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Overview of Advanced Cardiovascular Life Support

Advanced Cardiac Life Support, or ACLS, is a system of algorithms and best practice recommendations intended to provide the best outcome for patients in cardiopulmonary crisis. ACLS protocols are based on basic and clinical research, patient case studies, clinical studies, and reflect the consensus opinion of experts in the field. While the term Advanced Cardiovascular Life Support was coined by the American Heart Association, the content contained in this manual is based on the most recent guidelines published by the American Heart Association, the American College of Cardiology, the American Red Cross, and The European Society of Cardiology.

Prior to taking ACLS, it is assumed that you are proficient and currently certified in Basic Life Support (BLS). Once you become certified in ACLS, the certification is valid for two years. However, we encourage you to regularly login back in to your account to check for updates on resuscitation science advances.

This Advanced Life Support provider manual includes:

- Updates to ACLS in 2015
- Solo and Team BLS
- The ACLS Survey
- Cardiac and Respiratory Arrest
- Return of Spontaneous Circulation (ROSC) and Post Arrest Care
- Bradycardia and Tachycardia Management
- ECG Rhythm Recognition
- Atrioventricular Blocks
- Acute Coronary Syndrome and Acute Stroke Management
- Resuscitation Medications
- Team Dynamics and Systems of Care

Updates to ACLS in 2015

As we learn more about resuscitation science and medicine, physicians and researchers realize what works best and what works fastest in a critical, life-saving situation. Therefore, it is necessary to periodically update life-support techniques and algorithms. If you have previously certified in advanced cardiovascular life support, then you will probably be most interested in what has changed since the latest update in 2010. The table below also includes changes proposed since the last AHA manual was published. These changes will likely appear in future editions of the provider manual.

2015 Science Summary Table

Topic	2010	2015
Systematic Approach: BLS Assessment (name change)	<ul style="list-style-type: none"> 1-2-3-4 Check responsiveness: <ul style="list-style-type: none"> Tap and shout Scan chest for movement Activate the emergency response system and get an AED Circulation: Check the carotid pulse. If you cannot detect a pulse within 10 seconds, start CPR, beginning with chest compressions, immediately Defibrillation: If indicated, deliver a shock with an AED or defibrillator 	<ul style="list-style-type: none"> Check responsiveness <ul style="list-style-type: none"> Tap and shout Shout for nearby help/activate emergency response system/get AED Check breathing and pulse (simultaneously) Defibrillation: If indicated, deliver a shock with an AED or defibrillator
Systematic Approach: Primary Assessment (name change)	<ul style="list-style-type: none"> Airway Breathing Circulation Differential diagnosis (H's and T's) 	<ul style="list-style-type: none"> Airway Breathing Circulation Disability Exposure
Systematic Approach: Secondary Assessment (new)	<ul style="list-style-type: none"> NA 	<ul style="list-style-type: none"> SAMPLE H's and T's
BLS: High-Quality CPR	<ul style="list-style-type: none"> A rate of at least 100 chest compressions per minute A compression depth of at least 2 inches in adults Allowing complete chest recoil after each compression Minimizing interruptions in compressions (10 seconds or less) Avoiding excessive ventilation Switching provider/lead with others about every 2 minutes to avoid fatigue 	<ul style="list-style-type: none"> A rate of 100 to 120 chest compressions per minute A compression depth of at least 2 inches in adults* Allowing complete chest recoil after each compression Minimizing interruptions in compressions (10 seconds or less) Avoiding excessive ventilation Chest compression fraction of at least 60% but ideally greater than 80% Switch compressor about every 2 minutes or sooner if fatigued Use of audio and visual feedback devices to monitor CPR quality <p>*When a feedback device is available, adjust to a maximum depth of 2.4 inches (6 cm) in adolescents and adults.</p>
ACLS: Immediate Post-Cardiac Arrest Care	<ul style="list-style-type: none"> Consider therapeutic hypothermia (32°C to 34°C for 12 to 24 hours) to optimize survival and neurologic recovery in comatose patients 	<ul style="list-style-type: none"> Consider targeted temperature management to optimize survival and neurologic recovery in comatose patients—cool to 32°C to 36°C for at least 24 hours Out-of-hospital cooling of patients with rapid infusion of cold IV fluids after ROSC is not recommended
ACLS: Managing the Airway	<ul style="list-style-type: none"> For cardiac arrest with an advanced airway in place, ventilate once every 6 to 8 seconds 	<ul style="list-style-type: none"> For cardiac arrest with an advanced airway in place, ventilate once every 6 seconds
ACLS: Bradycardia	<ul style="list-style-type: none"> Dopamine dosing: 2 to 10 mcg/kg per minute 	<ul style="list-style-type: none"> Dopamine dosing: 2 to 20 mcg/kg per minute
ACLS: ACS	<ul style="list-style-type: none"> NSTEMI Titrate O₂ saturation to ≥94% 	<ul style="list-style-type: none"> NSTEMI-ACS Titrate O₂ saturation to ≥90%

Chain of Survival

Advanced Cardiovascular Life Support continues to emphasize the Chain of Survival. The Chain of Survival is a sequence of steps or links that, when followed to its completion, increases the likelihood that a victim of a life-threatening event will survive. The adult and pediatric chains of survival are slightly different. The person who is providing BLS is only responsible for the early links, that is, making sure the person is cared for by emergency personnel. The emphasis on **early** care is to reinforce that time is a critical factor in life support care. The 2015 standards include the concept of out of hospital care versus in-hospital care.

Adult BLS Chain of Survival (Out of Hospital)

The links of the Adult ACLS Chain of Survival are:



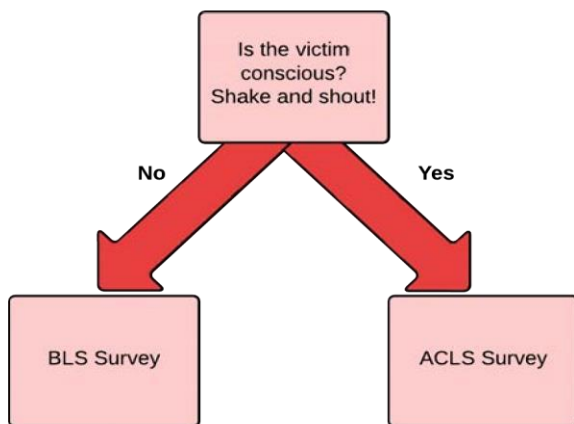
- EMS – Early activation of EMS
- CPR – Early administration of High-quality CPR
- AED – Early use of an AED
- ACLS – Early Advanced Cardiovascular Life Support
- Post-Arrest Care – Transport victim to the hospital

Adult BLS Chain of Survival (In Hospital)

This new chain should include: Primary Providers/ Code Team/ Cath Lab/ Post Arrest Care

BLS and ACLS Surveys

ACLS draws heavily on Basic Life Support (BLS). In fact, it is assumed that all people who are pursuing ACLS will be competent in the techniques of BLS—so much so that it is considered a prerequisite to ACLS.



The first step in any resuscitation is to make sure the rescuers (you!) and the victim are safe. Therefore, if your victim is in the middle of the highway or in a burning building, the first step is to move the victim to safety.

Assuming you and the victim are in a safe location, the next step is to assess whether the patient is responsive

*If patient **is not** responsive, move to BLS survey*

*If patient **is** responsive, move to ACLS survey*

The BLS Survey

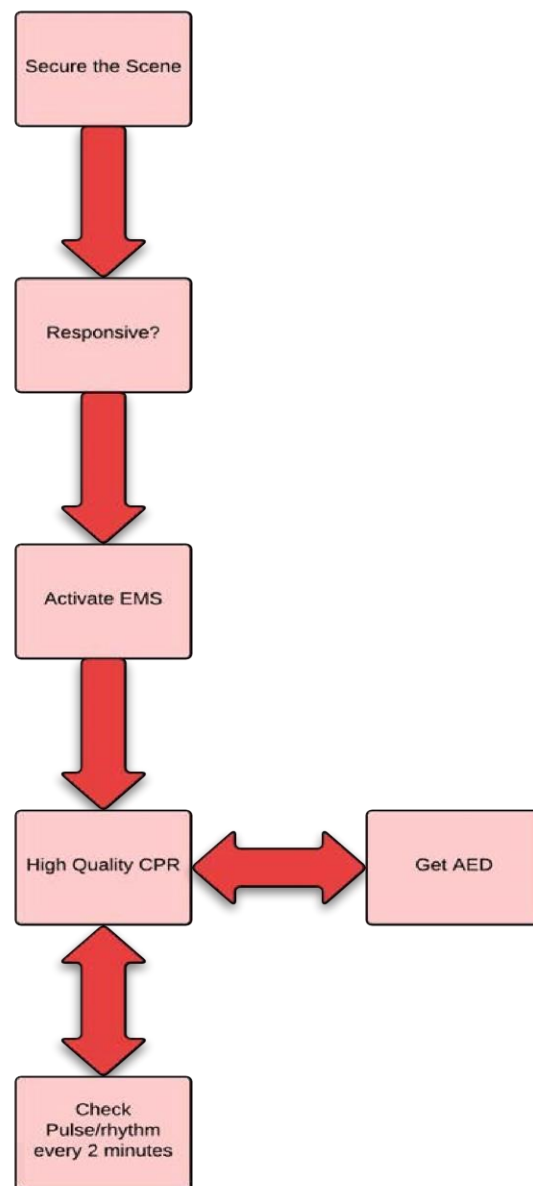
The BLS Survey	
1. Responsive?	Shake and Shout! Don't be afraid to make noise. Check for effective breathing for 5 to 10 seconds.
2. Activate EMS/Call Code	In the hospital, you can call a "code" and send someone to get a defibrillator. In the community, call 911 and send for an AED
3. Circulation	Simultaneously, check the carotid pulse for no more than 10 seconds while checking for respiratory effort. If no pulse, begin high quality CPR.
4. Defibrillation	If there is a shockable rhythm, pulseless ventricular tachycardia or ventricular fibrillation, provide a shock

Adult BLS is slightly different if there is one provider (solo) or more than one provider (team) present. The difference between solo provider BLS and team BLS is that responsibilities are shared when more than one person is present. These will be detailed in Solo and Team Adult BLS.

