

***Sudden cardiac arrest (SCA)***  
***&***  
***Sudden cardiac death (SCD)***

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# INTRODUCTION

- *Sudden cardiac arrest (SCA)* and *sudden cardiac death (SCD)* refer to the sudden cessation of cardiac activity with hemodynamic collapse
- If an intervention (eg defibrillation) restores circulation, the event is referred to as **SCA**
- If uncorrected, an SCA event leads to death and is then referred to as **SCD**

# SCD : Definition

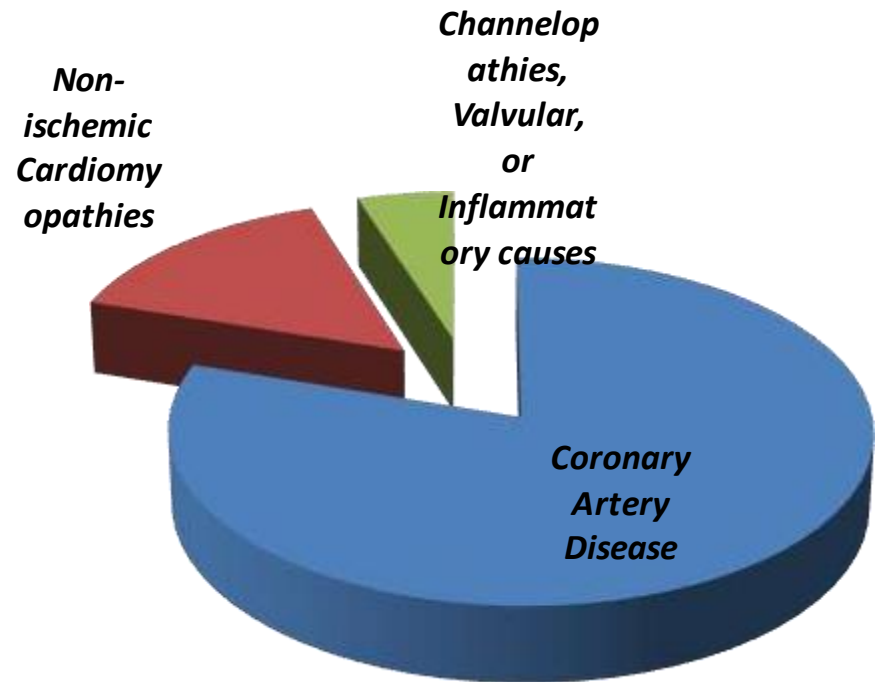
- *Sudden cardiac death (SCD)* is unexpected, abrupt natural death from cardiac causes within 1 hour of symptom onset

# Epidemiology

- **SCD accounts for 15% of all deaths and 50% of cardiac-related deaths**
- Overall incidence is 1-2 per 1000 each year (0.1-0.2%)
- Mean survival rate of out-of-hospital cardiac arrest is <10% to 20%
- In high-risk groups (eg CAD), the incidence is 100-120 per 1000 per year (10-12%)
- **However, more than two-thirds of patients who die from SCD are considered “low risk” with either no known cardiac risk factors or “low-risk” CAD**

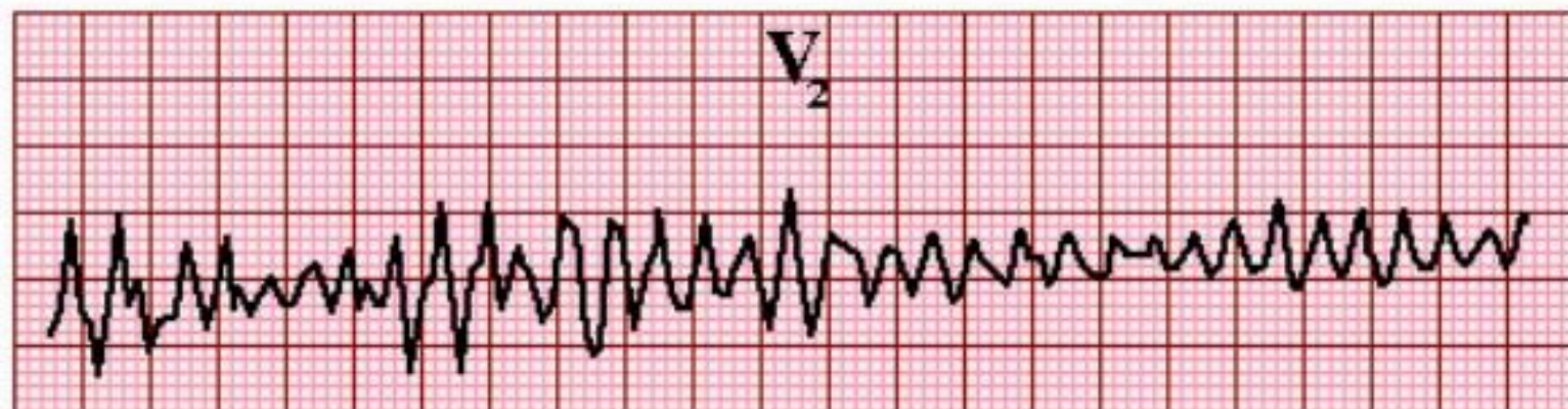
# Etiology

- **Coronary Artery Disease : 80%**
- Non-ischemic  
Cardiomyopathies : 10 - 15%
- Channelopathies, Valvular or  
Inflammatory causes : 5 - 10%



# Three Basic ECG Patterns with Cardiac Arrest

- ❑ Ventricular tachyarrhythmia-- ventricular fibrillation (VF)/sustained type of pulseless ventricular tachycardia
- ❑ Ventricular asystole or a brady-asystolic rhythm with an extremely slow rate
- ❑ Pulseless electrical activity (PEA), previously referred to as electromechanical dissociation.



**Ventricular fibrillation** There is a complete absence of properly formed QRS complexes and no obvious P waves. A recent onset (eg, within minutes) of the arrhythmia is suggested by the coarse morphology of the fibrillatory waves.



**Figure 18.** The “rhythm” of ventricular asystole. This patient is pulseless and unresponsive. Note the 2 QRS-like complexes at the start of this rhythm display. These complexes represent a minimum of electrical activity, probably ventricular escape beats. Note the long section in which electrical activity is completely absent. This patient is in asystole at this point.

# Ventricular Tachycardia

ID#: 050107213625 1May07 21:42:28 HR:132



# SUDDEN CARDIAC ARREST

- ❑ The probability of achieving successful resuscitation from cardiac arrest is related to-
- ❑ Interval from onset of loss of consciousness to institution of resuscitative efforts
- ❑ The setting in which the arrest occurs
- ❑ The mechanism ( VT, VF, PEA, ASYSTOLE) of CA
- ❑ Clinical status of the patient before the cardiac arrest.

# SUDDEN CARDIAC ARREST

- ❑ After 5 min, survival rates are no better than 25-30% in out of hospital setting
- ❑ Outcome in ICU and other in-hospital environments is heavily influenced by patients preceding clinical status

# SUDDEN CARDIAC ARREST

- When the mechanism is pulseless VT, the outcome is best
- VF is the next most successful
- Asystole and PEA generate dismal outcome statistics

# Acute Management

- Rapid recovery efforts are critical
- The time between onset and resuscitation has a dramatic effect on the rate of success
- **Irreversible brain damage begins within 5 minutes of arrest**

# **THE INITIAL ASSESSMENT**

# The Initial Assessment

- Make sure the **scene is safe** before approaching the individual
- **The first assessment is whether they are conscious or unconscious**
- If unconscious, **start with BLS Survey** and move on to ACLS Survey
- If conscious, start with **ACLS Survey**

# **BASIC LIFE SUPPORT**

# INITIATING THE CHAIN OF SURVIVAL

- **Early initiation of BLS** has been shown to increase the probability of survival for an individual dealing with cardiac arrest

## *Adult Chain of Survival*



# Signs and symptoms

- ❑ The most reliable sign is absence of pulse
- ❑ Unconsciousness/Unresponsiveness
- ❑ No respiratory movements
- ❑ No blood pressure
- ❑ Pupils begin dilating within 45 secs.
- ❑ Seizures- may or may not occur
- ❑ Death like appearance
- ❑ Lips and nail beds turn blue and skin turns pale

# Immediate recognition and activation of emergency response system

- ❑ If a lone rescuer finds an unresponsive adult or witnesses an adult who suddenly collapses, after ensuring that the scene is safe, the rescuer should check for a response by tapping the victim at the shoulder and by shouting at him
- ❑ The trained or untrained bystander should activate the community emergency response system, or if in an institution with an emergency response system call that facility's emergency response number

- 
- Unresponsiveness
  - If the victim also has absent or abnormal breathing(ie, only gasping) the rescuer should assume that the victim is in cardiac arrest

## └ **PULSE CHECK:**

- Studies have shown that both lay rescuers and health care providers (HCP) have difficulty detecting a pulse.
- The lay rescuer should not check for a pulse
- If the HCP doesn't definitely feel a pulse within 10 secs he should start chest compressions.

