The Basics

Electrical events precede mechanical events. Electrical events occur when positively charged ions cross the cell membrane allowing the cell to become more positively charged. This is referred to as depolarization. Mechanical events reflect the physical contraction and relaxation of the chambers of the heart. In cardiac conduction, the atria depolarize and trigger the mechanical event of contraction in the atria, causing the volume of blood to enter the ventricles. Repolarization represents the period of time where the ions return to their original place.
Measuring EKG’s; time and amplitude:

We count the boxes on the horizontal axis to determine timing or length of intervals, such as PR intervals and QRS waves and report the values in seconds. We count boxes on the vertical Axis to determine amplitude and degrees of depression or elevation and report the values in millimeters.

A: An interval measuring 3 boxes in length measures_______________________________

B: A segment depressed by 2 boxes measures___________________________________

The Steps in Rhythm Strip Analysis

1. Determine the rate
2. Determine the rhythm; p-p wave interval and R-R wave interval
3. Determine if p waves are present and the same in all complexes
4. Measure the PR interval
5. Measure the QRS complex duration
6. Examine the T wave shape
7. Assess the ST segment
Step 1: Determining Rate:

We can determine the heart rate by measuring the R-R interval in a regular rhythm but it is sometimes easier to determine the heart rate by counting the QRS complexes in a six second as seen in the figure below:

![Fig. 36-4](image)

Fig. 36-4 each segment between the dark lines (above the monitor strip) represents 3 seconds when the monitor is set at a speed of 25 mm/sec. To estimate the ventricular rate, count the QRS complexes in a 6-second strip and then multiply that number by 10 to estimate the rate for 1 minute. In this example, there are 9 QRS complexes in 6 seconds. Therefore the heart rate can be estimated to be 90 beats/min.


A sinus rhythm whose rate is less that 60 bpm is referred to as sinus bradycardia, sinus rhythms whose rate is greater than 100 bpm is called sinus tachycardia.

Practice (Use your Ignatavicius text as a reference)

| ![Image A](image) | Your answer |
| ![Image B](image) | Your answer |
| ![Image C](image) | Your answer |
Step 2: Determining Rhythm:

P-P interval

Using calipers or a marked scrap of paper, identify the P-P interval and mark of the start of two consecutive p waves and check each consecutive p-p interval to determine if they are equal.

If the intervals are the same for each consecutive complex, then it is call a regular rhythm. If it is not, then it is called irregular.

R-R interval

Using calipers or a marked scrap of paper, identify the R-R interval and mark of the start of two consecutive QRS complexes waves and check each consecutive R-R interval to determine if they are equal.
Step 3: Analyzing P waves:

P waves are always the same shape. Best seen in Lead II, they are small and rounded and precede the QRS wave. Arrhythmia may be present if they are undetectable, an unusual shape or absent. Atrial arrhythmias are identified by the absence of a normal p wave.

- Premature atrial contractions have a different shaped p wave from the sinus complexes
- Atrial fibrillation has no p waves, instead, a fibrillatory line is present with QRS complexes in an irregular pattern
- Atrial flutter has F waves in a characteristic saw tooth pattern
- Sinoatrial Block has an absent p wave and QRS complex
Step 4: Measuring PR interval:

The PR interval allows for the volume of blood in the atria to empty into the ventricles. Normal measures are 0.12-.20 seconds. Abnormal or undetectable PR intervals indicate that there is an arrhythmia. Common arrhythmias associated with abnormal PR interval measures are heart blocks as well as re-entrant tachycardias; both of which can lead to hemodynamic compromise.

- 1st Degree block: sinus rhythm with PR interval >.20 seconds
- 2nd Degree Type 1 block: Sinus rhythm with PR lengthening in consecutive complexes followed by a dropped complex. (Longer, longer longer block, that’s why they call it Wenckybach, !)
- 2nd Degree Type 2 block: p wave followed by dropped QRS complex
- 3rd Degree block: no PR interval; R-R intervals not equal to p-p intervals
- Supraventricular Tachycardia: narrow QRS tachycardia with no discernible p waves.

