Shock is defined as a physiological state characterized by inadequate tissue perfusion to meet metabolic demand and tissue oxygenation. In children it is often recognized by inadequate peripheral (slow capillary refill) and end-organ perfusion. It may also result in low cardiac output. However, in septic or anaphylactic shock, cardiac output may be high. All types of shock can result in impaired function of the vital organs such as the brain (decreased level of consciousness) and kidneys (low urine output and ineffective filtering). ***The presence of shock does not require the presence of hypotension. Shock can be present with a normal, increased, or decreased systolic blood pressure.*** It is important that you can identify compensated and hypotensive shock. There are **4** types of shock:

- **Cardiogenic:** Impaired cardiac contractility, most likely from an intrinsic or genetic heart problem, myocarditis, cardiomyopathy or arrhythmia.
- **Hypovolemic:** Inadequate blood volume or oxygen-carrying capacity (such as hypovolemic shock and including hemorrhagic shock). It can be caused by burns, gastroenteritis, diarrhea, dehydration, sepsis, or osmotic diuresis.
- **Distributive/Septic:** Inappropriate distribution of blood volume and flow; sepsis, anaphylaxis, or spinal cord injury.
- **Obstructive:** Obstructed blood flow from blood clot or pulmonary emboli. Possible causes are tension pneumothorax, cardiac tamponade, constriction of the ductus arteriosus in infants with ductal-dependent congenital heart lesions.

The goal for treating shock is to improve systemic perfusion and 02 delivery to help prevent end-organ injury and stop the progression to cardiopulmonary failure and cardiac arrest.

As shock develops, compensatory mechanisms attempt to maintain 02 delivery to vital organs. These may appear as tachycardia, delayed capillary refill, cool extremities, and weak central or peripheral pulses. When systemic vascular resistance cannot increase further to compensate for poor tissue perfusion, blood pressure begins to decline. Signs can be altered mental status and decreased urine output along with hypotension. These may rapidly lead to cardiovascular collapse, cardiac arrest, and irreversible end-organ injury.

Shock severity is frequently characterized by its effect on systolic blood pressure. Shock is described as **COMPENSATED** if the compensatory mechanisms can maintain a systolic blood pressure within a normal range.

Hypotensive **DECOMPENSATED** shock is characterized by evidence of impaired perfusion that will rapidly progress to cardiac arrest if not corrected. Signs may include abnormal clinical appearance (pale, lethargic), weak or absent distal pulses and weak central pulses, cool extremities, mottled skin and altered mental status. Hypotension is a late finding in most types of shock and may signal impending cardiac arrest.

COMPENSATED SHOCK→ MAY TAKE HOURS→**HYPOTENSIVE SHOCK**→MINUTES→**CARDIAC ARREST**

Shock progression may be unpredictable. It might take hours for compensated shock to progress to hypotensive shock but only minutes for hypotensive shock to progress to cardiopulmonary failure and cardiac arrest. *Early recognition and rapid intervention are critical to halting the progression from compensated shock to hypotensive shock to cardiopulmonary failure and cardiac arrest.*

Hypotension formula: In children 1-10 years of age, hypotension is present if the systolic blood pressure is **less than** 70 mm Hg + (child's age in years x2) mm Hg.*. The goal is for this age group to have a systolic BP of 90 + twice the child's age.

**While doing quick assessments of your patient, use this formula to estimate shock.*

Hypovolemic shock refers to a clinical state of reduced intravascular volume. It is the most common form of shock in pediatric patients. Volume loss leading to hypovolemic shock can result from:

- Diarrhea
- Vomiting
- Hemorrhage (internal or external)
- Inadequate fluid intake
- Osmotic diuresis (diabetic ketoacidosis)
- Third space losses
- Large burns

Since hypovolemic shock typically represents depletion of both intravascular and extravascular fluid, it is often necessary to administer fluid boluses that exceed the volume of the estimated intravascular deficit.

