

### Dose/Details

#### CPR Quality

- Push hard (at least 2 inches (5cm)) and fast (100-120/min) and allow complete chest recoil.
- Minimize interruptions in compressions.
- Avoid excessive ventilation
- Rotate compressor every 2 minutes, or sooner if fatigued.
- If no advanced airway, 30:2 compression-ventilation ratio.
- Quantitative waveform capnography
  - If PetCO<sub>2</sub> <10 mmHg, attempt to improve CPR quality.
- Intra-arterial pressure
  - If relaxation phase (diastolic) pressure <20 mmHg, attempt to improve CPR quality.

#### Shock Energy for Defibrillation

- **Biphasic:** Manufacturer recommendation (eg, initial dose of 120-200 J); if unknown, use maximum available. Second and subsequent doses should be equivalent, end higher doses may be considered.
- **Monophasic:** 360 J

#### Drug Therapy

- **Epinephrine IV/IO dose:** 1 mg every 3-5 minutes
- **Amiodarone IV/IO dose:** First dose: 300 mg bolus. Second dose: 150mg.

#### Advanced Airway

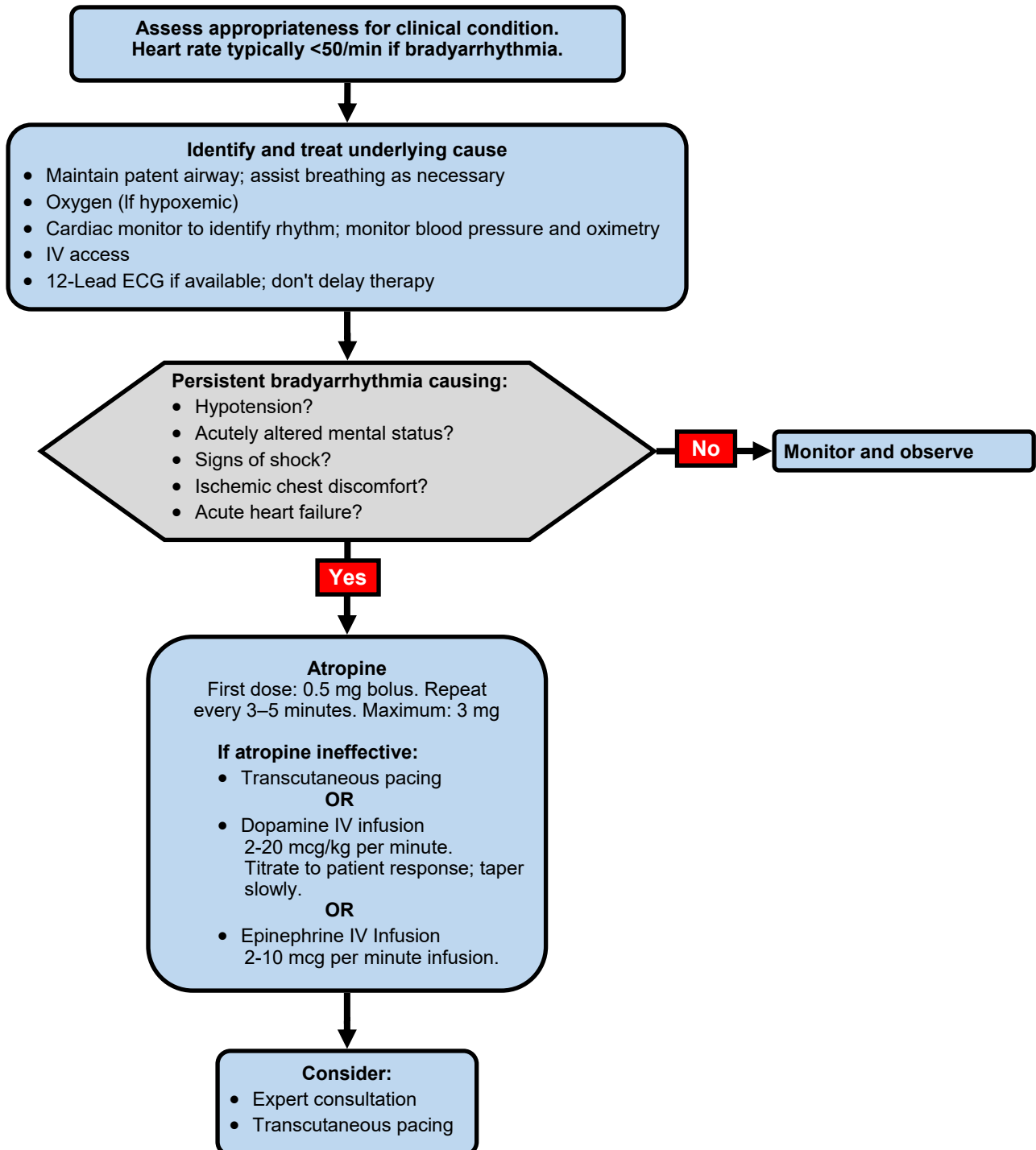
- Endotracheal intubation or supra-glottic advanced airway
- Waveform capnography or capnometry to confirm and monitor ET tube placement
- Once advanced airway in place give 1 breath every 6 seconds (10 breaths/min) with continuous chest compressions