<table>
<thead>
<tr>
<th>Practice</th>
<th>Your answer</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="ECG Image" /></td>
<td>Your answer</td>
</tr>
<tr>
<td><img src="image2.png" alt="ECG Image" /></td>
<td>Your answer</td>
</tr>
</tbody>
</table>
Step 5: Measuring QRS duration:

QRS complexes represent ventricular depolarization and come in an assortment of shapes and sizes that are either upright or downward facing depending on the lead selection. Below are a number of patterns that you may come across:

The duration of a QRS complex, regardless of the pattern, ranges from 0.06-0.10 seconds. QRS complexes are considered prolonged when they measure longer than 0.12 seconds. QRS complexes can be prolonged from conduction delays within the ventricles, medication effect or from abnormal sites of conduction origination call ectopy.

- Premature ventricular contractions (PVC) are wide, bizarre with the T wave in the opposite direction. QRS measures>0.12 seconds
- Ventricular tachycardia is characterized as intermittent “runs” of three or more PVC’s in a row at a rate >100 versus sustained wide QRS tachycardia with a rate greater than 100 beats per minute.
Step 6: Analyzing ST segment:

ST segment abnormalities are best evaluated in 12 lead EKG but can be early identified on the cardiac monitor warranting its analysis. The ST segment should return to the baseline (isoelectric line) following the QRS complex as it begins to form the T wave. Abnormal ST segments could indicate ischemia among other concerns and should be further evaluated by 12 Lead EKG when present in monitoring.
Understanding Tachycardias

The fast rhythms that you should familiarize yourself with are as follows:

Tachycardias:

- Sinus tachycardia
- Supraventricular Tachycardia
- Ventricular Tachycardia with a pulse

Medications used in Tachycardia:

- Adenosine
- Amiodarone
- Diltiazem
- Procainamide
- Sotolol

Review the algorithm below and cross reference the medications to the ACLS medication chart. For each of the following dysrhythmias, use the algorithm to complete the practice questions regarding treatment.
**Adult Tachycardia**
*(With Pulse)*

1. Assess appropriateness for clinical condition. Heart rate typically ≥150/min if tachyarrhythmia.

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

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

4. **Synchronized cardioversion**
   - Consider sedation
   - If regular narrow complex, consider adenosine

5. **No**

6. **Wide QRS? ≥0.12 second**
   - **Yes**
     - IV access and 12-lead ECG if available
     - Consider adenosine only if regular and monomorphic
     - Consider antiarrhythmic infusion
     - Consider expert consultation
   - **No**

---

**Doses/Details**

**Synchronized Cardioversion**
Initial recommended doses:
- Narrow regular: 50-100 J
- Narrow irregular: 120-200 J biphasic or 200 J monophasic
- Wide regular: 100 J
- Wide irregular: defibrillation dose (NOT synchronized)

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

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

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

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

**Sotalol IV Dose:**
100 mg (1.5 mg/kg) over 5 minutes.
Avoid if prolonged QT.

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You are caring for a post-operative colon resection client who appears anxious and cool and clammy to touch. On exam, his abdomen is noted to be firm, distended, no bowel sounds, suture line intact, no drainage. BP 88/50 RR: 30 Temp 97 F. Last void 4 hours ago. The above strip is handed to you. What is your next best action?

