Anatomy and Physiology of a Healthy Heart

The heart is a hollow muscle comprised of four chambers delineated by thick walls of tissue (septum). The atria are the two upper chambers whereas the ventricles are the two lower chambers. The left and right halves of the heart work together in teams to pump blood throughout the body. The right atrium (RA) and right ventricle (RV) pump deoxygenated blood to the lungs to be oxygenated after which the left atrium (LA) and left ventricle (LV) receive then pump the newly oxygenated blood throughout the rest of the body. Reverse blood flow is prevented by a valve between each pair of connected chambers. (Note: whenever referring to the left and right sides of the heart, you take the perspective of the patient). The two atria contract simultaneously, as do the ventricles, making the contractions of the heart go from top to bottom. Convention is that each beat begins in the RA.

The LV is the largest and thickest-walled of the four chambers; it is also responsible for pumping the newly oxygenated blood to the rest of the body.

Each of the cells of a healthy heart are able to generate an electrical pulse but it is the sinoatrial node (SA node) in the RA that creates the strong and organized rhythm for the rest of the cardiac cells to follow. This pulse then carries to the atrioventricular node (AV node), which is between the atria and ventricles. After remaining there briefly, it moves on to the Purkinje system, which is the group of cells that branches into the LV and RV stimulating them to contract and pump blood.
The pattern of pulses is called a **sinus rhythm**. It is the healthy, normal rhythm of the heart. Graphically (above), it is a wave showing the timing, polarity, and intensity of the electrical pulses. The resulting graph is known as an **electrocardiogram (ECG or EKG)**. The stronger or weaker the charge, the further it will be from the isoelectric line. Positive charges are waves above the x-axis, whereas negative charges are those below it.

EKGs are read left to right, with the most recent activity towards the right end of the graph. The first segment of the graph is the **P wave** which illustrates the contraction of the atria. Next is the **QRS complex**, showing the contraction of the ventricles. This is comprised of a drop, rise, and another drop on the graph. Last is the **T wave** which signifies the repolarization of the ventricles as they overcompensate and balance out awaiting the next pulse.

The two audible beats of the heart (the atrial and ventricular beats) are individually represented on the graph as the P and R waves. Together, they are referred to as the **PR interval**. An abnormality in this could be crucial to diagnosing and assessing a cardiac problem as well as treatment.

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**BLS Primary Survey and ACLS Secondary Survey**

**Learning Objectives**

1. Understand each of the steps of the BLS Primary Survey and the ACLS Secondary Survey
2. Understand specific assessment and management procedures during each step of the systematic approach
3. Understand and be able to apply the systematic approach to cardiopulmonary emergencies

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4. Note and understand the New 2010 Guidelines for the BLS Survey

Introduction

Resuscitation of a patient in cardiac or respiratory arrest revolves around the restoration of effective oxygenation, circulation, and ventilation. The initial goal should be the return of spontaneous circulation (ROSC) and the final circulation with intact neurological function. The systematic approach to the assessment of patients in cardiac or respiratory arrest uses two algorithms, the BLS Survey (using steps 1, 2, 3, and 4) and the ACLS Survey (steps A, B, C, and D).

The BLS and ACLS Surveys

If the patient APPEARS TO BE UNCONSCIOUS

- Start with BLS Survey to gain initial assessment of patient condition
- Use ACLS survey for more advanced patient management

If the patient APPEARS TO BE CONSCIOUS go straight to ACLS survey for initial assessment.

BLS Primary Survey

- systematic approach to basic life support
- aims to support effective ventilation, oxygenation, and circulation until ROSC or until ACLS interventions may be initiated
- emphasizes early CPR and early defibrillation
- increases patient’s chance of survival and retention of intact neurological function
- does not include advanced interventions, administration of drugs, or advanced airway techniques
- before initiating BLS Primary Survey, ensure safe environment around patient
- Assess first, then take appropriate action

<table>
<thead>
<tr>
<th>Assessment</th>
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<tbody>
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<td></td>
<td>Check breathing (absent/ abnormal/ gasping)</td>
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<td></td>
<td>Scan chest for movement for 5-10 seconds</td>
</tr>
<tr>
<td>2 Activate Emergency Response System</td>
<td>Activate the emergency response system and get an AED OR send a bystander to do so</td>
</tr>
<tr>
<td>Get AED</td>
<td>Check carotid pulse for &gt;5 seconds</td>
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<tr>
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<td>IF NO PULSE detected within 10 seconds:</td>
</tr>
<tr>
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<td>- Perform CPR (30:2) beginning with CHEST COMPRESSIONS</td>
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- Compressions at the center of the chest (>100 compressions per minute; >2 inches)
- Allow for complete chest recoil between each compression
- Minimize interruptions in chest compressions (<10 seconds)
- Switch CPR providers every 2 minutes to minimize fatigue
- Avoid over ventilation

IF PULSE detected – start rescue breathing, once every 5-6 seconds or 10-12 breaths per minute
Check pulse every 2 minutes

<table>
<thead>
<tr>
<th>4 Defibrillation</th>
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<td>Resume CPR immediately after each shock</td>
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**ACLS Survey**

-start here if patient appears to be CONSCIOUS

REMEMBER: assess first and then take appropriate action

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<td>If using advanced airway: -time insertion of airway; minimize interruptions of compressions and ventilation</td>
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<tr>
<td>Breathing</td>
<td>Circulation</td>
</tr>
<tr>
<td>----------------------------------</td>
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</table>
| -is there adequate oxygenation and ventilation? | -Rhythm?  
-IV placement?  
-IV fluids?  
-Medications? | -cause of the symptoms/ arrest?  
-reversible cause you can treat? |
| -monitor quantitative waveform capnography and oxyhemoglobin saturation | -achieve IV or IO access  
-attach ECG leads  
-monitor patient for cardiac arrhythmia  
-give IV fluids if needed | Diagnose and treat all reversible problems |

-ensure proper placement of airway thru physical examination  
-quantitative wave form capnography  
-generally: use class I for ET tube  
-reasonable for supraglottic airways  
-secure device  
-confirm placement with quantitative waveform capnography

Use supplemental oxygen if needed  
-Use pure O₂ for patients with cardiac arrest  
-Titrates O₂ administration to achieve O₂ saturation of >94% (monitor with pulse oximetry)

Monitor ventilation and oxygenation with clinical criteria (chest rise, cyanosis)
Case 1: Respiratory Arrest (with pulse)

Learning Objectives:

1. understand use of BLS and ACLS Survey in respiratory arrest
2. understand appropriate use of $O_2$ in management of patient with respiratory arrest
3. understand when to use the following airway devices:
   a. oropharyngeal airway (OPA)
   b. nasopharyngeal airway (NPA)
   c. bag-mask ventilation
   d. advanced airway

Introduction

- patient’s breathing is either absent or insufficient for oxygenation and ventilation, but pulse is present
- BLS and ACLS Survey are used when there is respiratory arrest even without cardiac abnormality
- management is focused on effective airway control

BLS and ACLS Surveys for Respiratory Arrest with a Pulse

When managing patients in respiratory arrest with a pulse, use both the BLS and ACLS Surveys, the following may also be used:

- administer $O_2$
- open the airway
- Administer basic ventilation
- Basic airway adjuncts
- Suctioning

BLS Survey for Respiratory Arrest

- since pulse is present, do not defibrillate or initiate chest compressions.
- assess with BLS Survey and follow with appropriate action

Assess and Reassess

Throughout the BLS Survey assess and reassess patient to account for change in patient condition.
Initiate chest compressions if pulse is lost

Ventilation and Pulse Check

Use bag-mask or advanced airway to administer 1 breath every 5-6 seconds (10-12 breaths per minute)

Recheck pulse every 2 minutes for 5-10 seconds

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If patient does not respond to measures done in Primary Survey, proceed with ACLS Survey. If bag-mask ventilation provides sufficient oxygenation and ventilation, it may not be necessary to use advanced airway during ACLS Survey. Use assessment stages of the ACLS Survey to determine this.
**ACLS Survey for Respiratory Arrest**

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<td><strong>Circulation</strong></td>
<td>Improve CPR IF:</td>
</tr>
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<td>-Chest compressions effective?</td>
<td>quantitative waveform capnography (if PETCO₂ is &lt;10mm HG, improve CPR)</td>
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<td>-intra-arterial pressure (if diastolic pressure &lt;20mm HG)</td>
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<td>Cardiac rhythm?</td>
<td>-attach monitor/defibrillator for arrhythmias/cardiac arrest rhythms (VF, pulseless VT, asystole, PEA)</td>
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<td>----------------------------------------------------------------------------------------------------</td>
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<tr>
<td>Defibrillation/ Cardioversion indicated?</td>
<td>-provide defibrillation/cardioversion</td>
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<tr>
<td>IV/IO access?</td>
<td>-obtain IV/IO access</td>
</tr>
<tr>
<td>ROSC?</td>
<td>-administer drugs as needed</td>
</tr>
<tr>
<td>Patient unstable with pulse?</td>
<td>-give IV fluids if needed</td>
</tr>
<tr>
<td>any medications needed for rhythm/blood pressure?</td>
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<td>fluid resuscitation indicated?</td>
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**Differential diagnosis**
- cause of the symptoms/arrest?
- reversible cause you can treat?

| Diagnosis | Diagnose and treat all reversible problems |

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**Managing Respiratory Arrest**

ACLS and BLS interventions in managing respiratory arrest may include:

- O₂ supplementation
- Opening of the airway
- Basic ventilation
- Use of OPA and NPA basic airway adjuncts
- Suctioning
- Ventilation with advanced airways

**Ventilation (if patient is in respiratory arrest but pulse is maintained)**

- Supply every 5-6 seconds (10-12 breaths per minute)
- Each should last >1 second and visibly raise patient’s chest
- Avoid excessive ventilation (both quantity and volume)

**NEW for 2010**

Continuous waveform capnography is recommended in addition to clinical assessment to verify placement and monitor ET tube

**Supplementary O₂**

- may be given to patients in respiratory distress or those with acute cardiac symptoms.
- Monitor O₂ saturation (>94%), use supplementary O₂

**Opening the Airway – Manual Maneuvers**
- Tongue may obstruct airway if patient is unconscious
- Snoring respirations in breathing patients may indicate an obstructed airway
- Airway obstruction by tongue may be resolved by repositioning head and jaw
- Maintenance of an open airway is the priority in CPR, BLS, and ACLS
- If patient is unconscious without gag reflex, insert OPA or NPA

Head tilt-chin life maneuver (Do not perform if neck trauma is suspected)

1. Place patient in supine position
2. With one hand on patient’s forehead, apply pressure with your palm to tilt patient’s head
3. Place fingertips under the bony part of patient’s chin. Lift and pull patient’s jaw forward without applying pressure to soft tissue which may cause obstruction of airway
4. Open patient’s mouth with thumb of hand used to lift chin by pulling downward on lower lip

Jaw-thrust technique

- Use when neck trauma is suspected
- Opens airway without head extension
- No longer taught to lay rescuers
1. Place patient in supine position. Use log-roll technique to avoid flexing of spinal column
2. Rest elbows on the same surface patient is lying on
3. Stabilize patient’s head in neutral position. Gently grasp the angle of the mandible with two or three fingers
4. Gently lift jaw upward with three middle fingers; use thumbs to open jaw

Basic Ventilation Skills

1. Bag Mask Ventilation
   - Device consists of ventilation bag attached to a facemask
   - Most common means of positive-pressure ventilation
2. Oropharyngeal Airway (OPA)
- Use on patients at risk for airway occlusion by the tongue
- Use on unconscious patients when other airway opening techniques fail
- J-shaped device that fits over the tongue
- Prevents tongue and soft palate from making contact with posterior wall of oropharynx
- Should NOT be used if patient is conscious or semiconscious to prevent gagging and or vomiting
  - Use of OPA that is too big may obstruct pharynx and/or cause trauma to laryngeal structures
  - An OPA that is too small or inserted improperly may obstruct airway by pushing the base of the tongue posteriorly

3. OPA Insertion
   a. Clear mouth and pharynx of secretions, blood, vomit, etc with rigid pharyngeal suction tip
   b. Select appropriate OPA size (tip of OPA should be at the corner of the patient’s mouth, phalange at the angle of the mandible)
   c. Insert OPA – should be backwards entering the patient’s mouth
d. Rotate OPA 180° as it passes through the oral cavity and approaches posterior wall of pharynx

*after insertion of OPA, ensure head and jaw positions maintain clear airway. Suction as needed.