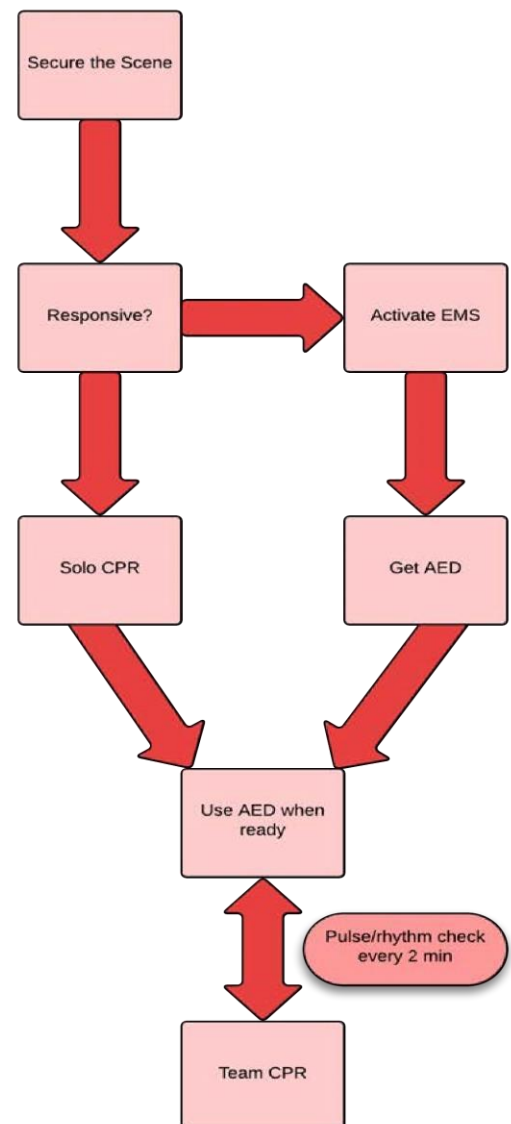
For healthcare providers, the difference between a witnessed cardiac arrest and a victim who is found down is the order of the initial steps.

- **If you are alone and witness a victim suddenly collapse:** Assume cardiac arrest with a shockable rhythm. If you can get an AED quickly, you may activate EMS, leave the victim to get an AED, provide CPR for 2 minutes, and use the AED.
- **If you are alone and find an unresponsive adult:** Tailor response to the prospective cause of injury.
 - If you suspect cardiac arrest: Activate EMS, get AED, 2 min of CPR, use AED
 - If you suspect asphyxia: 2 min of CPR, Activate EMS, get AED, use AED

- Always make sure that you are safe and the victim is safe before you start BLS.
- Check to see if the victim is responsive. Shake and shout! Is the victim breathing effectively? Does the victim have a pulse in the carotid artery?
- If you witnessed the victim suddenly collapse, assume cardiac arrest with a shockable rhythm. If you can get an AED quickly, you may activate EMS, leave the victim to get an AED, CPR for 2 minutes, and use AED.
- If you find an unresponsive adult, tailor response to the presumed cause of injury.
 - If you suspect cardiac arrest: Activate EMS, get AED, 2 min of CPR, use AED
 - If you suspect asphyxia: 2 min of CPR, Activate EMS, get AED, use AED
- High Quality CPR includes
 - Fast and deep compressions, 100 to 120 compressions per minute
 - Two inches deep, complete rebound
 - If you can provide respiration, 2 breaths for 30 comps
 - If you cannot provide respiration, just give chest comps
- Check for a pulse and cardiac rhythm every two minutes. Follow directions on the AED. After providing a shock, immediately resume CPR. Keep going until EMS arrives or the victim regains circulation.



- Always make sure that your team is safe and the victim is safe before you start BLS.
- Check to see if the victim is responsive. Shake and shout! Is the victim breathing effectively? Does the victim have a pulse in the carotid artery?
- One provider activates EMS and retrieves an AED. The other provider(s) stays with the victim.
- Provide High Quality CPR includes
 - Fast and deep compressions, 100 to 120 compressions per minute
 - Two inches deep, complete rebound
 - If you can provide breaths, 2 breaths for 30 comps
 - If you cannot provide breaths, just give chest comps
- The provider who retrieved the AED applies the AED and follows directions given by the device. The provider that stayed with the victim provides CPR until the AED is ready.
- Check for a pulse and cardiac rhythm every two minutes. Follow directions on the AED. If a shock is indicated, clear everyone and administer a shock. After providing a shock, immediately resume Team CPR.

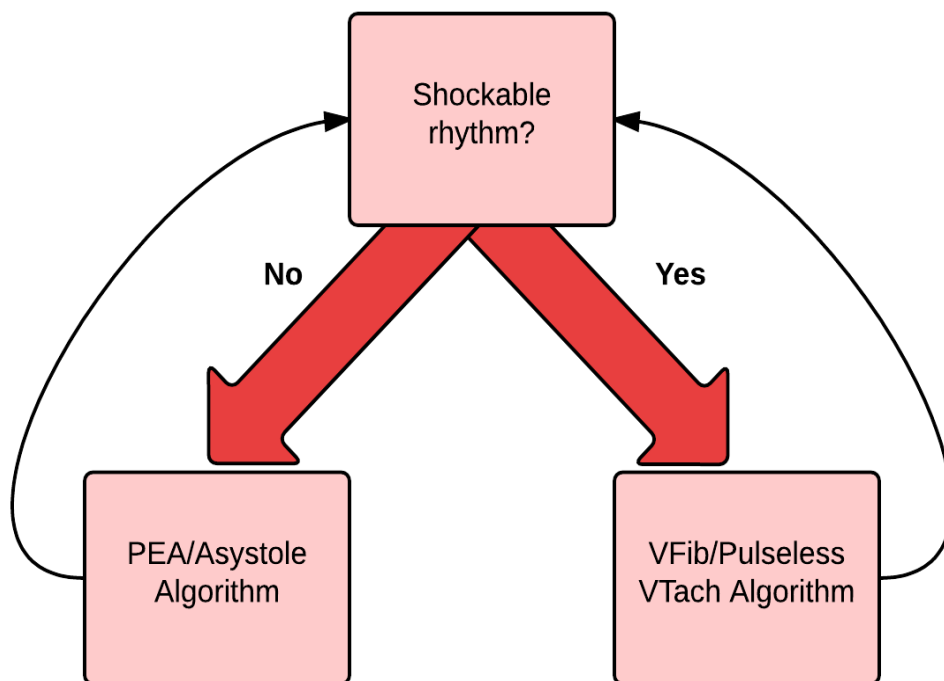


- In Team CPR, the provider giving chest compressions changes every 2 minutes
- Keep going until EMS arrives or the victim regains spontaneous circulation.

Cardiac Arrest

Cardiac arrest is the sudden cessation of blood flow to the tissues in brain the results from a heart that is not pumping effectively. Four rhythms may occur during cardiac arrest: ventricular fibrillation, pulseless ventricular tachycardia, pulseless electrical activity, and asystole. The primary intervention for ventricular fibrillation and pulseless ventricular tachycardia is unsynchronized cardioversion, more commonly known as a "shock." The primary intervention for pulseless electrical activity and asystole is pharmacological, beginning with the administration of epinephrine.

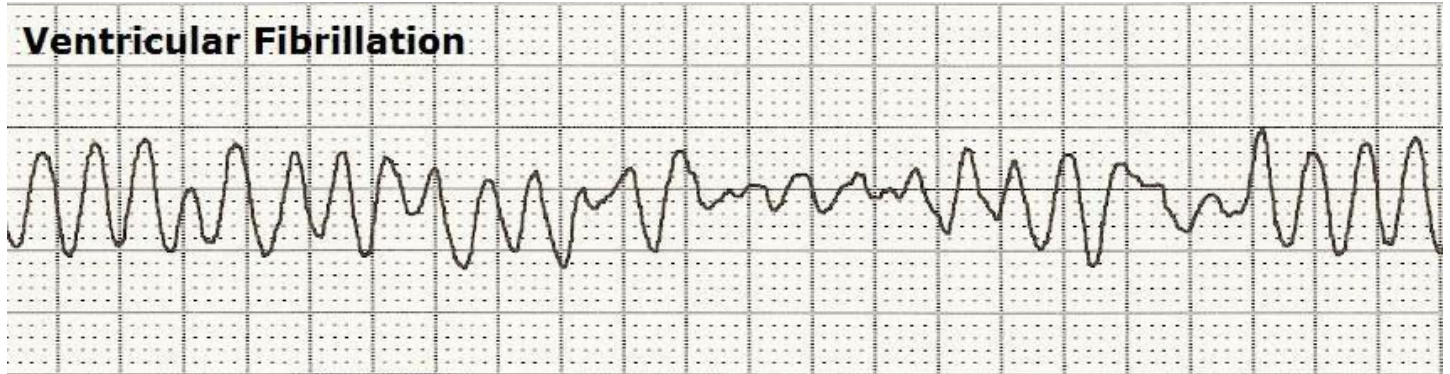
While ACLS provides algorithms for each of these cardiac arrest rhythms, in the real world a patient may move between these rhythms during a single instance of cardiac arrest. Therefore, the provider must be able to accurately assess and adapt to changing circumstances. After every 2 minutes of CPR, check for a pulse and check the cardiac rhythm. If the rhythm has switched from shockable or to shockable, then switch algorithms.



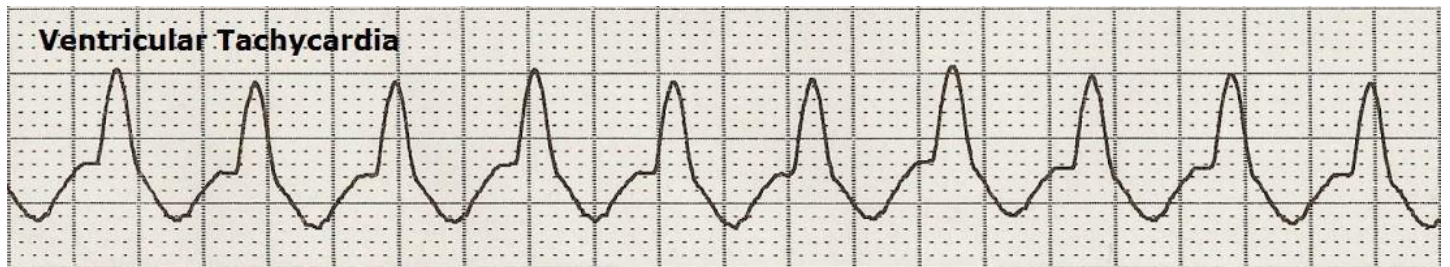
Ventricular Fibrillation and Pulseless Ventricular Tachycardia

In ventricular fibrillation or pulseless ventricular tachycardia, the heart's conduction system exhibits a disordered rhythm that can sometimes be corrected by applying energy to it. This energy may come in the form of an automated external defibrillator (AED) defibrillator paddles, or defibrillator pads. VFib and VTach are treated with unsynchronized cardioversion, since there is no way for the defibrillator to decipher the disordered waveform. In fact, it is important **not** to provide synchronized shock for these rhythms.