________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________

5. Sinus Tachycardia

<table>
<thead>
<tr>
<th>Pathophysiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>None—more a physical sign than an arrhythmia or pathologic condition</td>
</tr>
<tr>
<td>Normal impulse formation and conduction</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Defining Criteria and ECG Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate: &gt;100 beats/min</td>
</tr>
<tr>
<td>Rhythm: sinus</td>
</tr>
<tr>
<td>PR: ≤0.20 sec</td>
</tr>
<tr>
<td>QRS complex: normal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Clinical Manifestations</th>
</tr>
</thead>
<tbody>
<tr>
<td>None specific for the tachycardia</td>
</tr>
<tr>
<td>Symptoms may be present due to the cause of the tachycardia (fever, hypovolemia, etc)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Common Etiologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal exercise</td>
</tr>
<tr>
<td>Fever</td>
</tr>
<tr>
<td>Hypovolemia</td>
</tr>
<tr>
<td>Adrenergic stimulation; anxiety</td>
</tr>
<tr>
<td>Hyperthyroidism</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Recommended Therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>No specific treatment for sinus tachycardia</td>
</tr>
<tr>
<td>Never treat the tachycardia per se</td>
</tr>
<tr>
<td>Treat only the causes of the tachycardia</td>
</tr>
<tr>
<td>Never countershock</td>
</tr>
</tbody>
</table>
You are examining a client admitted for palpitations who develops sudden onset shortness of breath. You are handed the above rhythm strip from the telemetry technician. You are unable to obtain a blood pressure and the client is losing consciousness. What sequence of actions are essential at this time?

If your client had a blood pressure of 130/80 and was not in any significant distress, what sequence of actions would you have implemented?
The client who is s/p Myocardial infarction following thrombolytic therapy develops the above rhythm. The client is currently receiving heparin and nitroglycerine infusions. On exam the client is noted to have a blood pressure of 110/68, RR 24, and denies chest pain at this time. What sequence of actions should you initiate?
7. Atrial Fibrillation/Atrial Flutter

### Pathophysiology
- Atrial impulses faster than SA node impulses
- Atrial fibrillation → impulses take multiple, chaotic, random pathways through the atria
- Atrial flutter → impulses take a circular course around the atria, setting up the flutter waves
- Mechanism of impulse formation: reentry

### Defining Criteria and ECG Features

(Dissections here between atrial fibrillation vs atrial flutter; all other characteristics are the same)

**Atrial Fibrillation Key:** A classic clinical axiom: “Irregularly irregular rhythm—with variation in both interval and amplitude from R wave to R wave—is always atrial fibrillation.” This one is dependable.

**Atrial Flutter Key:** Flutter waves seen in classic “sawtooth pattern”

<table>
<thead>
<tr>
<th></th>
<th>Atrial Fibrillation</th>
<th>Atrial Flutter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rate</strong></td>
<td>Wide-ranging ventricular response to atrial rate of 300-400 beats/min</td>
<td>Atrial rate 220-350 beats/min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ventricular response = a function of AV node block or conduction of atrial impulses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ventricular response rarely &gt;150-180 beats because of AV node conduction limits</td>
</tr>
<tr>
<td><strong>Rhythm</strong></td>
<td>Irregular (classic “irregularly irregular”)</td>
<td>Regular (unlike atrial fibrillation)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ventricular rhythm often regular</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Set ratio to atrial rhythm, eg, 2-to-1 or 3-to-1</td>
</tr>
<tr>
<td><strong>P waves</strong></td>
<td>Chaotic atrial fibrillatory waves only</td>
<td>No true P waves seen</td>
</tr>
<tr>
<td></td>
<td>Creates disturbed baseline</td>
<td>Flutter waves in “sawtooth pattern” is classic</td>
</tr>
<tr>
<td><strong>PR</strong></td>
<td>Cannot be measured</td>
<td></td>
</tr>
<tr>
<td><strong>QRS</strong></td>
<td>Remains ≤0.10-0.12 sec unless QRS complex distorted by fibrillation/flutter waves or by conduction defects through ventricles</td>
<td></td>
</tr>
</tbody>
</table>

### Clinical Manifestations
- Signs and symptoms are function of the rate of ventricular response to atrial fibrillatory waves; “atrial fibrillation with rapid ventricular response” → DOE, SOB, acute pulmonary edema
- Loss of “atrial kick” may lead to drop in cardiac output and decreased coronary perfusion
- Irregular rhythm often perceived as “palpitations”
- Can be asymptomatic