#### Return of Spontaneous Circulation (ROSC)

- Pulse and blood pressure
- Abrupt sustained increase in PetCO<sub>2</sub> (typically ≥40 mmHg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

#### Reversible Causes (H's & T's)

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





Return of spontaneous circulation (ROSC)

**Optimize ventilation and oxygenation**

- Maintain oxygen saturation  $\geq 94\%$
- Consider advanced airway and waveform capnography
- Do not hyperventilate

**Treat hypotension (SBP  $< 90$  mm Hg)**

- IV/IO bolus
- Vasopressor infusion
- Consider treatable causes

12-Lead ECG:  
STEMI or high  
suspicion of AMI?

Yes

Coronary reperfusion

No

Follow commands?

Yes

Advanced critical care

No

Initiate targeted  
temperature management

**Dose/Details**

**Ventilation/oxygenation:**

Avoid excessive ventilation. Start at 10 breaths/min and titrate to target  $\text{PetCO}_2$  of 35-40 mm Hg. When feasible, titrate  $\text{FiO}_2$  to minimum necessary to achieve  $\text{SpO}_2 \geq 94\%$ .

**IV Bolus**

Approximately 1-2 L normal saline or lactated Ringer's

**Epinephrine IV infusion:**

0.1-0.5 mcg/kg per minute (in 70-kg adult: 7-35 mcg per minute)

**Dopamine IV infusion:**

5-10 mcg/kg per minute

**Norepinephrine IV infusion:**

0.1-0.5 mcg/kg per minute (in 70-kg adult: 7-35 mcg per minute)

**Reversible Causes (H's & T's)**

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



Follows American Heart Association ECC and CPR 2015 guidelines

Assess appropriateness for clinical condition.  
Heart rate typically  $\geq 150/\text{min}$  if tachyarrhythmia.

**Identify and Treat Underlying Cause**

- Maintain patient airway; assist breathing as necessary
- Oxygen (if O<sub>2</sub> sat < 94%)
- Cardiac monitor to identify rhythm; monitor blood pressure and oximetry

**Persistent Tachyarrhythmia Causing:**

- Hypotension?
- Acutely altered mental status?
- Signs of shock?
- Ischemic chest discomfort?
- Acute heart failure?

Yes

**Synchronized cardioversion:**

- Consider sedation
- If regular narrow complex, consider adenosine

No

Wide QRS?