Ventricular fibrillation is recognized by a disordered waveform, appearing as rapid peaks and valleys as shown in this ECG rhythm strip:

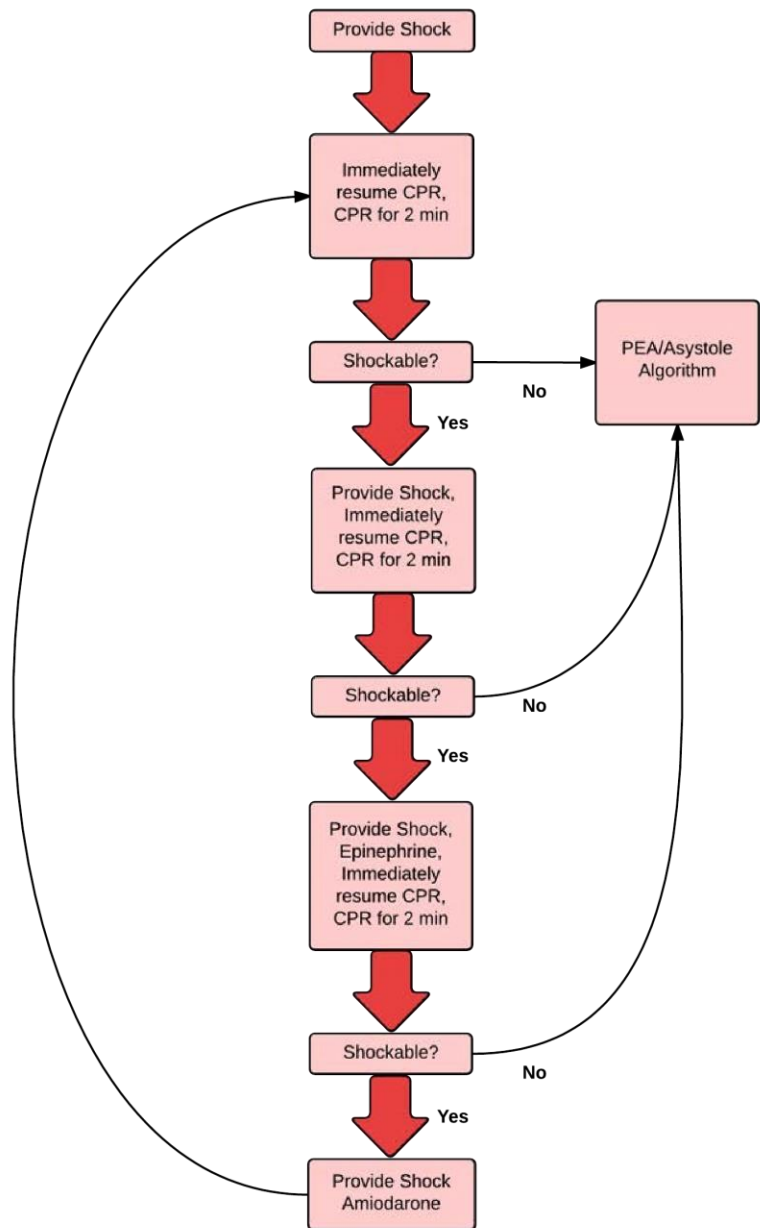


Ventricular tachycardia may provide waveform similar to any other tachycardia; however, the biggest difference in cardiac arrest is that the patient will not have a pulse and, consequently, will be unconscious and unresponsive. Two examples of ventricular tachycardia are shown in this ECG rhythm strips. The first is narrow complex tachycardia and the second is wide complex tachycardia:



Ventricular Fibrillation and Pulseless Ventricular Tachycardia Algorithm

- Once you have determined that a patient has a shockable rhythm, immediately provide an unsynchronized shock.
- If you are using **biphasic** energy, use recommended settings on the device. If you do not know what that setting is, use the highest available setting, (120 to 200 J).
- If you are using a **monophasic** energy source, administer 360 J.
- Resume CPR immediately after a shock. Minimize interruptions of chest compressions. Provide 2 rescue breaths for each 30 compressions.
- Epinephrine (1 mg IV/IO) is given every 3 to 5 minutes (two 2 minute cycles of CPR)
- Vasopressin (40 units IV/IO) can be used instead of the first or second dose of epinephrine
- Amiodarone (IV/IO)
 - First dose 300 mg
 - Second dose 150 mg

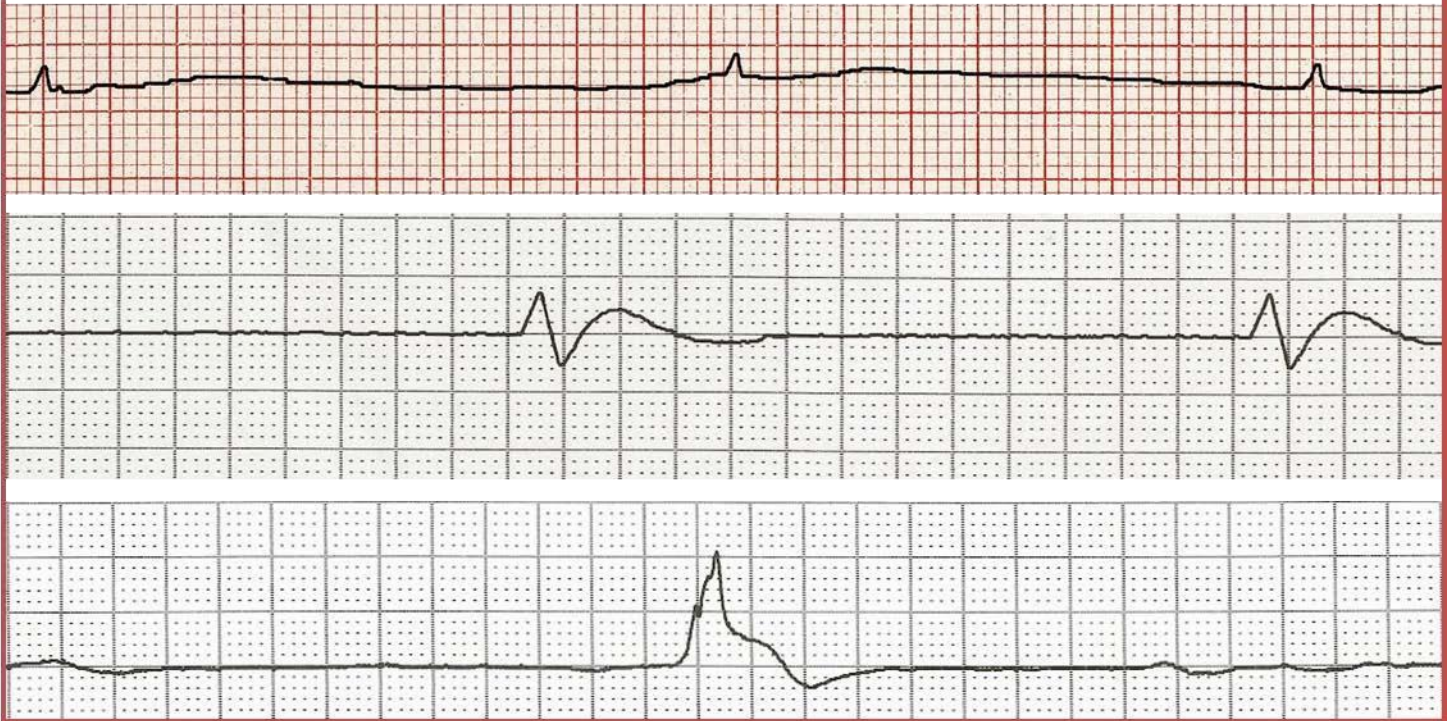


- Lidocaine may replace amiodarone when amiodarone is not available.
 - First dose: 1-1.5 mg/kg IV
 - Second dose: 0.5-0.75 mg/kg IV every 5 to 10 min
- If the arrest rhythm is no longer shockable, move to PEA/Asystole algorithm
- If the patient regains consciousness, move to ROSC algorithm for him and him

Pulseless Electrical Activity and Asystole

Pulseless electrical activity or PEA is a cardiac rhythm that does not create a palpable pulse even though it should. A PEA rhythm can be almost any rhythm except ventricular fibrillation (incl. torsade de pointes) or pulseless ventricular tachycardia.

Pulseless Electrical Activity



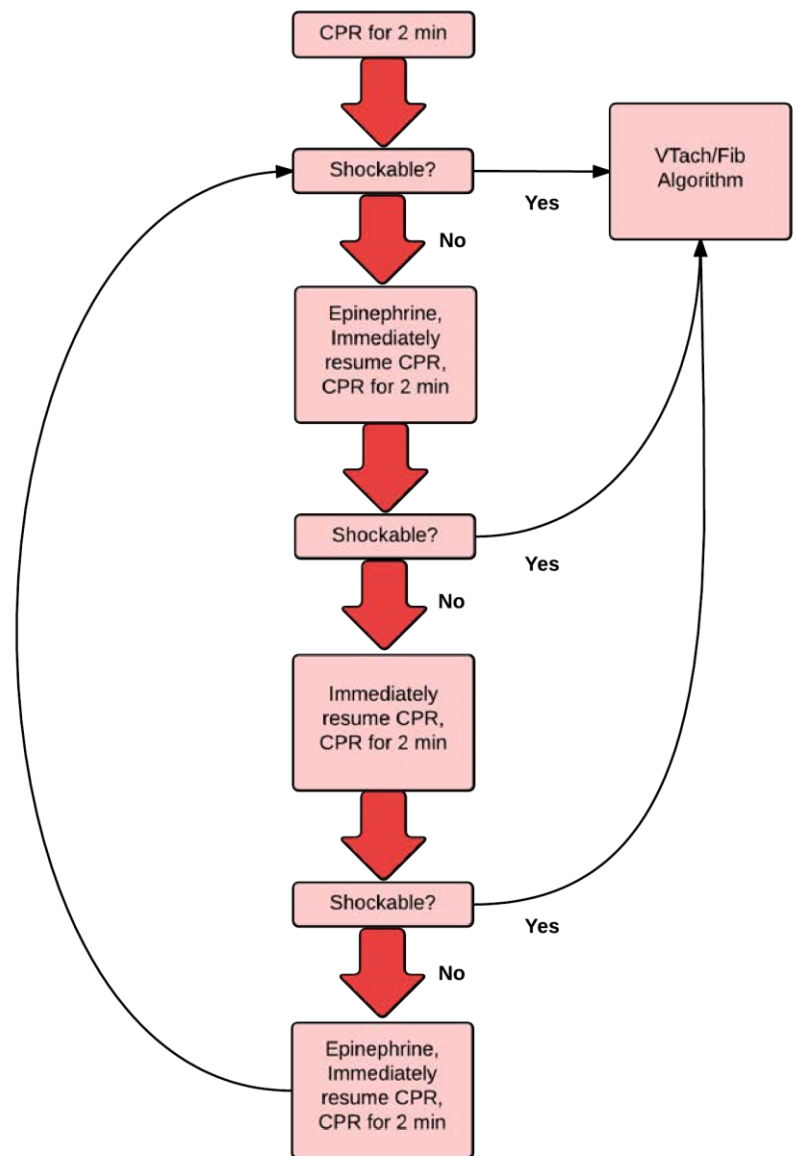
Asystole is the "flatline" on the ECG monitor. It represents a lack of electrical activity in the heart. It is critically important not to confuse true asystole with disconnected leads or an inappropriate gain setting on an in-hospital defibrillator. Asystole may also masquerade as a very fine ventricular fibrillation. If the ECG device is optimized and is functioning properly, a flatline rhythm is diagnosed as asystole. Note that asystole is also the rhythm one would expect from a person who has died. Consider halting ACLS efforts in people who have had prolonged asystole.