### Common Etiologies
- Acute coronary syndromes; CAD; CHF
- Disease at mitral or tricuspid valve
- Hypoxia; acute pulmonary embolism
- Drug-induced: digoxin or quinidine most common
- Hyperthyroidism
The client s/p CABG day 2 develops the rhythm above. The client denies increased shortness of breath or chest pain. You note the client’s chart indicates that the EF was 30%. The client has been on aspirin since the night of surgery. What would you prepare to administer?
Understanding Bradycardias

The slower rhythms that you should familiarize yourself with are as follows:

Bradycardias:

- Sinus bradycardia
- Heart block

Medications used in Bradycardias:

- Atropine
- Dopamine infusion
- Epinephrine infusion

Procedures:

- Transcutaneous pacemaker

Review the algorithm below and cross reference the medications to your drug guide. For each of the following dysrhythmias, use the algorithm to complete the practice questions regarding treatment.
Adult Bradycardia
(With Pulse)

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

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

4. Monitor and observe
   - No

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

6. Consider:
   - Expert consultation
   - Transvenous pacing

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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
The client being treated for acute coronary syndrome demonstrating inferior wall ischemia develops the following rhythm associated with syncope and hypotension. The client is currently receiving 3 lpm nasal cannula oxygen therapy as well as IV nitroglycerine and heparin infusions. What is your next best action?

The client does not respond to the therapy and becomes progressively hypotensive. What would the nurse prepare to administer?
Understanding Heart Block:

17. First-Degree Heart Block

| Pathophysiology | ■ Impulse conduction is slowed *(partial block)* at the AV node by a fixed amount  
|                 | ■ Closer to being a physical sign than an abnormal arrhythmia |

**Defining Criteria per ECG**  
Key: PR interval >0.20 sec

- **Rate:** First-degree heart block can be seen with both sinus bradycardia and sinus tachycardia
- **Rhythm:** sinus, regular, both atria and ventricles
- **PR:** prolonged, >0.20 sec, but does not vary *(fixed)*
- **P waves:** size and shape normal; every P wave is followed by a QRS complex; every QRS complex is preceded by a P wave
- **QRS complex:** narrow, ≤0.10 sec in absence of intraventricular conduction defect

| Clinical Manifestations | ■ Usually asymptomatic at rest  
|                        | ■ Rarely, if bradycardia worsens, person may become symptomatic from the slow rate |

| Common Etiologies | ■ Large majority of first-degree heart blocks are due to drugs, usually the AV nodal blockers: β-blockers, calcium channel blockers, and digoxin  
|                  | ■ Any condition that stimulates the parasympathetic nervous system *(eg. vasovagal reflex)*  
|                  | ■ Acute MIs that affect circulation to AV node *(right coronary artery)*; most often inferior AMIs |

If client is experiencing symptomatic bradycardia with 1\textsuperscript{st} degree heart block, follow the bradycardia algorithm.
If client is experiencing symptomatic bradycardia with 2nd degree heart block Type I, follow the bradycardia algorithm.