Yes

- IV access and 12-lead ECG *if available*
- Consider adenosine only if regular and monomorphic
- Consider antiarrhythmic infusion
- Consider expert consultation

No

- IV access and 12-lead ECG if available
- Vagal maneuvers
- Adenosine (if regular)
- $\beta$ -Blocker or calcium channel blocker
- Consider expert consultation

**Dose/Details**

**Synchronized cardioversion:**

Initial recommended doses:

- Narrow regular: 50-100 J
- Narrow irregular: 120-200 J biphasic or 200 J monophasic
- Wide regular: 100 J
- Wide irregular: defibrillation dose (*not* synchronized)

**Adenosine IV dose:**

First dose: 6 mg rapid IV push; follow with NS flush.  
Second dose: 12 mg if required.

**Antiarrhythmic Infusions for Stable Wide-QRS Tachycardia**

**Procainamide IV dose:**

20-50 mg/min until arrhythmia suppressed, hypotension ensues, QRS duration increases >50%, or maximum dose 17 mg/kg given. Maintenance infusion: 1-4 mg/min. Avoid if prolonged QT or CHF.

**Amiodarone IV dose:**

First dose: 150 mg over 10 minutes. Repeat as needed if VT recurs. Follow by maintenance infusion of 1 mg/min for first 6 hours.

**Sotalol IV dose:**

100 mg (1.5 mg/kg) over 5 minutes.  
Avoid if prolonged QT.



*Follows American Heart Association ECC and CPR 2015 guidelines*

**Assess appropriateness for clinical condition.**

**EMS assessment and care and hospital preparation**

- Monitor, support ABC's. Be prepared to provide CPR and defibrillation
- Administer aspirin and consider oxygen, nitroglycerin, and morphine if needed.
- Obtain **12-lead ECG**; if ST elevation, notify receiving hospital with transmission or interpretation; note time of onset and first medical contact.
- Notified hospital should mobilize hospital resources to respond to STEMI.

**Concurrent ED assessment (<10 minutes):**

- Check vital signs; evaluate oxygen saturation
- Establish IV access
- Perform brief, targeted history, physical exam
- Review/complete fibrinolytic checklist;
- check contraindications
- Obtain initial cardiac marker levels, Initial electrolyte and coagulation studies
- Obtain portable chest x-ray (<30 minutes)

**Immediate ED general treatment:**

- If O<sub>2</sub> sat <90% start oxygen at 4 l/min, titrate
- Aspirin 160 to 325 mg (if not given by EMS)
- Nitroglycerin sublingual or spray
- Morphine IV If discomfort not relieved by nitroglycerin

**ECG Interpretation**

ST elevation or new or presumably new LBBB; strongly suspicious for Injury  
**ST-elevation MI (STEMI)**

- **Start adjunctive therapies as Indicated**
- **Do not delay reperfusion**

**Time from onset of symptoms ≤12 hours?**

**Yes**

**No**

**Reperfusion goals:**

- Therapy defined by patient and center criteria.
- Door to-balloon-inflation (PCI) goal of 90 minutes
  - Door to-needle (fibrinolysis) goal of 30 minutes

ST depression or dynamic T-wave inversion; strongly suspicious for Ischemia  
**High-risk non-ST-elevation ACS (NSTEMI-ACS)**

- Troponin elevated or high-risk patient, consider early Invasive strategy if:**
- Refractory ischemic chest discomfort
  - Recurrent/persistent ST deviation
  - Ventricular tachycardia
  - Hemodynamic Instability
  - Signs of heart failure