# Recent BLS Guidelines

- The change from the traditional ***ABC (Airway, Breathing, Compressions)*** sequence to the ***CAB (Compressions, Airway, Breathing)***
- The **emphasis on early initiation of chest compressions** without delay for airway assessment or rescue breathing has resulted in improved outcomes

# BLS guidelines cont...

- Chest compressions at a rate of **100 to 120 per minute**
- Chest compressions at a depth of **2 to 2.4 inches (5 to 6 cm)**, greater depths may result in injury to vital organs
- **Full chest recoil in between compressions** to promote cardiac filling
- **Interruptions** of chest compressions, including pre and post-AED shocks should be **as short as possible**

# BLS guidelines cont...

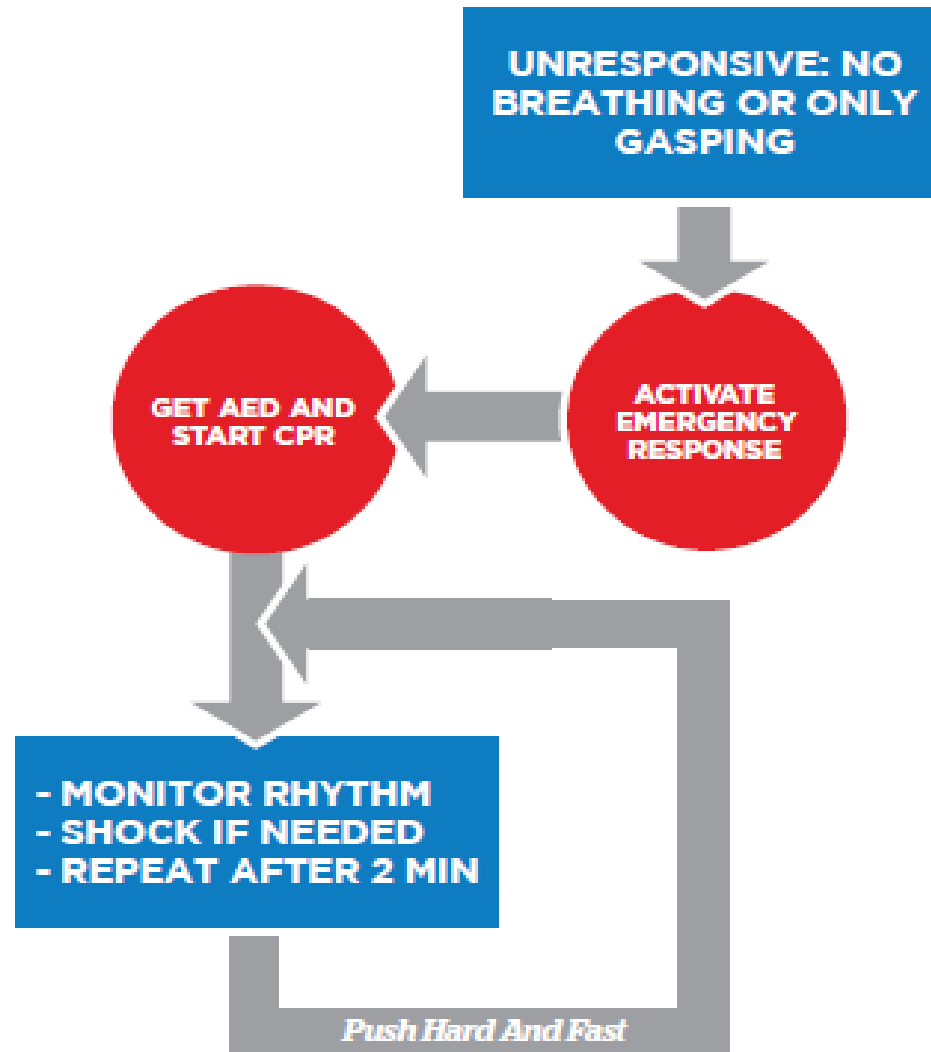
- ***Compression to ventilation ratio 30:2*** for an individual without an advanced airway
- Individuals with an **advanced airway** should **receive uninterrupted chest compressions** with ventilations at a rate of one every six seconds
- In cardiac arrest, the **defibrillator** should be used as soon as possible
- Standard dose **epinephrine (1 mg every 3 to 5 min)** is the preferred vasopressor

# Technique : chest compressions

- ❑ Place victim on a firm surface in supine position
- ❑ Rescuer kneeling besides victim's chest (out of hospital) or standing besides bed (in hospital)
- ❑ Place heel of one hand over the lower half of sternum. Heel of the other hand should be on top of the first so that they overlap and are parallel.
- ❑ Arms should be straight and perpendicular to chest of victim



# ***Simple Adult BLS Algorithm***



# ***CPR Steps***

1. Check for carotid pulse. **Never waste time trying to feel carotid for more than 10 seconds.** If not sure, begin CPR
2. Use the **heel of one hand** on the lower half of the sternum in the middle of the chest. Put your other hand on top of the first hand
3. **Straighten your arms** and press straight down
4. Compressions should be **at least two inches into the person's chest** and at a rate of **100 to 120 compressions per minute.** Allow the chest wall to return to its natural position



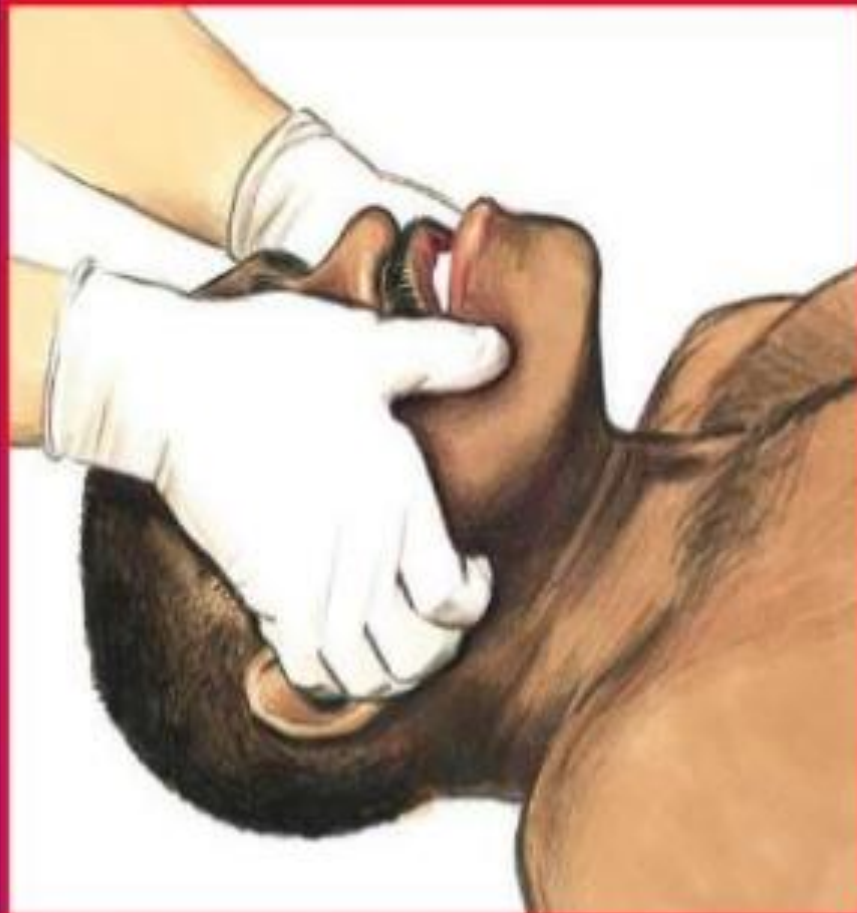
# ***CPR Steps cont...***

5. After 30 compressions, stop compressions and open the airway by tilting the head and lifting the chin.
6. **Do not perform** the head-tilt-chin lift maneuver if you suspect the person may have a neck injury. In that case the jaw-thrust is used
7. Give a breath while watching the chest rise. Repeat while giving a second breath. Breaths should be delivered over one second
8. Resume chest compressions. Switch quickly between compressions and rescue breaths to minimize interruptions in chest compressions