<table>
<thead>
<tr>
<th>Pathophysiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site of pathology: AV node</td>
</tr>
<tr>
<td>AV node blood supply comes from branches of the right coronary artery</td>
</tr>
<tr>
<td>Impulse conduction is increasingly slowed at the AV node (causing increasing PR interval)</td>
</tr>
<tr>
<td>Until one sinus impulse is completely blocked and a QRS complex fails to follow</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Defining Criteria per ECG</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Key:</strong> There is progressive lengthening of the PR interval until one P wave is not followed by a QRS complex (the dropped beat)</td>
</tr>
<tr>
<td><strong>Rate:</strong> atrial rate just slightly faster than ventricular (because of dropped beats); usually normal range</td>
</tr>
<tr>
<td><strong>Rhythm:</strong> regular for atrial beats; irregular for ventricular (because of dropped beats); can show regular P waves marching through irregular QRS</td>
</tr>
<tr>
<td><strong>PR:</strong> progressive lengthening of the PR interval occurs from cycle to cycle; then one P wave is not followed by a QRS complex (the &quot;dropped beat&quot;)</td>
</tr>
<tr>
<td><strong>P waves:</strong> size and shape remain normal; occasional P wave not followed by a QRS complex (the &quot;dropped beat&quot;)</td>
</tr>
<tr>
<td><strong>QRS complex:</strong> ≤0.10 sec most often, but a QRS &quot;drops out&quot; periodically</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Clinical Manifestations—Rate-Related</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Due to bradycardia:</strong></td>
</tr>
<tr>
<td><strong>Symptoms:</strong> chest pain, shortness of breath, decreased level of consciousness</td>
</tr>
<tr>
<td><strong>Signs:</strong> hypotension, shock, pulmonary congestion, CHF, angina</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Common Etiologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>AV nodal blocking agents: β-blockers, calcium channel blockers, digoxin</td>
</tr>
<tr>
<td>Conditions that stimulate the parasympathetic system</td>
</tr>
<tr>
<td>An acute coronary syndrome that involves the right coronary artery</td>
</tr>
</tbody>
</table>
If client is experiencing symptomatic bradycardia with 2nd degree heart block Type II, follow the bradycardia algorithm.
If client is experiencing symptomatic bradycardia with 3rd degree heart block, follow the bradycardia algorithm.
Understanding trancutaneous pacing:

Indications: Symptomatic bradycardia unresponsive to medication.
Outcome: Restorative of cardiac output (increase in blood pressure and pulse)

<table>
<thead>
<tr>
<th>Rhythm Strip</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Bradycardia (third-degree heart block): no pacing</strong>&lt;br&gt;(Note: Rates and intervals slightly altered due to monitor compensation for pacing stimulus)</td>
<td>- QRS rate = 41 beats/min&lt;br&gt;- P waves seen = 125 beats/min&lt;br&gt;- QRS = very wide, 0.24 sec; ventricular escape beats&lt;br&gt;- QRS and T wave polarity = both positive&lt;br&gt;- Patient: SOB at rest; severe SOB with walking; near syncope</td>
</tr>
<tr>
<td><strong>B. Transcutaneous pacing initiated at low current (35 mA) and slow rate (60 beats/min). Below the threshold current needed to stimulate the myocardium</strong></td>
<td>- With TCP, monitor electrodes are attached in modified lead II position&lt;br&gt;- As current (in milliamperes) is gradually increased, the monitor leads detect the pacing stimuli as a squared off, negative marker&lt;br&gt;- TC pacemakers incorporate standard ECG monitoring circuitry but incorporate filters to dampen the pacing stimuli&lt;br&gt;- A monitor without these filters records “border-to-border” tracings (off the edge of the screen or paper at the top and bottom borders) that cannot be interpreted</td>
</tr>
<tr>
<td><strong>C. Pacing current turned up above threshold (60 mA at 71 beats/min) and “captures” the myocardium</strong></td>
<td>- TCP stimulus does not work through the normal cardiac conduction system but by a direct electrical stimulus of the myocardium&lt;br&gt;- Therefore, a “capture,” where TCP stimulus results in a myocardial contraction, will resemble a PVC&lt;br&gt;- Electrical capture is characterized by a wide QRS complex, with the initial deflection and the terminal deflection always in opposite directions&lt;br&gt;- A “mechanically captured beat” will produce effective myocardial contraction with production of some blood flow (usually assessed by a palpable carotid pulse)</td>
</tr>
</tbody>
</table>

**Failure to capture**

![Failure to capture](image1)

**100% Pacing**

![100% Pacing](image2)
You are caring for a client in the emergency department who was found unconscious by family. The client is maintaining an airway, oxygen is applied and the client is placed on cardiac monitor. The following rhythm is observed:

![Heart rhythm strip]

ACLS is initiated; Oxygen is administered, IV access obtained, 12 lead EKG and bloodwork are obtained. What is your interpretation of the rhythm strip?

What is your next best action?

Following medication administration, the following strip is obtained.

![Heart rhythm strip]

What is your interpretation?