The Nasopharyngeal Airway (NPA)

-used for conscious or semiconscious patients
-used when patient has sensitive gag reflex, trismus, massive trauma around the mouth, or wiring of the jaws
-alternative to OPA for basic airway management adjunct
-uses a soft rubber or plastic uncuffed tube
NPA Insertion

1. Select proper NPA size.
   - Outer circumference of NPA should be slightly smaller than the inner opening of the nares.
   - Avoid blanching of the nostrils
   - Patient’s smallest finger may be used as a guide for proper NPA size
2. Lubricate airway with anesthetic jelly or other water-soluble lubricant
3. Insert NPA through nostril in posterior direction perpendicular to the plane of the face and thread along the floor of the nasopharynx
4. Monitor and maintain placement frequently. Maintain head tilt and anterior displacement of mandible with chin-lift or jaw-thrust techniques.

* maintain airway patency after insertion via suctioning as NPA may become obstructed with blood, gastric contents, or soft tissue.

*NPA may potentially irritate mucosal lining of the upper airway by lacerating adenoidal tissue.

*NPA may cause laryngospasm and vomiting

Suctioning

- essential to maintaining patency of patient’s airway
- removes occlusions to upper airway
- may be portable or wall-mounted
  - Portable suction devices – easily transportable but less suction power (-80 - -120 mm HG)
Wall-mounted suction devices – suction power of > - 300 mm HG

Catheters

a. Soft and flexible (image below, on the left) – typically used for suctioning of the mouth or nose
b. Rigid (on the right) – used on oropharynx or for thick fluids and particulate materials

Oropharyngeal Suction

1. Insert catheter into oropharynx but no further than the distance between tip of patient’s nose and earlobe
2. Alternate suctioning and administration of pure O₂
   - suction by covering side opening of catheter and withdrawing catheter in rotating motion
   - suction for no more than 10 seconds at a time

Endotracheal Tube Suctioning

1. Sterilize whenever possible
2. Insert catheter into ET tube.
   - ensure non-occlusion of side openings of catheter
3. Alternate suctioning and administration of pure O₂
   - suction by covering side opening of catheter and withdrawing catheter in rotating motion
   - suction for no more than 10 seconds at a time
4. Monitor heart rate, pulse, O₂ saturation, and clinical appearance
- stop suctioning if bradycardia, O₂ saturation levels drop, or if clinical deterioration occurs

- administer high-flow O₂ until condition improves

*remove occlusions from airway by instilling 1 – 2 mL sterile saline solution into patient’s airway before suctioning; disperse via positive pressure ventilation

**Advanced Airway Devices**

1. **Combitude**
   - dual-lumen tube used as an alternate to endotracheal intubation
   - has two balloon cuffs
   - only employ if you are experienced and trained to avoid potentially fatal complications

2. **Laryngeal Mask Airway (LMA)**
   - alternative to ET tube and facemask
   - only employ if you are experienced and trained to avoid potentially fatal complications

3. **Endotracheal Tube (ET)**
   - tube placed directly into trachea
   - only employ if you are experienced and trained to avoid potentially fatal complications

   a. Assemble necessary equipment
   b. Apply cricoid pressure (preferably by someone else)
   c. Intubate
   d. Inflate tube cuffs
   e. Attach ventilation bag
   f. Ensure correct placement by physically checking, listening for breath sounds over both lung fields and use of CO₂ detector
g. Secure ET with tape
h. Monitor ET for displacement

NEW for 2010

- Cricoid pressure is no longer recommended for routine treatment of cardiac arrest
- Cricoid pressure may help prevent aspiration and regurgitation of gastric contents when combined with bag-mask ventilation
- Cricoid pressure may impede ventilation and appropriate positioning of advanced airway

Precautions for Trauma Patients

- Avoid unnecessary spine movement during ventilation especially when trauma is suspected or known
- An estimated 2% of patients with blunt trauma examined with spinal imaging techniques also have spinal injuries
- This goes up to 6% when combined with facial or head injuries
- Patients with head, facial, or multiple traumas should be assumed to have cervical spine injury as well
- When ventilating with suspected cervical spine trauma:
  - Use jaw thrust without head extension when opening airway
  - If jaw thrust elicits no response, employ head tilt-chin maneuver
  - Have second team member stabilize patient’s head during ventilation. Manual spinal motion restriction is preferred to an immobilization device
  - Consider use of immobilization device during transport

Case 2: Ventricular Fibrillation (VF) with CPR and AED

Learning Objectives:

1. Be able to recognize and treat VF or pulseless VT with just AED and CPR
2. Understand BLS Primary Survey Algorithm
3. Learn 1-person CPR and AED operation
Introduction

- Ventricular Fibrillation (VF) involves irregular, uncoordinated contraction of the ventricle cardiac muscles resulting in failure to pump blood to the pulmonary and systemic circuits
- VF quickly degrades to asystole and sudden cardiac death
- Patient in VF will have no detectable pulse at major pulse points
- Treatment of patient with either VF or VT when you only have an AED with a pocket facemask
- Treatment is feasible without other responders

VF

[ECG image]

ECG: Ventricular Tachycardia

[ECG image]

ECG: Normal Heartbeat

[ECG image]
Monomorphic VT

Polymorphic VT

Sustained VT
# Nonsustained VT

## Nonsustained Ventricular Tachycardia

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## BLS Primary Survey for VF or Pulseless VT

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Check breathing (absent/ abnormal/ gasping)  
Scan chest for movement for 5-10 seconds                                                                                     |
| 2 Activate Emergency Response System            | Activate the emergency response system and get an AED OR send a bystander to do so                                                                                                                     |
| 3 Circulation                                   | Check carotid pulse for >5 seconds  
IF NO PULSE detected within 10 seconds:  
- Perform CPR (30:2) beginning with CHEST COMPRESSIONS  
- Compressions at the center of the chest (>100 compressions per minute; >2 inches)  
- Allow for complete chest recoil between each compression  
- Minimize interruptions in chest compressions (<10 seconds)  
- Switch CPR providers every 2 minutes to minimize fatigue  
- Avoid over ventilation  
IF PULSE detected – start rescue breathing, once every 5-6 seconds or 10-12 breaths per minute  
Check pulse every 2 minutes                                                                                                          |
| 4 Defibrillation                                | IF NO PULSE check for shockable rhythm with manual defibrillator or AED  
Connect AED to patient; if shockable rhythm is present, administer shocks  
Resume CPR immediately after each shock  
BEGINNING WITH CHEST COMPRESSIONS                                                 |
Adult BLS Healthcare Providers

1. Unresponsive
   No breathing or no normal breathing
   (ie, only gasping)

2. Activate emergency response system
   Get AED/defibrillator
   or send second rescuer (if available) to do this

3. Check pulse:
   DEFINITE pulse within 10 seconds?

3A. Definite Pulse
   - Give 1 breath every 5 to 6 seconds
   - Recheck pulse every 2 minutes

4. No Pulse
   Begin cycles of 30 COMPRESSIONS and 2 BREATHS

5. AED/defibrillator ARRIVES

6. Check rhythm
   Shockable rhythm?

7. Shockable
   - Give 1 shock
   - Resume CPR immediately for 2 minutes

8. Not Shockable
   - Resume CPR immediately for 2 minutes
   - Check rhythm every 2 minutes; continue until ALS providers take over or victim starts to move

Note: The boxes bordered with dashed lines are performed by healthcare providers and not by lay rescuers

High-Quality CPR
- Rate at least 100/min
- Compression depth at least 2 inches (5 cm)
- Allow complete chest recoil after each compression
- Minimize interruptions in chest compressions
- Avoid excessive ventilation

© 2010 American Heart Association
Simplified Adult BLS

Unresponsive
No breathing or no normal breathing (only gasping)

Activate emergency response

Get defibrillator

Start CPR

Check rhythm/shock if indicated
Repeat every 2 minutes

Push Hard • Push Fast

© 2010 American Heart Association
Defibrillation

- Definitive treatment for VF and pulseless VT
- Does not restart the heart
- Stops arrhythmia, allowing heart to resume normal rhythm
- Process of shocking the heart with an electrical impulse which causes a brief stop in cardiac activity
- Normal sinus rhythm resumes if heart is still viable
- Follow defibrillation with CPR (even when it is successful)

Importance of Early Defibrillation during VF

- Early defibrillation is crucial for survival from sudden cardiac arrest
- VF and pulseless VT are the most common initial rhythms during this time
- Pulseless VT quickly degrades to VF and then asystole and cardiac death if not treated with defibrillation
- CPR alone, although allows for some blood flow to the brain and heart, does not help it resume normal rhythm and blood flow to systemic and pulmonary circuits
- Survival rate decreases 7-10%/min between collapse and defibrillation
- Survival rate decreases 3-4%/min when there is immediate CPR
- CPR between defibrillations may double or triple chances of survival

AED Operation

1. Turn on AED
2. Attach electrode pads to patient’s chest
   a. Choose correct pads (children pads if patient is <8 years; adult if 8 or older)
   b. Peel backing off of each pad
   c. Ensure patient’s chest is dry
   d. Attach electrodes to patient’s chest
      i. Anterolateral Placement (standard)
         1. One pad on upper right side of chest, directly below the collarbone and right of the breastbone
         2. The other lateral to patient’s left nipple with top margin a few inches below left armpit
         3. Attach AED cables to AED if they are not already preconnected
      ii. Anteroposterior
      iii. Anterior-left infrascapular
      iv. Anterior-right infrascapular
3. Analyze cardiac rhythm
   a. Always clear patient first
   b. Some AEDs automatically do analysis; some require the pressing of a button
   c. AED will determine if shock is required
4. Clear the patient if AED advises electric shock
   a. Ensure no one is touching patient
   b. Loudly announce a clear the patient message. (Clear!)
   c. Visually double-check
   d. Press shock button
   e. Wait for muscle contraction to end
5. Resume CPR STARTING WITH CHEST COMPRESSIONS (30:2)
   a. Do not perform rhythm or pulse check
   b. Repeat 3 and 4 after 2 minutes of CPR