Asystole



It is inappropriate to provide a shock to pulseless electrical activity or asystole. Cardiac function can only be recovered in PEA or asystole through the administration of medications.

- ☐ As long as the patient is in PEA or asystole, the rhythm is not shockable.
- ☐ Chest compressions/high-quality CPR should be interrupted as little as possible during resuscitation.
- ☐ After 2 min. of high-quality CPR, give 1 mg of epinephrine IV/IO. Consider advanced airway and waveform capnography.
- ☐ Remember, chest compressions are a means of artificial circulation, which should deliver the epinephrine to the heart. Without chest compressions, epinephrine is not likely to be effective.
- ☐ Chest compressions should be continued while epinephrine is administered.

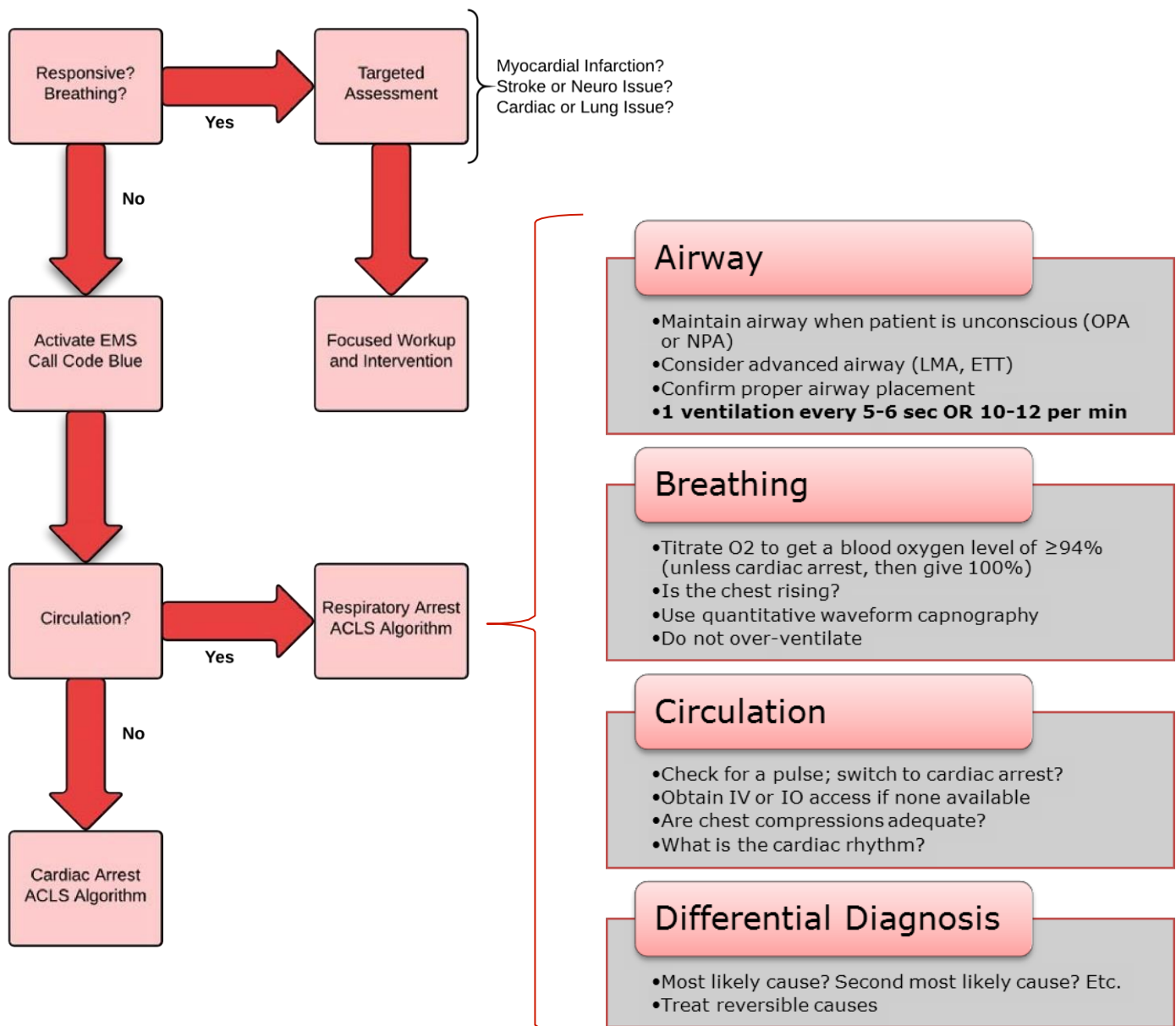


- ☐ Rhythm checks every 2 min.
- ☐ Epinephrine (1 mg IV/IO) is given every 3 to 5 minutes (after two, 2 minute cycles of CPR)
- ☐ Vasopressin (40 units IV/IO) can be used instead of the first or second dose of epinephrine
- ☐ If the arrest rhythm becomes shockable, move to VFib/Pulseless VTach algorithm
- ☐ If the patient regains circulation, move to ROSC algorithm

Respiratory Arrest

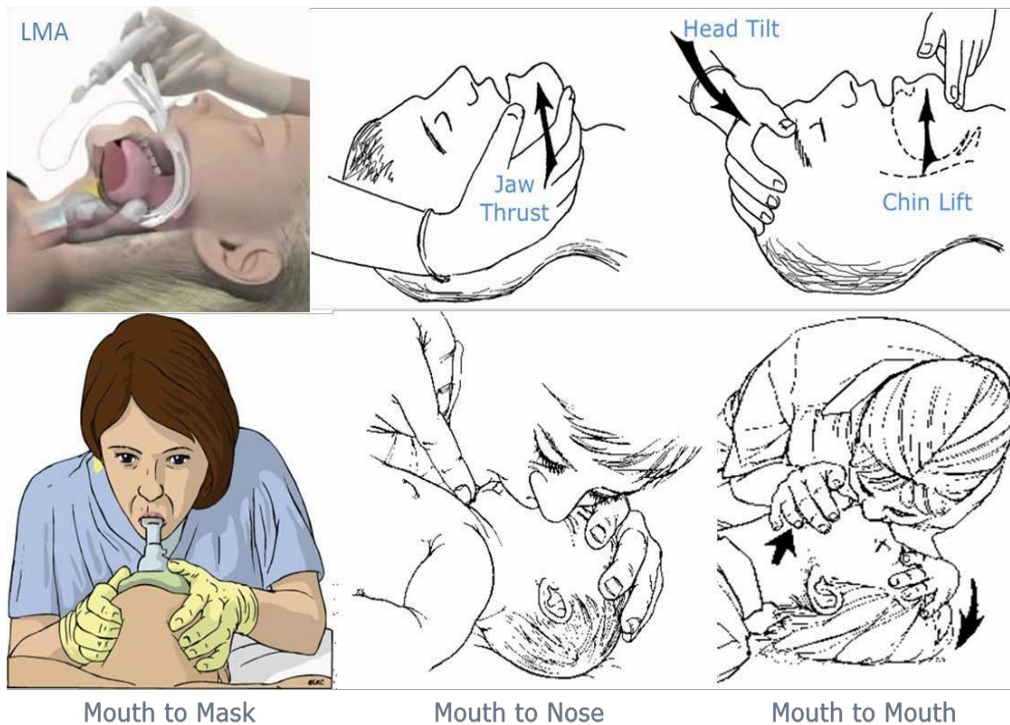
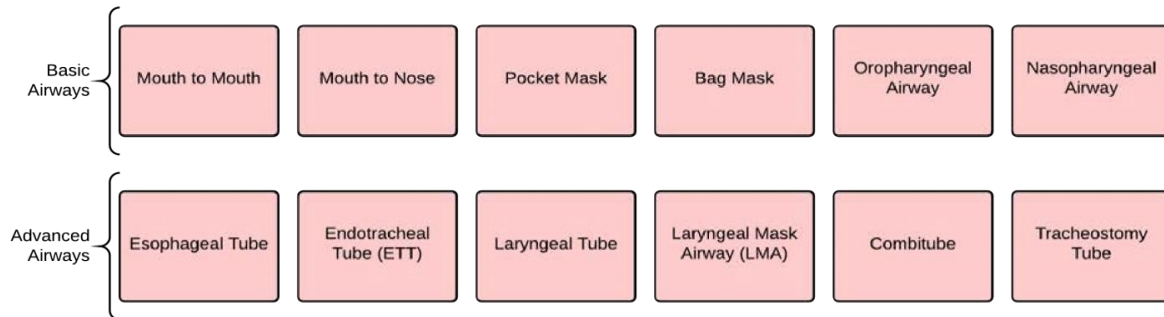
While cardiac arrest is more common in adults than respiratory arrest, there are times when patients will have a pulse but are not breathing or not breathing *effectively* (e.g., agonal breathing). A person who has a pulse but is not breathing effectively is in respiratory arrest.

When you encounter a patient in need, you will not know he or she is in respiratory arrest, so perform a BLS assessment:



Airway Management

In ACLS, the term airway is used to refer both to the pathway between the lungs and the outside world and victim in the devices that help keep that airway open. The simplest way to “manage an airway” is the head tilt-chin lift, which creates the straightest passageway for air to flow into the lungs. As if the victim may have experienced head or neck trauma, airway



management should include a jaw thrust, which leaves the head and neck unmoved, but which opens up the airway. Current guidelines recommend that ventilations for a victim with pulses should be delivered every 5 to 6 seconds. It is critical that the provider avoid delivering excessive ventilation which can lead to less effective circulation and cerebral vasoconstriction.

If one is to use a pocket mask or a bag mask to perform ventilations, it is important to make a tight seal with a mask on the victim's face. Proper use of these masks may require the rescuer to use one or even two hands to secure the mask to the victim's face.

A nasopharyngeal airway, which extends from the nose to the pharynx, can be used in both conscious and unconscious patients. An oropharyngeal airway can only be used in unconscious patients because it may stimulate the gag reflex.