The physician prescribes a Dopamine infusion. The client’s remains unconscious and the blood pressure is below 80 systolic. What should you the nurse prepare to perform?

It was determined that the client was experiencing a high risk NSTEMI MI. A transvenous pacemaker was inserted in the cardiac catheterization lab and the client was stented. Following a lengthy hospital stay and insertion of a permanent pacemaker the client discharged home.
During your clinical rotation you will participate in clinical simulations. Please review these materials prior to that scheduled activity.

The cardiac rhythms that you should familiarize yourself for the mock code simulation are as follows:

- Pulseless ventricular tachycardia/ventricular fibrillation
- Pulseless electrical activity
- Asystole

Medications used in cardiac arrest include:

- Epinephrine
- Vasopressin
- Amiodarone
- Magnesium
- Lidocaine

Procedures:

- Defibrillation

Review the algorithm below and cross reference the medications to your drug guide. For each of the following dysrhythmias, use the algorithm to complete the practice questions regarding treatment.
Figure 2
Simplified Adult BLS Algorithm

- 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
Adult Cardiac Arrest

**Shout for Help/Activate Emergency Response**

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

2. **Rhythm shockable?**
   - Yes
   - **VF/VT**
   - Shock
   - **CPR 2 min**
     - IV/IO access
     - Epinephrine every 3-5 min
     - Consider advanced airway, capnography

3. **Rhythm shockable?**
   - Yes
   - Shock
   - **CPR 2 min**
     - IV/IO access
     - Epinephrine every 3-5 min
     - Consider advanced airway, capnography

4. **Rhythm shockable?**
   - No

5. **Shock**

6. **CPR 2 min**
   - Epinephrine every 3-5 min
   - Consider advanced airway, capnography

7. **Shock**

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

9. **Asystole/PEA**

10. **CPR 2 min**
    - IV/IO access
    - Epinephrine every 3-5 min
    - Consider advanced airway, capnography

11. **CPR 2 min**
    - Treat reversible causes

12. **Rhythm shockable?**
    - Yes
    - **Go to 5 or 7**
    - No

**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 Pco₂ <10 mm Hg, attempt to improve CPR quality
  - Intra-arterial pressure
  - If relaxation phase (diastolic) pressure <20 mm Hg, attempt to improve CPR quality

**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

**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.

**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
- Hypoxia (acidosis)
- Hypo-hyperkalemia
- Hypothermia
- Tension pneumothorax
- Tamponade, cardiac
- Toxins
- Thrombosis, pulmonary
- Thrombosis, coronary

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# The Cardiac Arrest Rhythms

## 2. Ventricular Fibrillation/Pulseless Ventricular Tachycardia

<table>
<thead>
<tr>
<th>Pathophysiology</th>
<th>Ventricles consist of areas of normal myocardium alternating with areas of ischemic, injured, or infarcted myocardium, leading to chaotic pattern of ventricular depolarization</th>
</tr>
</thead>
</table>
| Defining Criteria per ECG | Rate/QRS complex: unable to determine, no recognizable P, QRS, or T waves  
| | Rhythm: indeterminate, pattern of sharp up (peak) and down (trough) deflections  
| | Amplitude: measured from peak-to-trough; often used subjectively to describe VF as fine (peak-to-trough 2 to <5 mm), medium-moderate (5 to <10 mm), coarse (10 to <15 mm), very coarse (>15 mm) |
| Clinical Manifestations | Pulse disappears with onset of VF  
| | Collapse, unconsciousness  
| | Agonal breaths → apnea in <5 min  
| | Onset of reversible death |
| Common Etiologies | Acute coronary syndromes leading to ischemic areas of myocardium  
| | Stable-to-unstable VT, untreated  
| | PVCs with R-on-T phenomenon  
| | Multiple drug, electrolyte, or acid-base abnormalities that prolong the relative refractory period  
| | Primary or secondary QT prolongation  
| | Electrocution, hypoxia, many others |

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**Recommended Treatment**

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Coarse VF

Fine VF

---
### 3. PEA (Pulseless Electrical Activity)