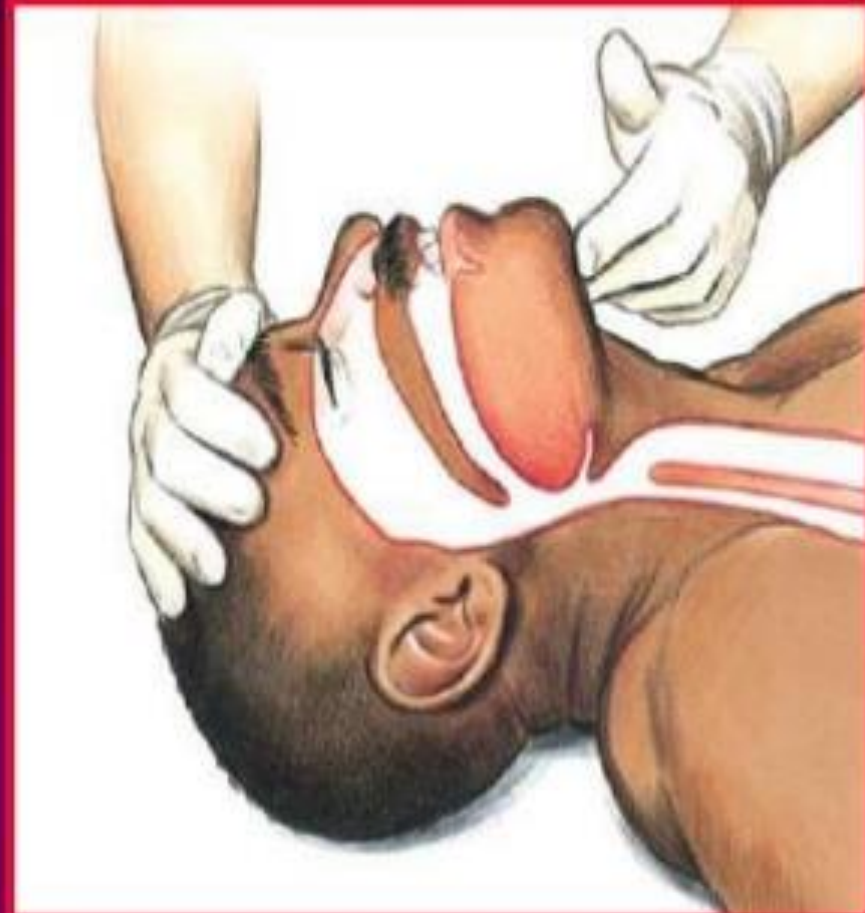


## Opening the Airway

Jaw thrust



Head tilt–chin lift



# *ONE-RESCUER BLS/CPR FOR ADULTS*

## ***Be Safe***

- Move the person out of traffic/ water and dry the person.
- Be sure you do not become injured yourself.

## ***Assess the Person***

- Shake the person and talk to them loudly.
- Check to see if the person is breathing.

## ***Call EMS***

- Send someone for help and to get an AED.
- If alone, call for help while assessing for breathing and pulse.

## ***CPR***

- Check pulse.
- Begin chest compressions and delivering breaths.

## ***Defibrillate***

- Attach the AED when available.
- Listen and perform the steps as directed.

# *TWO-RESCUER BLS/CPR FOR ADULTS*

- The second rescuer prepares the AED for use.
- Begin chest compressions and count the compressions out loud.
- The second rescuer applies the AED pads.
- The second rescuer opens the person's airway and gives rescue breaths.
- Switch roles after every five cycles of compressions and breaths. **One cycle consists of 30 compressions and two breaths.**
- **Quickly switch between roles** to minimize interruptions in delivering chest compressions.
- When the AED is connected, minimize interruptions of CPR by switching rescuers while the AED analyzes the heart rhythm.
- If a shock is indicated, minimize interruptions in CPR.
- **Resume CPR as soon as possible.**

# Technique: Rescue breaths

- ❑ Open airway- Head tilt and chin lift/ Jaw thrust
- ❑ Mouth to mouth
- ❑ Mouth to barrier device
- ❑ Mouth to nose and mouth and stoma
- ❑ Ventilation with bag and mask
- ❑ Ventilation with supraglottic airway- LMA, esophageal combitube, king airway device

# Technique: Rescue breaths

- ❑ To provide mouth-to-mouth rescue breaths, open the victim's airway- pinch the victim's nose- and create an airtight mouth-to-mouth seal. Give 1 breath over 1 second, take a "regular" (not a deep) breath, and give a second rescue breath over 1 second
- ❑ Advanced airway- 1 breath every 6-8 secs  
ASYNCHRONOUS with compressions