Advanced airways such as endotracheal tubes (ET tubes) and laryngeal mask airways (LMAs) usually require specialized training, but are useful in-hospital resuscitations (especially LMAs).

While nasopharyngeal and oropharyngeal airways are basic airways, they do require a bit of preparation and skill to use correctly.

Inserting an Oropharyngeal Airway

- Select an airway that is the correct size for the patient
- Too big and it will damage the throat
- Too small and it will press the tongue into the airway
- Place the device at the side of the patient's face. Choose the device that extends from the corner of the mouth to the earlobe
- Clear the mouth of blood or secretions with suction, if possible.
- Insert the device so that the point is toward the roof of the mouth or parallel to the teeth
- Do not press the tongue back into the throat
- Once the device is almost fully inserted, turn it so that the tongue is cupped by the interior curve of the device.

Inserting an Nasopharyngeal Airway

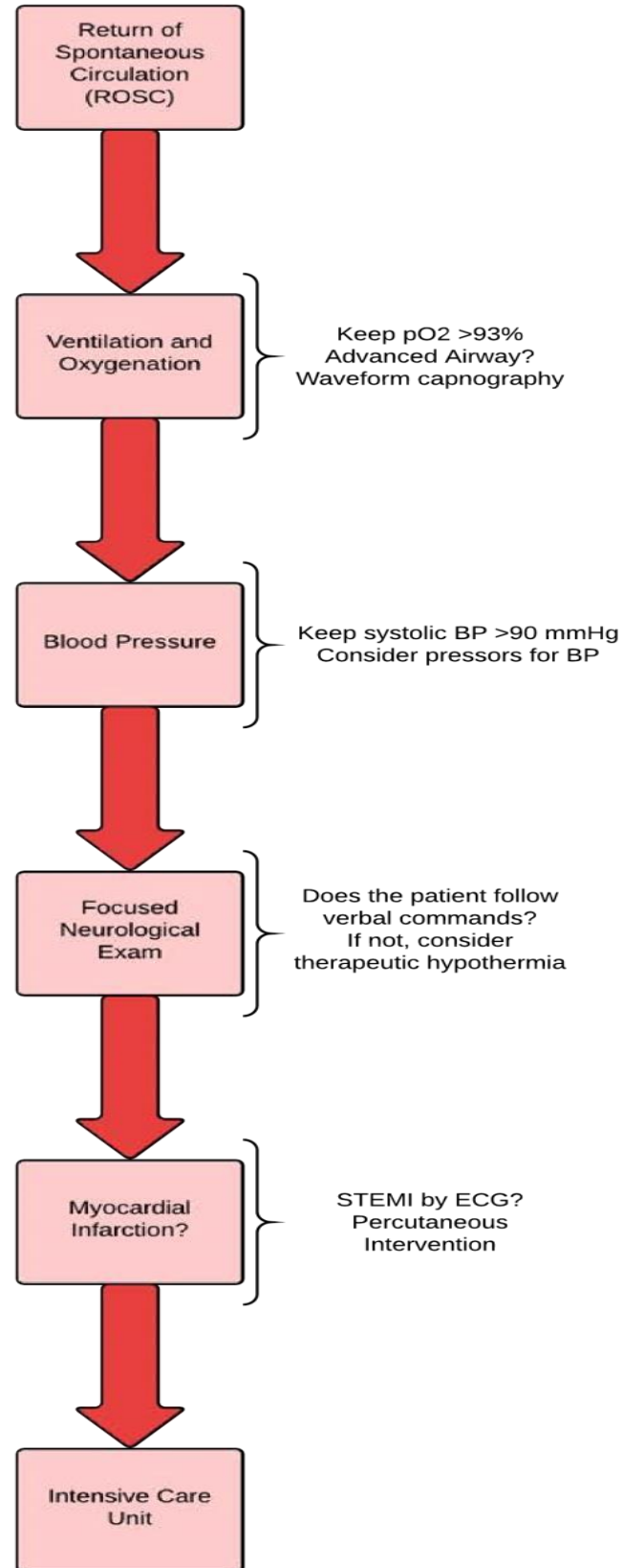
- Select an airway that is the correct size for the patient
- Place the device at the side of the patient's face. Choose the device that extends from the tip of the nose to the earlobe. Use the largest diameter device that will fit.
- Lubricate the airway with a water-soluble lubricant
- Insert the device slowly, straight into the face (not toward the brain!)
- It should feel snug; do not force the device. If it feels stuck, remove it and try the other nostril.

Tips on Suctioning

- Adequate suctioning usually requires negative pressures of -80 to -120 mmHg. Wallmounted suction can deliver this, but portable devices may not.
- When suctioning the oropharynx, do not insert the catheter too deeply. Extend the catheter to the maximum safe depth and suction as you withdraw.
- When suctioning an endotracheal tube, remember that the tube is within the trachea and you may be suctioning near the bronchi/lung. Therefore sterile technique should be used.
- Each suction attempt should be for no longer than 10 seconds. Prior to suctioning, give a brief period of 100% oxygen—remember that the patient will get no oxygen during suctioning.
- Monitor vital signs during suctioning and stop suctioning immediately if the patient experiences hypoxemia (O_2 sats <94%), has a new arrhythmia, or becomes cyanotic.

Return of Spontaneous Circulation (ROSC) and Post Arrest Care

- ☐ The patient who has been successfully resuscitated will regain spontaneous circulation.
- ☐ You can detect spontaneous circulation by feeling a palpable pulse at the carotid artery.
- ☐ Even after Return of Spontaneous Circulation (ROSC), the patient still needs close attention and support. The patient is at risk for reentering cardiac arrest at any time. Therefore, the patient should be moved to an intensive care unit.
- Titrate the patient's blood oxygen levels to $\geq 94\%$
- ☐ Does the person need an advanced airway? If so, it should be placed.
- ☐ Add quantitative waveform capnography
- ☐ Titrate the patient's systolic blood pressure to at least 90 mmHg. this may require the addition of fluids and/or vasopressors
 - Epinephrine IV 0.1-0.5 mcg/kg/min
 - Dopamine IV 5-10 mcg/kg/min
 - Norepinephrine IV 0.1-0.5 mcg/kg/min
 - 1-2 liters of fluid resuscitation
- Does the person follow verbal commands? If not, there may be neurological compromise. Consider inducing therapeutic hypothermia with 4°C fluids during fluid resuscitation.
- ☐ Does the person have signs of myocardial infarction by ECG? Move to ACS algorithm.



Rapid Differential Diagnosis of Cardiac Arrest

Many different disease processes and traumatic events can cause cardiac arrest, but in an emergency, it is important to be able to rapidly consider and eliminate or treat the most typical causes of cardiac arrest. To facilitate remembering the main, reversible causes of cardiac arrest, they can be organized as the Hs and the Ts.

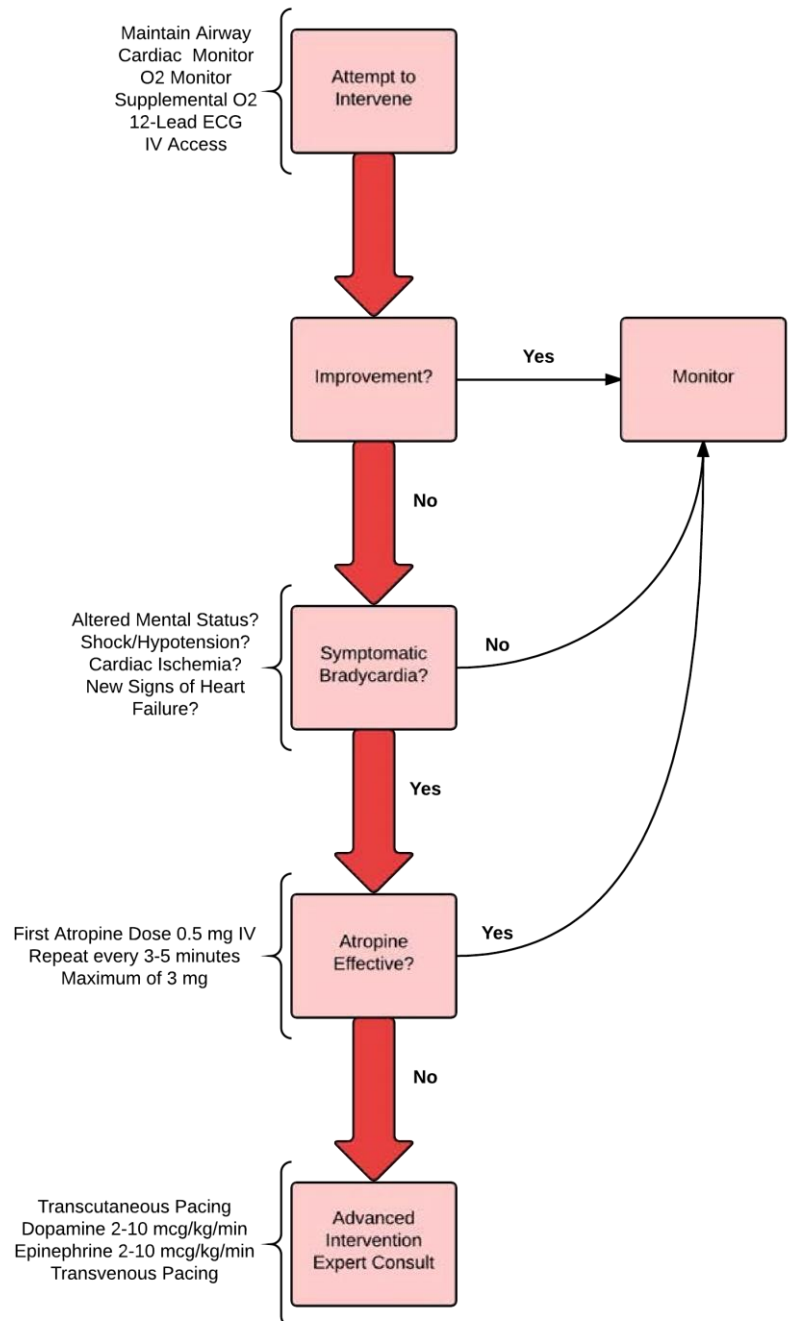
The Hs	Symptoms/Signs/Tests	Intervention
Hypovolemia	Rapid heart rate, narrow QRS complex,	Fluid resuscitation
Hypoxia	Decreased heart rate	Airway management, oxygen
Hydrogen Ion (Acidosis)	Low amplitude QRS complex	Hyperventilation, sodium bicarb
Hypoglycemia	Fingerstick glucose testing	IV Dextrose
Hypokalemia	Flat T waves, pathological U wave	IV Magnesium
Hyperkalemia	Peaked T waves, wide QRS complex	Calcium chloride, sodium bicarb, insulin/glucose, hemodialysis
Hypothermia	History of cold exposure	Rewarming blankets/fluids