<table>
<thead>
<tr>
<th>Pathophysiology</th>
<th>Cardiac conduction impulses occur in organized pattern, but this fails to produce myocardial contraction (former “electromechanical dissociation”); or insufficient ventricular filling during diastole; or ineffective contractions</th>
</tr>
</thead>
</table>
| Defining Criteria per ECG | - Rhythm displays organized electrical activity (not VF/pulseless VT)  
- Seldom as organized as normal sinus rhythm  
- Can be narrow (QRS <0.10 mm) or wide (QRS >0.12 mm); fast (>100 beats/min) or slow (<60 beats/min)  
- Most frequently: fast and narrow (noncardiac etiology) or slow and wide (cardiac etiology) |
| Clinical Manifestations | - Collapse; unconscious  
- Agonal respirations or apnea  
- No pulse detectable by arterial palpation (thus could still be as high as 50-60 mm Hg, in such cases termed pseudot-PEA) |
| Common Etiologies | **Mnemonic of 5 Hs and 5 T’s aids recall:**  
- Hypovolemia  
- Hypoxia  
- Hydrogen ion—acidosis  
- Hyperkalemia/Hypokalemia  
- Hypothermia  
- “Tablets” (drug OD, ingestions)  
- Tamponade, cardiac  
- Tension pneumothorax  
- Thrombosis, coronary (ACS)  
- Thrombosis, pulmonary (embolism) |

No detectable pulse

| Recommended Treatment | |
|-----------------------| |
### 4. Asystole

<table>
<thead>
<tr>
<th>Defining Criteria per ECG</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Classically asystole presents as a “flat line”, any defining criteria are virtually nonexistent.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rate: no ventricular activity seen or ≤60/min; so-called “P-wave asystole” occurs with only atrial impulses present to form P waves.</td>
</tr>
<tr>
<td></td>
<td>Rhythm: no ventricular activity seen; or ≤60/min</td>
</tr>
<tr>
<td></td>
<td>PR: cannot be determined; occasionally P wave seen, but by definition R wave must be absent</td>
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<tr>
<td></td>
<td>QRS complex: no deflections seen that are consistent with a QRS complex</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Clinical Manifestations</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Early may see agonal respirations; unconscious; unresponsive</td>
<td></td>
</tr>
<tr>
<td>No pulse; no blood pressure</td>
<td></td>
</tr>
<tr>
<td>Cardiac arrest</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Common Etiologies</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>End of life (death)</td>
<td></td>
</tr>
<tr>
<td>Ischemia/hypoxia from many causes</td>
<td></td>
</tr>
<tr>
<td>Acute respiratory failure (no oxygen; apnea; asphyxiation)</td>
<td></td>
</tr>
<tr>
<td>Massive electrical shock; electrocution; lightning strike</td>
<td></td>
</tr>
<tr>
<td>Postdefibrillatory shocks</td>
<td></td>
</tr>
</tbody>
</table>

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**Recommended Treatment**

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Cardiac Arrest Rhythms and Treatment Practice:

You are the nurse caring for eight patients on a telemetry unit. The telemetry technician alerts you to evaluate the following rhythm:

![EKG Image]


Your first action is to check the client. Why is that the priority action?

The client experiencing this dysrhythmia is hospitalized for an abdominal aortic aneurysm repair and is post-op day 2. Upon assessment of the client, you note that the client has no detectable pulse. According to the algorithm, what should you prepare to do? (List all actions in sequence)

Following your CPR for 2 minutes, the client develops the following rhythm:

![EKG Image]

What should you prepare to do?
The client remains pulseless. The following rhythm is noted on the chart:

![ECG Chart]

How do you interpret the client’s rhythm?

What is your next best action?

The Rapid response team continues resuscitative efforts. What should be considered with the client’s current rhythm?

The client is noted to have a board-like abdomen and Turners sign. The RRT implements volume fluid resuscitation and the client has a pulse on repeat assessment. The surgical team attends to the client and he is returned to the OR.