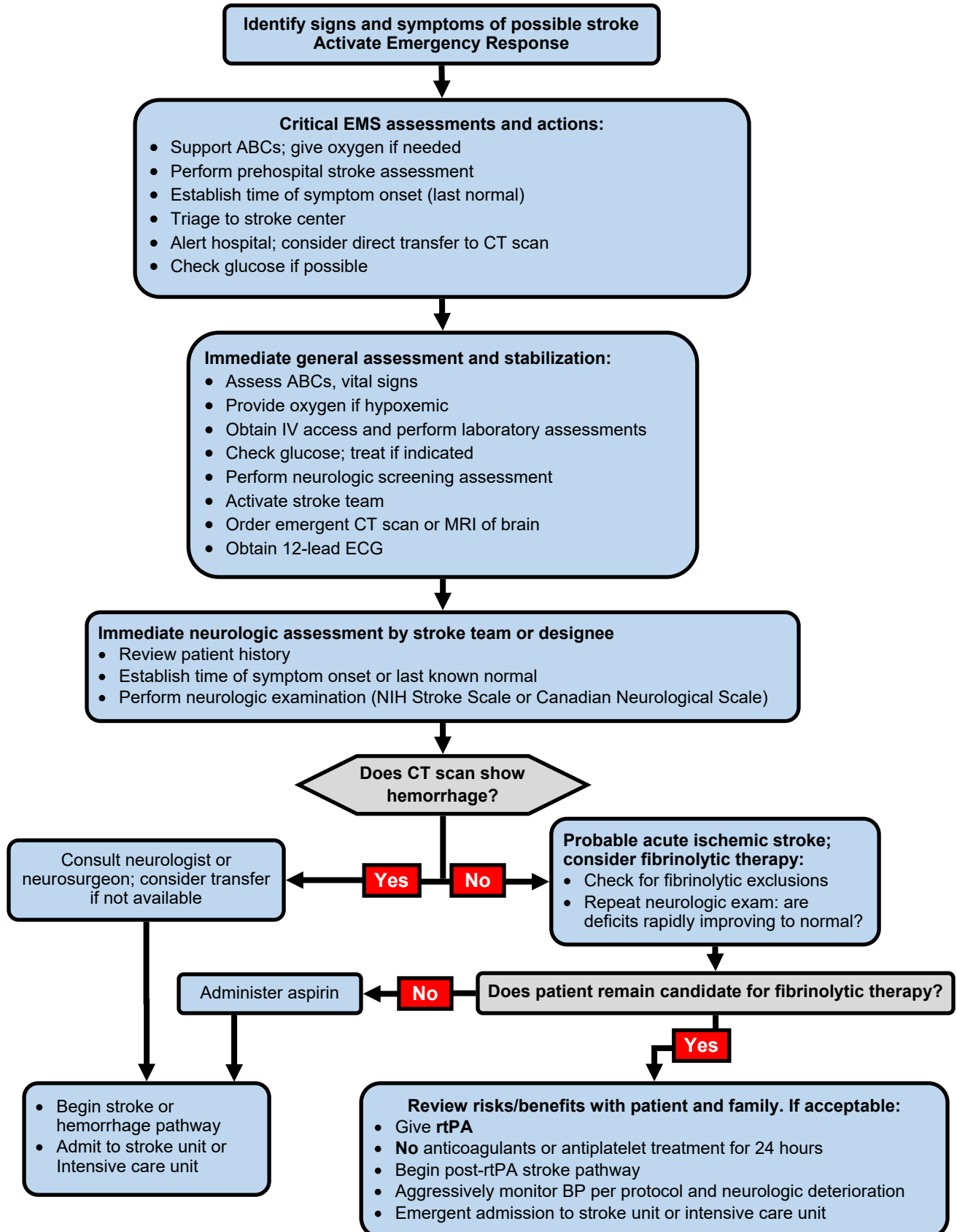
**Start adjunctive therapies**  
(eg, nitroglycerin, heparin) as Indicated  
See AHA/ACC NSTEMI-ACS Guidelines

Normal or non-diagnostic changes in ST segment or T-wave  
**Low/Intermediate-risk ACS**