Tachypnea, a respiratory compensation to maintain acid-base balance, is often present in hypovolemic shock. The respiratory alkalosis that results from hyperventilation partially compensates for the metabolic acidosis (lactic acidosis) that accompanies shock.

During the primary assessment, look for the following findings:

Airway- typically open and patent unless level of consciousness is significantly impaired.

Breathing- Tachypnea without increased effort (quiet tachypnea).

Circulation- Tachycardia, adequate systolic BP, narrow pulse pressure, or systolic hypotension with a narrow pulse pressure*, weak or absent peripheral pulses, normal or weak central pulses, delayed capillary refill, cool or cold, pale, or mottled diaphoretic skin, dusky or pale extremities, oliguria, and changes in level of consciousness.

Disability- Decreasing level of consciousness as shock progresses.

Exposure-Extremities may be cooler than the trunk.

Distributive shock refers to a clinical state characterized by reduced SVR leading to maldistribution of blood volume and blood flow. This group includes septic shock, anaphylactic shock, and neurogenic shock (e.g., spinal injury). (*See p. 175 in your student manual*).

The temperature of the patient may be normal or febrile. Early in the clinical course, a child with distributive shock may present with decreased SVR and increased blood flow to the skin, producing warm extremities and bounding peripheral pulses ("warm shock").

As distributive shock progresses, hypovolemia and/or myocardial dysfunction produces a decrease in cardiac output. SVR may increase, resulting in inadequate blood flow to the skin, cold extremities, and weak pulses ("cold shock").

Concept: *Although most types of distributive shock are not typically classified as hypovolemic shock, all are characterized by relative hypovolemia unless adequate fluid resuscitation is provided.*

Findings in Distributive shock

Airway: open and usually patent

Breathing: quiet tachypnea, unless the child has ARDS, pneumonia, pulmonary edema, or bronchospasm.

Circulation: Usually tachycardic, (rarely bradycardic), early bounding pulses and late decreased peripheral pulses; delayed cap refill; early: warm flushed skin, late: pale, mottled skin, possibly normotensive, and changes in mental status.

Disability: changes in level of consciousness

Exposure: fever or hypothermia, petechial or purpuric rash (septic shock) or urticarial rash (anaphylaxis).

Septic Shock is an important cause of shock in infants and children. Sepsis and septic shock are terms used to describe shock caused by an infectious agent or inflammatory stimulus.

Septic Shock is the most common form of **distributive shock**. It is an abnormal host immune response to infectious organisms or their by-products (e.g., endotoxin) that lead the small blood vessels to dilate and leak fluid into the tissues. Cultures, tissue stain, clinical exam, or other lab tests (white count), imaging or rashes can lead the clinician to the diagnosis of septic shock.

Read more on anaphylactic shock and neurogenic shock on p. 17-1809 in your provider manual.

Cardiogenic shock refers to reduced cardiac output secondary to abnormal cardiac function or pump failure, resulting in decreased systolic function and cardiac output.

Common causes of cardiogenic shock include:

- Congenital heart disease
- Myocarditis
- Cardiomyopathy (an inherited abnormality of pump function)
- Arrhythmias
- Sepsis
- Poisoning or drug toxicity
- Myocardial injury, such as trauma

Findings consistent with cardiogenic shock:

Airway: usually open and patent unless of LOC is impaired

Breathing: tachypnea, increased respiratory effort (retractions, grunting, nasal flaring) resulting from pulmonary edema

Circulation: tachycardia, normal or low BP, weak or absent peripheral pulses, signs of CHF (pulmonary edema, hepatomegaly, JVD, gallop, or murmur), cyanosis, cold, pale, diaphoretic, and mottled skin, change in LOC, oliguria

Disability: changes in LOC

Exposure: extremities may be cooler than the trunk

Concept: Increased respiratory effort often distinguishes cardiogenic shock from hypovolemic shock. Hypovolemic shock is characterized by "quiet tachypnea," while children with cardiogenic shock may present with retractions, grunting and use of accessory muscles.