The Ts	Symptoms/Signs/Tests	Intervention
Tension Pneumothorax	Slow heart rate, narrow QRS complex, acute dyspnea, history of chest trauma	Thoracotomy, needle decompression
Tamponade (Cardiac)	Rapid heart rate and narrow QRS complex	Pericardiocentesis
Toxins	Variable, prolonged QT interval, neuro deficits	Antidote/antivenom (toxin-specific)
Thrombosis (pulmonary)	Rapid heart rate, narrow QRS complex	Fibrinolytics, embolectomy
Thrombosis (coronary)	ST segment elevation/depression, abnormal T waves	Fibrinolytics, Percutaneous intervention

Bradycardia

Bradycardia Algorithm

- ☐ Bradycardia is any heart rate less than 60 bpm. In practice, however, bradycardia is only a concern if it is unusual or abnormal for the patient or causing symptoms.
- ☐ New cases of bradycardia should be evaluated, but most will not require specific treatment.
- ☐ Evaluation of bradycardia includes cardiac and blood oxygen monitoring and a 12 lead ECG if available.
- ☐ Bradycardia may be treated by providing supplemental oxygen and supporting the patient's airway if needed.
- ☐ Unstable bradycardia (i.e., an abnormally slow heart rate that causes altered mental status, hypotension, symptoms of shock, cardiac chest pain, or new signs and symptoms of heart failure) should be treated immediately.
- ☐ Unstable bradycardia is first treated with intravenous atropine at a dose of 0.5 mg. Additional doses can be given every 3 to 5 min. up to a maximum of 3 mg. Pulseless bradycardia is considered PEA.
- ☐ If atropine is unsuccessful in treating symptomatic, unstable bradycardia, consider transcutaneous pacing, dopamine or epinephrine infusion, or transvenous pacing. An intensive or cardiologist may need to be consulted for these interventions and the patient may need to be moved to the intensive care unit

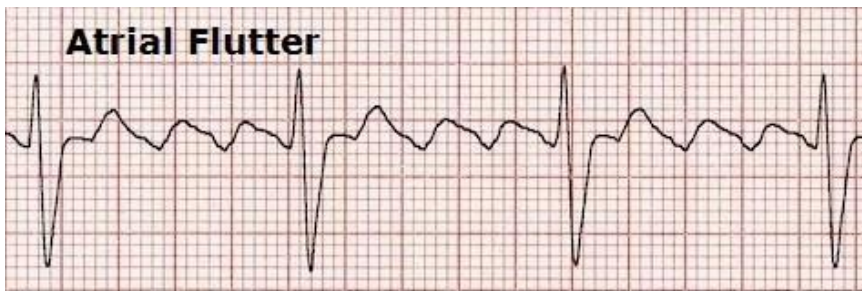


Tachycardia

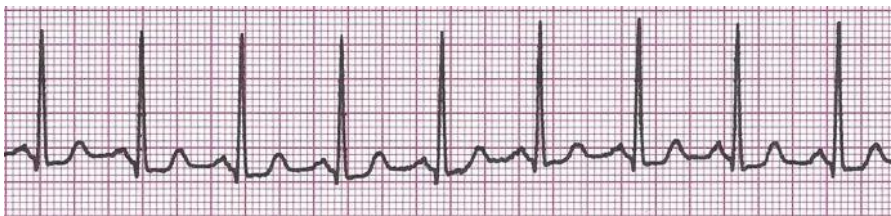
Atrial fibrillation is the most common arrhythmia. It is diagnosed by electrocardiogram, specifically the RR intervals follow no repetitive pattern. Some leads may show P waves while most leads do not. Atrial contraction rates may exceed 300 bpm. The ventricular rate often range is between 100 to 180 bpm. The pulse may be "irregularly irregular."



Atrial flutter is a cardiac arrhythmia that generates rapid, regular atrial depolarizations at a rate of about 300 bpm. This often translates to a regular ventricular rate of 150 bpm, but may be far less if there is a 3:1 or 4:1 conduction. By electrocardiogram, or atrial flutter is recognized by a sawtooth pattern sometimes called F waves. These waves are most notable in leads II, III, and aVF.



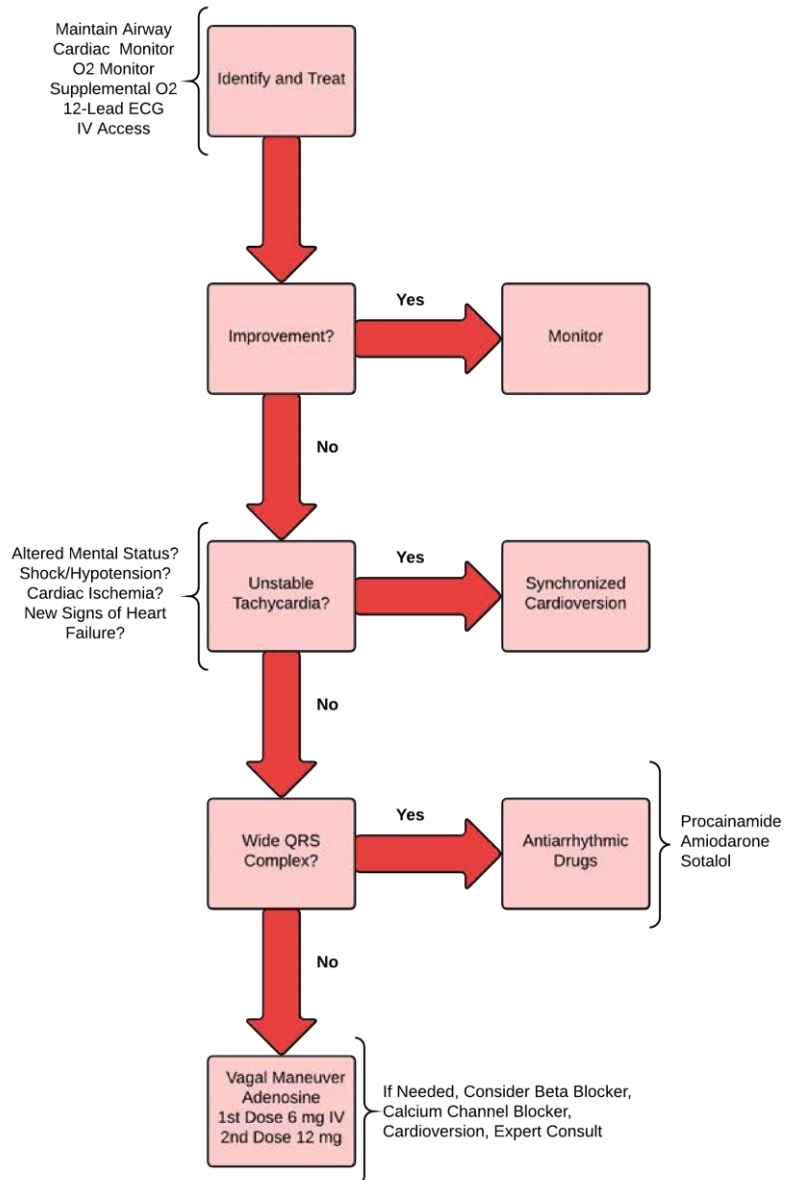
Narrow QRS complex tachycardias include several different tachyarrhythmias. A narrow QRS complex tachycardia is distinguished by a QRS complex of less than 120 ms. One of the more common narrow complex tachycardias is supraventricular tachycardia, shown below.



Wide complex tachycardias are difficult to distinguish from ventricular tachycardia. Ventricular tachycardia leading to cardiac arrest should be treated using the ventricular tachycardia algorithm. A wide complex tachycardia in a conscious person should be treated using the tachycardia algorithm.

Tachycardia Algorithm

- ❑ Tachycardia is any heart rate greater than 100 bpm. In practice, however, tachycardia is usually only a concern if it is <150 bpm or causing symptoms.
- ❑ New cases of tachycardia should be evaluated with cardiac and blood oxygen monitoring and a 12 lead ECG if available.
- ❑ Tachycardia may be treated by providing supplemental oxygen, supporting the patient's airway if needed, vagal maneuvers, and IV adenosine.
- ❑ Adenosine IV rapid push
 - First dose: 6 mg
 - Second dose: 12 mg
- ❑ Unstable tachycardia (i.e., an abnormally slow heart rate that causes altered mental status, hypotension, symptoms of shock, cardiac chest pain, or new signs and symptoms of heart failure) should be treated with synchronized cardioversion or adenosine. Consider beta-blocker or calcium channel blocker.



- ❑ Wide QRS tachycardia may require antiarrhythmic drugs.

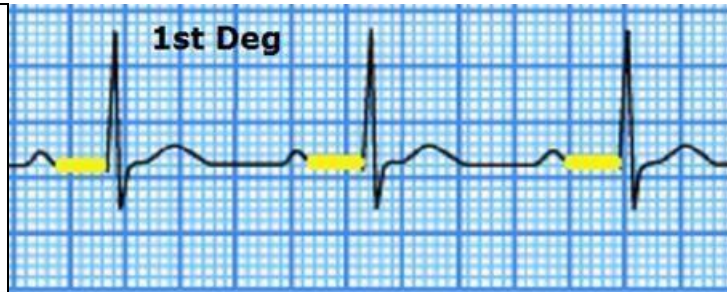
Procainamide	Amiodarone	Sotalol
20-50 mg IV, stop if hypotensive or max dose of 17 mg/kg. Maintenance infusion at 1-4 mg/min.	150 mg IV over 10 minutes with second dose for recurrent VT. Maintenance at 1 mg/min for 6 h	100 mg (1.5 mg/kg) over 5 min.

Atrioventricular (Heart) Block

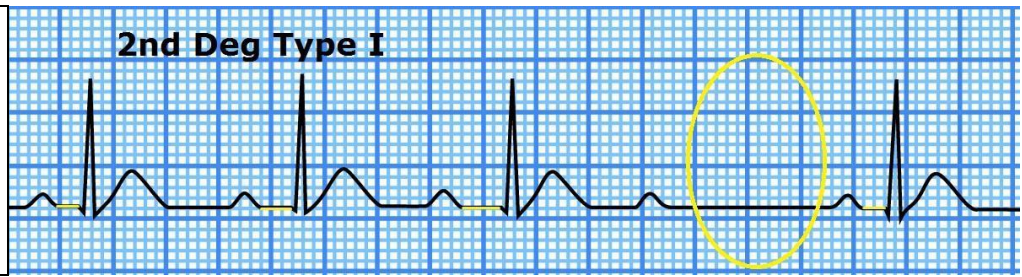
Atrioventricular block or heart block is a failure of the heart's electrical system to properly coordinate conduction. There are four main types of atrioventricular block: first degree, second degree type I, second degree type II, and third degree heart block. The types of second degree heart block are referred to as Mobitz type I and Mobitz type II. Second degree heart block Mobitz type I is also known as the Wenckebach phenomenon.