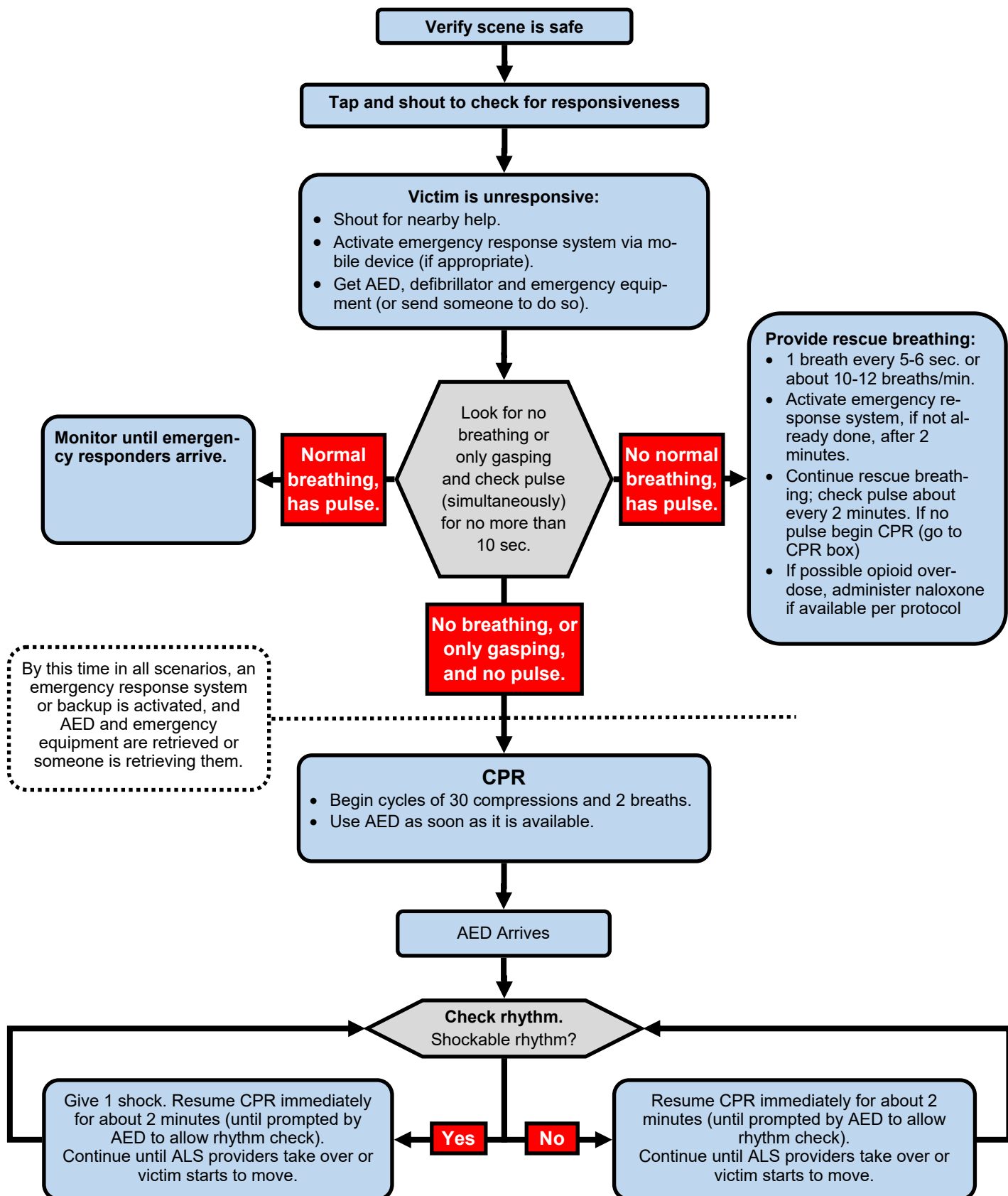
**Consider admission to ED chest pain unit or to appropriate bed for further monitoring and possible intervention.**



Follows American Heart Association ECC and CPR 2015 guidelines



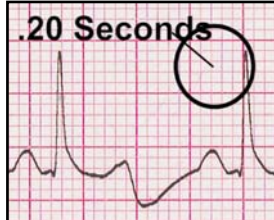
**Reference:** Link MS, Berkow LC, Kudenchuk PJ, Halperin HR, Hess EP, Moitra VK, Neumar RW, O'Neil BJ, Paxton JH, Silvers SM, White RD, Yannopoulos D, Donnino MW. "Part 7: Adult Advanced Cardiovascular Life Support." ECC Guidelines 2015. American Heart Association, 15 Oct. 2015. Web. 01 Mar. 2017.