It would NOT be appropriate to provide fluids in large doses in this situation but rather use fluids sparingly (5-10 mL/kg) and deliver over a longer time period (10-20 minutes). Inotropes may be used and adjunctive airway devices, such as Bi-Pap or C-Pap may be helpful. Lasix may be needed for fluid overload as fluids for shock resuscitation are administered. Examine for crackles, hepatomegaly during the physical assessment.

Obstructive Shock refers to conditions that physically impair blood flow by limiting venous return to the heart, or limit pumping of blood from the heart. This results in decreased cardiac output.

Causes of obstructive shock include.

- Pericardial tamponade
- Tension pneumothorax
- Pulmonary embolism
- Ductal-dependent congenital heart defects (e.g., coarctation of the aorta, hypoplastic left ventricle)

The physical obstruction to blood flow results in low cardiac output, inadequate tissue perfusion, and a compensatory increase in systemic vascular resistance (SVR). Early signs of obstructive shock can mimic hypotensive shock. However, on physical exam, the clinician may recognize pulmonary congestion that is NOT consistent with hypovolemia. In the case of PE, tension pneumothorax and tamponade, the onset is usually acute. Look for increased respiratory effort, cyanosis, and signs of vascular congestion.

Cardiac tamponade, caused by fluid or blood in the pericardial space, impedes ventricular filling, leading to cardiac arrest with pulseless electrical activity. Tamponade may be caused by surgery or penetrating trauma, or develop as a result of pericardial effusion, a tumor or very high white blood cell count.

Tension pneumothorax is air in the pleural space under pressure and compromising the ability to breathe resulting in respiratory failure. High pressures during ventilation or rapid deterioration after intubation should lead the clinician to suspect the etiology of pneumothorax.

Pulmonary embolism is a total or partial obstruction of the pulmonary artery or its branches by a blood clot, fat, air, amniotic fluid, catheter fragment or other injected matter. Examples would be immobility, CVCs, sickle cell or inherited disorders of coagulation. It results in a ventilation/perfusion mismatch, hypoxemia and pulmonary vascular resistance leading to right heart failure and decreased left ventricular filling, decreased cardiac output and ultimately cardiac arrest.

This table shows the S/S and treatments for shock emergencies:

Condition	S/S	Causes	Treatment
Hypovolemic Shock	Low BP, altered mental status, poor skin turgor, dry lips, sunken fontanelle, quiet tachypnea, delayed cap refill.	Vomiting, diarrhea, poor fluid intake, hemorrhage, third space losses, burns, ketoacidosis	**Fluids 10-20 mL/kg, repeat as needed.** rapidly if necessary, until BP increases and capillary refill improves significantly.
Distributive/Septic Shock **Septic, Anaphylactic, Neurogenic such as spinal injury**	Low or normal BP, fever, delayed cap refill, tachycardia, warm flushed skin early followed by pale, mottled skin, oliguria, changes mental status, purpuric rash or urticaria	Abnormal host immune response to infectious organisms or their by-products that lead the small blood vessels to dilate and leak fluid into the tissues, infection	**Fluids 10-20mL/kg over 5-20 minutes,** Antipyretics, pressors such as milrinone, hemodynamic support, antibiotics, correct metabolic derangements, avoid organ failure, identify and control infection, correct adrenal insufficiency
Obstructive Shock	Cardiac tamponade, muffled heart sounds, inadequate tissue perfusion, increased respiratory effort, PEA, distended neck veins, chest pain	Pericardial tamponade, pulmonary embolism, tension pneumothorax, ductal dependent lesions	Needle decompression, Cardiac window, restore patency of ductus arteriosus, improve 02 delivery, manage tissue perfusion, support organ function, prevent cardiac arrest.
Cardiogenic Shock	Tachypnea, increased respiratory effort, grunting, delayed cap refill, pulmonary edema, diminished renal blood flow	Congenital heart disease, myocarditis, cardiomyopathy, sepsis, poisoning, myocardial trauma	Smaller fluid boluses, diuretics, CPAP support, improve 02 delivery, correct metabolic acidosis, support bp