AED Use for Special Situations

Hairy Chested Patient

- Excessive chest hair may impede connection between electrodes and skin resulting in improper/ lack of readings
1. If AED says “Check Electrode” error, firmly depress each electrode again
2. If AED still displays error message, remove each pad which will also pull out hair
3. Shave off any remaining hair that may continue to interfere with AED
4. Replace pads on electrodes

Water

- Presence of water may diffuse effectivity of AED shock
- If patient is immersed in water, remove patient from water
- If chest is wet, wipe it dry

Implanted Pacemaker
- check patient for implanted pacemaker or defibrillator
- patient will have a well-defined rectangular lump with a scar on either the chest or the abdomen
- use of AED when patient already has a pacemaker is not dangerous but putting the pads over the pacemaker may prevent administration of adequate shock
- place electrode >1 inch away from either side of the pacemaker

Transdermal Medication Patch

- transdermal patch may block shock
- remove patch first and wipe off area
- use AED as normal

Case 3: VF/ Pulseless VT

Introduction

- Treatment of VF/ pulseless VT where cardiac event is witnessed and either resistant to initial shock or recurrent
- Requires manual defibrillator instead of AED
- Requires teamwork
- Combines CPR, bag-mask ventilation, and defibrillation
- Team leader must
  - Conduct ACLS Secondary Survey
  - Perform rhythm analysis and recognition
  - Determine if rhythm is shockable or not
  - Administer shocks
  - Administer necessary drugs
  - Discuss IV/IO access and use of advanced airway
- Case to be used for the following rhythms:
  - VF
VT

- ECG artifact resembling VF
- New left bundle branch block

Drugs
- Vasopressor drugs
  - Epinephrine
  - Vasopressin
- Anti-arrhythmic drugs
  - Amiodarone
  - Lidocaine
  - Magnesium sulfate
- For treatment of hypotension
  - Epinephrine
  - Norepinephrine
  - Dopamine

ACLS Adult Cardiac Arrest Algorithm

- Used when adult patient is pulseless and fails to respond to BLS primary survey
- Treats pulseless patients in VF/VT, asystole, and PEA
- Algorithm has two pathways
NEW for 2010

2005 AHA Adult Cardiac Arrest Algorithm has been changed to Cardiac Arrest Algorithm which highlights the importance of high-quality CPR with minimal interruptions and beginning with chest compressions.
### Adult Cardiac Arrest

**Shout for Help/Activate Emergency Response**

1. **Start CPR**
   - Give oxygen
   - Attach monitor/defibrillator

2. **Rhythm shockable?**
   - Yes: **VF/VT**
   - No: **Asystole/PEA**

3. **Shock**

4. **CPR 2 min**
   - IV/I/O access

5. **Rhythm shockable?**
   - Yes: **Epinephrine every 3-5 min**
   - Consider advanced airway, capnography

6. **CPR 2 min**
   - IV/I/O access
   - Epinephrine every 3-5 min
   - Consider advanced airway, capnography

7. **CPR 2 min**
   - Amiodarone
   - Treat reversible causes

8. **Rhythm shockable?**
   - Yes: **Shock**
   - No: **CPR 2 min**

9. **Return of Spontaneous Circulation (ROSC)**
   - Pulse and blood pressure
   - Abrupt sustained increase in PetCO₂ (typically >40 mm Hg)
   - Spontaneous arterial pressure waves with intra-arterial monitoring

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

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

12. **Advanced Airway**
    - Supraglottic advanced airway or endotracheal intubation
    - waveform capnography to confirm and monitor ET tube placement
    - 8-10 breaths per minute with continuous chest compressions

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

**CPR Quality**
- Push hard (≥2 inches [5 cm]) and fast (≥100/min) and allow complete chest recoil
- Minimize interruptions in compressions
- Avoid excessive ventilation
- Rotate compressor every 2 minutes
- If no advanced airway, 30:2 compression-ventilation ratio
- Quantitative waveform capnography
  - If PetCO₂ <10 mm Hg, attempt to improve CPR quality
  - Intra-arterial pressure
    - If relaxation phase (diastolic) pressure <20 mm Hg, attempt to improve CPR quality

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VF/ Pulseless VT (Left Side of the ACLS Adult Cardiac Arrest Algorithm)

- VF and pulseless VT are to be treated in the same manner
- Conduct BLS Survey FIRST (activate emergency response system as well)
- Ensure safe environment around patient before starting
- Continue CPR
- Initial shock should be done via manual defibrillator
- REMEMBER: chest compressions should only be interrupted for ventilation without advanced airway, rhythm check, and shock transmission. This is vital for resuscitation. Delay checking pulse until organized rhythm is re-established
- Use manual defibrillator provided it is available and team leader is comfortable interpreting rhythm
- Continue CPR (high quality chest compressions) while defibrillator is charging; the shorter the interval between compressions and shock, the more effective the shock becomes and this also improves patient outcome

Box 3 – Deliver Initial shock

- Be sure patient is clear before administering shock
- Energy dosage depends on type of device
  a. Monophasic model: use 360 J
  b. Biphasic model
    a. Truncated exponential waveform – use initial charge between 150 and 200 J
    b. Rectilinear waveform – initial charge of 120 J
    c. If range of device is unknown, use initial charge of 200 J
- Though VF may be terminated by shock, it may return; re-administer shock at recent successful charge level
- Always follow shock with quality CPR (30:2)
- Conductive materials (electrode paste, gel pads, self-adhesive pads) decrease electrical resistance towards patient. Research findings do not show that one is more effective than another however self-adhesive pads may reduce arcing, allow for faster shock delivery, and facilitate continued rhythm monitoring

Box 4 – Resume CPR

- Remember to always start with compressions
- Delay rhythm or pulse check
- Have another team member get IV/ IO access without interrupting CPR

Boxes 5 and 12 – Check Rhythm

- Perform rhythm check after 2 minutes or 5 cycles of CPR (30:2)
- Check pulse if organized rhythm is detected
- Immediately resume CPR if no pulse is detected or if there is doubt on pulse
  - If rhythm is unshockable with no pulse, proceed to box 9 on the RIGHT SIDE of the ACLS Adult Cardiac Arrest Algorithm
  - If rhythm is shockable, resume CPR while charging defibrillator and proceed to box 3
  - Start post-cardiac arrest care if rhythm is organized with detectable pulse

**Box 6 – Deliver 1 shock and Vasopressors**

- Clear patient before administering shock
- Resume CPR immediately after shocking patient
- Administer vasopressor (epinephrine or vasopressin) during CPR, before or after the shock
- Dosages:
  - 1 mg IV/IO epinephrine every 3-5 minutes
  - 40 U IV/IO vasopressin
    - Use vasopressin ONLY ONCE: as substitution for the first or second dose of epinephrine
- Prepare drugs early to save time

**Box 7 – Check Rhythm**

- Perform rhythm check after 2 minutes or 5 cycles of CPR (30:2)
- If organized rhythm is found, check pulse during rhythm analysis
- If no pulse is found or there is doubt, resume CPR
- If rhythm is UNSHOCKABLE WITH NO PULSE, go to BOX 10 on the RIGHT SIDE of ACLS Cardiac Arrest Algorithm
- If rhythm is SHOCKABLE, resume CPR while charging defibrillator

**Box 8 – Deliver 1 Shock and Administer Anti-arrhythmics**

- Clear patient before administering shock
- Resume CPR immediately after shocking patient
- Administer anti-arrhythmic (amiodarone, lidocaine, or magnesium sulfate) during CPR, before or after the shock
- Dosages:
  - Amiodarone: 300 mg IV/IO once followed by 150 mg IV/IO if needed
  - Lidocaine: 1-1.5 mg/kg IV/IO once followed by 0.5-0.7 mg/kg IV/IO every 5-10 minutes
    *observe maximum dosage of 3 mg/kg
  - Magnesium sulfate: 1-2 g IV/IO diluted in 10 mL D5W administered over 5-20 minutes; used for torsades de pointes
- Prepare drugs early to save time
NEW for 2010

- Cardiac Arrest Treatment Sequence has been replaced with the 2010 Cardiac Arrest Circular Algorithm
- This emphasizes importance of high-quality CPR with minimal interruptions

**Treatment of VF/VT Patients with Hypothermia**

- hypothermic patient (temperature <30° C/ 86° F) may not respond to defibrillation
- if this occurs, continue normally with BLS algorithm while raising core body temperature above hypothermic levels
- delay administration of drugs to severely hypothermic patients to avoid buildup of toxic levels of medication caused by decreased metabolism. Focus intervention on raising core temperature
- increase time interval between doses of medicine for moderately hypothermic patients (30-34 °C)
- there is no evidence to support giving antiarrhythmic drugs to hypothermic patients; consider instead vasopressor (ACLS algorithm) while rewarming the patient


**Drug Administration during Cardiac Arrest**

...do not allow drug administration to disrupt CPR and defibrillation

1. **Intravenous (IV)**  
   a. **Central IV Line**  
      i. Uses large vein in chest or abdomen  
      ii. Usually superior vena cava, inferior vena cava, or right atrium of heart  
      iii. Allows for immediate drug delivery  
      iv. Insertion and access to central IV line may interrupt CPR  
   b. **Peripheral IV line**  
      i. Any vein not in chest or abdomen  
      ii. Preferred method (minimizes interruption to CPR)  
      iii. Drugs administered in this manner take approx. 1-2 minutes to get to central circulatory system  
      iv. **Steps**  
         1. Administer via bolus injection (unless otherwise instructed)  
         2. Follow with 20 mL bolus of IV fluid  
         3. Elevate extremity above heart level for 10-20 seconds to hasten drug delivery

2. **Intraosseous (IO)**  
   a. Injection of medication directly into bone marrow  
   b. Can be used on patients of all ages (most common with pediatrics)  
   c. Can be established in 30-60 seconds  
   d. If drug can be IV then it can be administered IO  
   e. IO preferred over ET

3. **Endotracheal (ET)**  
   a. Injection of medication into trachea  
   b. **ONLY USE** when IV/IO cannot be established  
   c. **CONSIDERATIONS**  
      i. Drugs are absorbed poorly  
      ii. Optional drug dosing is unknown  
      iii. Dosages must be 2-2.5 times IV/IO dosage  
      iv. Use for epinephrine, vasopressin, atropine, lidocaine, and naloxone  
      v. Must dilute drug with 5-10 mL H₂O/ saline

**Vasopressors**

- have been shown to increase probability of initial resuscitation with ROSC  
- have NOT been shown to increase survival rate leading to discharge  
- increase cardiac output and blood pressure  
- epinephrine
- 1 mg IV/IO every 3-5 minutes
- if peripheral IV is used, remember to flush and elevate
- high/ increasing dosages are not shown to improve ROSC and not recommended
  - vasopressin
    - 40 U in lieu of 1st or 2nd dose of epinephrine
    - increases arterial blood pressure
    - if continued use is indicated, resume epi 3-5 minutes after vasopressin
  - if ET administration is unavoidable: dilute 2-2.5 mg epi in 5-10 mL sterile H₂O/ saline and inject into ET tube.