# *ADULT MOUTH-TO-MASK* VENTILATION



# *ADULT BAG-MASK VENTILATION IN TWO-RESCUER CPR*



# Advanced airways



LMA



combitube



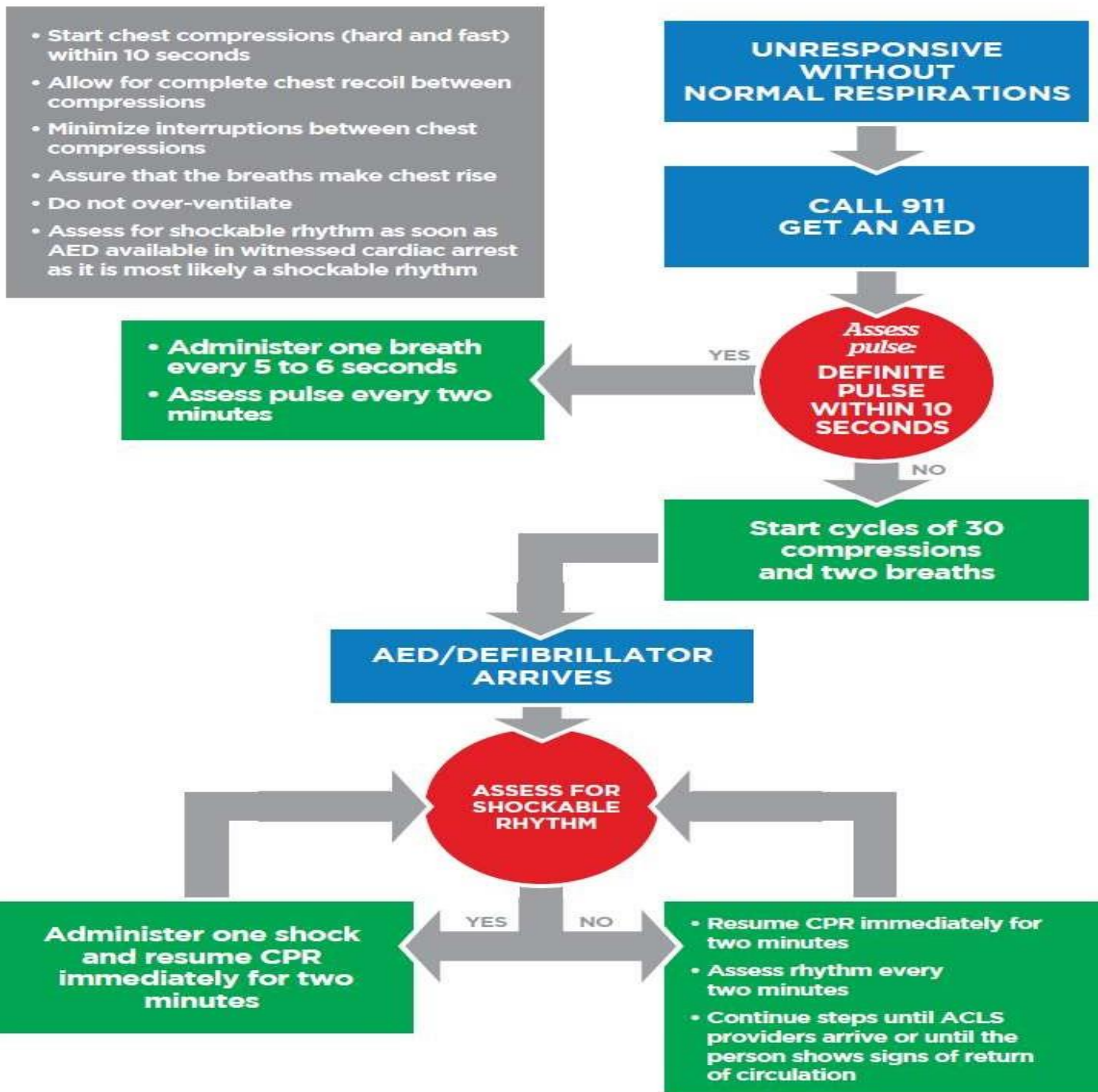
ET tube

# Summary of Key BLS Components for Adults, Children and Infants

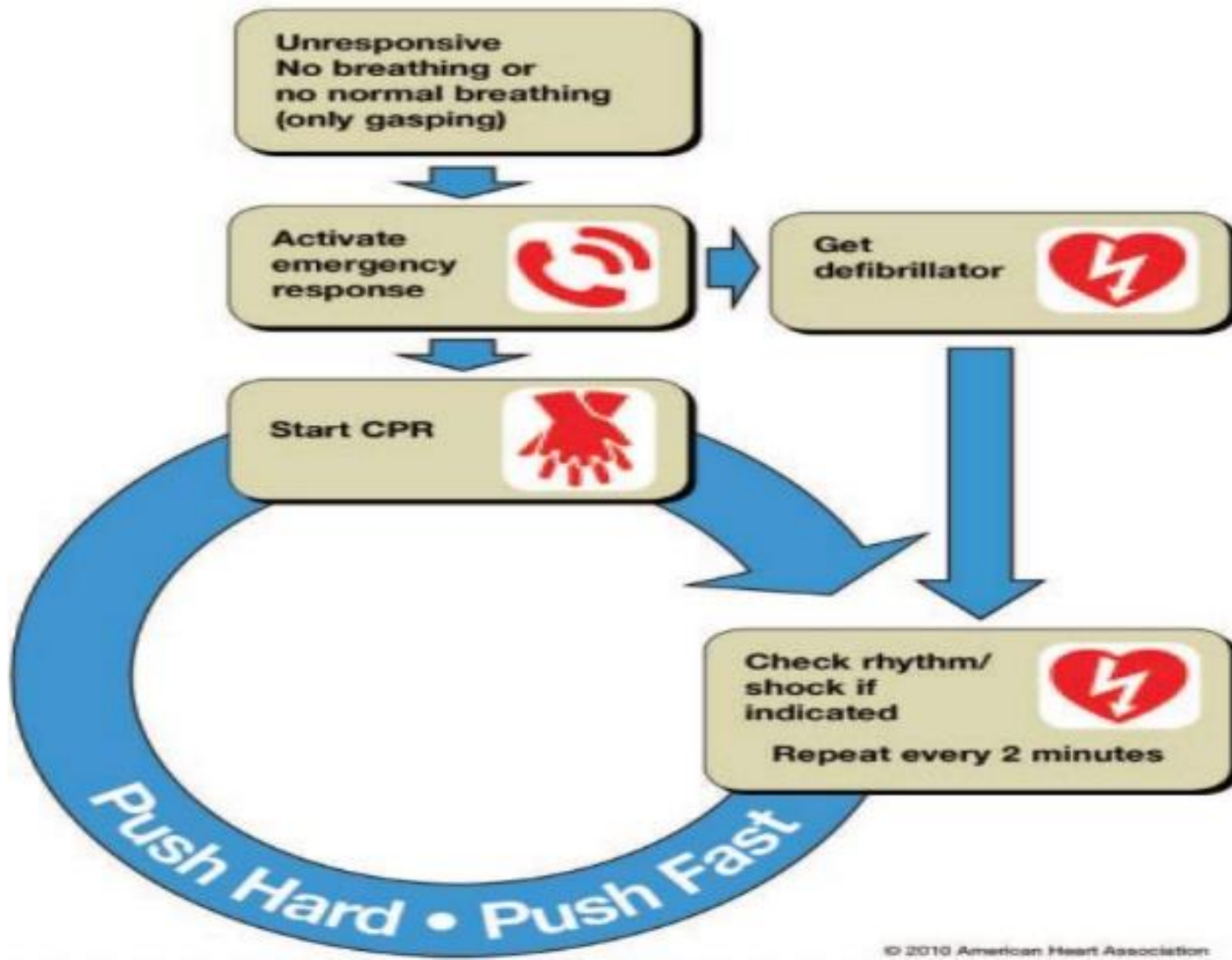
## Recommendations

| Component         | Adults                                                                                                                                           | Children                                       | Infants                                                      |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|--------------------------------------------------------------|
| Recognition       | Unresponsive (for all ages)<br><br>No breathing, not breathing normally (eg, only gasping)<br><br>No pulse palpated within 10 seconds (HCP Only) |                                                |                                                              |
| CPR Sequence      | CAB                                                                                                                                              | CAB                                            | CAB                                                          |
| Compression Rate  | At least 100/min                                                                                                                                 |                                                |                                                              |
| Compression Depth | At least 2 inches (5 cm)                                                                                                                         | At least 1/3 AP Depth<br>About 2 inches (5 cm) | At least 1/3 AP Depth<br>About 1 $\frac{1}{2}$ inches (4 cm) |

|                                                                    |                                                                                                        |                                                  |                                                  |
|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| Chest Wall Recoil                                                  | Allow Complete Recoil Between Compressions<br>HCPs Rotate Compressors Every 2 minutes                  |                                                  |                                                  |
| Compression Interruptions                                          | Minimize Interruptions in Chest Compressions<br>Attempt to limit interruptions to less than 10 seconds |                                                  |                                                  |
| Airway                                                             | Head tilt-chin lift (HCP suspected trauma: jaw thrust)                                                 |                                                  |                                                  |
| Compression to Ventilation Ratio (until advanced airway placed)    | 30:2<br>(1 or 2 rescuers)                                                                              | 30:2<br>Single Rescuer<br>15:2<br>2 HCP Rescuers | 30:2<br>Single Rescuer<br>15:2<br>2 HCP Rescuers |
| Ventilations: When rescuer Untrained or Trained and Not Proficient | Compressions Only                                                                                      |                                                  |                                                  |



## Simplified Adult BLS



# **ADVANCED CARDIAC LIFE SUPPORT**

# Goals of ACLS

- ❑ Revert the cardiac rhythm to one that is hemodynamically effective-by defibrillation/cardioversion
- ❑ To optimize ventilation-through placement of an advanced airway (i.e., intubation)
- ❑ To maintain and support the restored circulation-monitoring and use of drugs

# Basics of ACLS

- Immediately after activating emergency response, start CPR
- Attach monitor/defibrillator minimizing interruptions in CPR
- Shockable rhythm- defibrillate with recommended shock energy and immediately resume CPR for 2 mins (5 cycles)

# THE ACLS SURVEY (A-B-C-D)

## **AIRWAY**

- Maintain airway in unconscious patient
- Consider advanced airway
- Monitor advanced airway if placed with quantitative waveform capnography

## **BREATHING**

- Give 100% oxygen
- Assess effective ventilation with quantitative waveform capnography
- Do NOT over-ventilate

# THE ACLS SURVEY (A-B-C-D)

## ***CIRCULATION***

- Evaluate rhythm and pulse
- Defibrillation/cardioversion
- Obtain IV/IO access
- Give rhythm-specific medications
- Give IV/IO fluids if needed

## ***DIFFERENTIAL DIAGNOSIS***

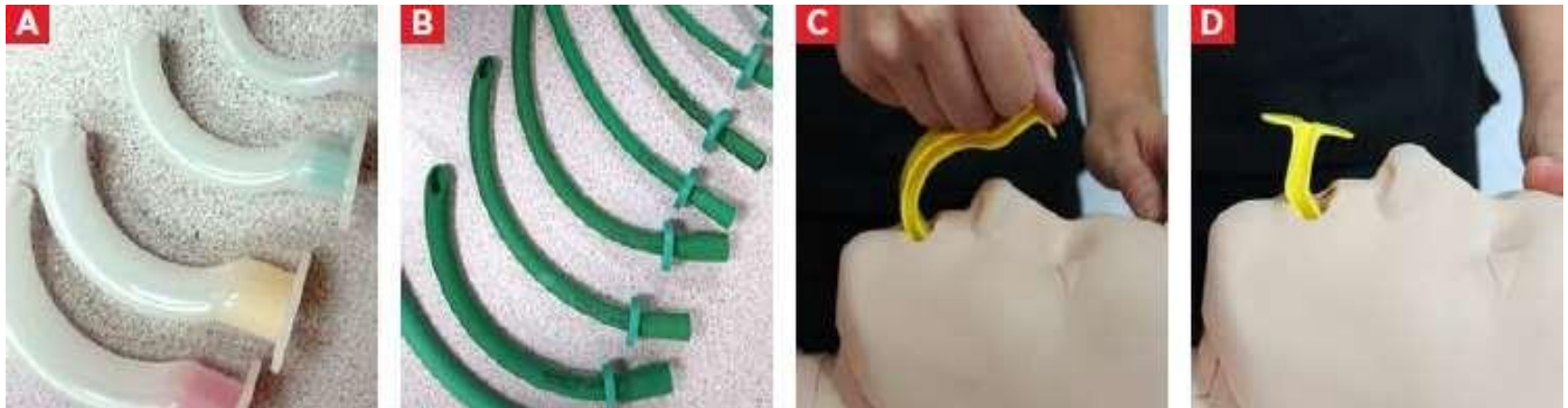
- Identify and treat reversible causes
- Cardiac rhythm and patient history
- Assess when to shock versus medicate

# AIRWAY MANAGEMENT

- **If bag-mask ventilation is adequate, providers may defer insertion of an advanced airway**
- The value of securing the airway must be balanced against the need to minimize the interruption in perfusion that results in halting CPR during airway placement