Atrioventricular blocks may be acute or chronic. Chronic heart block may be treated with pacemaker devices. From the perspective of ACLS assessment and intervention, heart block is important because it can cause hemodynamic instability and can evolve into cardiac arrest. In ACLS, heart block is often treated as a bradyarrhythmia.

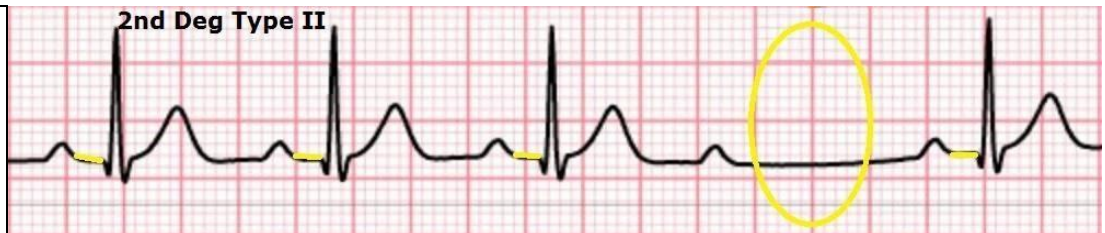
The PR interval is a consistent size, but longer or larger than it should be in first degree heart block.



The PR interval increases in size until a QRS complex is dropped, resulting in missed "beat."



A QRS wave will occasionally drop, though the PR interval is the same size.

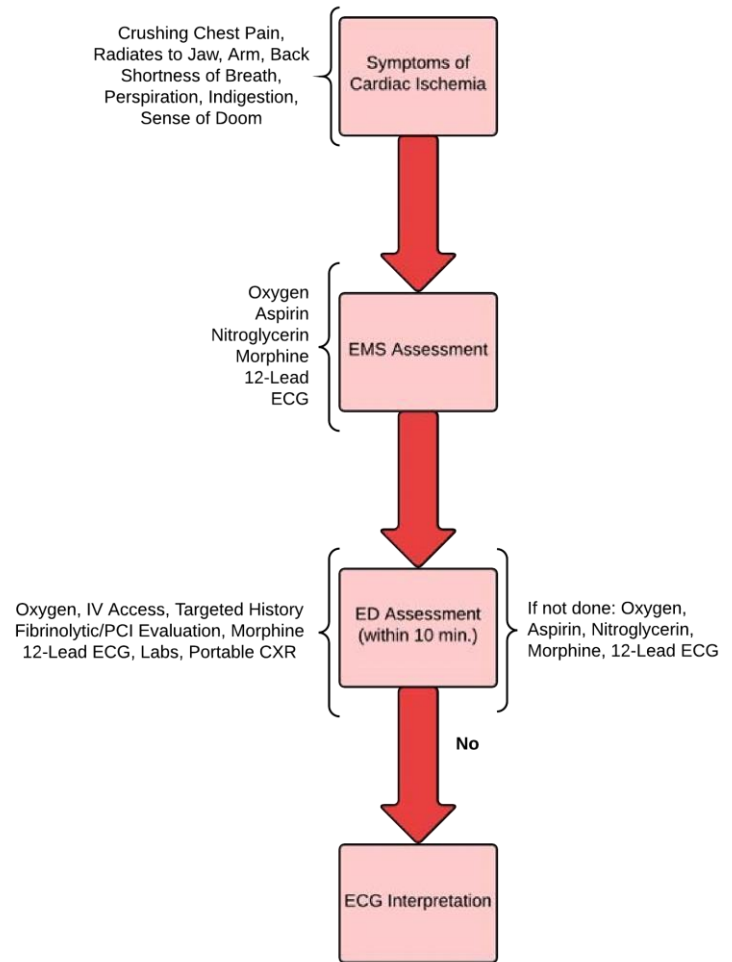


Complete dissociation between P waves and the QRS complex. No atrial impulses reach the ventricle.



Acute Coronary Syndrome

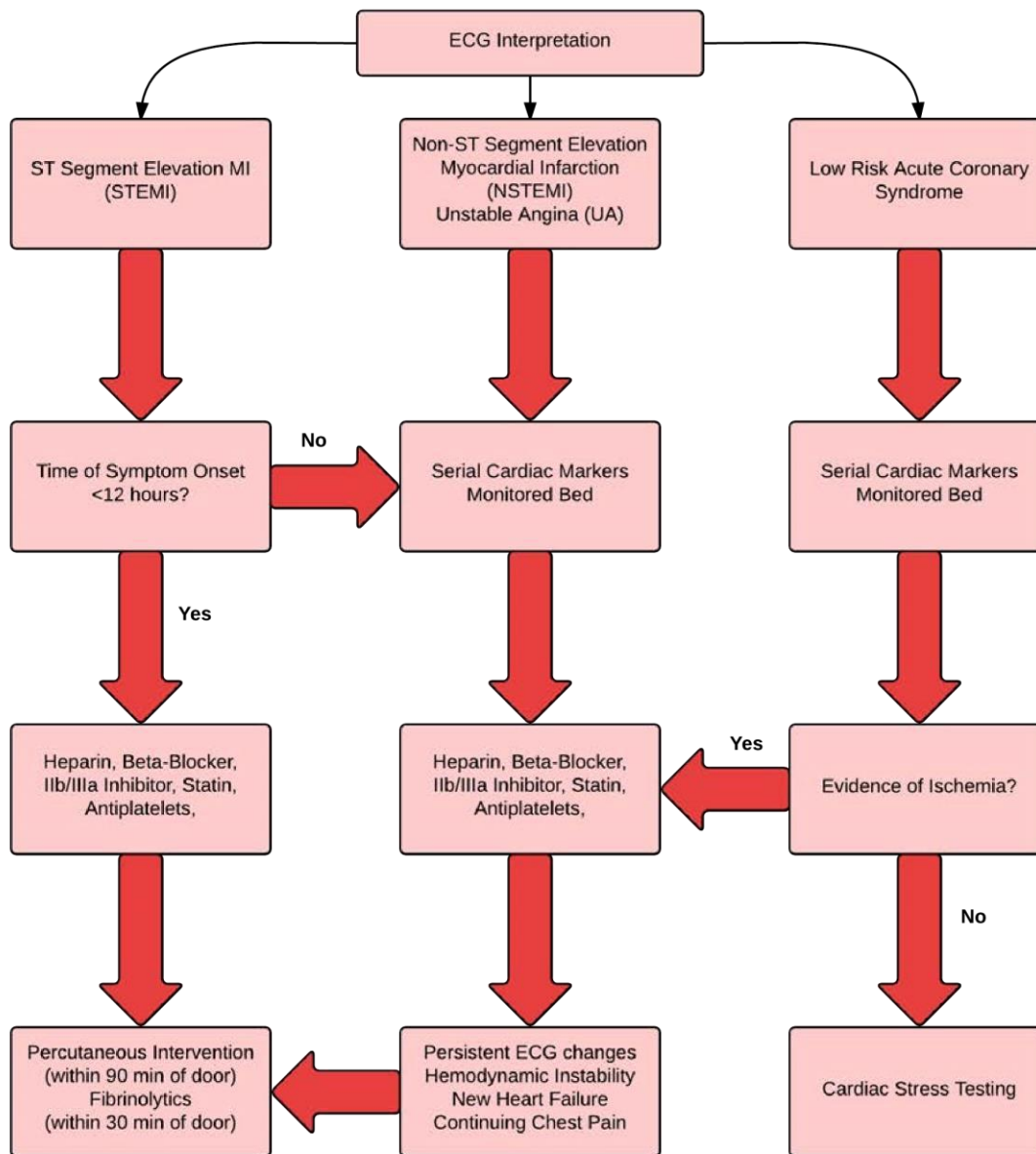
- Acute coronary syndrome or ACS is a spectrum of signs and symptoms ranging from angina to myocardial infarction. ACS includes ST segment elevation myocardial infarction (STEMI) non-ST segment elevation myocardial infarction (NSTEMI), and unstable angina.
- Cardiac chest pain (any new chest discomfort) should be evaluated promptly. This includes high degree of suspicion by individuals in the community, prompt action by EMS personnel, rapid assessment in the emergency department, and definitive treatment.
- People with symptoms of cardiac ischemia should be given oxygen, aspirin (if not allergic), nitroglycerin, and possibly morphine. Obtain a 12 lead ECG ASAP.
- The patient should be assessed in the ED within 10 min. of arrival. Draw and send labs (e.g., cardiac enzymes, coags), Obtain IV access. Give statin (if not contraindicated). Obtain chest Xray.



The results of the ECG will be the primary guidance for how the patient with possible cardiac chest pain is managed. The ECG diagnosis of acute coronary syndrome can be complex. STEMI is recognized by ST segment elevation with/without pathological Q waves.

- NSTEMI can be a more challenging electrocardiographic diagnosis. It may result in ST segment depression, "flipped" T waves (T wave flattening or inversion), peaked T waves, U wave inversion, and bundle branch block. The electrocardiographic diagnosis of an NSTEMI is beyond the scope of ACLS.
- ❑ Unstable angina is new onset cardiac chest pain without ECG changes, angina that occurs at rest and lasts for more than 20 min., and/or angina that has become rapidly and progressively worse.
- ❑ STEMI and NSTEMI patients will have elevated cardiac markers in the blood (e.g. troponins) several hours after the acute event. People with unstable angina will not have elevated cardiac markers.