**Antiarrhythmic Agents**

- have not been shown to increase survival to hospital discharge
  - amiodarone
    - has been shown to increase short-term survival
    - use if VF/pulseless VT is nonresponsive to shock, CPR, and vasopressor
    - first dose: 300 mg IV/IO push
    - consider second dose of 150 mg after 3-5 minutes if still unresponsive
  - lidocaine
    - consider if amiodarone is unavailable
    - has not been shown to produce short or long term effectiveness in cardiac arrest
    - first dose: 1-1.5 mg/kg IV/IO
    - repeat every 5-10 minutes (if needed) at 0.5-0.75 mg/kg IV/IO maintaining maximum dosage of 3 mg/kg
    - if ET administration is unavoidable: use 2-4 mg/kg
  - magnesium sulfate
    - may prevent/ terminate recurrent torsades de pointes in patients with prolonged QT interval with normal sinus rhythm, IF delivered IV
    - dose: dilute 1-2 g in 10 mL D5W IV/IO every 5-10 minutes
    - helps counter low serum magnesium levels (in alcoholism, malnutrition, etc)

**Immediate Post-Cardiac Arrest Care**

- high quality Post-cardiac arrest care after ROSC increases patient survival and quality of life
  - GOALS
    - Optimizes homodynamic and ventilation status
    - Initiates therapeutic hypothermia
    - Immediate coronary reperfusion with PCI
    - Institutes glycemic control
    - Anticipates/ provides for neurological care and other interventions
  - Begin after achieving ROSC
- Continue ventilation and oxygenation

**Box 1 – ROSC**
- Patient has been successfully resuscitated with BLS/ACLS Surveys
- Rhythm check (Box 12 of Adult Cardiac Arrest Algorithm) shows organized rhythm with pulse

**Box 2 – Optimize Ventilation and Oxygenation**
- Is patient is unresponsive/unconscious, advanced airway device may be required
- For ET Tube
  - Employ continuous waveform capnography to confirm and monitor placement of ET tube
  - Maintain oxyhemoglobin concentration of >94% with lowest inspired O₂ concentration
  - If you cannot determine O₂ concentration, give patient pure O₂ until able to do so

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**Adult Immediate Post-Cardiac Arrest Care**

1. **Return of Spontaneous Circulation (ROSC)**
2. **Optimize ventilation and oxygenation**
   - Maintain oxygen saturation ≥94%
   - Consider advanced airway and waveform capnography
   - Do not hyperventilate
3. **Treat hypotension (SBP <90 mm Hg)**
   - IV/IO bolus
   - Vasopressor infusion
   - Consider treatable causes
   - 12-Lead ECG
4. **Follow commands?**
5. **Consider induced hypothermia**
6. **STEMI or high suspicion of AMI**
7. **Coronary reperfusion**
8. **Advanced critical care**

**Doses/Details**

**Ventilation/Oxygenation**
Avoid excessive ventilation. Start at 10–12 breaths/min and titrate to target PETCO₂ of 35–40 mm Hg. When feasible, titrate FiO₂ to minimum necessary to achieve SpO₂ ≥94%.

**IV Bolus**
1–2 L normal saline or lactated Ringer’s.
If inducing hypothermia, may use 4°C fluid.

**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**
- Hypovolemia
- Hypoxia
- Hydrogen ion (acidosis)
- Hypo-/hyperkalemia
- Hypothermia
- Tension pneumothorax
- Tamponade, cardiac
- Toxins
- Thrombosis, pulmonary
- Thrombosis, coronary
o Avoid hyperventilation
  ▪ 10-12 breaths / minute
  ▪ Maintain PETCO\textsubscript{2} of 35-40 mm Hg OR PaCO\textsubscript{2} of 40-45 mm Hg
  ▪ Do not tie/ secure advanced airway around patient’s neck; this may inhibit blood return from brain

- Waveform capnography
  o Allows for monitoring of CPR quality
  o Maximizes chest compressions
  o Allows for detection of ROSC

NEW for 2010

Waveform capnography and clinical assessment are recommended to confirm and monitor proper placement of ET tube

Box 3 – Hypotension Treatment (SBP < 90 mm Hg)

- Obtain IV access
- Continue use of ECG to monitor patient after ROSC
- Drug dosages (refer to diagram)

Box 5 – Therapeutic hypothermia

- Can protect brain and other organs if patient is unresponsive
- If ROSC is achieved after VF cardiac arrest out-of-hospital, start cooling process and then transport
- Lowering of core body temperature to 32-34 °C for 12-24 hours via:
  o Rapid infusion of anice-cold, isotonic, non-glucose containing fluid (30mL/kg)
  o Surface cooling device
  o Ice bags
- Also consider this if:
  o In-hospital cardiac arrest with initial rhythm present
  o Out-of-hospital cardiac arrest with PEA/ asystole initial rhythm
- CONSIDERATIONS:
  o Avoid rewarming patient for 12-24 hours after ROSC
  o This is the only intervention proven to improve recovery of neurological function
  o Recommended duration: 12-24 hours
  o Monitor core body temperature via esophageal thermometer, bladder catheter, or pulmonary artery catheter
  o Maintenance with PCI is safe
Box 6 – STEMI / high suspicion of AMI

- Obtain 12-lead ECG ASAP after ROSC
- Use this to identify STEMI or high suspicion of AMI
- Transport patient to hospital that can provide coronary reperfusion (Box 7) if either is detected

Box 7 – Coronary reperfusion

- Aggressive treatment for STEMI or AMI
- Done in-hospital via PCI
- Notify hospital of this need beforehand

Case 4: Pulseless Electrical Activity (PEA)

Learning objectives

1. Be able to recognize and treat PEA with the ACLS Pulseless Arrest Algorithm
2. Understand and be able to perform ACLS Pulseless Arrest Algorithm
3. Integration of new 2010 guidelines

Notes

- PEA is a set of heart rhythms that produce organized cardiac rhythms while the patient is unresponsive without a discernible pulse
- There is electrical activity in the heart, but no mechanical activity
- Includes the following rhythms
  - Idioventricular rhythms
  - Ventricular escape rhythms
  - Post-defibrillation idioventricular rhythms
  - Bradyasystolic rhythms
  - Any pulseless rhythm except VF, VT, and asystole
- Formerly referred to as EMD (electromechanical dissociation)
- Treat with ACLS Pulseless Arrest Algorithm
- REMEMBER: the probability of resuscitation is dependent on uninterrupted high quality CPR
- Teamwork is still critical for treatment
- Commonly caused by a primary condition (H’s and T’s)
  - Hypovolemia – decreased blood volume
  - Hypoxia – decreased partial pressure of \( O_2 \) in blood
  - Hydrogenion (acidosis) – increase in the concentration of hydrogen ions in blood
  - Hyper/hypokalemia – abnormally high/low potassium concentration in blood
  - Hypoglycemia – abnormally low blood glucose concentration in blood
- Hypothermia – core body temperature < 30° C (86° F)
- Toxins – poisonous substances
- Tamponade (cardiac) – compression of the heart caused by excess fluids in chest cavity
- Tension pneumothorax – lung displacement, compression of the heart, and possible lung collapse due to air in pleural cavity around the lungs
- Thrombosis (coronary/ pulmonary) – blockage (partial or full) of a blood vessel caused by a blood clot
- Trauma
- Hypovolemia and hypoxia are the most common and easiest to treat

**NEW for 2010**

DO NOT administer atropine during cardiac arrest
Treatment of PEA with ACLS Adult Cardiac Arrest Algorithm

- Performed BLS survey
- Activated emergency response system as well
- Ensured safe environment around patient before starting
- Step 1 of ACLS Adult Cardiac Arrest Algorithm has been done
- Monitor/defibrillator displayed PEA rhythm
- Continued high-quality CPR (30:2) ensuring chest compressions are not interrupted for >10 seconds (box 10 of ACLS Adult Cardiac Arrest Algorithm)
- If shockable rhythm is found, resume CPR while charging defibrillator and go to Box 3

Box 10 – Administration of Vasopressors

- Administer vasopressors while still providing high quality CPR
- Prioritize IV/IO access over advanced airway UNLESS:
  - Ventilation via bag mask device is ineffective OR
  - Patient is hypoxic
- 1 mg IV/IO epinephrine every 3-5 minutes
- 40 U IV/IO vasopressin
  - Use vasopressin ONLY ONCE: as substitution for the first or second dose of epinephrine
- Consider advanced airway and capnography if necessary

Rhythm check

- After giving drugs, administer CPR for 2 minutes / 5 cycles (30:2)
- Perform rhythm check
  - If organized rhythm is found, follow with pulse check
  - If NOT, resume CPR
  - If in doubt, resume CPR
- If rhythm is NONSCHOCKABLE: continue on RIGHT side of ACLS Cardiac Arrest Algorithm
- If rhythm is SCHOCKABLE: go over to LEFT side of ACLS Cardiac Arrest Algorithm

Box 11 / 12 – Nonshockable rhythm

- If no electrical activity (asystolic), return to Box 10 or 11 and continue on asystolic pathway
- If electrical activity found, check pulse
  - If no pulse is found, continue CPR (30:2) for 2 minutes and return to box 10
  - If pulse is found with organized rhythm, move on to post-cardiac arrest care

Box 11 – Shockable rhythm
- Resume CPR while charging defibrillator
- Return to step 5 or 7 (shock)

NEW for 2010

- Cardiac Arrest Treatment Sequence has been replaced with the 2010 Cardiac Arrest Circular Algorithm
- This emphasizes importance of high-quality CPR with minimal interruptions

**Case 5: Asystole**

**Learning objectives**

1. Be able to recognize and treat asystole with ACLS Adult Cardiac Arrest Algorithm
2. Familiarization with 2010 Cardiac Arrest Circular Algorithm and it’s use
3. Know when to cease resuscitation
4. Integration of new 2010 guidelines

Notes
- No electrical activity on ECG + no pulse = asystole
- Ensure ECG flat line is due to asystole and not user error before starting treatment via checking
  - Leads are properly connected
  - Power / unit is on
  - Signal gain/ amplitude/ strength is not turned down
  - That flat line is not another pattern
- Uses the right side of ACLS Cardiac Arrest Algorithm because it is a nonshockable rhythm
- Use ACLS Pulseless Arrest Algorithm (right side/ nonshockable)
- Consider stopping resuscitation efforts if:
  - There are clear signs of irreversible death (rigor mortis, etc)
  - DNAR Status (do not attempt resuscitation status) as indicated by bracelet, anklet, or written document
  - Living will/ family refuse
  - Situation is dangerous for rescuers