1 small square = .04 sec.

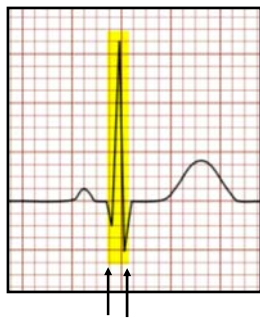


1 large box = .2 sec.  
(5 small squares long)



5 large boxes = 1 sec.

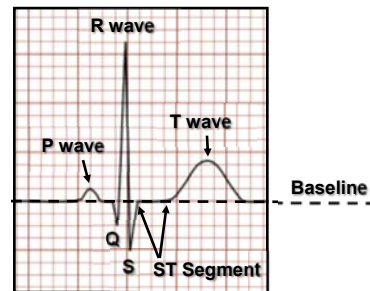
30 large boxes = 6 sec.



**QRS Complex-**  
Normal is 0.04 - 0.12 sec.  
(1-3 small boxes)



**PR Interval-**  
Normal is 0.12 - 0.20 sec.  
(3-5 small boxes)



**ST Segment-**  
Normally level with baseline. If higher,  
possible ST elevation MI. 12 lead ECG is  
needed to properly evaluate ST elevation.



### Normal Sinus Rhythm

*Rhythm:* Regular

*Rate:* 80 bpm (normal range= 60-100 bpm)

*P Waves:* Upright and regular

*P-R Interval:* 0.16 sec (normal range= 0.12-0.20), one P wave for each QRS

*QRS:* 0.08 sec (normal range= 0.04-0.12)

**Clinical Significance:** Unless the patient has no pulse or other serious signs or symptoms, there is no significance to this cardiac rhythm.



## Dysrhythmias Originating in the SA Node



### Sinus Bradycardia

*Rhythm:* Regular

*Rate:* 50 bpm (normal range= 60-100 bpm)

*P Waves:* Upright and regular

*P-R Interval:* 0.16 sec (normal range= 0.12-0.20), one P wave for each QRS

*QRS:* 0.08 sec (normal range= 0.04-0.12)

*Clinical Significance:* A decreased heart rate can result in decreased cardiac output, hypotension, or other serious problems depending on the cause of the bradycardia. Unless the patient has hypotension or other serious signs or symptoms, no treatment is necessary. For hypotension or other serious symptoms, Atropine 0.5mg can be given every 3-5 minutes. If atropine is ineffective, transcutaneous pacing should be done. Other treatments include Dopamine 2 to 20 mcg/kg per minute or Epinephrine 2 to 10 mcg/min.



### Sinus Tachycardia

*Rhythm:* Regular

*Rate:* 130 bpm (normal range= 60-100 bpm)

*P Waves:* Upright and regular

*P-R Interval:* 0.16 sec (normal range= 0.12-0.20), one P wave for each QRS

*QRS:* 0.04 sec (normal range= 0.04-0.12)

*Clinical Significance:* Typically sinus tachycardia needs no treatment. It is most often a compensatory mechanism to an underlying cause such as fever, anxiety, hypovolemia, or shock. It is most important to identify and treat the underlying cause as needed. Rates less than 150bpm do not usually cause serious signs and symptoms. Rates over 150bpm may cause reduced cardiac output and may require treatment. Synchronized cardioversion is the first choice. If regular narrow QRS complex, consider adenosine.