# ***BASIC AIRWAY ADJUNCTS***

- The oropharyngeal airway (OPA) and the nasopharyngeal airway (NPA)
- OPA is placed in the mouth while a NPA is inserted through the nose
- Both airway equipment terminate in the pharynx
- The main advantage of a NPA over an OPA is that it can be used in either conscious or unconscious individuals because the device does not stimulate the gag reflex



# ***ADVANCED AIRWAY ADJUNCTS***

## ***ENDOTRACHEAL TUBE***

- It is the most technically difficult airway to place; however, it is the **most secure airway available**
- Only experienced providers should perform ET intubation
- This technique requires the use of a laryngoscope

## ***LARYNGEAL MASK AIRWAY***

- Rapid placement of the LMA device by an ACLS provider

## ***LARYNGEAL TUBE***

- It is more compact and less complicated to insert
- This tube can be inserted blindly

# ROUTES OF ACCESS

## ***INTRAVENOUS ROUTE***

- **A peripheral IV line is preferred**
- Central line access not necessary, as it may cause interruptions in CPR & complications during insertion

## ***INTRAOSSEOUS ROUTE***

- IO route only if IV access is not available

## ***ENDOTRACHEAL ROUTE***

- Historically, drugs were administered via ET route
- **ET absorption of drugs is poor,** and optimal drug dosing is unknown

# ***COMMON DRUGS***

***Adenosine***

- Narrow PSVT/SVT

***Amiodarone***

- VF/pulseless VT
- VT with pulse

***Atropine***

- Symptomatic bradycardia
- Specific toxins/overdose(eg Organophosphates)

***Dopamine***

- Shock/CHF

***Epinephrine***

- Cardiac Arrest
- Anaphylaxis
- Symptomatic bradycardia/Shock

# ***COMMON DRUGS***

## ***Lidocaine***

- Cardiac Arrest (VF/VT)
- Wide complex tachycardia with pulse

## ***Magnesium Sulfate***

- Cardiac arrest
- Torsades de pointes

## ***Procainamide***

- Wide QRS tachycardia
- VT with pulse (stable)

## ***Sotalol***

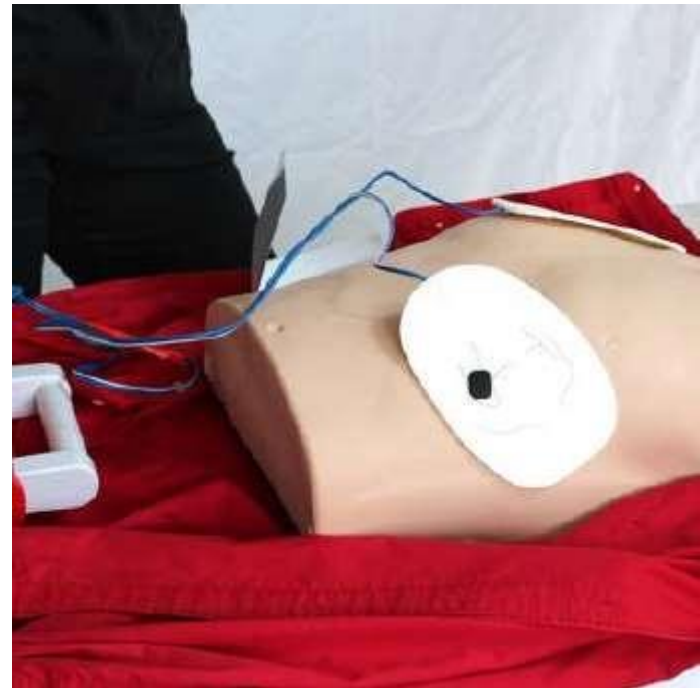
- Tachyarrhythmia
- Monomorphic VT

# PRINCIPLES OF EARLY DEFIBRILLATION

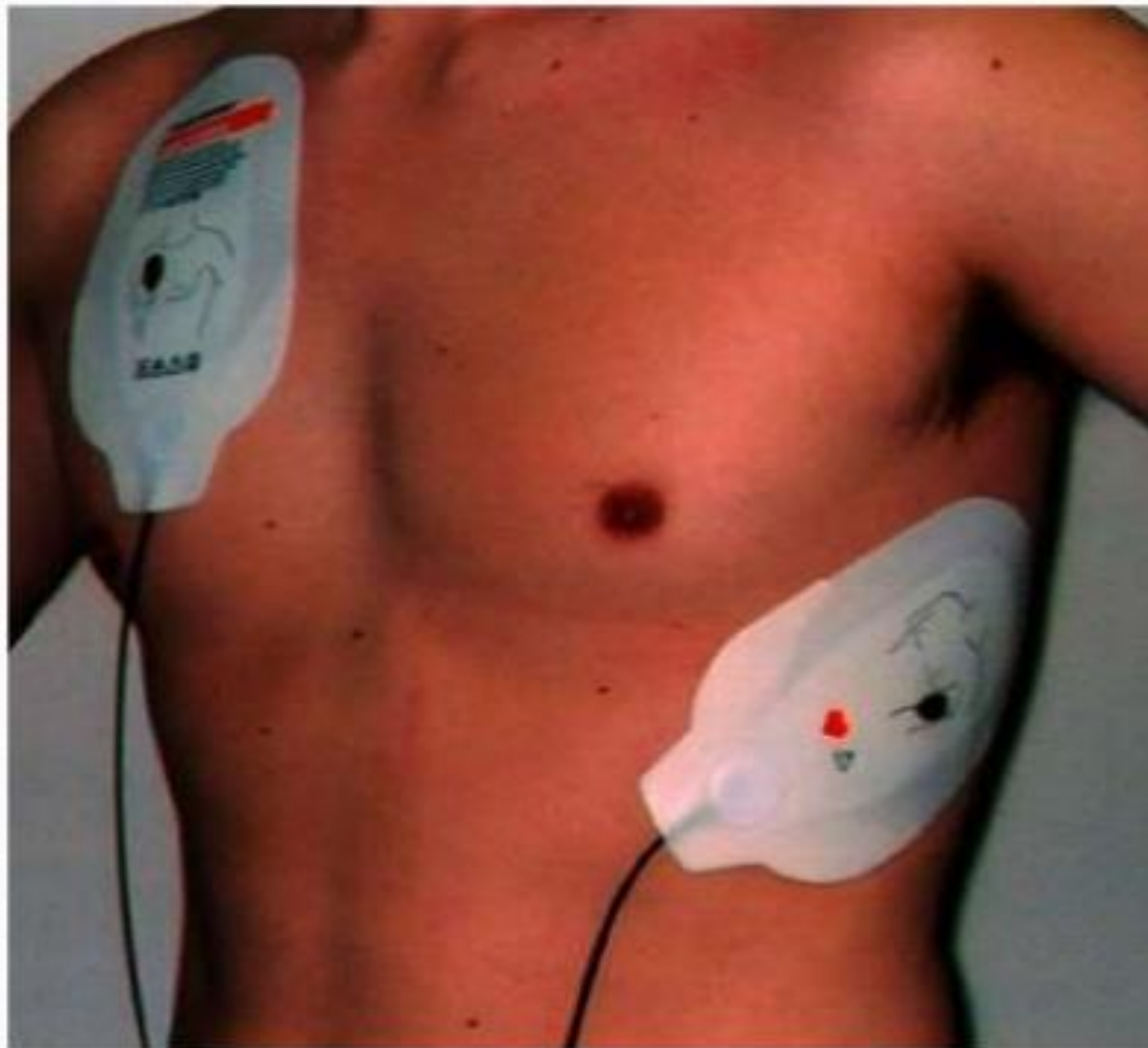
- When a fatal arrhythmia is present, CPR can provide a small amount of blood flow to the heart and the brain, but it cannot directly restore an organized rhythm
- Defibrillation disrupts a chaotic rhythm and allow the heart's normal pacemakers to resume effective electrical activity

# AUTOMATED EXTERNAL DEFIBRILLATOR

- Attach the pads to the upper right side and lower left side of the individual's chest
- Once the pads are attached correctly, the device will read the heart rhythm



# Defibrillation: Electrode Placement



# AED cont...

- Once the rhythm is analyzed, the device will direct you to shock the individual if a shock is indicated
- A shock depolarizes all heart muscle cells at once, attempting to organize its electrical activity



# ***CRITERIA TO APPLY AED***

- The individual does not respond to shouting or shaking their shoulders
- The individual is not breathing or breathing ineffectively
- The carotid artery pulse cannot be detected