NEW for 2010

DO NOT administer atropine during cardiac arrest

Managing Asystole with ACLS Adult Cardiac Arrest Algorithm
- Step 1 of ACLS Adult Cardiac Arrest Algorithm has been performed
- Monitor displays asystole
- Continue uninterrupted CPR (30:2)
- Obtain IV/IO access (highest priority)
- Team leader coordinates ACLS Adult Cardiac Arrest Algorithm starting at Step 10

Looking for underlying causes of asystole
- If (possible) underlying cause is resolved, chances for successful resuscitation increase
- Check H’s and T’s
  - Hypovolemia – decreased blood volume
  - Hypoxia – decreased partial pressure of O₂ in blood
  - Hydrogenion (acidosis) – increase in the concentration of hydrogen ions in blood
  - Hyper/hypokalemia – abnormally high/ low potassium concentration in blood
  - Hypoglycemia – abnormally low blood glucose concentration in blood
  - Hypothermia – core body temperature < 30° C (86° F)
  - Toxins – poisonous substances
o Tamponade (cardiac) – compression of the heart caused by excess fluids in chest cavity
o Tension pneumothorax – lung displacement, compression of the heart, and possible lung collapse due to air in pleural cavity around the lungs
o Thrombosis (coronary/ pulmonary) – blockage (partial or full) of a blood vessel caused by a blood clot
o Trauma

Box 1 – Administration of Vasopressors
- Administer vasopressors while still providing high quality CPR
- 1 mg IV/IO epinephrine every 3-5 minutes
- 40 U IV/IO vasopressin
  o Use vasopressin ONLY ONCE: as substitution for the first or second dose of epinephrine

Rhythm check
- Administer CPR for 2 minutes / 5 cycles (30:2)
- Perform rhythm check
  o If organized rhythm is found, follow with pulse check
  o If NOT, resume CPR
  o If in doubt, resume CPR
- If rhythm is NONSHOCKABLE: continue on RIGHT side of ACLS Cardiac Arrest Algorithm
- If rhythm is SHOCKABLE: go over to LEFT side of ACLS Cardiac Arrest Algorithm

Box 11 / 12 – Nonshockable rhythm
- If no electrical activity (asystolic), return to Box 10 or 11 and continue on asystolic pathway
- If electrical activity found, check pulse
  o If no pulse is found, continue CPR (30:2) for 2 minutes and return to box 10
  o If pulse is found with organized rhythm, move on to post-cardiac arrest care

Box 11 – Shockable rhythm
- Resume CPR while charging defibrillator
- Return to step 5 or 7 (shock)

*do not stop chest compressions for >10 seconds
*transcutaneous pacing is not recommended for asystole
*shock treatment is not recommended for asystole
*if unsure if rhythm is asystole or fine VF, attempt initial defibrillation
*if fine VF is suspected, 5 cycles of CPR may help before defibrillation

NEW for 2010

- Cardiac Arrest Treatment Sequence has been replaced with the 2010 Cardiac Arrest Circular Algorithm
- This emphasizes importance of high-quality CPR with minimal interruptions

When to Terminate Resuscitation Attempts

- Attending physician’s responsibility in the hospital
- If no underlying cause can be determined (H’s and T’s)
- If patient does not respond to BLS or ACLS Survey
- Other factors to consider
  - How long did it take to start CPR?
  - How long did it take before patient was defibrillated?
  - Pre-existing disease or condition?
  - What condition was the patient in before arrest?
  - What was the preliminary arrest rhythm?
**Extended asystole**

- Agonal rhythm is common in irreversibly dead patients
- Asystole is common as
  - Final rhythm for patient who started arrest in VF/VT
  - Initial rhythm for patient in prolonged arrest
- Usually causes extensive, irreversible damage to patient due to lack of blood flow to organs
- Results in severe cardiac damage due to myocardial ischemia
- 15 minutes usually ends in patient becoming brain dead
- Successful recovery is more likely in-hospital

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**Case 6: Acute Coronary Syndrome**

**Learning Objectives**

1. Understand the use of AHA Acute Coronary Syndromes Algorithm in treating ischemia, UA, and STEMI
2. Familiarization with Fibrinolytic checklist and it’s use
3. Integration of new 2010 guidelines

**Notes**
- ACS comprises conditions resulting in acute myocardial ischemia
- Acute myocardial ischemia is chest pain caused by insufficient blood supply to the heart due to CAD / CHD
- Composed of 3 categories of disease, grouped by risk and ECG pattern
  - STEMI - ST segment elevation myocardial infarction
  - High-risk unstable angina (UA) or Non-ST segment elevation myocardial infarction (NSTEMI)
    - Intermediate/ Low-Risk Unstable Angina
- Often first sign of CAD
- By 60 years, 1 in 5 men and 1 in 17 women with have some form of CAD
- Estimated 13 M emergency department ACS cases per year
- Treatments used in the ACLS algorithm for ACS
  - Oxygen
  - Aspirin
  - Nitroglycerin
  - Morphine
  - Fibrinolytic (thrombolytic) therapy
  - Heparin
- Primary goal in treating ACS is quick identification and treatment
- STEMI – carries the highest risk; acute treatment includes early reperfusion therapy
- Early reperfusion therapy – re-opening an occluded coronary artery using one of the following:
  - thrombolytic (fibrinolytic) therapy
    - must be done within 12 hours of onset of symptoms
    - most successful during first 2 hours
    - risks outweigh benefit after 12 hours
  - bypass surgery
  - percutaneous coronary intervention (PCI)
    - coronary angiogram to find occluded vessel
    - balloon angioplasty
    - stent placement (optional)
- Conditions leading to ACS
  - Unstable angina (features)
    - Sever pain new in onset
    - Occurs with crescendo pattern (more severe, prolonged, or frequent than before)
    - Occurs at rest / with minimal exertion; lasting >20 minutes
  - Microemboli
    - composed of cholesterol, calcium, and platelets from nearby atherosclerotic plaques
- dislodgment may occlude coronary microvasculature causing small elevations in cardiac troponin
  - occlusive thrombus
    - myocardial ischemia results when myocardial demand exceeds supply, possibly caused by large enough thrombus
  - unstable plaque

**NEW for 2010**

AHA Acute Coronary Syndromes Algorithm allows for maximum benefit for myocardial salvage

New algorithm allows early management of UA and STEMI

**Box 1 – Identifying Signs and Symptoms of Ischemia**

- uncomfortable feeling of pressure, tightening, fullness, squeezing, or pain in the middle of the chest lasting several minutes
- discomfort originating in chest, spreading to shoulders, neck, arm/s, or jaw
- discomfort originating in chest, spreading to back or between shoulder blades
- discomfort in chest with lightheadedness, fainting, nausea, or sweating
- unusual episodes of shortness of breath, with/out chest pain
- after identifying ischemia, go to Box 2 and prepare patient for transport to an ED

**Box 2 – EMS Assessment and care and hospital preparation**

- possible medications (MONA)
  - Morphine - use when patient is unresponsive to nitroglycerin
  - Oxygen – proven to reduce ST segment elevation during anterior infarction
  - Nitroglycerin
    - 3 sublingual tablets 3-5 minutes apart
    - Only allow if patient is hemodynamically stable
    - Contraindicated if SBP <90 mm Hg or 30 mm Hg below patient’s baseline
    - Contraindicated for patients with
      - Inferior MI and RV infarction
      - Hypotension, bradycardia, tachycardia
      - Viagra or phosphodiesterase inhibitor
  - aspirin
    - 325 mg (ASA), chewed
    - Relative contraindications: aspirin/ salicylate allergy, history of GI bleed, kidney disease, hyperuricemia, and gout
ASA suppository may be given to patients with nausea, vomiting, peptic ulcer, or other upper GI disorder

- Patient Assessment (under 10 minutes)
  - Attach cardiorespiratory monitor
  - Obtain IV access
  - Review 12-lead ECG
  - Complete fibrinolytic checklist and check for contraindications
  - Get blood sample for initial cardiac marker, electrolyte, and coagulation levels (should not interfere with reperfusion therapy unless clinically necessary)
  - History and physical exam
  - Obtain/ review chest x-ray within 30 minutes of arrival at ED (should not interfere with reperfusion therapy)

ACS Categories

1. STEMI
   - ST Segment Elevation Myocardial Infarction
   - ST segment elevation >1 mm (0.1 mV) in 2 or more contiguous leads, 2 or more adjacent limb leads, or new and presumed new left bundle branch block

2. High-risk unstable angina (UA) or Non-ST Segment Elevation Myocardial Infarction (NSTEMI)
   - ST depression of 0.5 mm (0.005 mV) or greater dynamic T-wave inversion
   - Associated with chest pain and discomfort
   - Also includes non-persistent/ transient ST segment elevation (0.5 mm or 0.005 mV)

3. Intermediate/ Low-Risk Unstable Angina
   - Includes patients with normal ECGs
   - ST segment deviation <0.5 mm (0.05 mV) or T-wave inversion of <2 mm (0.02 mV)
Box 5-8: STEMI

Acute Coronary Syndromes

1. Symptoms suggestive of ischemia or infarction

EMS assessment and care and hospital preparation:
- Monitor, support ABCDs. 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
- If considering prehospital fibrinolysis, use fibrinolytic checklist

2. Concurrent ED assessment (<10 minutes)
- Check vital signs; evaluate oxygen saturation
- Establish IV access
- Perform brief, targeted history, physical exam
- Review/complete fibrinolytic checklist (Figure 2); check contraindications (Table 5)
- Obtain initial cardiac marker levels, initial electrolyte and coagulation studies
- Obtain portable chest x-ray (<30 minutes)

3. Immediate ED general treatment
- If O₂ sat <94%, 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

4. ECG interpretation

5. ST elevation or new or presumably new LBBB; strongly suspicious for injury
ST-elevation MI (STEMI)

6. Start adjunctive therapies as indicated (see text)
7. Do not delay reperfusion
8. Reparfusion goals: Therapy defined by patient and center criteria (Table 1)
   - Door-to-balloon inflation (PCI) goal of 90 minutes
   - Door-to-needle (fibrinolysis) goal of 30 minutes

9. ST depression or dynamic T-wave inversion; strongly suspicious for ischemia
High-risk unstable non-ST-elevation MI (UA/NSTEMI)

10. Troponin elevated or high-risk patient (Tables 3, 4 for risk stratification).
    Consider early invasive strategy if:
    - Refractory ischemic chest discomfort
    - Recurrent/persistent ST deviation
    - Ventricular tachycardia
    - Hemodynamic instability
    - Signs of heart failure

11. Start adjunctive treatments as indicated (see text)
    - Nitroglycerin
    - Heparin (UFH or LMWH)
    - Consider: PO ß-blockers
    - Consider: Cilostazol
    - Consider: Glycoprotein IIb/IIIa inhibitor

12. Admit to monitored bed
    Assess risk status (Tables 3, 4)
    Continue ASA, heparin, and other therapies as indicated
    - ACE inhibitor/ARB
    - HMG CoA reductase inhibitor (statin therapy)
    - Not at high risk: cardiology to risk stratify

13. Normal or nondiagnostic changes in ST segment or T wave
Low-intermediate-risk ACS

14. Consider admission to ED chest pain unit or to appropriate bed and follow:
    - Serial cardiac markers (including troponin)
    - Repeat ECG/continuous ST-segment monitoring
    - Consider noninvasive diagnostic test