## Dysrhythmias Originating in the Atria



### Supraventricular Tachycardia

*Rhythm:* Regular

*Rate:* 280 bpm (SVT is defined as >100bpm. Typically under 150bpm has no symptoms.)

*P Waves:* Present but difficult to see on the end of the T wave because of rapid rate

*P-R Interval:* 0.12 sec (normal range= 0.12-0.20), one P wave for each QRS, again difficult to see

*QRS:* 0.04 sec (normal range= 0.04-0.12)

*Clinical Significance:* SVT usually has an abrupt onset and termination in patients with high levels of stress, over exertion, high levels of caffeine, Wolff-Parkinson-White (WPW) syndrome, etc... and can usually be tolerated for short periods of time. Runs of SVT are often felt as palpitations. Treatment is not normally needed for self-terminating SVT. If the patient is unstable, rapid treatment must be given to correct the SVT. Synchronized cardioversion at 50-100 joules with a monophasic or biphasic defibrillator should be given immediately. For symptomatic, but stable SVT, Vagal maneuvers should be tried first. If unsuccessful, then 6mg Adenosine rapid IV push would be given. 12mg Adenosine may be tried if the first dose did not convert the rhythm.



### Atrial Flutter

*Rhythm:* Regular (Can be irregular)

*Rate:* 110 bpm (Atrial rate is 210. Typical "sawtooth" pattern of atrial flutter.)

*P Waves:* Flutter waves, or F waves, are present.

*P-R Interval:* F waves are consistent, 2 for every QRS (2:1 or 3:1 is typical)

*QRS:* 0.12 sec (normal range= 0.04-0.12)

*Clinical Significance:* Treatment is not normally necessary. Rather an expert consultation is required. Patients will often feel weak or dizzy. Treatment is necessary if there is a rapid ventricular rate that creates hemodynamic instability. For an unstable patient, perform synchronized cardioversion with 50 to 100 J with a monophasic or biphasic defibrillator. Pharmacologic therapy should be done only upon expert consultation or medical control direction.



### **Atrial Fibrillation**

*Rhythm:* Irregular

*Rate:* 90 bpm (Atrial rate is very fast and chaotic, and cannot be counted) *P*

*Waves:* Not discernible. Chaotic.

*P-R Interval:* None

*QRS:* 0.08 sec (normal range= 0.04-0.12)

*Clinical Significance:* Treatment is not normally necessary. Rather an expert consultation is required. Patients will often feel weak or dizzy. For an unstable patient, perform synchronized cardioversion with 200 Joules with a monophasic or 120 to 200 joules with a biphasic defibrillator. Pharmacologic therapy should be done only upon expert consultation or medical control direction.

## **Dysrhythmias Originating in the Ventricles**



### **Ventricular Tachycardia (V-tach)**

*Rhythm:* Regular (Can be slightly irregular)

*Rate:* 200 bpm (Typically between 100-250)

*P Waves:* Absent

*P-R Interval:* Absent

*QRS:* Wide, 0.32 sec (usually wide and bizarre)

*Clinical Significance:* Ventricular tachycardia severely compromises cardiac output and coronary artery perfusion. V-tach May be perfusing or non-perfusing. If there is a pulse and patient is stable, then Procainamide or Amiodarone may be administered. If unstable with a pulse, then synchronized cardioversion is needed. If pulseless, then defibrillate with an initial unsynchronized dose of 360 joules monophasic or 120-200 joules biphasic.





### **Torsade's De Pointes**

*Rhythm:* 210  
*Rate:* Irregular  
*P Waves:* Absent  
*P-R Interval:* Absent  
*QRS:* Wide

*Clinical Significance:* A person with Torsade's will be unstable, but may present with or without a pulse. Torsade's is a polymorphic ventricular tachycardia with the characteristic illusion of a twisting of the QRS complex around the baseline. Magnesium Sulfate should be administered. Either should be treated as with V-fib.