# ***BASIC AED OPERATION***

- Attach the pads to bare chest (not over medication patches). Dry the chest if necessary
- Place one pad on upper right side and the other on the chest a few inches below the left arm
- Clear the area to allow AED to read rhythm
- **If no rhythm in 15 seconds, restart CPR**
- **If AED indicates a shock is needed, clear the individual, making sure no one is touching them and that the oxygen has been removed**
- Press the “Shock” button
- Immediately resume CPR starting with chest compressions
- After two minutes of CPR, analyze the rhythm with the AED
- Continue to follow the AED prompts



# **Rhythm-Based Management of Cardiac Arrest**

# Defibrillation Strategies

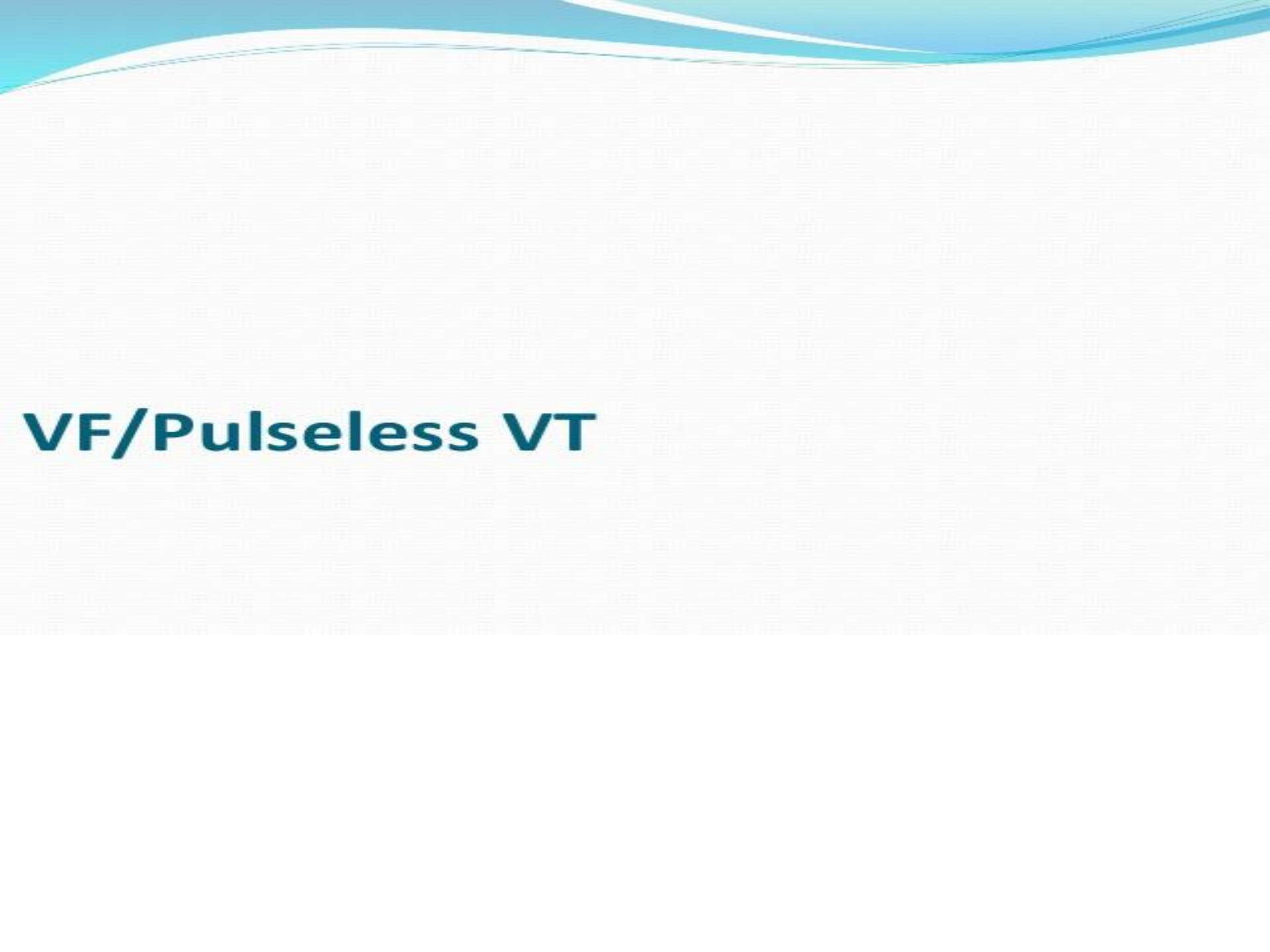
## Waveform and Energy

- Biphasic defibrillator: manufacturer's recommended energy dose (120-200 J)
- Unaware of the effective dose range: maximal dose

# Defibrillation Strategies

## Waveform and Energy

- ❑ Second and subsequent energy levels should be at least equivalent, and higher energy levels may be considered if available.
- ❑ Monophasic defibrillator: 360 J
- ❑ Subsequent shocks at the previously successful energy level



# **VF/Pulseless VT**

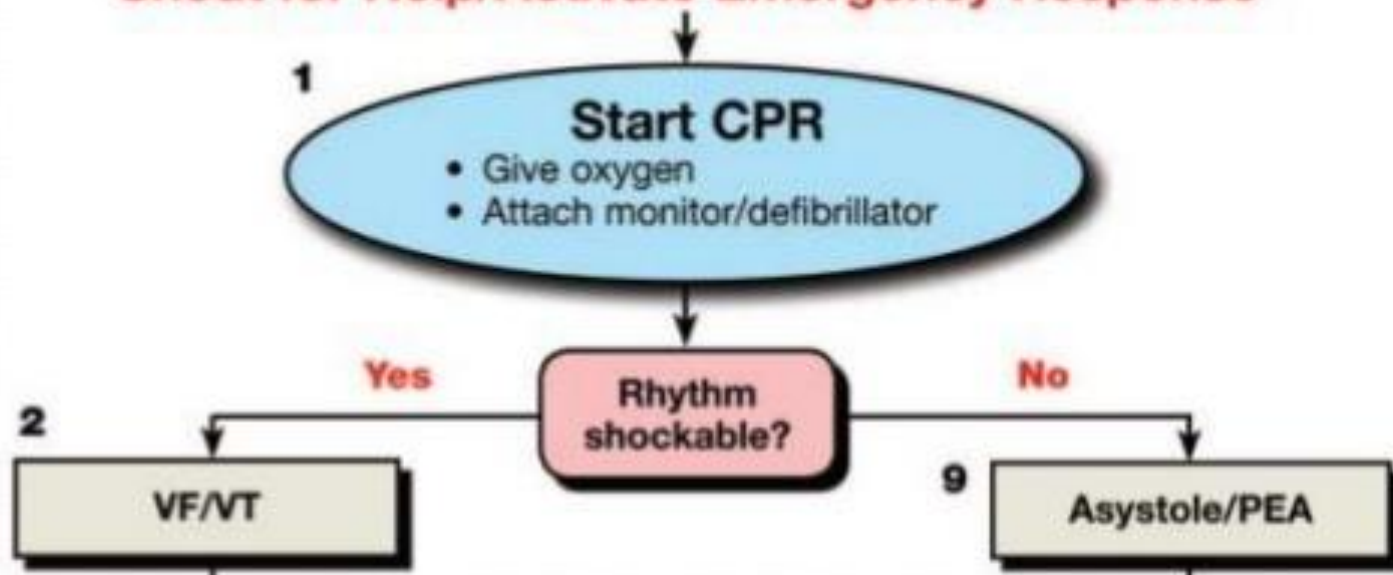
# Drug Therapy in VF/Pulseless VT

- ❑ Amiodarone: first-line antiarrhythmic agent
- ❑ Magnesium sulfate
  - ❑ Torsades de pointes associated with a long QT interval