Acute Coronary Syndrome Algorithm



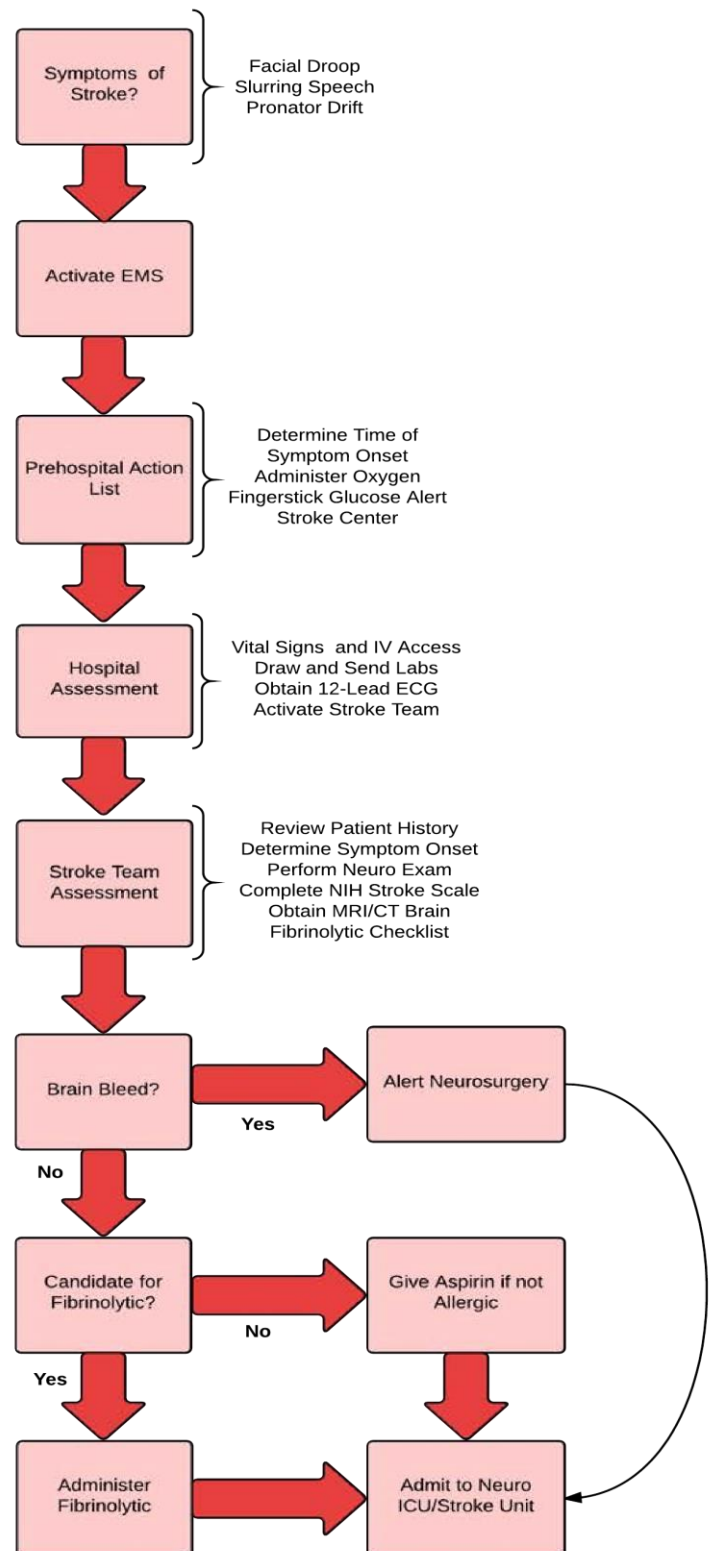
- ☐ STEMI patients should be treated per hospital protocol. This may include anti-platelet drug(s), anticoagulation, a beta-blocker, an ACE inhibitor, a statin, and either PCI or a fibrinolytic.
- ☐ NSTEMI is treated with medical therapy as above without a PCI or fibrinolytic, unless they do not improve with medical therapy.
- ☐ Patients with unstable angina are admitted and monitored for evidence of MI. Patients who do not “rule in” (develop MI) can undergo cardiac stress testing the next day or as an outpatient.

Acute Stroke

The Cincinnati Prehospital Stroke Scale

Task	Abnormal
Ask the patient to smile	Face droops on one side
Ask the patient to say "you can't teach an old dog new tricks"	Speech slurs
Ask patient to close eyes and extend both arms inward (pronator drift) straight out, palms up	One arm drifts lower and turns and extend both arms inward (pronator drift) straight out, palms up
If one of these tasks is abnormal, stroke probability is 72% If all three tasks are abnormal, stroke probability is >85%	

- ☐ The EMS team should take patients with suspected stroke to a stroke center. While in transit, the EMS team should try to determine the time at which the patient was last normal, which is considered the onset of symptoms. EMS administer oxygen via nasal cannula or face mask, obtain a fingerstick glucose measurement, and alert the stroke center.
- ☐ Within 10 min. of the patient's arrival at the hospital, personnel should assess the patient. They should obtain vital signs and IV access, draw and send labs (e.g. coags), obtain a 12-lead ECG, order CT, and perform a general assessment.
- ☐ Within 25 min. of the patient's arrival at the hospital, the stroke team should determine symptom onset, perform and narrow exam including the NIH stroke scale or equivalent, perform the fibrinolytic checklist, have the results of the CT scan of the brain.
- ☐ Within 45 min. of the patient's arrival at the hospital, the CT scan of the brain should be read for the presence of ischemic or hemorrhagic stroke.
- ☐ Within 60 min. of the patient's arrival at the hospital, fibrinolytic therapy should be administered in cases of ischemic stroke if the patient is a candidate. If the patient with an ischemic stroke is not a candidate for fibrinolytic, administer aspirin if the patient is not allergic. If the patient is having a hemorrhagic stroke, neurosurgery should be consulted.
- ☐ Within three hours of the patient's arrival at the hospital, the patient should be moved to the neurology/neurosurgery intensive care unit, stroke unit, or med/surg intensive care unit.



Time is Brain! Stroke Time Goals for Evaluation and Therapy

In people who are candidates for fibrinolytics, the goal is to administer the agent within 3 hours of the onset of symptoms.

Fibrinolytic Checklist	
Inclusion Criteria	Exclusion Criteria
Ischemic stroke with neurological deficit	Stroke/ head trauma in last 3 months
Onset of symptoms <3 hours	History of brain
Age >18 years old	Brain tumor, arteriovenous malformation, or aneurysm
	Brain or spine surgery in last
	Arterial line or blood draw in last week
	Possible subarachnoid hemorrhage
	Systolic ≥ 185 mmHg or diastolic ≥ 110 mmHg consistently
	Serum glucose <50 mg/dL (<2.8 mmol/L)
	Currently bleeding internally or bleeding diathesis
	Platelet <100,000/mm (if known)
	INR >1.7 or PT >15 seconds (if known)
	Elevated aPTT (if known)
	Currently taking anticoagulants
	Hemorrhage on CT
	Stroke includes > 1/3 of entire cerebrum
	Relative Exclusion Criteria
	Minor neurologic deficits
	Rapidly improving neurologic deficits
	Major surgery/serious trauma in last 2 weeks
	Gastrointestinal/urinary tract bleeding in last 3 weeks
	Heart attack in last 3 months
	Seizure with stroke with postictal period
	Pregnant

In select individuals, the window for fibrinolytics can be extended to 4.5 hours.

Fibrinolytic Checklist for 3 to 4.5 Hours from Symptom Onset	
Meets all criteria for fibrinolytic use at 3 hours plus these criteria:	
Inclusion Criteria	Exclusion Criteria
Ischemic stroke with neurological deficit	Currently taking anticoagulants
Onset of symptoms 3 to 4.5 hours	Severe stroke; NIH Stroke Scale score >25
Age 18 to 79 years old	Previous ischemic stroke and diabetes

Time Goals from Arrival in ED



Team Dynamics

The 2015 edition of the AHA ACLS guidelines continues to highlight the importance of effective team dynamics during resuscitation. ACLS in the hospital will be performed by several providers. These individuals must provide coordinated, organized care. Providers must organize themselves rapidly and efficiently. The AHA recommends establishing a Team Leader and several Team Members.

The Team Leader is usually a physician, ideally the provider with the most experience in leading ACLS codes. Resuscitation demands mutual respect, knowledge sharing, and constructive criticism, after the code.

Team Leader Responsibilities	Team Member Responsibilities
Usually stands at the foot of the bed	Stands in a position dictated by role
Competent in all ACLS duties	Competent in specific role (at least)
Directs Team Members in a professional, calm voice	Responds with eye contact and voice affirmation
Assigns roles	Clearly states when he/she cannot perform a role
Listens for confirmation from Team Member	Informs Team Leader when task is complete
Ask for ideas from Team Members when needed	Openly share suggestions if it does not disrupt flow
Critiques Team Performance after code	Provides constructive feedback after code
Documents resuscitation in patient chart	Provides information for documentation as needed



When performing a resuscitation, the Team Leader and Team Members should assort themselves around the patient so they can be maximally effective and have sufficient room to perform their role.

Resuscitation and Life Support Medications

Drug	Use(s)	Dosage/Route	Contraindications/Warnings
Adenosine	Supraventricular Tachycardia; May be used for other tachycardia rhythms	First dose: 6 mg IV push Second dose: 12 mg IV	Second or third degree heart block; tachycardia due to poisoning
Amiodarone	Pulseless ventricular tachycardia Ventricular fibrillation	First dose: 300 mg bolus Second dose: 150 mg Max: 2.2 grams/day	Second or third degree heart block; hypotension may result with rapid infusion or multiple doses
Atropine	Symptomatic bradycardia (No longer recommended for PEA or asystole)	0.5 mg IV every 3-5 min Max: 3 mg max dose Higher doses may be required for organophosphate poisoning	Doses < 0.5 mg may worsen bradycardia
	Toxins, poisons, and overdoses	Up to 2 to 4 mg until symptoms resolve	
Dopamine	Symptomatic bradycardia (if atropine fails) Pressor for shock/hypotension	2 to 20 mcg/kg IV per min Titrate to blood pressure response	Do not mix with sodium bicarbonate or alkalis/bases Correct hypovolemia before administration
Epinephrine	Cardiac arrest Anaphylaxis Symptomatic bradycardia instead of dopamine	1 mg (1:10000) IV OR 2-2.5 mg (1:1000) ETT q3 to 5 min Then infuse 0.1-0.5 mcg/kg/min titrated to blood pressure response	Cocaine-induced ventricular tachycardia May increase oxygen demand
	Symptomatic bradycardia (if atropine fails) Pressor for hypotension	2-10 mcg/minute infusion titrated to blood pressure response	
Lidocaine	Cardiac arrest VFib/VTach	First dose: 1-1.5 mg/kg IV Second dose: 0.5-0.75 mg/kg IV every 5 to 10 min Max: 3 mg/kg Infuse 1-4 mg IV per min	Wide complex bradycardia Should not be used in cases of acute myocardial infarction Observe for signs of toxicity
	Wide complex tachycardia	Wide complex tachycardia with pulse: 0.5-1.5 mg/kg IV; may repeat twice at half dose in 5-10 minutes to total of 3mg/kg; followed with infusion of 1-4 mg per minute infusion	Wide complex bradycardia
Magnesium Sulfate	Torsades de pointes	Pulseless Torsades: 1-2 gram IV bolus Torsades with a pulse: 1-2 gram IV over 5-60 minutes followed by infusion at 0.5-1 gram per hour IV	Rapid bolus may cause hypotension and bradycardia; Can also be used to reverse digitalis poisoning
	Hypomagnesemia with cardiac arrest	1-2 gram IV bolus	
Vasopressin	Ventricular fibrillation Pulseless ventricular tachycardia Asystole PEA	40 units IV instead of epinephrine	Deliver through central line Peripheral IV administration can cause tissue necrosis
	Shock	Infuse 0.02-0.04 units/min IV	