15. Develops 1 or more:
    - Clinical high-risk features
    - Dynamic ECG changes consistent with ischemia
    - Troponin elevated

16. Abnormal diagnostic noninvasive imaging or physiologic testing?

17. If no evidence of ischemia or infarction by testing, can discharge with follow-up

Carrying highest risk

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Patients usually have complete occlusion of an epicardial coronary artery

**EARLY reperfusion therapy is crucial**

- **Fibrinolytic therapy**
  - When >1 mm ST segment elevation in 2 contiguous leads on ECG
  - Results in reperfusion 50% of the time
  - Check first for contra/indications
  - Use fibrinolytic checklist (see diagram below)
  - Treatment should commence within 30 minutes of arrival at hospital

- **PCI**
  - Used on patients who do not reperfuse after fibrinolytic therapy
  - Been found to lead to better patient outcomes

---

### CHEST PAIN CHECKLIST FOR STEMI FIBRINOLYTIC THERAPY

**Step One:**

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has patient experienced chest discomfort for greater than 15 minutes and less than 12 hours?</td>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
</table>

**Step Two:**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP greater than 180 mm Hg</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Diastolic BP greater than 110 mm Hg</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Right vs. left arm systolic BP difference greater than 15 mm Hg</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>History of structural central nervous system disease</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Significant closed head/facial trauma within the previous 3 months</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Recent (within 6 wks) major trauma, surgery (including laser eye surgery), GI/GU bleed</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Bleeding or clotting problem or on blood thinners</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>CPR greater than 10 minutes</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Pregnant female</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Serious systemic disease (eg, advanced/terminal cancer, severe liver or kidney disease)</td>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
</table>

**Step Three:**

If ANY of the following is CHECKED YES, consider transport/transfer to PCI facility

<table>
<thead>
<tr>
<th>Condition</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate greater than or equal to 100 bpm AND systolic BP less than 100 mm Hg</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Pulmonary edema (rales)</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Signs of shock (cool, clammy)</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Contraindications to fibrinolytic therapy</td>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
</table>
Adjunctive Treatment for STEMI

- Angiotensin converting enzyme (ACE) inhibitors
- Beta blockers
- Clopidogrel
- Heparin
- HMG coenzyme inhibitor therapy
- IV nitroglycerin
  - Indicated for:
    - STEMI complicated by hypertension
    - CTEMI complicated by pulmonary edema
    - Chest discomfort that is unresponsive to spray nitroglycerin, morphine, or SL

Case 7: Bradycardia

Learning Objectives

1. Be able to treat bradycardia with ACLS Adult Bradycardia (with pulse) Algorithm
2. Be able to recognize bradycardia in patients
3. Integration of new 2010 guidelines

Notes

- Bradycardia = unusually slow heart rate (<60 bpm), dangerous to patient’s health that may result in
  - Fainting
  - Shortness of breath
  - Cardiac arrest
  - Death
- Relative bradycardia – bradycardia with bpm > 60 due to factors increasing patient’s heart rate
- Management includes:
  - Differentiation of bradycardic symptoms from those that are unrelated
  - Recognition and identification of possible AV block
  - Administration of atropine
  - Initiation of transcutaneous pacing (TCP)
  - Maintenance of heart rate and blood pressure by administration of epinephrine and/or dopamine when needed

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Bradycardic ECG Rhythms

Sinus bradycardia

1\textsuperscript{st} degree AV block – PR interval >0.2 seconds

2\textsuperscript{nd} degree AV block – Type I (Wenckebach-Mobitz II) – PR interval progressively lengthens and drops a beat
2\textsuperscript{nd} degree AV block – Type II (Mobitz II) – PR interval remains constant and drops a beat

3\textsuperscript{rd} degree AV block – no connection between P waves and QRS complexes

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest pain/ discomfort</td>
<td>Congestive heart failure</td>
</tr>
<tr>
<td>Dizziness</td>
<td>Diaphoresis</td>
</tr>
<tr>
<td>Fatigue</td>
<td>Hypotension</td>
</tr>
<tr>
<td>Presyncope</td>
<td>Orthostatic hypotension</td>
</tr>
<tr>
<td>Reduced level of consciousness</td>
<td>Premature ventricular contractions (PVCs)</td>
</tr>
<tr>
<td>Shortness of breath</td>
<td>Pulmonary congestion/ edema</td>
</tr>
<tr>
<td>syncope</td>
<td>Ventricular tachycardia</td>
</tr>
<tr>
<td>Weakness</td>
<td></td>
</tr>
</tbody>
</table>
NEW for 2010

- Initial treatment has become atropine
- If patient is unresponsive to atropine, proceed to IV infusion of dopamine or epinephrine
- TCP may be effective for patient being prepped for emergent transvenous temporary pacing

Box 1: Verify symptomatic bradycardia

Box 2: Perform BLS and ACLS Surveys

- Administer and monitor O₂
- Check rhythm and blood pressure
- Establish IV access

Box 3: Check for poor perfusion

- Check for signs and symptoms of bradycardia (see table above)
- If patient presents adequate perfusion, proceed to Box 4
- If NOT, proceed to Box 5

Box 5: Treatment for Inadequate Perfusion

- Administer 0.5 mg IV atropine, repeat if needed (up to 3 mg)
- If patient does not respond to atropine try
  - Transcutaneous pacing (TCP) OR
  - Dopamine (2-10 mcg/kg/min IV) OR
  - Epinephrine (2-10 mcg/kg/min IV)
- REMEMBER: Patients who present with symptomatic bradycardia and inadequate perfusion may degrade to cardiac arrest
- Commence TCP IF:
  - Patient does not respond to atropine
  - Atropine is predetermined to be ineffective
  - IV access is delayed
  - Patient’s condition is rapidly degrading
- After TCP is initiated
  - Confirm correct placement and functioning
  - Check for improved perfusion and condition
  - Administer analgesics and sedatives as necessary
  - If TCP does not work, begin infusion of dopamine/epinephrine and prepare for transvenous pacing
- REMEMBER:
  - Medications for bradycardia may produce confusion and altered state of consciousness
  - TCP may be painful
TCP may not work, especially if there is an underlying cause.

**ACLS Adult Bradycardia (with Pulse) Algorithm**

1. **Assess appropriateness for clinical condition.**
   Heart rate typically <50/min if bradycardia.

2. **Identify and treat underlying cause**
   - Maintain patent airway; assist breathing as necessary
   - Oxygen (if hypoxemic)
   - Cardiac monitor to identify rhythm; monitor blood pressure and oximetry
   - IV access
   - 12-Lead ECG if available; don’t delay therapy

3. **Persistent bradycardia causing:**
   - Hypotension?
   - Acutely altered mental status?
   - Signs of shock?
   - Ischemic chest discomfort?
   - Acute heart failure?

4. **Monitor and observe**
   - **No**

5. **Atropine**
   - If atropine ineffective:
     - Transcutaneous pacing OR
     - Dopamine infusion OR
     - Epinephrine infusion

6. **Consider:**
   - Expert consultation
   - Transvenous pacing

**Doses/Details**
- **Atropine IV Dose:**
  - First dose: 0.5 mg bolus
  - Repeat every 3-5 minutes
  - Maximum: 3 mg

- **Dopamine IV Infusion:**
  - 2-10 mcg/kg per minute

- **Epinephrine IV Infusion:**
  - 2-10 mcg per minute

**Case 8: Unstable Tachycardia**
Learning Objectives

1. Be able to recognize different rhythms classified as unstable tachycardia
2. Familiarization with different heart rhythms
3. Familiarization with ACLS Adult Tachycardia Algorithm
4. Integration of 2010 guidelines

Notes

- Tachycardia (HR >100bpm) leads to less blood flow to systemic and pulmonary circuits and less O₂ to organs
- Increase in O₂ demand and lack of supply may lead to ischemia then myocardial infarction
- Both rapid and unstable heart rate

Rhythms Classified as Unstable Tachycardia

1. Atrial Fibrillation - caused by “trembling” atrium muscles
2. Atrial flutter – originating in atrium, often leading to atrial fibrillation
3. Reentry supraventricular tachycardia (SVT) – any rapid rhythm starting in atrium
4. Monomorphic VT – rapid VT with similar peaks on ECG
5. Polymorphic VT – rapid VT, irregular ECG
6. Wide-complex tachycardia of an uncertain type

Atrial Fibrillation (AFib)

- Results from altered rapid firing of impulses in atria
- Causes atrial muscles to fibrillate (tremble)
- Hinders full atrial contractions, leads to decrease in stroke volume
- Decreased cardiac output
- Increases risk for stroke since blood is not properly pumped out, potential for clotting
- Associated with:
  - Advanced age
  - Cardiomyopathy
  - Congenital heart failure
  - Congestive heart failure
  - Diabetes
- **Characteristics**
  - Rate
    - Ventricular: may vary
    - Atrial: 400-600 bpm
  - Rhythm – irregularly irregular
  - P waves – not identifiable with fibrillatory waves present; wavy, erratic baseline
  - PR interval – not measurable
  - QRS duration – usually <0.1 second

- **Treatment**
  - Depends on:
    - Duration of rhythm
    - Patient’s health
    - Ventricular rate
    - Other factors
  - May focus on
    - Controlling ventricular rate
    - Reestablishing sinus rhythm if AFib is associated with rapid ventricular rate and patient is symptomatic yet stable
  - Consider synchronized cardioversion when patient has rapid ventricular rate and other serious symptom ie heart failure, low blood pressure, or shock

Atrial Flutter
- Ectopic atrial rhythm wherein irritable sites fire at regular, rapid rates
- Flutter waves are evident – waveforms that look like teeth of a saw
- Associated with:
  o Cardiac surgery
  o Cardiomyopathy
  o Chronic lung disease
  o Complications of myocardial infarction
  o Digitalism/ quinidine toxicity
  o Hyperthyroidism
  o Hypoxia
  o Ischemic heart disease
  o Mitral/ tricuspid valve stenosis/ regurgitation
  o Myocarditis
  o Pericarditis
  o Pneumonia
  o Pulmonary embolism
- Characteristics
  o Rate
    - Type I: 250-350 bpm
    - Type II: 350-450 bpm
  o Rhythm
    - Atrial – regular
    - Ventricular – ir/regular, depends on AV conduction
  o P waves – not identifiable with fibrillatory waves present
  o PR interval – not measurable
  o QRS duration – usually <0.1 second
- Treatment
  o Depends on:
    - Duration of rhythm
    - Patient’s health
    - Ventricular rate
    - Other factors
  o May focus on
    - Controlling ventricular rate
    - Reestablishing sinus rhythm if flutter is associated with rapid ventricular rate and patient is symptomatic yet stable
  o Consider synchronized cardioversion when patient has rapid ventricular rate and other serious symptom ie heart failure, low blood pressure, or shock
- Vagal maneuvers may help identify rhythm and slow down AV conduction to reveal flutter
- Considered “uncontrolled” when ventricular rate >100 bpm
Considered “controlled” when ventricular rate <100 bpm
  - May result from
    - Normal AV node protecting ventricles from fast atrial impulses
    - Drugs used to control impulse conduction through AV node reducing number of impulses reaching ventricles