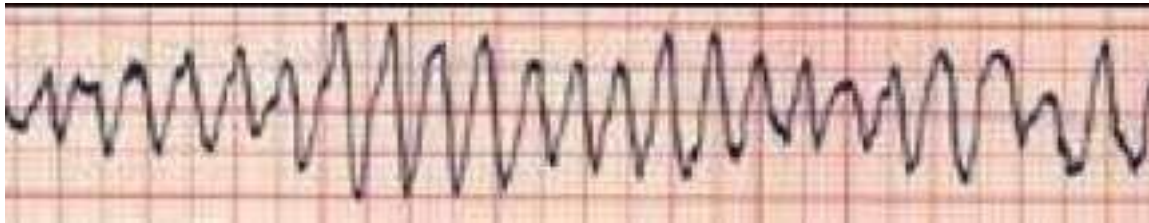
## Adult Cardiac Arrest

Shout for Help/Activate Emergency Response

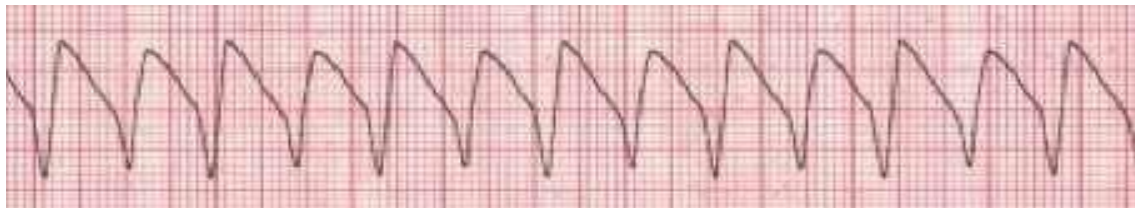


# ***SHOCKABLE RHYTHMS***

## **VENTRICULAR FIBRILLATION**



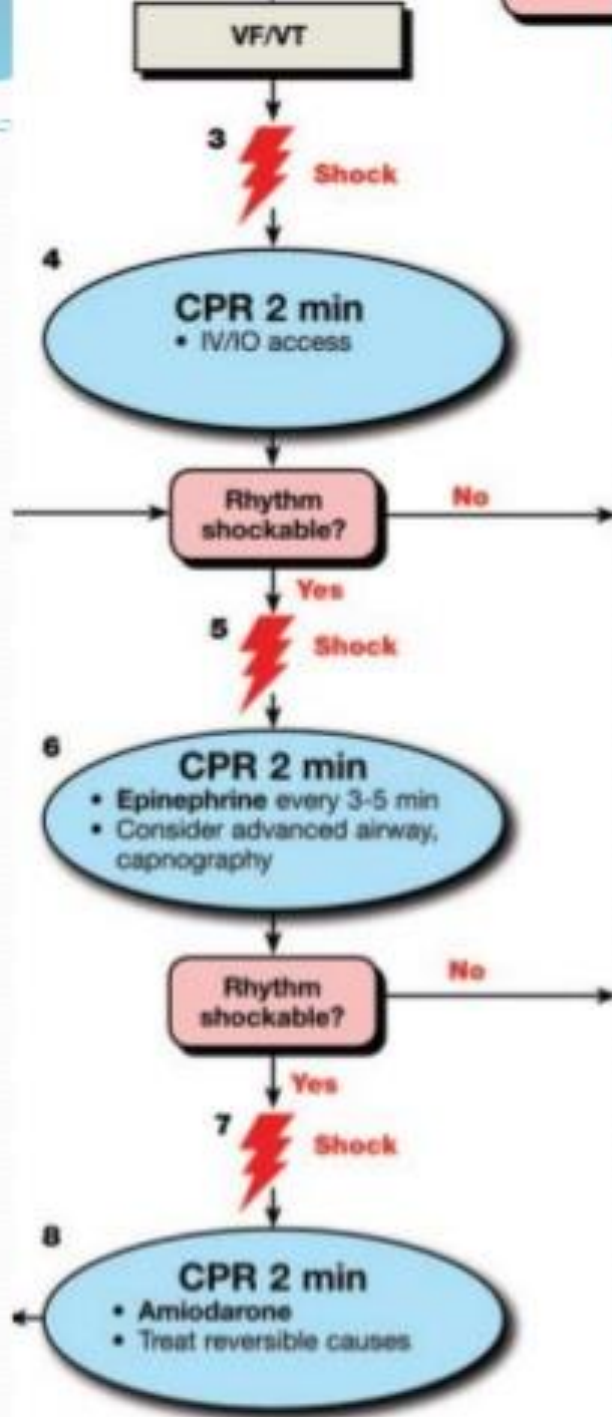
## **VENTRICULAR TACHYCARDIA**



# ***UNSHOCKABLE RHYTHMS***

- Pulseless electrical activity (PEA)
- Asystole





### Shock Energy

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

### Drug Therapy

- **Epinephrine IV/IO Dose:** 1 mg every 3-5 minutes
- **Vasopressin IV/IO Dose:** 40 units can replace first or second dose of epinephrine
- **Amiodarone IV/IO Dose:** First dose: 300 mg bolus. Second dose: 150 mg.



## PEA/Asystole

# Drug Therapy for PEA/Asystole

- ❑ Vasopressor can be given as soon as feasible
- ❑ Available evidence suggests that the routine use of atropine during PEA or asystole is unlikely to have a therapeutic benefit .
- ❑ For this reason atropine has been removed from the cardiac arrest algorithm.

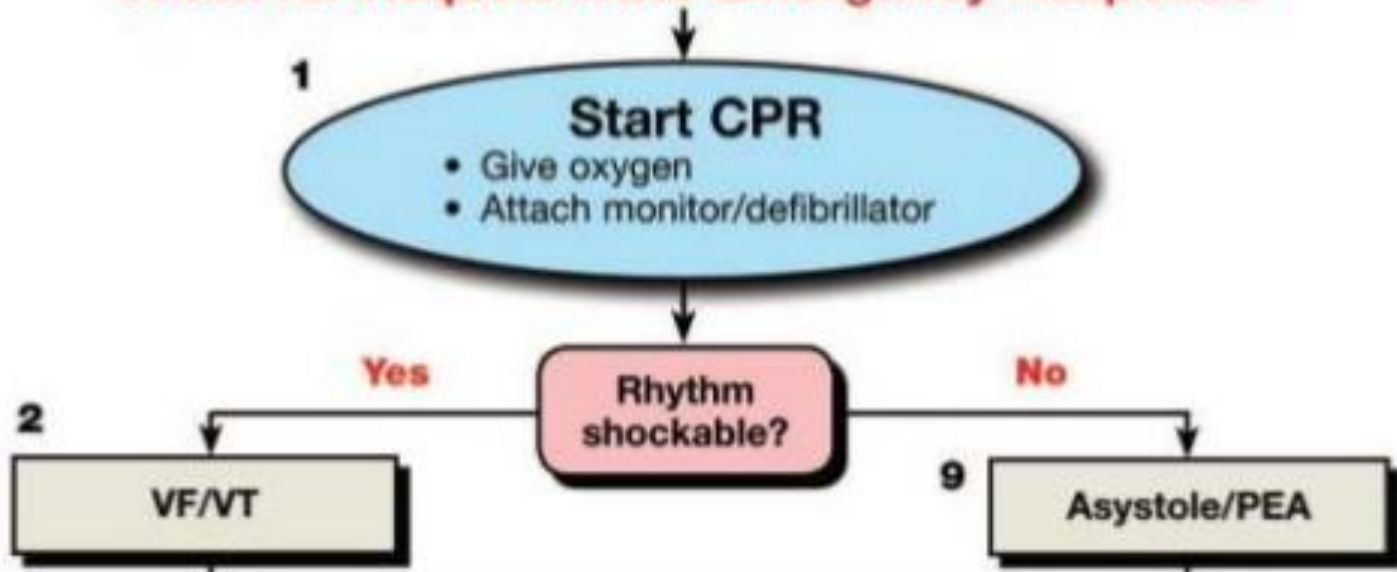
# Treating Potentially Reversible Causes of PEA/Asystole

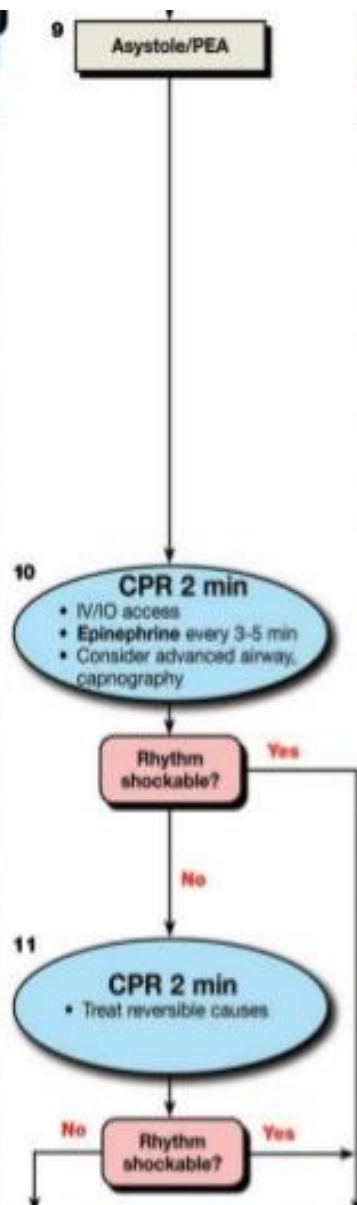
## └ PEA

- └ reversible conditions
- └ treated successfully if those conditions are identified and corrected
- └ Hypoxemia: advanced airway
- └ severe volume loss or sepsis: administration of empirical IV/IO crystalloid.
- └ severe blood loss: blood transfusion
- └ pulmonary embolism: empirical fibrinolytic therapy (Class IIa, LOE B)
- └ tension pneumothorax: needle decompression

## Adult Cardiac Arrest

**Shout for Help/Activate Emergency Response**





#### Drug Therapy

- **Epinephrine IV/IO Dose:**  
1 mg every 3-5 minutes
- **Vasopressin IV/IO Dose:**  
40 units can replace  
first or second dose of  
epinephrine

# MONITORING DURING CPR

## Mechanical parameteres

- Rate of compression:  $\geq 100/\text{min}$
- Depth of compression:  $\geq 2$  inches (5 cm)
- Rate of ventilation: 1 breath every 6-8 s (8-10 breath/min)

# Physiologic Parameters

- Pulse
- End-Tidal CO<sub>2</sub>
- Coronary Perfusion Pressure and Arterial Relaxation Pressure
- Central Venous Oxygen Saturation
- Pulse Oximetry
- Arterial Blood Gases
- Echocardiography



# **Medications for Arrest Rhythms**

# Epinephrine

- It is reasonable to consider administering a 1 mg dose of IV/IO epinephrine every 3-5 minutes during adult cardiac arrest .
- If IV/IO access is delayed or cannot be established, epinephrine may be given endotracheally at a dose of 2-2.5 mg.