### **Ventricular Fibrillation (V-fib)**

*Rhythm:* Chaotic  
*Rate:* Chaotic  
*P Waves:* Absent  
*P-R Interval:* Absent  
*QRS:* Absent

*Clinical Significance:* Ventricular fibrillation is lethal with no cardiac output. Defibrillate with an initial unsynchronized dose of 360 joules monophasic or 120-200 joules biphasic. 1mg Ephinephrine 1:10,000 is the drug of choice given every 3-5 minutes.



### **Asystole**

*Rhythm:* None  
*Rate:* None  
*P Waves:* Absent  
*P-R Interval:* Absent  
*QRS:* Absent

*Clinical Significance:* Asystole is cardiac arrest with no electrical activity. Treat with high quality CPR and 1mg Epinephrine 1:10,000 given every 3-5 minutes. Try to correct underlying causes such as H's and T's.

## Atrioventricular (AV) Heart Blocks



### First-Degree AV Block

*Rhythm:* Regular (can be slightly irregular)

*Rate:* 90

*P Waves:* Normal

*P-R Interval:* 0.24 sec (normal range= 0.12-0.20), one P wave for each QRS

*QRS:* 0.04 sec (normal range= 0.04-0.12)

*Clinical Significance:* The prolonged P-R interval with one P wave for each QRS is the most identifiable sign to recognize first-degree AV block. Although first-degree block is not usually serious by itself, it can be a precursor to a more serious type of block. Usually treatment is not needed unless other serious signs or symptoms are evident.

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### Second-Degree AV Block Mobitz Type I – Wenckebach

*Rhythm:* Ventricular rhythm is irregular; Atrial rhythm is Regular

*Rate:* 70 (typically normal or slow)

*P Waves:* Normal; Some are not followed by QRS complexes

*P-R Interval:* Becomes progressively longer until QRS is dropped.

*QRS:* 0.04 sec (usually within normal range= 0.04-0.12)

*Clinical Significance:* If beats are frequently dropped, cardiac output can be compromised. This can cause syncope and angina. Usually treatment is not needed immediately unless other serious signs or symptoms are evident. If symptomatic bradycardia occurs, then 0.5mg of Atropine should be administered IV. If atropine fails, transcutaneous pacing should be administered.

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### **Second-Degree AV Block Mobitz Type II**

*Rhythm:* Ventricular rhythm is irregular; Atrial rhythm is Regular

*Rate:* 60 (typically bradycardic)

*P Waves:* Normal; Some are not followed by QRS complexes

*P-R Interval:* Constant for p-waves followed by a QRS

*QRS:* 0.04 sec (can be longer than normal range= 0.04-0.12)

*Clinical Significance:* Regular P-waves with a regular P-R interval and occasional dropped QRS complexes is the most identifiable characteristic of second-degree AV block type II. If beats are frequently dropped, cardiac output can be compromised. This can cause syncope and angina. Usually treatment is not needed immediately unless other serious signs or symptoms are evident. If symptomatic bradycardia occurs, then transcutaneous pacing should be the first choice. Atropine is more likely to be ineffective as it can accelerate the atrial rate but worsen the AV block in a second-degree type II block. Atropine may be used, but with caution.



### **Third-Degree AV Block**

*Rhythm:* Ventricular rhythm is regular; Atrial rhythm is regular

*Rate:* 60 (typically bradycardic)

*P Waves:* Normal; Some are hard to see and buried in QRS complexes

*P-R Interval:* Varies; disassociated from QRS

*QRS:* 0.16 sec (normal range is= 0.04-0.12)

*Clinical Significance:* A third degree block is an absence of conduction between the atria and the ventricles. There is a complete electrical block between the two and they pace the heart independent of each other. Cardiac output is severely compromised. If symptomatic bradycardia is present, then transcutaneous pacing should be the first choice. Atropine is more likely to be ineffective as it can accelerate the atrial rate but worsen the AV block in a third-degree block. Atropine may be used, but with caution.