Supraventricular Tachycardia (SVT)

- Any tachycardic rhythm originating above the ventricular tissue in the atria or AV node

- Atrioventricular Nodal Reentrant Tachycardia (AVNRT)
  - More common type of SVT
  - Results from a reentry circuit that forms the AV node (or next to it)
  - More common in women (75%) than men
  - Can occur at any age and in patients without heart disease
  - Associated with
    - Chronic obstructive pulmonary disease
    - Coronary artery disease
    - Valvular heart diseases
    - Other
  - May cause myocardial infarction in patients with coronary artery disease or angina
  - May be triggered by
    - Anxiety
    - Caffeine
    - Hypoxia
    - Lack of sleep
    - Other medications
    - Smoking
- **signs and symptoms**
  - chest pain or pressure
  - congestive heart failure
  - dyspnea
  - lightheadedness
  - nausea
  - neck vein pulsations
  - nervousness and anxiety
  - palpitations
  - signs of shock
  - syncope or near-syncope
  - weakness
- **Characteristics**
  - Rate – 150-250 bpm (usually 170-250 bpm)
  - Rhythm - regular
  - P waves
    - Hidden in QRS complex
    - Inverted P wave appears after QRS leads II, III, and VF
    - Occurs when ventricles are stimulated before atria
    - End of QRS complex becomes distorted by P wave if atria are depolarized after ventricles
  - PR interval – not measurable
  - QRS duration – usually <0.1 second, barring intraventricular conduction delay
- **treatment**
  - oxygen
  - vagal maneuvers
    - if this fails, follow with adenosine treatment
  - IV access
  - Follow successful treatment with synchronized cardioversion

**Wolff-Parkinson White Syndrome (WPW)**
- Occurs when the bundle of Kent pre-exites the ventricles
- WPW Syndrome is type of AVNRT
- Occurs in between 0.9 and 3% of the population, more commonly in men
- One of the most common causes of tachydysrhythmias in infants and children
- Patients are usually asymptomatic but with risk of sudden death

Ventricular Tachycardia (VT)

- Occurs when 3 or more premature ventricular contractions occur immediately in quick succession at >100 bpm
- May last <30 seconds and be unsustained
- Usually lasts >30 seconds (sustained)
- May occur with or without a pulse
- Patient may be stable or unstable
- May originate from an ectopic focus in one of the ventricles
- Becomes monomorphic VT when QRS complexes are the same size and shape
- Becomes polymorphic VT when QRS complexes differ each beat
- Associated with
  o Acid-base imbalance
  o Acute coronary syndromes
  o Cardiomyopathy
  o Cocaine abuse
  o Digitalis toxicity
  o Hyperkalemia
  o Hypokalemia
  o Mitral valve prolapse
  o Trauma (invasive heart procedures/ myocardial contusion)
  o Valvular heart disease
- Signs and symptoms
  o Vary
  o May occur with or without a pulse
- Sustained monomorphic VT may remain stable for extended periods of time
- Monomorphic VT may degenerate to polymorphic VT or VFib if ventricular rate is very fast or myocardial ischemia occurs
- Syncope or near-syncope may occur with sudden onset of VT

- Treatment of monomorphic VT
  - Treat and search for cause of VT simultaneously
  - If without pulse, use ACLS Cardiact Arrest Algorithm
  - If stable but symptomatic, suppress rhythm with IV, O₂, and ventricular arrhythmics
  - If unstable with sustained heart rate of >150 bpm, treat with IV access, O₂, and sedate patient; follow with synchronized cardioversion
- SVT with intraventricular conduction delay is difficult to distinguish from VT
- If there is doubt whether a rhythm is VT or SVT, treat it as VT, and use 12-lead ECG to determine later on

Monomorphic VT

- occurs when QRS complexes on ECG are the same shape and size
- common in patients with structural heart disease
- scarring may have resulted from an area of slow conduction
- occasionally seen in patients with normal hearts
- may be triggered by
  - acid-base imbalance
  - acute coronary syndromes
  - cardiomyopathy
  - cocaine abuse
  - digitalis toxicity
  - hyperkalemia
  - hypokalemia
  - mitral valve prolapse
  - trauma
  - tricyclic antidepressant overdose
  - valvular heart disease
- may degrade to polymorphic VT or VFib
- there may be brief lightheadedness followed by near/ syncope when VT occurs abruptly
- Characteristics
  - Rate – 101-250 bpm
  - Rhythm - regular
  - P waves – usually absent
  - PR interval – not measurable
  - QRS duration – usually <0.1 second, usually difficult to differentiate between QRS and T wave

Polymorphic VT

- caused by slow heart rate
- Associated with electrolyte disturbances or medications prolonging QT interval
- QRS complexes go from upright to negative and negative to positive
- Symptoms related to decreased cardiac output resulting from increased ventricular rate
- Characteristics
  - Rate – 150-300 bpm (usually 200-250 bpm)
  - Rhythm – regular or irregular
  - P waves - none
  - PR interval – not measurable
  - QRS duration – usually <0.12 seconds, with irregular peaks and changing directions of QRS complexes

Uncertain Wide-Complex Tachycardia
- usually caused by VT or SVT with unusually wide QRS complex
- Sustained rate of >100 bpm
- QRS complexes last >0.12 seconds
- Treatment
  - Find pulse if patient presents with rapid heart rate
  - If pulse is found, determine stability of rhythm
  - Follow ACLS Tachycardia Algorithm
  - Consider H’s and T’s as causes of tachycardia with pulse

Sinus Tachycardia
- Rapid heart rate in response to stimulus
- Normal rhythm starting in sinoatrial node but at an increased rate
- Other causes include
  - Anemia
Dehydration
Hypovolemia

NEW for 2010
- Focus on identifying tachycardia as symptom or underlying cause
- Algorithm has been simplified and reorganized to facilitate retention
- ACLS Tachycardia Algorithm may be used in treatment of stable or unstable tachycardia

Box 1 – Assess Appropriateness of Algorithm to Clinical Situation
- Determine tachycardic rhythm first (>150 bpm)
- Find pulse
- If pulse cannot be found or is lost, follow ACLS Cardiac Arrest Algorithm

Box 3
- Decide whether persistent tachycardia is causing significant signs/ symptoms
  - YES, then patient is unstable, go to box 4
  - NO, patient is stable, go to Box 5
- Signs of unstable tachycardic patient
  - Acute heart failure
  - Acutely altered mental state
  - Hypotension
  - Ongoing chest pain/ discomfort
  - Presyncope
  - Shock
  - Shortness of breath
  - Syncope

Box 4 – Synchronized Cardioversion
- Uses electric shocks to reestablish normal rhythm after tachycardia
- Establish IV access first
- Sedate patient
- Consider adenosine if patient is not hypotensive with regular narrow-complex SVT or monomorphic wide-complex tachycardia
- Synchronized cardioversion
  - Shocks are delivered simultaneously with regular intervals (at QRS complex peaks)
  - Uses the lower energy setting
  - Benefit: prevents shock from being administered during cardiac repolarization (which may lead to VF)
  - Employ when:
Unstable atrial fibrillation
- Unstable atrial flutter
- Unstable regular monomorphic tachycardia with pulse
- Unstable SVT
  - Preferred method of treatment with symptomatic reentry SVT or VT with pulses
- Unsyncronized cardioversion
  - Shocks are delivered on demand of responder
  - Uses high-energy setting
  - Employ with
    - Patient who may become pulseless
    - Patient with critical deterioration (severe shock/ polymorphic VT)
    - Tachycardic patient without pulse
    - Unsure if patient has monomorphic/ polymorphic VT
- Shock dosages
  - Unstable atrial fibrillation – 200 J
  - Unstable monomorphic VT – 100 J
  - Other unstable SVT, atrial flutter – 200 J
  - Polymorphic VT (irregular and unstable) – treat as VF with high-energy shock
- Procedure
  - Sedate patient unless condition is rapidly deteriorating/ unstable
  - Turn on defibrillator
  - Attach leads/ electrodes
  - Press SYNC
  - Look for indications of sync mode (usually on R wave)
  - Sync with R wave if necessary
  - Set energy level
  - Announce CLEAR the patient
  - Press charge button
  - CLEAR patient
  - Hit SHOCK button
  - Determine if tachycardia is still present, if yes, increase energy
  - Press sync button

* may not be effective in treating junctionatachycardia or ectopic or multifocal atrial tachycardia

Case 9: Stable Tachycardia

Learning Objectives
1. Be able to recognize stable narrow-complex and wide-complex tachycardia
2. Know when treatment with ACLS Adult Tachycardia Algorithm is appropriate

Notes
- Caused by cardiac electrical problem
- If patient has a pulse, proceed with ACLS Tachycardia Algorithm
- If NOT, use ACLS Pulseless Arrest Algorithm
- May be evidenced by
  o Sinus tachycardia

- Heart rate between 101-180 bpm (>200 bpm in infants, >160 in children over 5)
- Caused by increase in O₂ demand
- Symptoms
  • Palpitations
  • Racing heart
  • Pounding in chest
- Related causes:
  • Acute myocardial infarction
  • Caffeine
  • Congestive heart failure
  • Dehydration
  • Drugs (amphetamines, cannabis)
  • Exercise
  • Fear/ anxiety
  • Fever
  • Hyperthyroidism
  • Hypovolemia
  • Hypoxia
  • Infection
  • Medications (epinephrine, dopamine, atropine, dobutamine)
  • Nicotine
  • Pain
  • Pulmonary embolism
- Shock
- Sympathetic stimulation

- Atrial fibrillation
  - **ECG: Atrial Fibrillation**
  - Caused by inappropriate firing in the atria or reentry involving one or more circuits in atria
  - Rapid impulses inhibit atria from contracting properly
  - Results in decreased cardiac output; loss of atrial kick
  - Treatment
    - Depends on:
      - Duration of rhythm
      - Patient’s health
      - Ventricular rate
      - Other factors
    - May focus on
      - Controlling ventricular rate
      - Reestablishing sinus rhythm if AFib is associated with rapid ventricular rate and patient is symptomatic yet stable

- Atrial flutter
  - **ECG: Atrial Flutter**
  - Ectopic atrial rhythm wherein irritable sites fire at regular, rapid rates
  - Flutter waves are evident – waveforms that look like teeth of a saw
  - May be observed in leads II, III, aVF, and V₁
- Multifocal atrial tachycardia
  - Aka chaotic atrial tachycardia
  - Exhibits wandering atrial pacemaker rhythm and >100 bpm ventricular rate
  - Wandering rhythm – P waves differ, sometimes from beat to beat

- AVNRT
  - Caused by the presence of two pathways in AV node conducting impulses and recovering at different rates

- Monomorphic VT
  - Evidenced by QRS complexes of the same shape and size
  - May arise from 3 or more PVCs occurring in succession at a rate >100 bpm
  - Causes include
    - Acute coronary syndromes
    - Tricyclic antidepressant overdose
    - Cocaine abuse
    - Cardiomyopathy