# Vasopressin

- ❑ Nonadrenergic peripheral vasoconstrictor
- ❑ 1 dose of vasopressin 40 units IV/IO may replace either the first or second dose of epinephrine in the treatment of cardiac arrest .

# Amiodarone

- An initial dose of 300 mg IV/IO can be followed by 1 dose of 150 mg IV/IO.
- For recurrent or refractory VF/VT.

# Lidocaine

- ❑ Considered if amiodarone is not available
- ❑ The initial dose is 1-1.5 mg/kg IV.
- ❑ If VF/pulseless VT persists, additional doses of 0.5-0.75 mg/kg IV push may be administered at 5- to 10-minute intervals to a maximum dose of 3 mg/kg.

# Magnesium Sulfate

- ❑ Torsades de pointes
- ❑ IV/IO bolus of magnesium sulfate at a dose of 1-2 g diluted in 10 mL D5W.



# POST CARDIAC ARREST CARE

- 
- Initial management is focused on establishing and maintaining hemodynamic stability and supportive care.
  - Amiodarone or lidocaine is often used to prevent recurrent ventricular tachyarrhythmia
  - Therapeutic hypothermia-confers a modest improvement in neurological outcome
  - Immediate coronary angiography with revascularization if indicated may improve survival in pt with ischemic etiology

- 
- ❑ Survivors of SCA should have a detailed CVS evaluation including:-
  - ❑ ECG/ECG Monitoring/24 hr ambulatory ECG
  - ❑ Lab:- cardiac markers, electrolytes, drug levels for toxicity, tox screen,
  - ❑ Echocardiography
  - ❑ Electrophysiological testing
  - ❑ Cardiac MRI
  - ❑ Genetic testing for channelopathies

**Table 1. Treatable Causes of Cardiac Arrest: The H's and T's**

| H's                     | T's                   |
|-------------------------|-----------------------|
| Hypoxia                 | Toxins                |
| Hypovolemia             | Tamponade (cardiac)   |
| Hydrogen ion (acidosis) | Tension pneumothorax  |
| Hypo-/hyperkalemia      | Thrombosis, pulmonary |
| Hypothermia             | Thrombosis, coronary  |

For further explanation of the H's and T's, see Part 12: "Special Resuscitation Situations."

# ***SUMMARY***

## ***ADULT CARDIAC ARREST ALGORITHM***

### ***CPR Quality***

- **Push hard ( $\geq 2$  inches) and fast ( $\geq 100$  bpm) and allow chest recoil**
- **Minimize interruptions**
- Do not over ventilate
- If no advanced airway, **30:2 compression to ventilation ratio**
- Quantitative waveform capnography

### ***Shock Energy***

- **Biphasic**: Biphasic more effective than older monophasic waveforms. Follow **manufacturer recommendation** (e.g., **initial dose of 120 to 200 J**); if unknown, use maximum available. Second and subsequent doses should be equivalent, and higher doses should be considered.
- **Monophasic**: **360 J**

# ***ACLS ALGORITHM Cont...***

## ***Return of Spontaneous Circulation***

- Return of pulse and blood pressure
- Sudden sustained increase in PETCO<sub>2</sub> (typically  $\geq 40$  mm Hg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

## ***Advanced Airway***

- Supraglottic advanced airway or ET intubation
- Waveform capnography to confirm and monitor ET tube placement
- 8 to 10 breaths per minute with continuous chest compressions

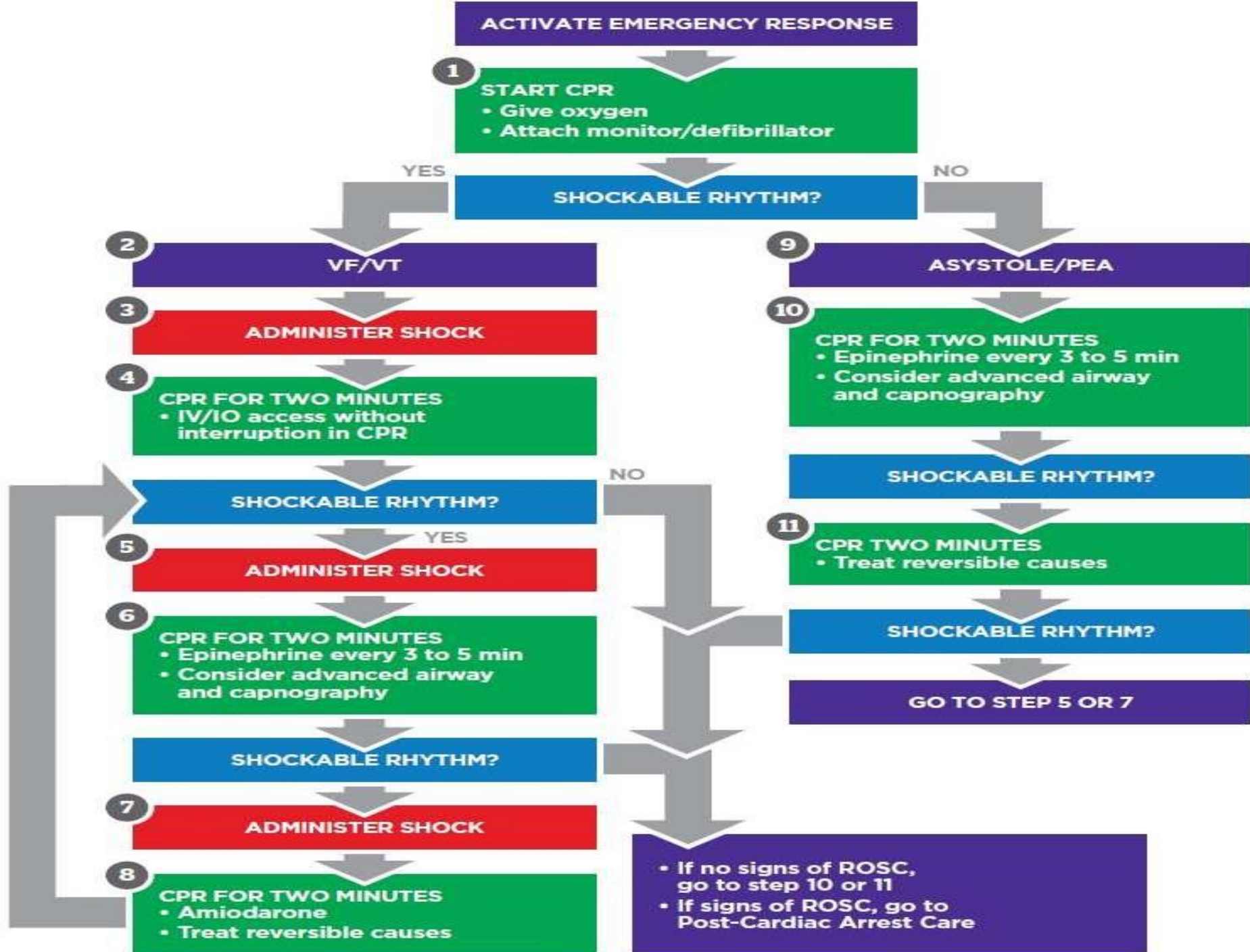
# ***ACLS ALGORITHM Cont...***

## ***Drug Therapy***

- **Epinephrine** IV/IO Dose: 1 mg every 3 to 5 minutes
- **Amiodarone** IV/IO Dose: first dose is 300 mg bolus, second dose is 150 mg

## ***Reversible Causes***

- Hypovolemia
- Hypoxia
- H<sup>+</sup>(acidosis)
- Hypothermia
- Hypo-/hyperkalemia
- Tamponade, cardiac
- Toxins
- Tension pneumothorax
- Thrombosis, pulmonary or coronary



***Thank You***