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- Valvular heart disease
- Mitral valve prolapse
- Acid-base imbalance
- Trauma (myocardial contusion, invasive cardiac procedures)
- Electrolyte imbalance
  - Polymorphic VT
    - Evidenced by varying QRS complexes
    - Waves usually go from upright to negative and vice versa
    - May degrade to VFib
Box 1: Assess Appropriateness of Algorithm to clinical situation

- Determine Tachycardic rhythm (>150 bpm)
- Find pulse
- If pulse cannot be found/ is suddenly lost, proceed to ACLS Cardiac Arrest Algorithm

Box 2: Identify and Treat Underlying Causes

- Perform BLS and ACLS Surveys
- Administer O₂
- Check rhythm and blood pressure
- Establish IV access
- Identify and treat primary/ reversible causes
- If tachycardia persists, proceed to Box 3

Box 3: Decision Point
- Decide whether persistent tachycardia is causing significant signs/ symptoms
  o YES, then patient is unstable, go to box 4
  o NO, patient is stable, go to Box 5

- Signs of unstable tachycardic patient
  o Acute heart failure
  o Acutely altered mental state
  o Hypotension
  o Ongoing chest pain/ discomfort
  o Presyncope
  o Shock
  o Shortness of breath
  o Syncope

Box 5: IV Access and ECG Analysis

- Once patient is stable, start IV line
- Obtain 12-lead ECG or use rhythm strip
- Examine QRS region
  o If QRS region is wide, proceed to Box 6
  o If QRS region is narrow, proceed to Box 7

Protocol for narrow QRS region with regular rhythm

- Apply vagal techniques (successful 20-25% of cases)
  o Coughing
  o Holding of breath
  o Squatting
  o Carotid sinus pressure
  o Cold stimulus application to the face
  o Valsalva’s maneuver
    ▪ Have patient blow through partially occluded straw
    ▪ Have patient bear down as if moving bowels for 10 seconds
  o Gagging
  o Maintain 12-lead ECG during procedure
  o Monitor ECG, mark beginning and end of procedure on strip
  o Have O₂, suction, defibrillator, and emergency medications ready before commencing procedure
  o Do not use carotid massage in children
  o Do not apply external ocular pressure

- Administer adenosine (successful in 90% of cases)
  o 6 mg rapid IV push
Case 10: Acute Stroke

Learning Objectives

1. Familiarization with signs, symptoms, and treatment of acute stroke
2. Understand ACLS Adult Suspected Stroke Algorithm

Notes

- Rapid response is critical for successful rescue of stroke patient
- 2 major types
  - Ischemic stroke (85% of cases) – blockage of artery in brain
  - Hemorrhagic stroke (15% of cases) – rupture of blood vessel in brain
- 700,000 people / year have strokes in the US
- 1 in 15 deaths are stroke related

Stroke Chain of Survival

- Designed to reduce brain injury and chance of death
- Recognize and react to the signs/ symptoms of a stroke
- EMS response/ dispatch
- Quick EMS transport
- Diagnosis and treatment in hospital

7 D’s of Stroke Care
- Detection of signs and symptoms
- Dispatch of EMS thru 911 or emergency response system
- Delivery and pre-arrival notification to facility that can treat stroke
- Door of ED
- Data including CT scan
- Drug administration

**Goals of Stroke Care**

- Immediate general assessment within 10 minutes of patient arrival, non-contrast CT scan
- Neurological assessment by stroke team, CT scan within 25 minutes of arrival
- CT scan interpretation within 45 minutes of arrival
- Fibrinolytic therapy within 1 hour of arrival and 3 hours from onset of symptoms
- Door to admission time of 3 hours

**Signs and Symptoms**

- Weakness and numbness of face, arm, leg (possibly only on one side)
- Mental confusion
- Trouble speaking or understanding conversation
- Visual impairment
- Difficulty walking
- Dizziness
- Lack of balance/coordination
- Sudden, severe headache

**Treatment**

1. Perform BLS survey
2. Administer O₂ if necessary
3. Perform pre-hospital stroke assessment
4. Determine onset of symptoms if possible
5. Transport patient to stroke center
6. Alert hospital
7. Check glucose level
8. GOAL: arrive at ED within 10 minutes
### Critical time limits

<table>
<thead>
<tr>
<th>Goal</th>
<th>Time limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate general assessment</td>
<td>Within 10 minutes</td>
</tr>
<tr>
<td>Neurological assessment</td>
<td>Within 25 minutes</td>
</tr>
<tr>
<td>Head CT</td>
<td>Within 25 minutes</td>
</tr>
<tr>
<td>CT scan interpretation</td>
<td>Within 45 minutes</td>
</tr>
<tr>
<td>Fibrinolytic therapy</td>
<td>Within 60 minutes-3 hours</td>
</tr>
<tr>
<td>Admission</td>
<td>Within 3 hours</td>
</tr>
</tbody>
</table>
Adult Suspected Stroke

1. Identify signs and symptoms of possible stroke
   Activate Emergency Response

2. Critical EMS assessments and actions
   - Support ABCs; give oxygen if needed
   - Perform prehospital stroke assessment (Table 1)
   - Establish time of symptom onset (last normal)
   - Triage to stroke center
   - Alert hospital
   - Check glucose if possible

3. Immediate general assessment and stabilization
   - Assess ABCs, vital signs
   - Provide oxygen if hypoxic
   - Obtain IV access and perform laboratory assessments
   - Check glucose; treat if indicated
   - Perform neurologic screening assessment
   - Activate stroke team
   - Order emergent CT scan or MRI of brain
   - Obtain 12-lead ECG

4. Immediate neurologic assessment by stroke team or designee
   - Review patient history
   - Establish time of symptom onset or last known normal
   - Perform neurologic examination (NIH Stroke Scale or Canadian Neurological Scale)

5. Does CT scan show hemorrhage?
   - No Hemorrhage
   - Hemorrhage

6. Probable acute ischemic stroke; consider fibrinolytic therapy
   - Check for fibrinolytic exclusions (Tables 4 and 5)
   - Repeat neurologic exam: are deficits rapidly improving to normal?

7. Consult neurologist or neurosurgeon; consider transfer if not available

8. Patient remains candidate for fibrinolytic therapy?
   - Not a Candidate
   - Candidate

9. Administer aspirin

10. Review risks/benefits with patient and family. If acceptable:
    - Give rtPA
    - No anticoagulants or antiplatelet treatment for 24 hours

11. Begin post-rtPA stroke pathway
    - Aggressively monitor:
      - BP per protocol (Tables 2 and 3)
      - For neurologic deterioration
      - Emergent admission to stroke unit or intensive care unit

12. Begin stroke or hemorrhage pathway
    - Admit to stroke unit or intensive care unit
Stroke Assessment Tools

- 2010 AHA Guidelines for CPR and ECC recommend that EMTs/paramedics be trained to recognize a stroke with CPSS

Cincinnati Prehospital Stroke Scale (CPSS)

- Does 3 physical observations, if anything is found to be abnormal, stroke probability raises to 72%
  1. Facial weakness – show teeth or smile
     a. Normal – face moves equally
     b. Abnormal – one side of the face does not move
  2. Motor weakness – ask patient to extend arms 90 ° if sitting, 45 ° if supine; score drift if arm/s fall/s before 10 seconds
     a. Normal – both arms move the same or not at all
     b. Abnormal – one arm drifts
  3. Aphasia – ask patient to say “The sky is blue in Cincinnati” or “You can’t teach an old dog new tricks”
     a. Normal – phrase is repeated correctly without slurring
     b. Abnormal – slurring, patient uses incorrect words, or is unable to talk

Box 5 – CT Scan

- Important step in stroke treatment
- Main purpose is to assist in differentiation between ischemic and hemorrhagic stroke
- Helps identify structural abnormalities that may become contraindicative to fibrinolytic therapy

Box 8 – Fibrinolytic Therapy

- Patients must be screened using AHA Stroke Fibrinolytic Checklist

<table>
<thead>
<tr>
<th>tPA in Acute Ischemic Stroke- All boxes must be checked before tPA can be considered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note: The following checklist includes FDA-approved indications and contraindications for tPA administration for acute ischemic stroke. A physician with expertise in acute stroke can modify this list.</td>
</tr>
<tr>
<td><strong>Inclusion Criteria (all Yes boxes must be checked)</strong></td>
</tr>
<tr>
<td><strong>Yes:</strong></td>
</tr>
<tr>
<td>☐ Age 18 years or older?</td>
</tr>
<tr>
<td>☐ Clinical diagnosis of ischemic stroke with a measurable neurologic deficit?</td>
</tr>
<tr>
<td>☐ Time of symptom onset (when patient was last seen normal) well established as &lt;180 minutes (3 hours) before treatment would begin?</td>
</tr>
<tr>
<td><strong>Exclusion Criteria (all No boxes must be checked)</strong></td>
</tr>
<tr>
<td><strong>No:</strong></td>
</tr>
<tr>
<td>☐ Evidence of intracranial hemorrhage on pretreatment noncontrast head CT?</td>
</tr>
</tbody>
</table>
Clinical presentation suggestive of subarachnoid hemorrhage even with normal CT?
☐ CT shows multilobar infarction (hypodensity greater than one third cerebral hemisphere)?
☐ History of intracranial hemorrhage?
☐ Uncontrolled hypertension: SBP > 185 mm Hg or DBP > 110 mm Hg despite repeated measurements? More
☐ Known arteriovenous malformation, neoplasm, or aneurysm?
☐ Witnessed seizure at stroke onset?
☐ Active internal bleeding or acute trauma (fracture)?
☐ Acute bleeding diathesis, including
  - Platelet count <100 000/mm3?
  - Heparin received within 48 hours
  - Current use of anticoagulant with INR > 1.7 or prothrombin time PT > 15 seconds?*
☐ Within 3 months of intracranial or intraspinal surgery, serious head trauma, or previous stroke?
☐ Arterial puncture at a noncompressible site within past 7 days?

Relative Contraindications/Precautions:
- Only minor or rapidly improving stroke symptoms (clearing spontaneously)
- Within 14 days of major surgery or serious trauma
- Recent gastrointestinal or urinary tract hemorrhage (within previous 21 days)
- Recent acute myocardial infarction (within previous 3 months)
- Postmyocardial infarction pericarditis
- Abnormal blood glucose level (<50 or >400 mg/dL [<2.8 or >22.2 mmol/L])*  
  *In patients without recent use of oral anticoagulants or heparin, treatment with tPA can be initiated before availability of coagulation study results but should be discontinued if the INR is > 1.7 or the partial thromboplastin time is elevated by local laboratory standards.

Boxes 11 and 12 General Stroke Care
- Begin stroke pathway
- Monitor and support patient’s airway, breathing, and circulation
- Monitor for complications of stroke and fibrinolytic therapy
- Monitor blood glucose levels
- Monitor blood pressure
- Screen dysphagia
- Monitor for complications of stroke and fibrinolytic therapy
- Transfer to intensive care, if needed

References:
