BASIC ARRHYTHMIA REVIEW GUIDE

ADVANCED

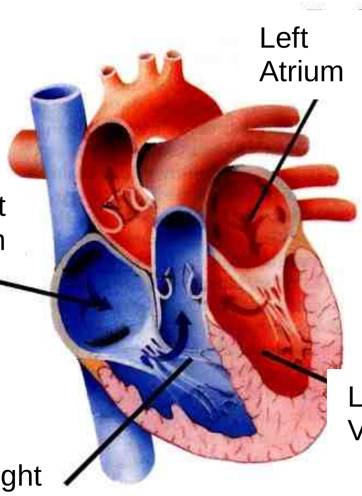
The following study guide provides a review of information covered in the basic arrhythmia competency.

- Preparation with this guide will help to achieve success on the exam.
- Sample questions and websites are provided at the end of this guide.

Jackson
HEALTH SYSTEM
Miracles made daily.

DESCRIPTION OF THE HEART

The adult heart is a muscular organ weighing less than a pound and about the size of a clenched fist. It lies between the right and left lung in an area called the mediastinal cavity behind the sternum of the breast bone. Approximately two-thirds of the heart lies to the left of the sternum and one-third to the right of the sternum.



HEART MUSCLES

The heart is composed of three layers each with its own special function. The outermost layer is called the pericardium, essentially a sac around the heart.

The middle and thickest layer of the heart is called the myocardium. This layer contains all the atrial and ventricular muscle fibers needed for contraction as well as the blood supply and electrical conduction system.

The innermost layer of the heart is the endocardium and is composed of endothelium and connective tissue. Any disruption or injury to this endothelium can lead to infection, which in turn can cause valve damage, sepsis, or death.

CHAMBERS

A normal human heart contains four separate chambers: right atrium, left atrium, right ventricle, and left ventricle. The right and left sides of the heart are divided by a septum. The right atrium (RA) receives oxygen-poor (venous) blood from the body's organs via the superior and inferior vena cava (SVC and IVC). The left atrium (LA) receives oxygen-rich (arterial) blood from the lungs via the pulmonary veins (PV).

VALVES

There are four valves, two between the atria and ventricles ("atrioventricular") and two between the ventricles and the great vessels ("semilunar") through which they eject blood. Each valve must function properly for efficient cardiac performance.

The atrioventricular (AV) valves are the **TRICUSPID VALVE** between right atrium and right ventricle and the **MITRAL VALVE** between the left atrium and left ventricle.

The semilunar valves are the **PULMONIC VALVE** between the right ventricle and pulmonary artery and the **AORTIC VALVE** between the left ventricle and aorta.

BLOOD FLOW

Blood flows from the systemic circulation to the **RIGHT ATRIUM** via the inferior and superior vena cava. From the right atrium blood flow continues to the **RIGHT VENTRICLE** to the **LUNGS** via the pulmonary artery. Gas exchange occurs and oxygenated blood flows from the lungs to the **LEFT ATRIUM** via the pulmonary veins, to the **LEFT VENTRICLE**, and finally to the **AORTA** back to the systemic circulation.

FUNCTION OF THE HEART

The heart functions as a pump. It is responsible for delivering oxygen and nutrients to the organs of the body via arterial circulation and removing the waste products of metabolism via venous circulation. This is accomplished by the heart muscle contracting, called **SYSTOLE**, and relaxing, called **DIASTOLE.**

CARDIAC OUTPUT

THE HEART RATE (HR) is the number of heartbeats in a minute. The stroke volume (SV) refers to the amount of blood pumped out of the heart with each contraction or beat. This averages about 70 mL with each beat. **CARDIAC OUTPUT** (CO) is the amount of blood pumped by the heart in a minute.

SV x HR = CO

BLOOD SUPPLY TO THE MYOCARDIUM

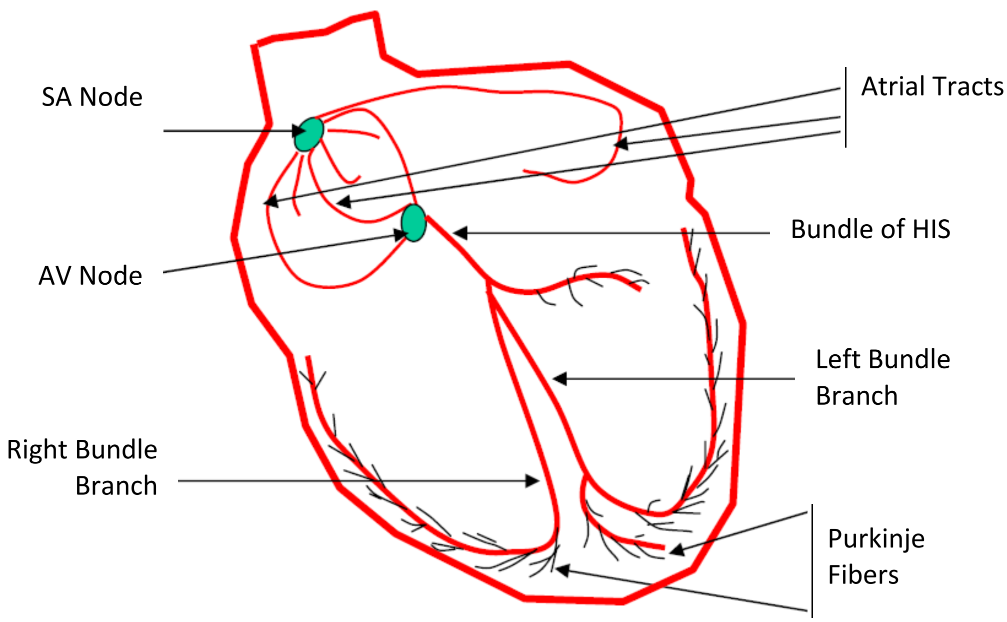
The right coronary artery supplies oxygenated blood to the right side of the heart. The left coronary artery supplies oxygenated blood to the left side of the heart.

PROPERTIES OF CARDIAC CELLS

The muscle cells of the heart are unique and responsible for the electrical stimulation that leads to proper mechanical function. Myocardial cells have several different electrophysiological properties: automaticity, excitability, conductivity, contractility.

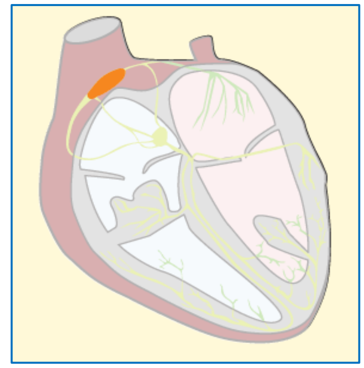
ELECTRICAL CONDUCTION SYSTEM

The components of the cardiac electrical conduction system transmit the electrical impulses initiated by the **SA node** (**the main pacemaker**) through the Atria, **AV node**/**JUNCTIONAL** tissue, **BUNDLE OF HIS**, **RIGHT AND LEFT BUNDLE BRANCHES**, and **PURKINJE FIBERS**.



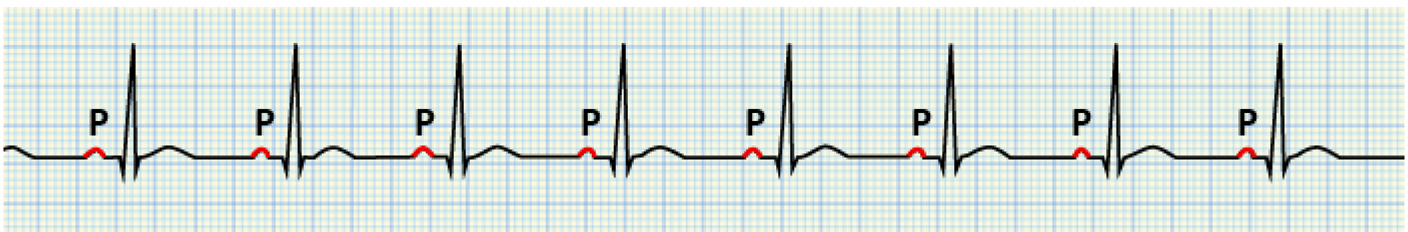
CARDIAC PACEMAKERS

SINOATRIAL NODE (SA NODE)

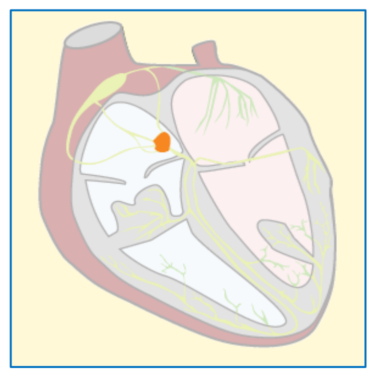


The sinoatrial (SA) node, the normal or intrinsic pacemaker of the heart, is located in the wall of the right atrium near the opening of the superior vena cava, and represents ***P Wave on*** the ECG. Atrial contraction follows electrical stimulation.

The SA node automatically creates and rhythmically sends out electrical impulses at a rate of **60-100 times per minute**. Hence, a "normal" rhythm has a heart rate of 60-100 beats per minute.



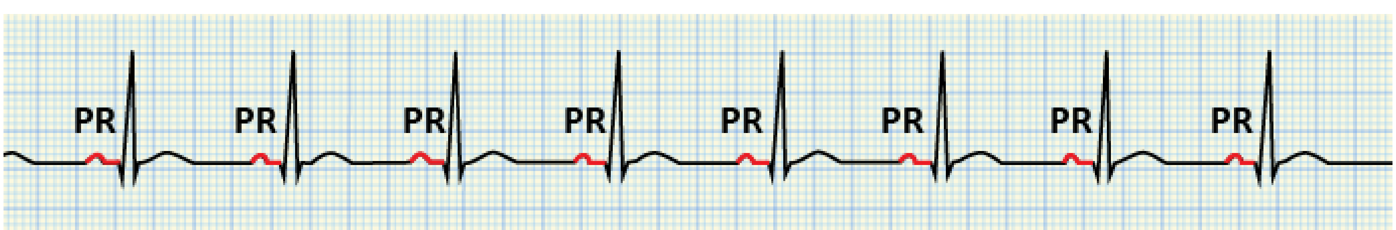
ATRIOVENTRICULAR NODE (AV NODE)



The atrioventricular (AV) node and surrounding junctional myocardial tissue, located near the ***junction*** of the right atrium and right ventricle, has three main functions. The first is to slow conduction and give the atria time to contract, emptying blood completely into the ventricles (atrial kick).

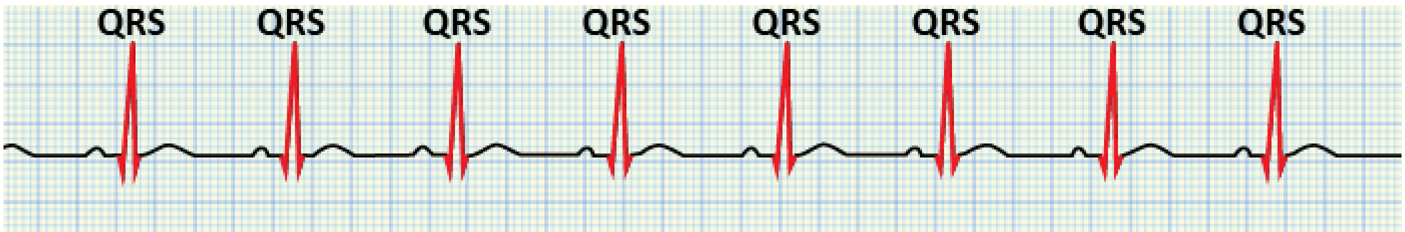
Secondly, it can function as a "back-up" pacemaker generating and discharging electrical impulses if the SA node does not work normally. If an electrical impulse originates from the AV node or junction, the **P wave** will be ***inverted or absent***. These cells initiate impulses at an intrinsic ***rate*** of **40- 60 beats per minute**.

A third function of the AV node is to block impulses that are coming too fast from the atria. The ventricles are thus protected from dangerously rapid heart rates. The delay though the AV node is depicted by the ***PR interval*** on the ECG. These three functions take a "normal" amount of time: ***0.12-0.20 seconds***.



VENTRICULAR DEPOLARIZATION

Electrical impulses travel from the AV node to the junctional tissue to the ventricles via the Bundle of His and then down both sides of the interventricular septum via the right and left bundle branches. The left bundle branch divides further into the anterior-superior and posterior-inferior fascicles and septal perforator. (It has three components because the left ventricle is larger than the right.) Bundle branches and fascicles end in, the Purkinje fibers. This electrical function takes a "normal" amount of time: 0.04-0.10 seconds. Ventricular contraction ensues. The Purkinje cells recover and return to a resting state before the entire process starts again.



ABNORMAL VENTRICULAR DEPOLARIZATION

In the event that both the SA node and the AV junction fail to initiate an electrical impulse, the **PURKINJE FIBERS OF THE VENTRICLE** serve as a second "back-up" pacemaker. These ventricular cells send out impulses at a ***rate*** of **40 or less beats per minute**. ***No P wave*** will be recorded when an electrical impulse is ventricular in origin. The pathway taken to depolarize the ventricle is "abnormal" and takes more time and therefore, the **QRS complex** will be ***abnormally wide***.

In a normal healthy heart, spontaneous stimulation of the SA node results in the conduction of the impulse through the AV node, Bundle of His, right and left Bundle Branches, and the Purkinje Fibers. This natural conduction of an electrical stimulus reflects a 1:1 relationship between the atria and ventricles and is known as **AV SYNCHRONY**. When the conduction system does not work properly, the atria and ventricular systems may work independently. This is known as **AV DISSOCIATION**.

CARDIAC MONITORING

The purpose of cardiac monitoring is to obtain a picture of the heart's electrical activity that can be observed dynamically, in real time as the image progresses across the screen of a cardiac monitor. Early recognition of potentially fatal dysrhythmias allows for prompt interventions that may save lives.

The cardiac monitor receives the heart's electrical activity and creates an image that can be produced as a cardiac tracing printed on graph paper. The recorded strip may be used to evaluate the cardiac rhythm and can be kept for future reference and comparison.

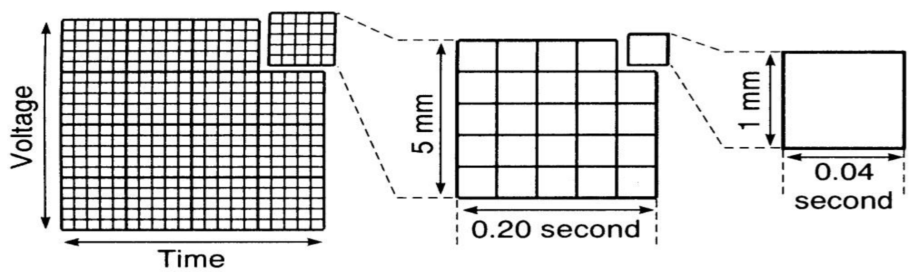
ECG GRAPH PAPER

An image of the heart's electrical activity is recorded on ECG graph paper. The speed at which the ECG recorder produces the ECG tracing is standard at 25 mm per second. This picture of cardiac electrical activity only reflects the few seconds in time that the strip is being printed.

Cardiac monitoring or ECG graph paper is standardized in the form of a grid. The horizontal and vertical lines are precisely spaced. The **HORIZONTAL LINES** that march across the horizontal axis from left to right represent ***time*** as measured in seconds or fractions of seconds. From each single vertical line to the next equals 0.04 seconds in time.

The **VERTICAL LINES** proceeding up and down along the vertical axis represent ***voltage*** (amplitude) as measured in millivolts (mV). Each small square measured vertically equals 0.1 mV.

Together the horizontal and vertical lines create a grid of squares or boxes. Every fifth line both horizontally and vertically is marked more heavily for ease of reading and measuring. So there are five squares or boxes in between each heavy line. Moving horizontally from one heavy vertical line to the next equals 0.20 seconds. The squares created by the heavy black lines are called “large boxes” and the little squares created by the lighter lines are called “small boxes” or “baby boxes”.



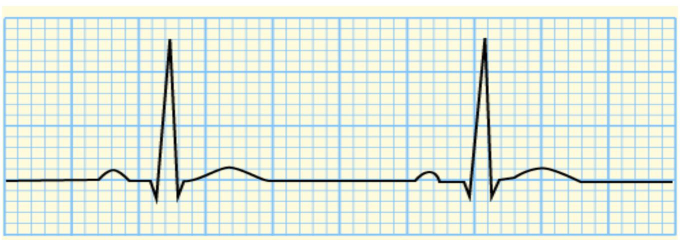
WAVEFORMS AND ELECTRICAL EVENTS

When electrical current or wave of depolarization travels toward the positive electrode, an upright (positive) deflection is recorded. When the depolarization wave travels away from the positive electrode, a downward (negative) deflection is recorded. A current traveling perpendicular to the positive electrode will record a biphasic deflection, that is, both positive and negative. When electrical forces are equal or no electrical event is occurring, an isoelectric line is recorded.

The stronger the current (millivolts) is the larger the deflection or amplitude, either positive or negative. If two positive electrical currents occur simultaneously, this may be reflected by a larger-than-normal upward deflection or the weaker (less amplitude) current may be “lost” in the stronger (greater amplitude) current. Also, if one positive and one negative electrical event of about the same strength happen at the same time, the currents may cancel each other out resulting in an isoelectric line.

The components of the ECG waveform are waves, complexes, segments, and intervals. These reflect electrical depolarization and repolarization of the atria and ventricles. Each wave is individually named for common reference.

The **P WAVE** reflects atrial depolarization, the **QRS COMPLEX** (QRSc) is generated by ventricular depolarization, the **T WAVE** results from ventricular repolarization. Atrial repolarization is not typically seen in the ECG recording because it normally occurs during ventricular depolarization. Ventricular depolarization is the stronger electrical event and, therefore, supersedes and prevents seeing atrial repolarization reflected in the ECG tracing. Each **P-QRS-T** electrical sequence generates one mechanical heartbeat.



The **PR interval (PRi)** reflects the time it takes for an electrical impulse to leave the sinus node, depolarize the atria, and arrive at the atrioventricular node. The **ST SEGMENT** is the early part of ventricular repolarization. The **QT INTERVAL** encompasses the entire ventricular cycle (depolarization and repolarization). Finally, the **TP SEGMENT** occurs between heartbeats when electrical activity is absent and cells are at rest.

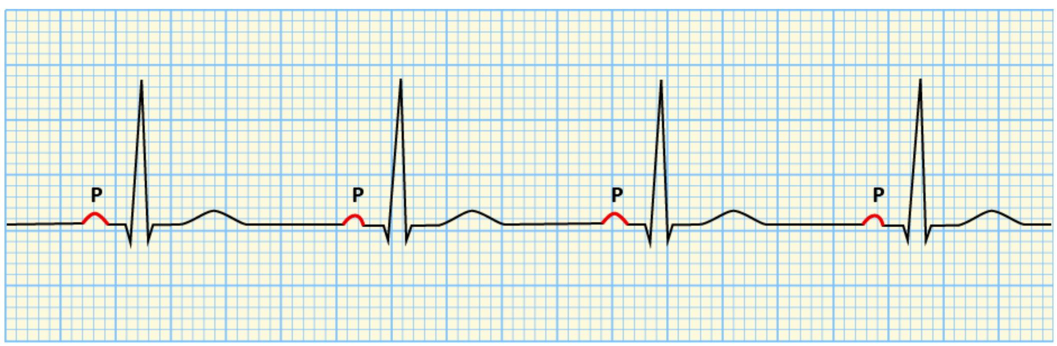
ECG rhythm interpretation begins with analysis of the characteristics of each wave, complex, segment, and interval. Normal or abnormal components of the waveform are identified.

As the ECG tracing moves across the graph paper (across the vertical lines), the amount of **time** it takes for the current or electrical impulse to travel throughout the heart can be determined. ECG rhythm interpretation also includes measuring the duration of the heart's electrical events and evaluating for normalcy or abnormality.

P WAVES

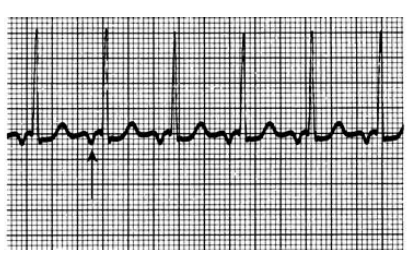
Normal characteristics

- Present
- Smooth and rounded
- Usually positive (upright)
- Followed by a QRS complex
- 1:1 relationship with QRS complex

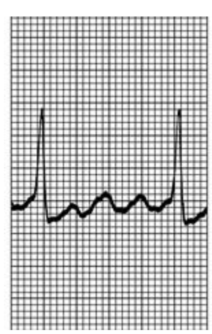


Abnormal Characteristics

- Peaked
- Tall
- Notched
- Biphasic
- Inverted
- Absent
- Not followed by QRS complex
- More P's than QRS complex



Inverted



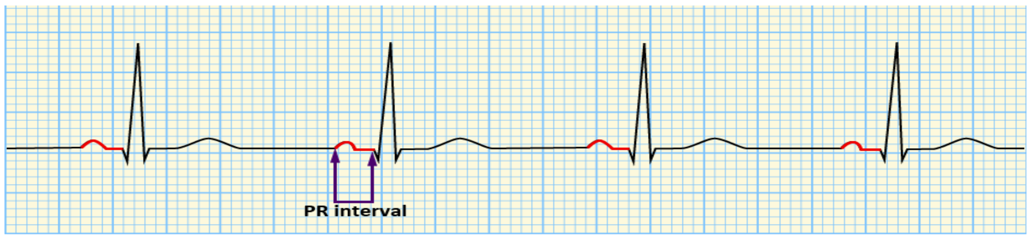
Saw-tooth

Wavy

PR INTERVALS

Normal characteristics

- Duration 0.12-0.20 seconds (measure from beginning of P wave to beginning of Q wave)
- Isoelectric
- Remains constant
- Followed by a QRS complex



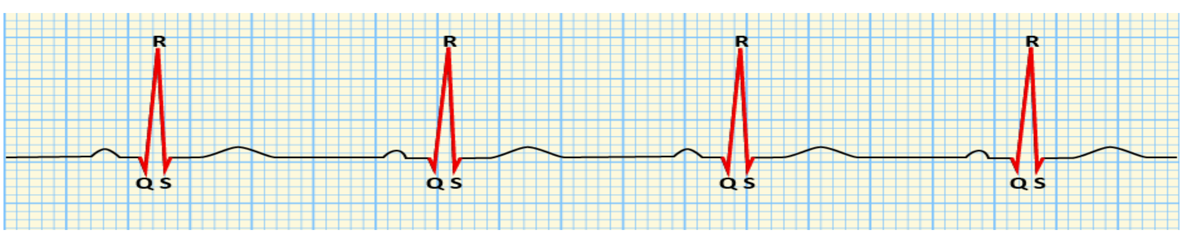
Abnormal Characteristics

- Duration < 0.12 seconds
- Duration > 0.20 seconds
- Not constant (intervals vary)

QRS COMPLEX

Normal characteristics

- May have different shapes *but consistent for a particular rhythm*, portions may be absent (see variations below)
- QRS primarily positive in Lead II
- QRS primarily negative in MCL1
- preceded by one P wave
- duration 0.04-0.10 seconds (measure from beginning of Q wave to ending of S wave)
- Values vary for pediatric patients



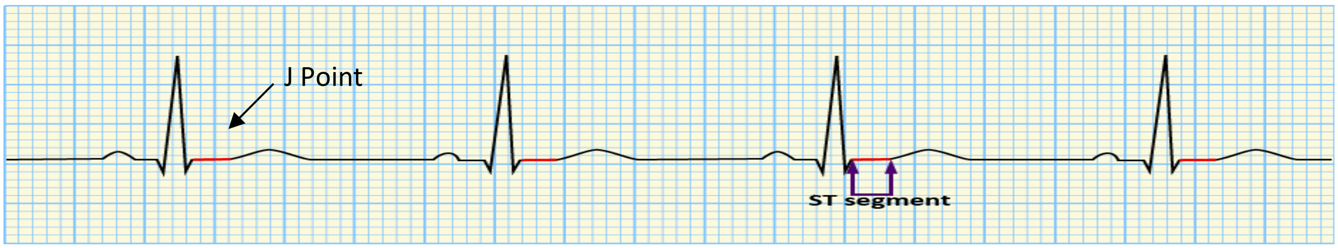
Abnormal Characteristics

- Slurred
- Notched
- Absent
- Nor preceded by p wave
- Duration > 0.10 seconds (wide)

ST SEGMENT

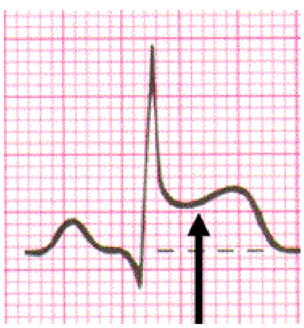
Normal characteristics

- Begins at ending of S wave and ends at the beginning of T wave
- Isoelectric component: 0.04 seconds **after** J point (junction), end of S wave and beginning of ST segment



Abnormal Characteristics

- ST elevation: Displacement of the ST segment above the isoelectric line greater than 1 mm. Most common cause is myocardial injury.
- ST Depression: Displacement of the ST segment below the isoelectric line greater than 1 mm. Most common cause is myocardial ischemia.



ST Elevation

ST Depression

T WAVE

Normal characteristics

- More sharply blunted or rounded than P wave and slightly asymmetrical
- Positive if QRS complex positive
- Always follows QRS c complex

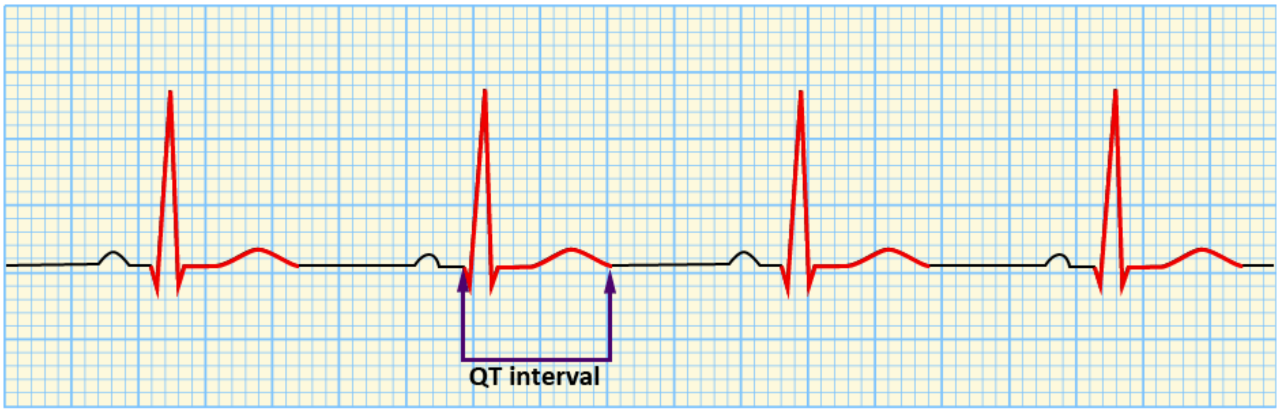
Abnormal Characteristics

- Inverted
- Sharply peaked
- Tall
- Wide
- Biphasic
- Flat or absent

QT INTERVAL

Normal characteristics

- Measure from beginning of Q wave to ending of T wave
- Varies with heart rate (slower HR, longer QT)
- Generally, < 0.45 seconds
- Generally, < one-half previous R-R interval but varies depending upon heart rate (and sex)

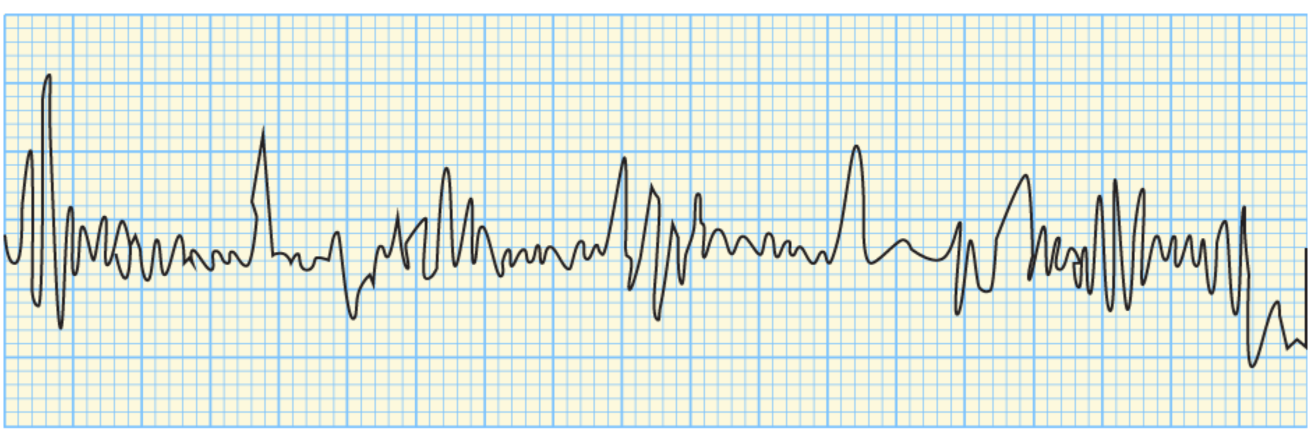


Abnormal Characteristics

- > 0.44 seconds, generally
- One-half previous R-R interval, generally

ARTIFACT

Distorted waveforms can be caused by external sources. The underlying cardiac rhythm recorded from the heart's electrical activity can be difficult or impossible to see through the distortion or interference. Types of external causes of ***artifact*** include muscle tremors, shivering, patient movement, and breathing, poor electrode contact with the skin, broken wire, alternating current (AC) or 60-cycle interference. Artifact should be considered whenever an abnormal ECG tracing is seen. The cause of the artifact should be identified and rectified prior to cardiac rhythm analysis. Patient assessment and equipment evaluation will help with proper rhythm interpretation.



STEPS IN RHYTHM INTERPRETATION

To properly interpret an ECG rhythm, a consistent set of steps must be followed. After systematic analysis to determine normal or abnormal components, the rhythm is identified. The steps in rhythm interpretation are:

1. Determine regularity
2. Calculate HR
3. Examine P-waves
4. Measure PR interval
5. Measure QRS complex
6. Identify/Name the rhythm

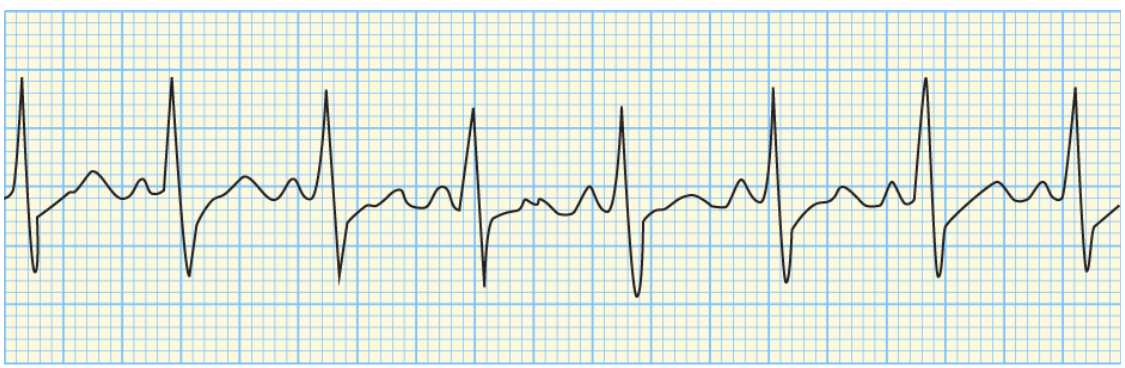
Step 1 – Determine Rhythm Regularity

There are two types of regularity:

- Regular
- Irregular

A rhythm is considered REGULAR if the R-R intervals do not vary by more than 0.12 seconds or three small boxes. When the R-R interval varies by more than 0.12 seconds, the rhythm is irregular.

A "regular except" rhythm is when most beats occur regularly but this regularity is interrupted by one or two beats that occur earlier or later. Look for a pattern to the irregularity. An "irregularly irregular" rhythm is when there is no predictability to the rhythm.



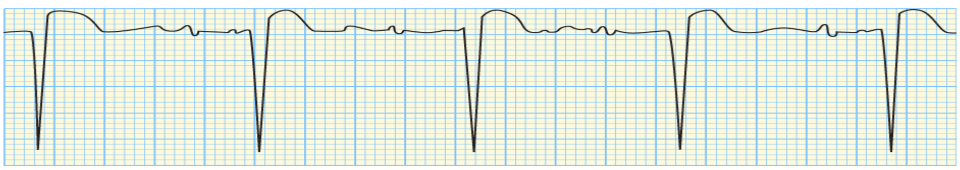
Measuring Rhythm Regularity:

There are multiple methods for determining rhythm regularity. They are listed as follows.

One method for determining rhythm regularity is to use ECG calipers. Both caliper points are placed on adjacent QRS complex peaks. Then, without changing the distance, swing one point or move both points of the calipers to each consecutive QRS complex peak. Ventricular regularity, irregularity, or interruptions can be identified.

Regularity may also be calculated using a paper and pencil. Place the edge of the paper over the strip so that only the R- R peaks are visible. Mark a tic on the paper for the first two peaks. Move the paper to the right measuring each R-R interval. The ventricular rhythm is regular if they match. This method may be particularly useful if multiple tic marks are made on the paper for each R wave and then the tic marks can be realigned over the tips of many different R waves. Regular and irregularly irregular rhythms may be more easily identified.

The final method for determining rhythm regularity involves counting. Simply count the number of boxes between each QRS complex peak and compare all the R-R intervals. This is an accurate but time-consuming method for determining rhythm.



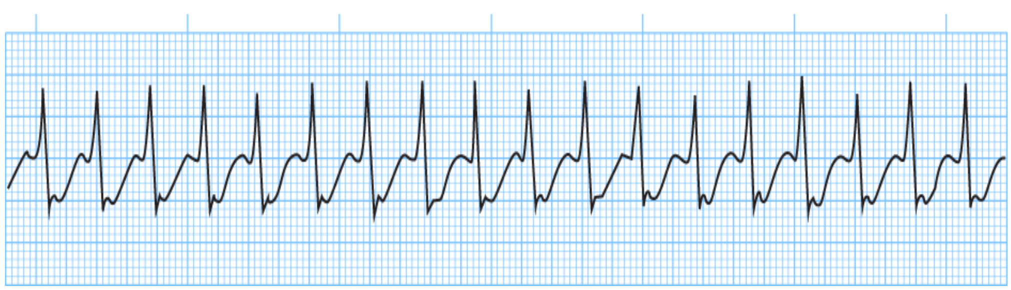
Noting ventricular regularity is a primary concern because the ventricular complex initiates the mechanical contraction of the ventricle that results in a pulse. It may also be helpful to evaluate the P waves for atrial regularity when interpreting a rhythm. All the above techniques can be applied similarly to P waves. However, it can be more challenging if the 1:1 relationship between the P wave and QRS is lost. Are there too many P waves or do the PR intervals vary? If either occurs, the P wave may get "lost" or "hidden" in a QRS or land on a T wave. Just because an electrical event is not "seen" by being recorded on the ECG does not mean it did not occur.

STEP 2 - CALCULATE HEART RATE

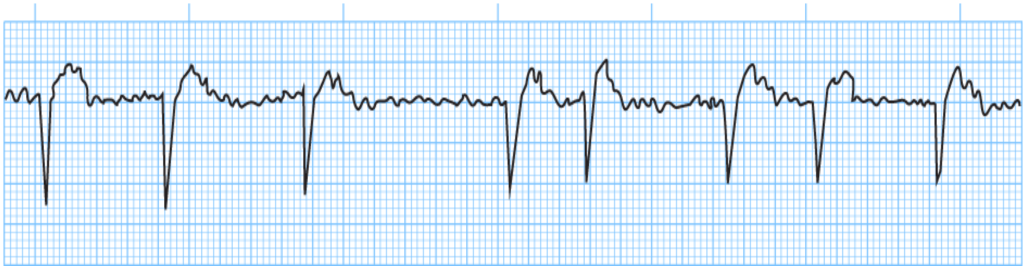
There are a number of ways to determine the Atrial and Ventricular rates.

ECG paper is marked in three - second intervals or sometimes every second. (Every five large boxes equal one second.)

1. When the rhythm is **REGULAR**, a **MOST ACCURATE METHOD** for determining heart rate is to count the number of small boxes between <u>two adjacent QRS complexes (or P waves)</u>. Divide this number into **1500** to determine the ventricular (or atrial) rate. This is the basis for a "<u>Heart Rate Table</u>" in which the heart rates are already calculated.



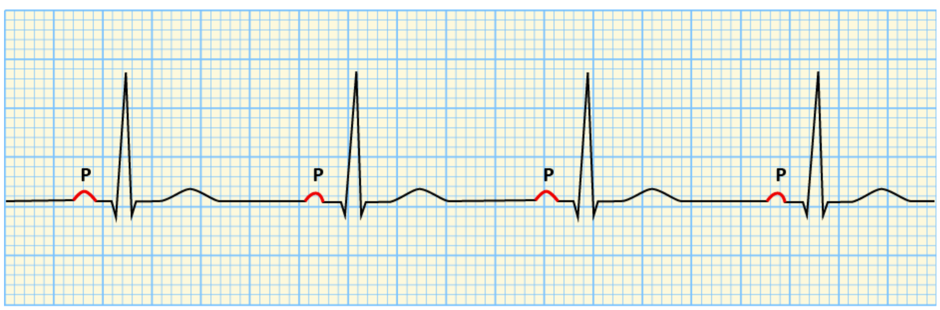
2. When the rhythm is ***IRREGULAR***, simply count the number of QRS complexes in any six-second interval and multiply this number by ten. The atrial rate can be calculated the same way using P waves. Don't forget some P waves may be hidden; they still count because the atria are depolarizing and contracting.



KEY POINTS: Premature ectopic beats are not included when calculating heart rate

Step 3 – Identify and examine the P Waves

Once identified, determine whether they have normal characteristics. Are they all the same size, shape, and direction? Are they upright (positive), smooth, and rounded? And, what relationship do the P waves have with the QRS complexes? Are they consistently present before each QRS complex (1:1)? Is the P-P interval regular?

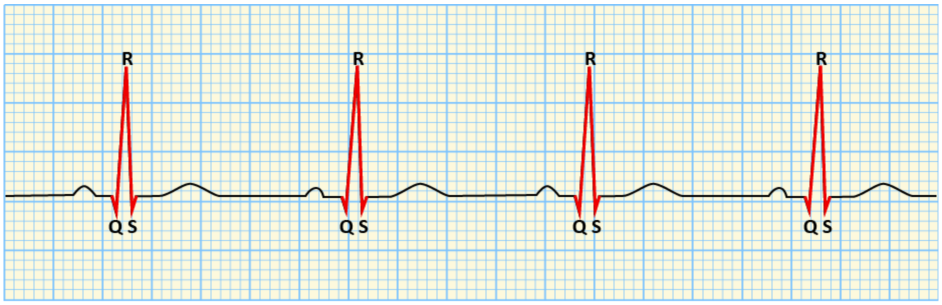


Step 4 – Measure PR Interval

PR interval is between 0.12 and 0.20 seconds. Evaluate if PR intervals varies, constant or do they progressively lengthen.

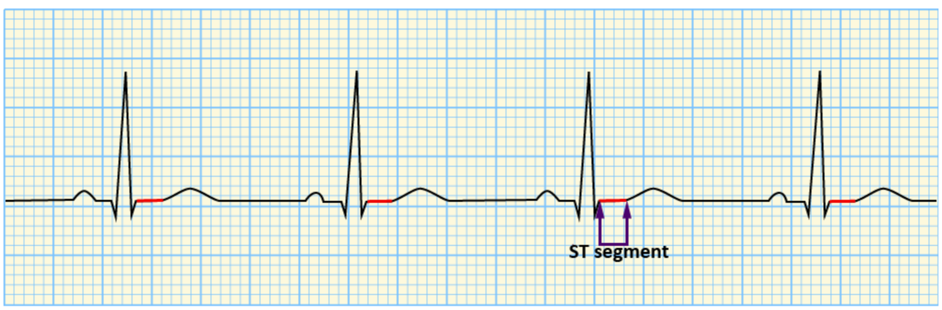
Step 5 – Measure the QRS Complex

Evaluate if the QRS complexes are all the same size, shape, and direction, consistently after a P wave and before a T wave, QRS duration normal (0.10 seconds or less).



Evaluate the ST Segment

Evaluation of the ST segments comes next. To evaluate the ST segment, identify the J point, move one small box to the right and compare it to the isoelectric baseline. The isoelectric baseline is the T-P segment and/or the PR segment. Is this point isoelectric (on the same level as the isoelectric line), depressed, or elevated? A depressed ST segment may indicate hypoxia, whereas an elevated ST segment may indicate myocardial injury or infarct

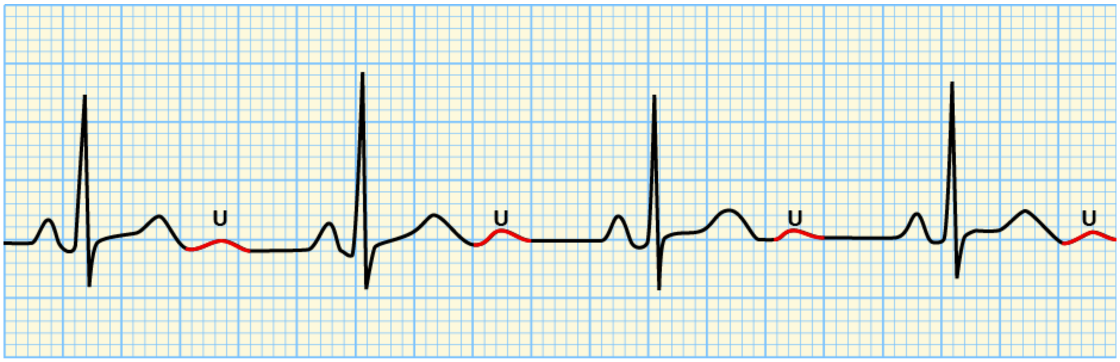


Evaluate the T Waves

Is the T wave normal (upright, positive), inverted, flat, or biphasic? Also, does the T wave appear peaked? Altered T waves may be due to possible myocardial ischemia, altered electrolyte levels, effects from drugs, diseased myocardial tissue or even the lead used for monitoring

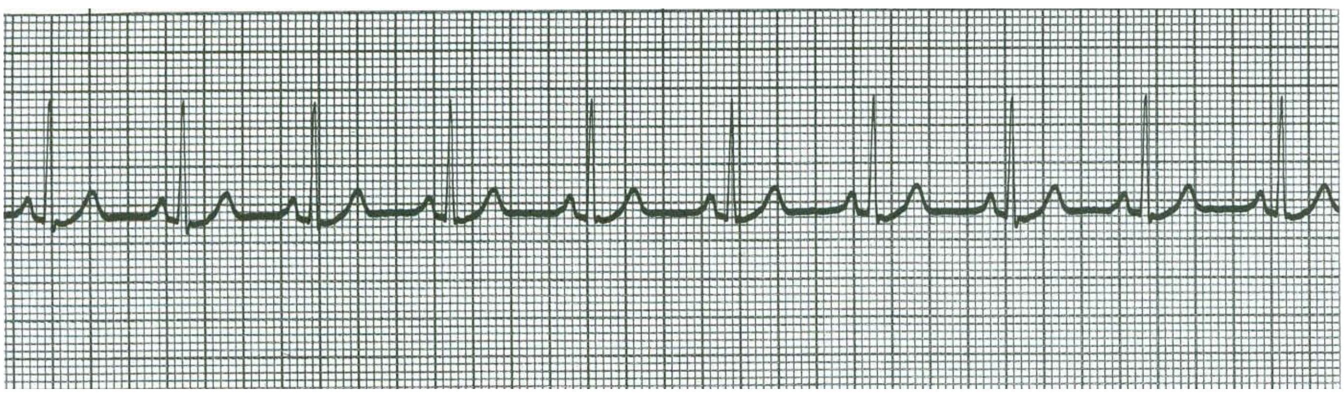
Check for presence of U Waves

The presence of U waves should be noted, especially to distinguish between U waves and P waves. U waves may become more pronounced in an abnormally long repolarization, when there is hypokalemia or with certain drugs.



SINUS ARRHYTHMIAS

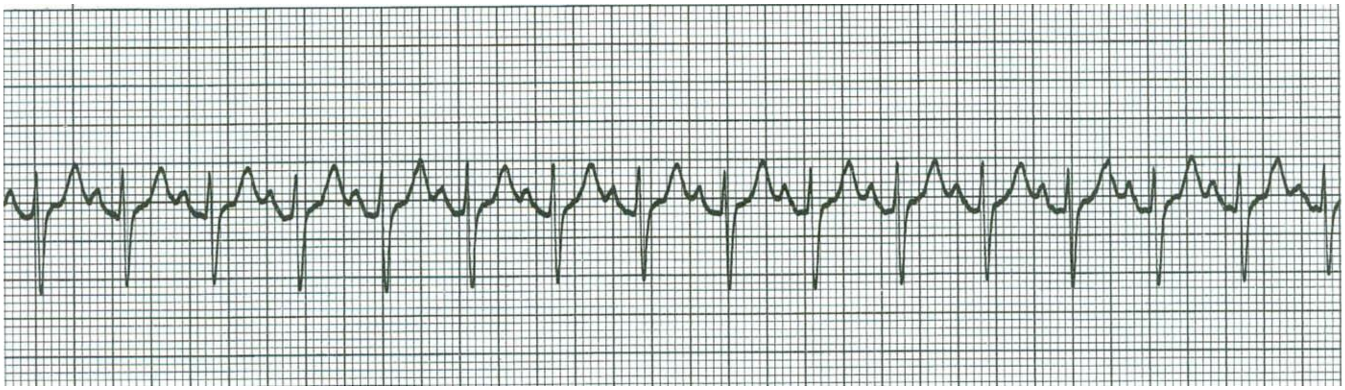
Normal Sinus Rhythm



Identifying ECG Features

- **Rhythm:**
  - Atrial: Regular
  - Ventricular: Regular
- **Rate:** 60-100 beats/ minute
- **P waves:** Positive in lead II; normal in size, shape, direction, P wave preceeds each QRS
- **PR Interval:** Normal (0.12-o.20 sec)
- **QRS complex:** Normal 0.10 sec or less

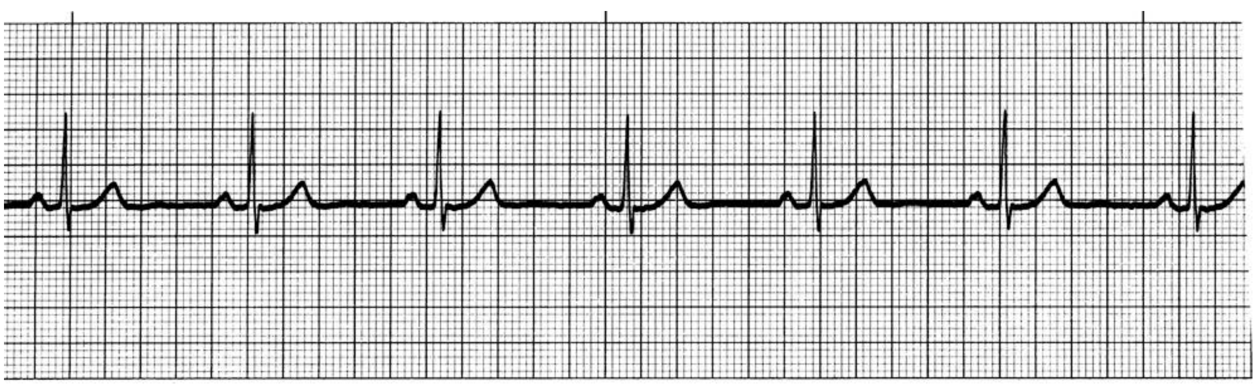
Sinus Tachycardia



Identifying ECG Features

- **Rhythm:**
  - Atrial: Regular
  - Ventricular: Regular
- **Rate:** 100-160 beats/ minute
- **P waves:** Positive in lead II; normal in size, shape, direction, P wave precedes each QRS
- **PR Interval:** Normal (0.12-o.20 sec)
- **QRS complex:** Normal (0.10 sec or less)

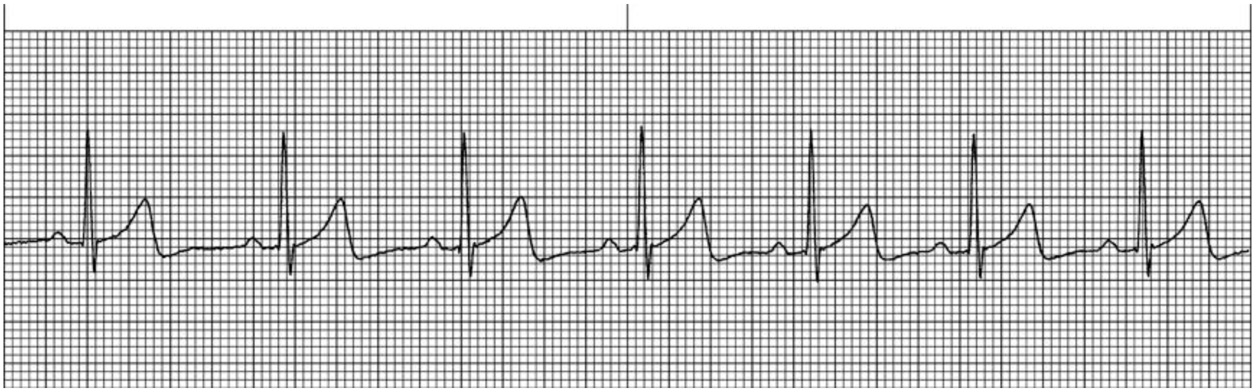
Sinus Bradycardia



Identifying ECG features

- **Rhythm:** Regular
- **Rate:** 40 to 60 beats/minute
- **P waves:** Normal in size, shape, direction; positive in lead II, a positive lead; one P wave precedes each QRS complex
- **PR interval:** Normal (0.12 to 0.20 second)
- **QRS complex:** Normal (0.10 second or less)

Sinus Arrhythmia

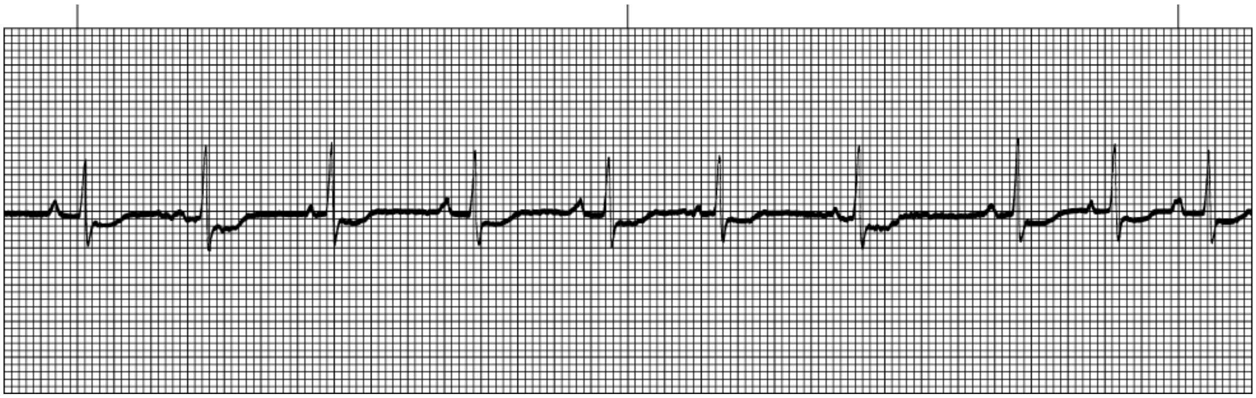


Identifying ECG features

- **Rhythm:** Irregular – If there is a different of 3 or more small boxes (0.12 sec. or greater)
- **Rate:** Normal (60 to 100 beats/minute) or slow (less than 60 beats/minute; often seen with a bradycardic rate)
- **P waves:** Normal in size, shape, direction; one P wave precedes each QRS complex
- **PR interval:** Normal (0.12 to 0.20 second)
- **QRS complex:** Normal (0.10 second or less)

ATRIAL ARRHYTHMIAS

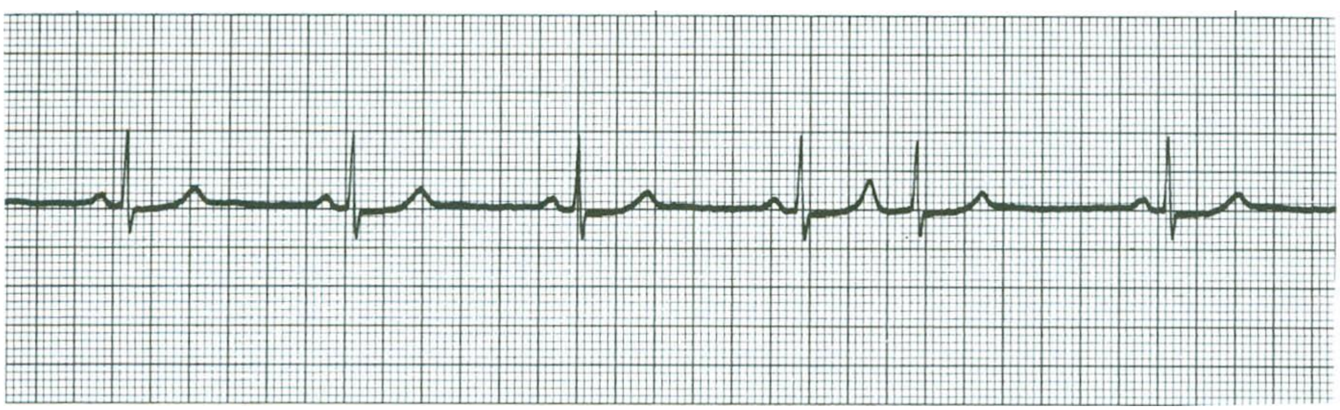
Wandering Atrial Pacemaker



Identifying ECG features

- **Rhythm:** Regular or irregular
- **Rate:** Normal (60 to 100 beats/minute) or slow (less than 60 beats/minute)
- **P waves:** Vary in size, shape, direction across rhythm strip (3 or more P wave variations); one P wave precedes each QRS complex
- **PR interval:** Usually normal duration, but may be abnormal depending on changing pacemaker locations
- **QRS complex:** Normal (0.10 second or less)

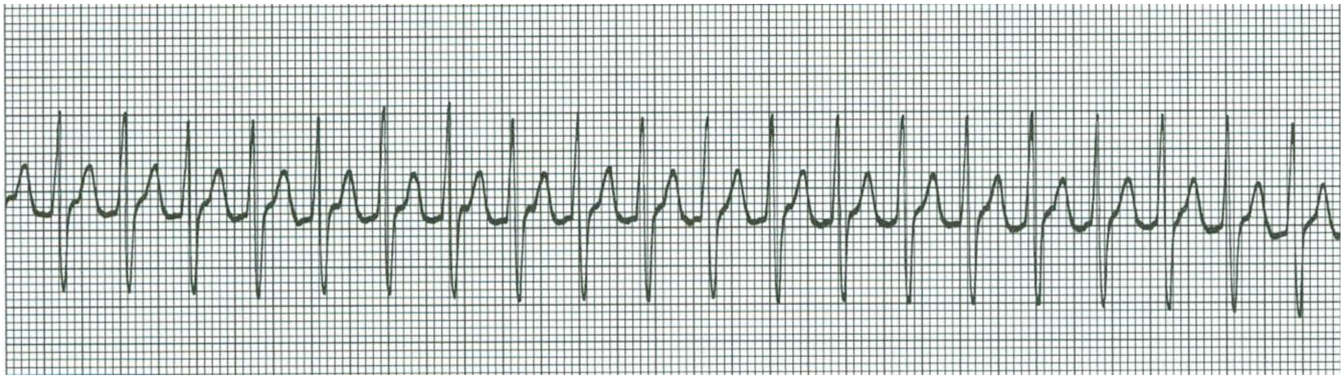
Premature Atrial Contraction (PAC)



Identifying ECG Features

- **Rhythm:** Usually regular on basic rhythm; irregular with PAC
- **Rate:** That of basic rhythm
- **P waves:** Abnormal in size, shape, direction, often found hidden in preceding T-wave distorting T-wave contour
- **PR Interval:** Usually normal but maybe abnormal, not measurable if hidden in preceding T-wave
- **QRS complex:** Normal (0.10 sec or less)

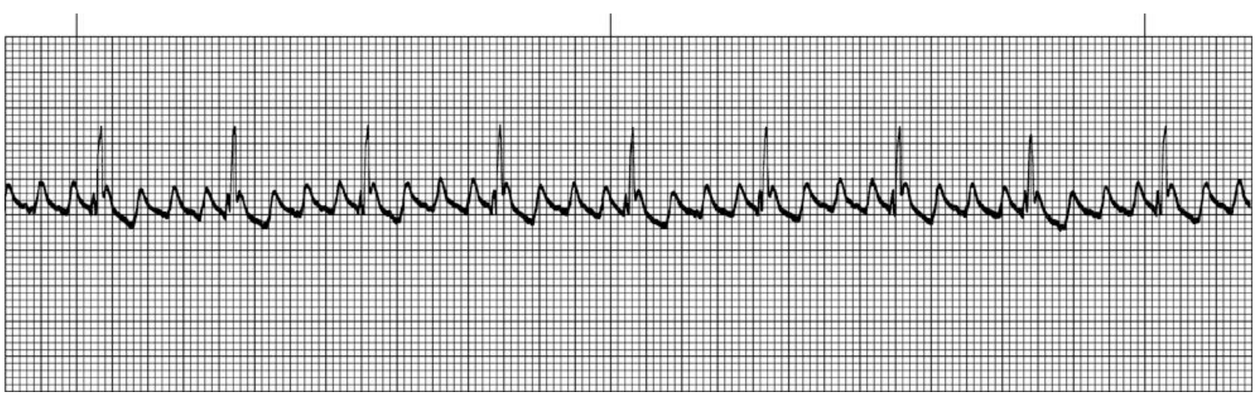
Supraventricular Tachycardia (SVT) / Paroxysmal Atrial Tachycardia (PAT)



Identifying ECG features

- **Rhythm:** Regular
- **Rate:** 140 to 250 beats/minute
- **P waves:** Abnormal (commonly pointed); usually hidden in preceding T wave so that T wave and P wave appear as one wave defection (T-P wave); one P wave to each QRS unless AV block is present
- **PR interval:** Usually not measurable
- **QRS complex:** Normal (0.10 second or less)

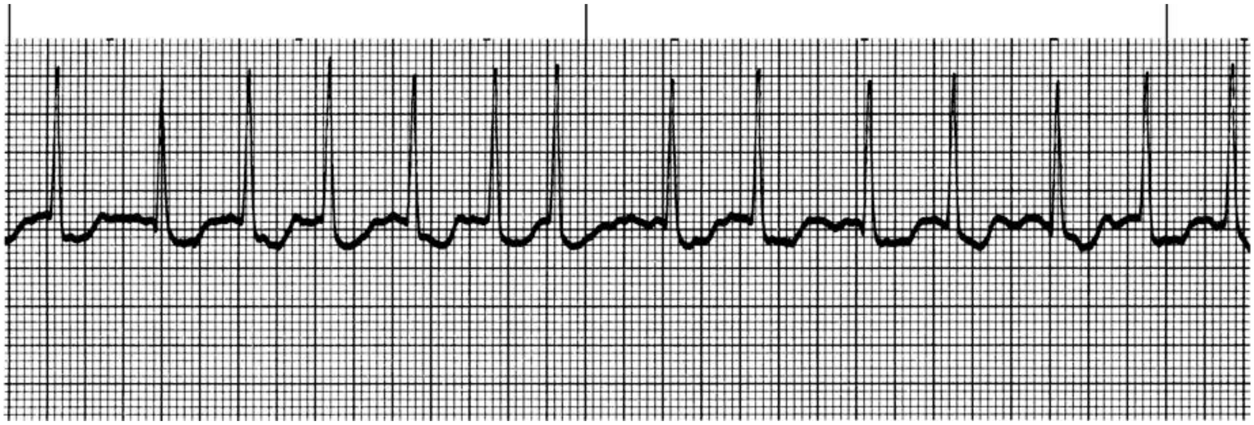
Atrial Flutter



Identifying ECG features

- **Rhythm:** Regular or irregular (depends on AV conduction ratios)
- **Rate: Ventricular -** Varies with number of impulses conducted through AV node; will be less than that of the atrial rate
- **P waves:** Sawtooth-wave deflections affecting the entire baseline
- **PR interval:** Not measurable
- **QRS complex:** Normal (0.10 second or less)

Atrial Fibrillation with Uncontrolled Ventricular Rate



Identifying ECG features

- **Rhythm:** Grossly irregular (unless ventricular rate is rapid, in which case the rhythm becomes more regular)
- **Rate: Ventricular - Varies with number of impulses conducted through AV node to ventricles; ventricular rate is uncontrolled if rate is greater than 100 beats/minute**
- **P waves:** Wavy deflections that affect the entire baseline
- **PR interval:** Not measurable
- **QRS complex:** Normal (0.10 second or less)

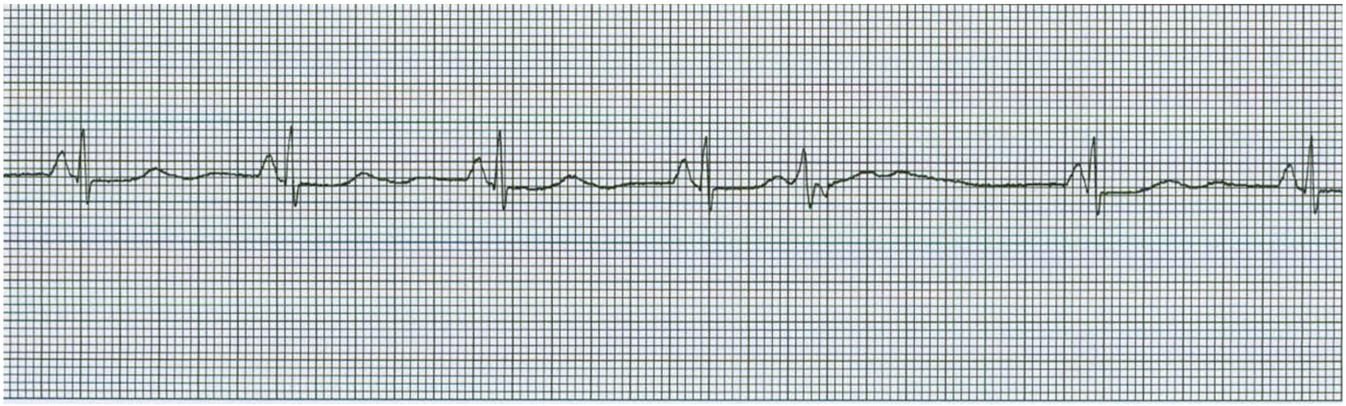
Atrial Fibrillation with Controlled Ventricular Rate

Identifying ECG features

- **Rhythm**: Grossly irregular (unless ventricular rate is rapid, in which case the rhythm becomes more regular)
- **Rate: Ventricular**: Varies with number of impulses conducted through AV node to ventricles; ventricular rate is controlled if rate is less than 100 beats/minute
- **P waves**: Wavy deflections that affect the entire baseline
- **PR interval**: Not measurable
- **QRS complex**: Normal (0.10 second or less)

JUNCTIONAL ARRHYTMIAS & AV BLOCKS

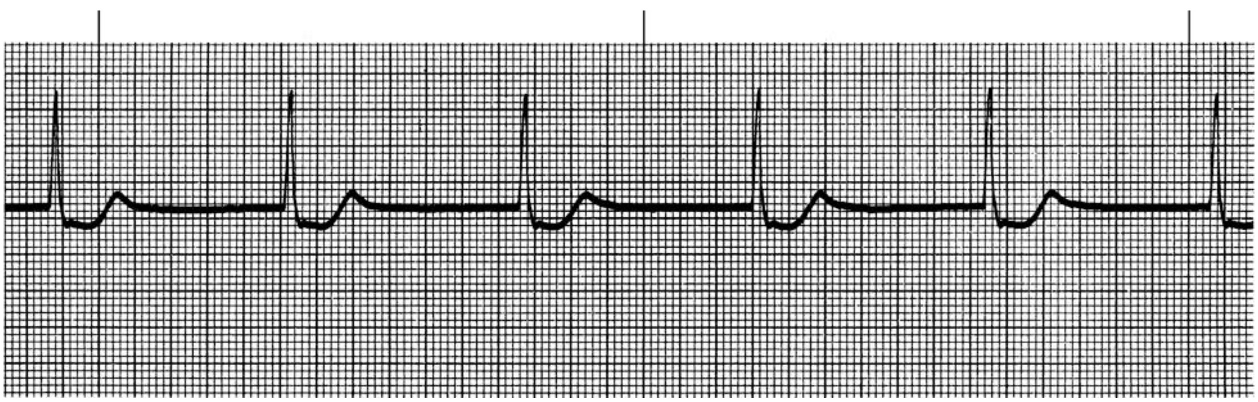
Premature Junctional Contraction



Identifying ECG Features

- **Rhythm:** Usually regular on basic rhythm; irregular with PJC
- **Rate:** That of basic rhythm
- **P waves:** Inverted in lead II; occurs immediately before QRS, immediately after QRS, or hidden within QRS.
- **PR Interval:** Short (0.10 sec or less)
- **QRS complex:** Normal (0.10 sec or less)

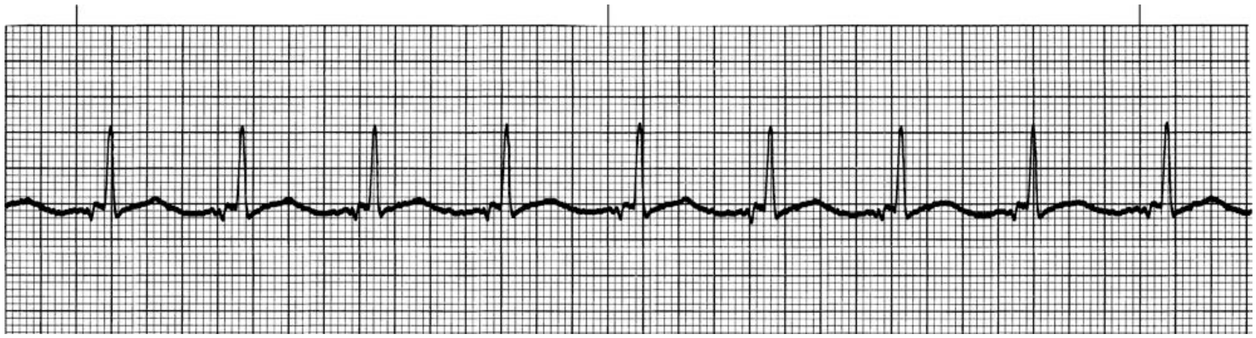
Junctional Rhythm



Identifying ECG features

- Rhythm: Regular
- **Rate:** 40 to 60 beats/minute
- **P waves:** Inverted will occur immediately before the QRS, immediately after the QRS, or will be hidden within the QRS complex
- **PR interval:** Short (0.10 second or less)
- **QRS complex:** Normal (0.10 second or less)

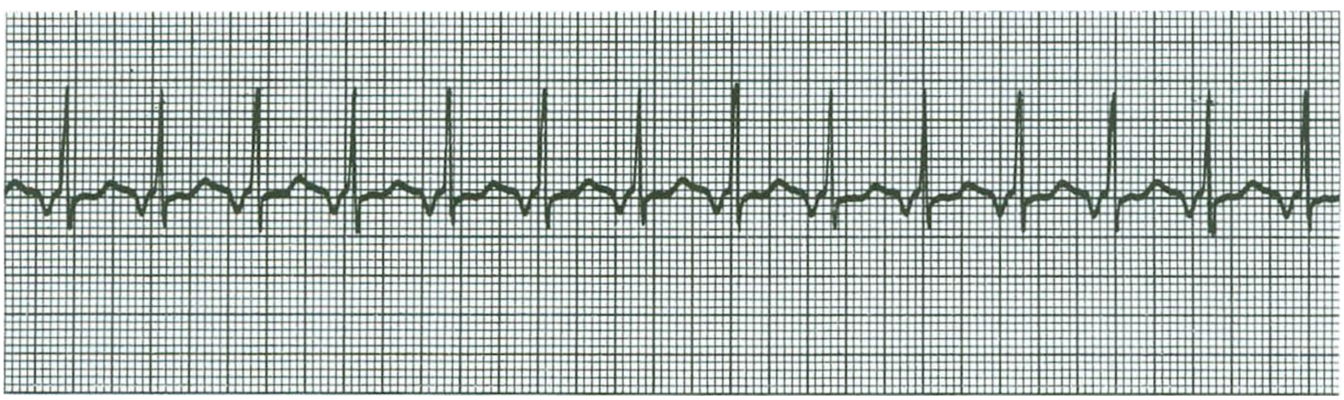
Accelerated Junctional Rhythm



Identifying ECG features

- **Rhythm:** Regular
- **Rate:** 60 to 100 beats/minute
- **P waves:** Inverted and will occur immediately before the QRS, immediately after the QRS, or will be hidden within the QRS complex
- **PR interval:** Short (0.10 second or less)
- **QRS complex:** Normal (0.10 second or less)

Junctional Tachycardia



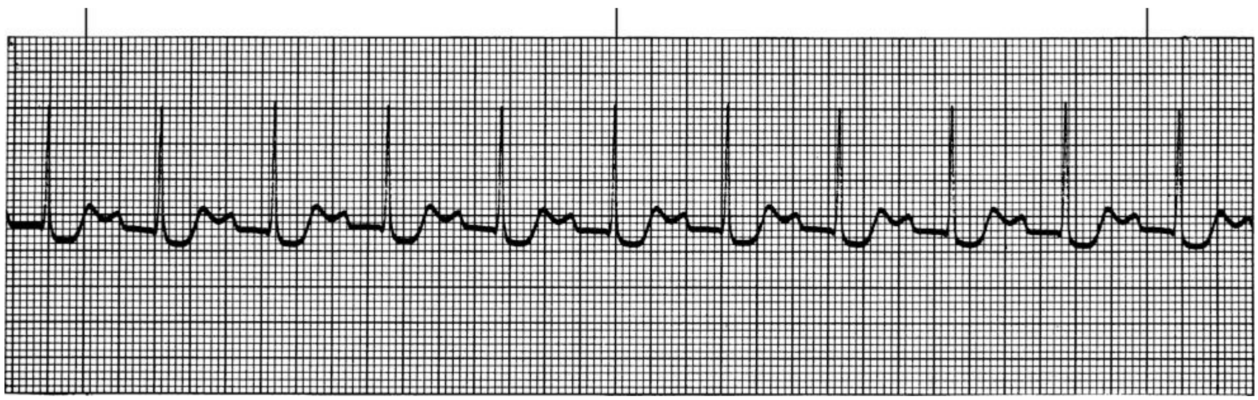
Identifying ECG Features

- **Rhythm:** Regular
- **Rate:** >100 beats/ minute
- **P waves:** Inverted in lead II; occurs immediately before QRS, immediately after QRS, or hidden within QRS.
- **PR Interval:** Short (0.10 sec or less)
- **QRS complex:** Normal (0.10 sec or less)

A-V BLOCKS

- The term heart block is used to describe arrhythmias in which there is delayed conduction or failed conduction of impulses through the AV node into the ventricles.
- AV blocks are classified into first degree, second degree (type I and II), and third-degree AV block.
- The PR interval is the key to identify the type of block present.
- The QRS complex and the ventricular rate are keys to differentiating the location of the block.
    - The lower the location of the block the wider the QRS and the slower the ventricular rate.

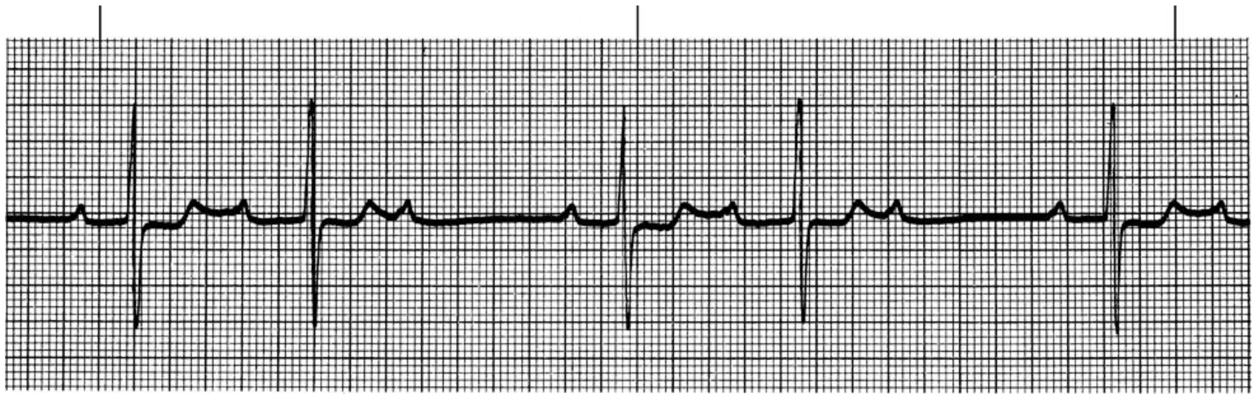
First Degree AV-Block



Identifying ECG features

- **Rhythm:** Usually regular
- **Rate:** That of the underlying sinus rhythm
- **P waves:** Sinus; one P wave to each QRS complex
- **PR interval:** Prolonged (greater than 0.20 second); remains consistent
- **QRS complex:** Normal (0.10 second or less)

Second Degree AV-Block Type I (Mobitz I)



Identifying ECG features

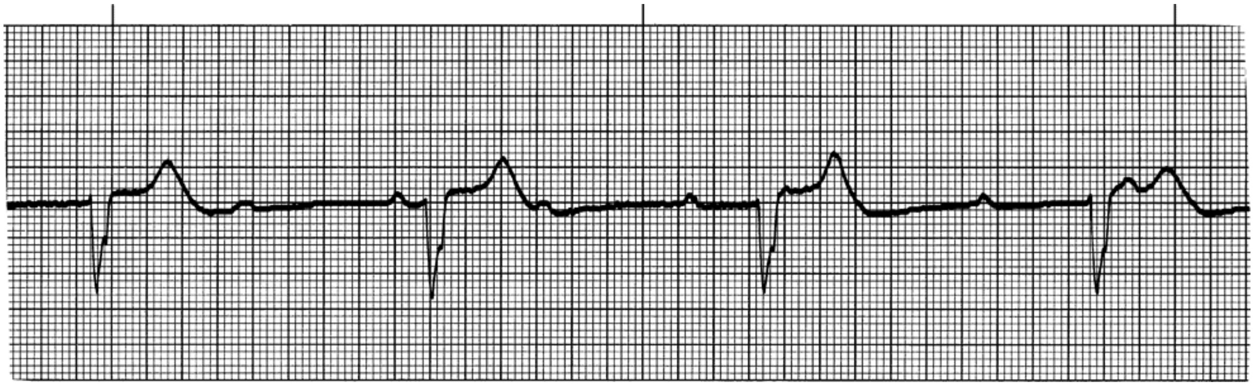
- **Rhythm:**
  - **Atrial:** Regular
  - **Ventricular:** Irregular
- **P waves:** Sinus
- **PR interval:** Progressively lengthens until a P wave isn't conducted (P wave appears without QRS complex); a pause follows the dropped QRS complex
- **QRS complex:** Normal (0.10 second or less)

Second Degree AV-Block Type II (Mobitz II)

Identifying ECG features

- **Rhythm:**
  - **Atrial:** Regular
  - **Ventricular:** Usually regular; may be irregular if AV conduction ratios vary
- **P waves:** Sinus; two or three P waves (sometimes more) before each QRS complex
- **PR interval:** Normal or prolonged; remains consistent
- **QRS complex:** Normal duration if block at bundle of His; wide if block in bundle branches

Third Degree AV-Block (Complete Heart Block)

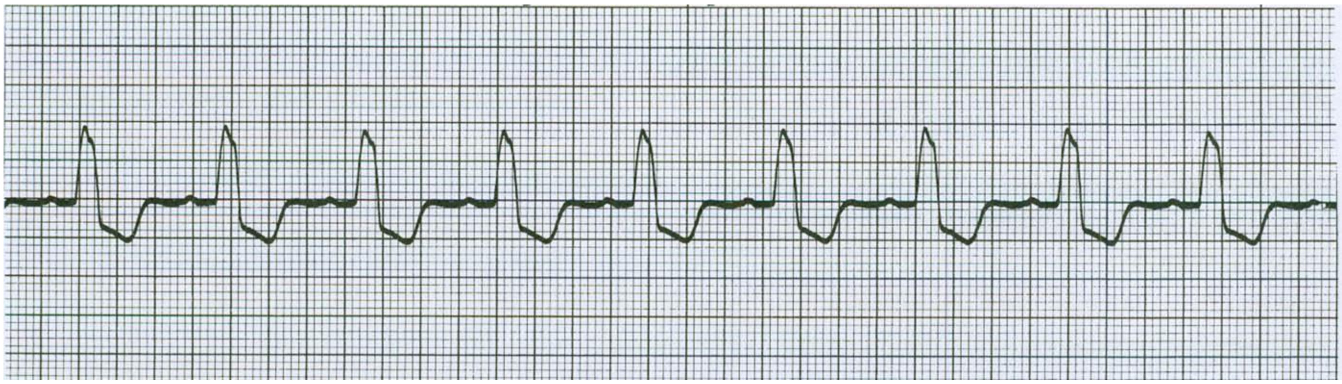


Identifying ECG features

- **Rhythm:**
  - Atrial: Regular
  - Ventricular: Regular
- **P waves:** Sinus P waves with no consistent relationship to the QRS complex; P waves found hidden in QRS complexes, ST segments, and T waves
- **PR interval:** Varies (is not consistent)
- **QRS complex: Normal duration if block at level of AV node or bundle of His; wide if block in bundle branches**

VENTRICULAR RHYTHMS & BUNDLE BRANCH BLOCK

Bundle Branch Block



Identifying ECG Features

- **Rhythm:** Regular
- **Rate:** That of basic rhythm (usually sinus)
- **P waves:** Sinus origin
- **PR Interval:** Normal (0.12-0.20 sec)
- **QRS complex:** Wide (0.12 sec or greater)

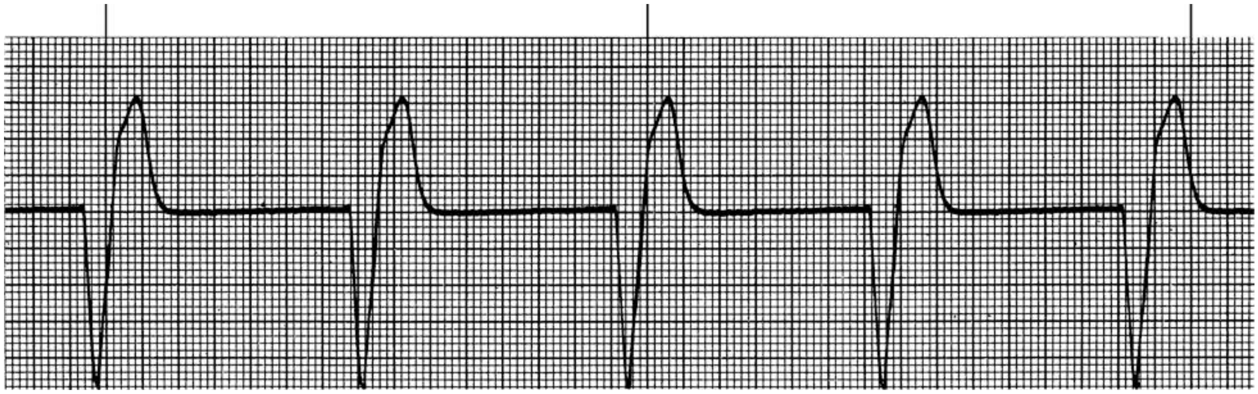
Premature Ventricular Contraction (PVC)

Identifying ECG Features

- Rhythm: Basic rhythm usually regular; irregular with PVC
- Rate: That of underlying rhythm
- P waves: None associated with PVC
- PR Interval: Not measurable
- QRS complex**:** Premature, abnormal, wide (0.12 sec or greater)
- **Patterns:**
  - Bigeminy: PVC every other beat
  - Trigeminy: PVC every 3rd beat
  - Quadrigeminy: PVC every 4th beat
  - Couplet: PVCs in pairs, 2 in a row

KEY POINT: Run of 3 or more PVCs constitute a Rhythm. The rate will determine which rhythm is present.

Idioventricular Rhythm



Identifying ECG features

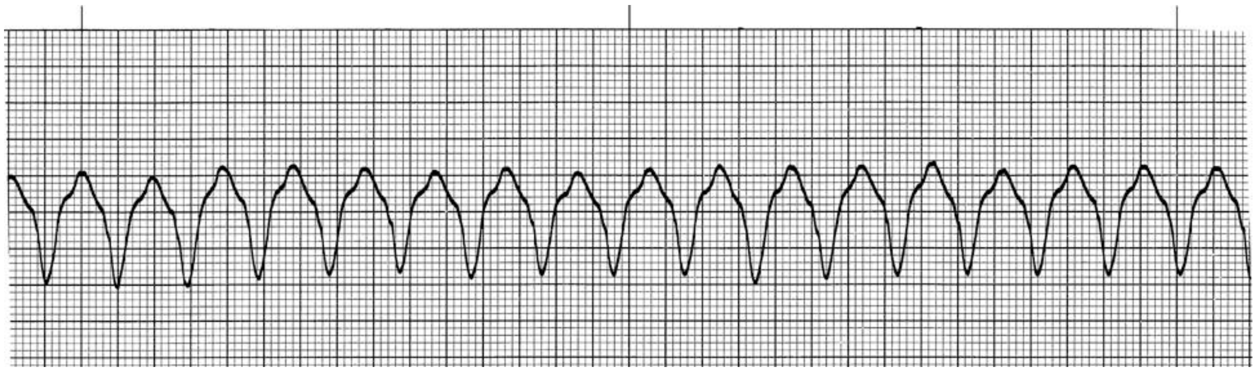
- **Rhythm:** Regular
- **Rate:** 30 to 40 beats/minute (sometimes less)
- **P waves:** Absent
- **PR interval:** Not measurable
- **QRS complex:** Wide (0.12 second or greater)

Accelerated Idioventricular Rhythm (AIVR)

Identifying ECG Features

- **Rhythm:** Regular
- **Rate:** 50-100 beats/min
- **P waves:** Absent
- **PR Interval:** Not measurable
- **QRS complex:** Wide (o.12 sec or greater)

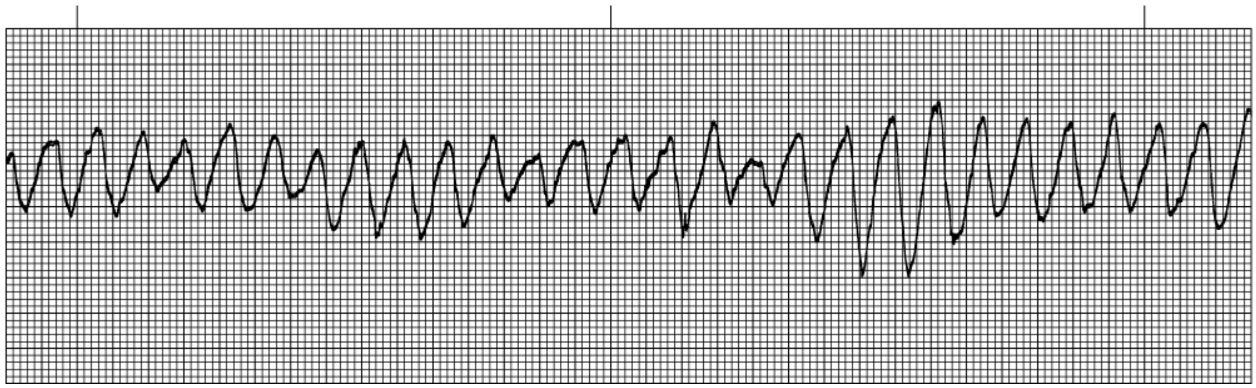
Ventricular Tachycardia (Sustained VT, Monomorphic)



Identifying ECG features

- **Rhythm**: Usually regular (may be slightly irregular)
- **Rate**: 140 to 250 beats/minute
- **P waves**: No associated P waves
- **PR interval**: Not measurable
- **QRS complex**: Wide (0.12 second or greater) with ST segments and T waves sloping opposite the main QRS deflection

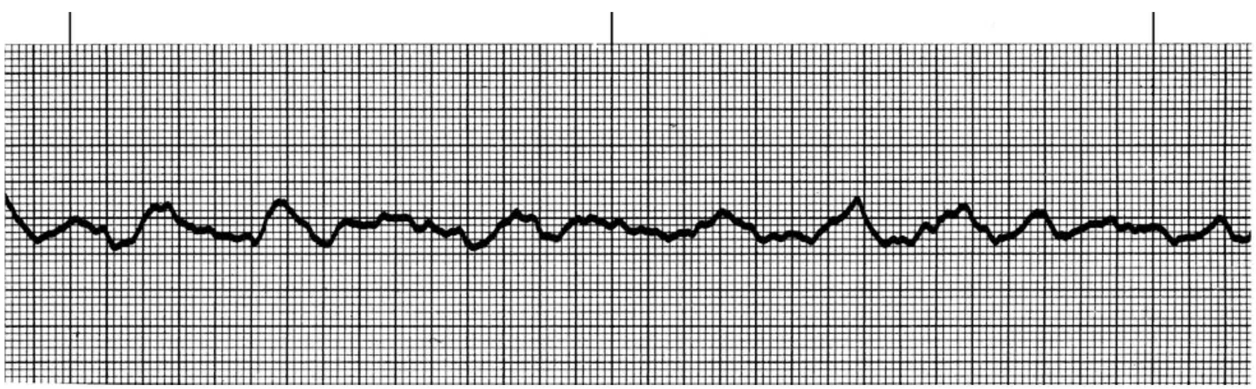
Torsade de Pointes (Polymorphic Ventricular Tachycardia)



Identifying ECG features

- **Rhythm:** Usually regular (may be slightly irregular)
- **Rate:** 200 beats/minute or more
- **P waves:** None
- **PR interval:** Not measurable
- **QRS complex:** 0.12 second or greater (some much wider than others)

Ventricular Fibrillation

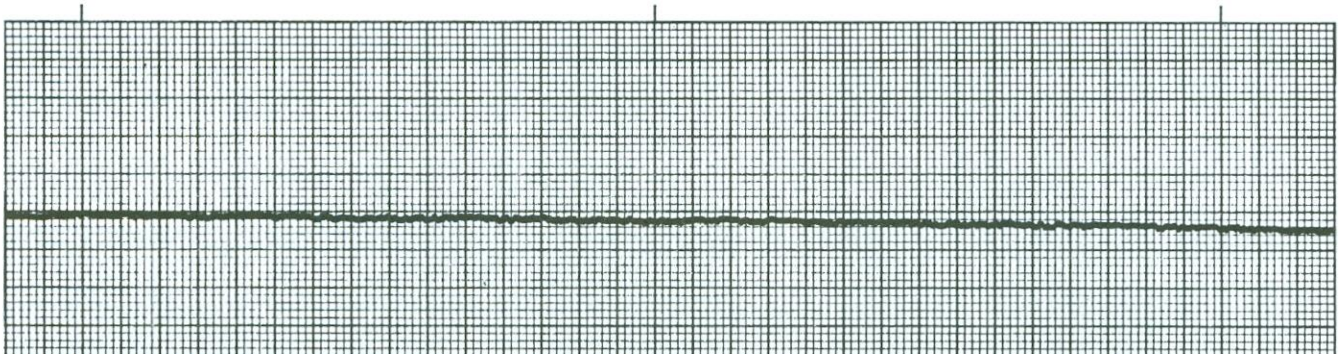


VFib is a chaotic and disorganized rhythm that generates absolutely no perfusion! The heart is quivering as it is dying and requires IMMEDIATE defibrillation…do not delay! The sooner the heart in VF can be defibrillated, the higher the chances of successfully converting to an organized rhythm.

Identifying ECG features

- **Rhythm:** None (P wave and QRS are absent)
- **Rate:** None (P wave and QRS are absent)
- **P waves:** Wavy, irregular deflection representative of ventricular quivering; deflections may be small (fine ventricular fibrillation) or coarse (coarse ventricular fibrillation)
- **PR interval:** Not measurable
- **QRS complex:** Absent

Asystole- Ventricular Standstill

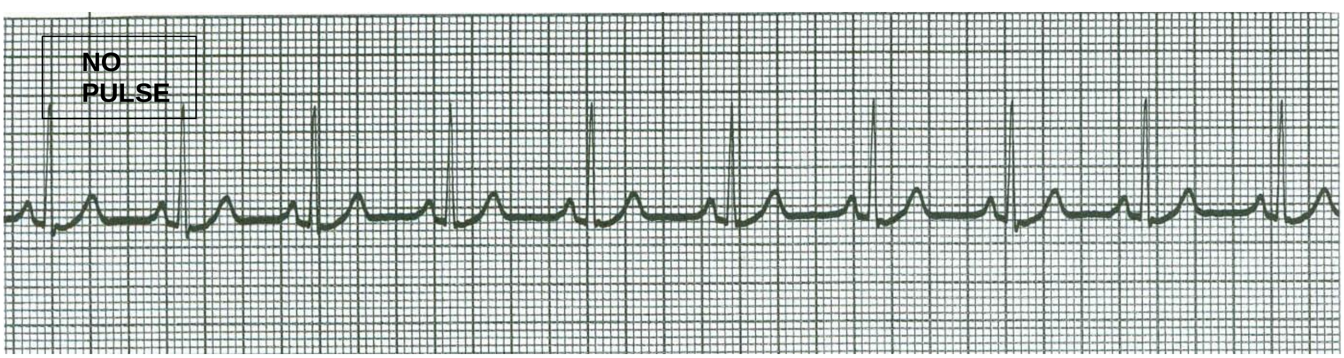


Absolutely no electrical or mechanical activity!

Identifying ECG features

- **Rhythm:**
  - **Atrial:** If waves present, will have atrial rhythm
  - **Ventricular:** None; no QRS complexes are present
- **Rate:**
  - **Atrial:** If P waves present, will have atrial rate
  - **Ventricular:** None; no QRS complexes are present
- **P waves:** Tracing will show only P waves or a straight line
- **PR interval:** Not measurable
- **QRS complex:** Absent

Pulseless Electrical Activity (PEA)



Electrical Activity without mechanical contractility, you have an organized rhythm, but the heart isn't pumping.

Identifying ECG features

- **Rhythm:** P wave and QRS may be present
- **Rate:** may be able to calculate a rate on a ECG strip
- **P waves:** may appear normal or abnormal
- **PR interval:** may be measurable if present
- **QRS complex:** may be measurable if present

KEY POINTS: PEA is a clinical situation (not a specific arrhythmia) in which an organized rhythm (excluding pulseless VT) is observed on the monitor but no pulse is palpated.

PUTTING IT ALL TOGETHER

Bradycardias

- Stable (asymptomatic)
  - Monitor closely, correct underlying cause if applicable.
- Unstable (symptomatic)
  - Atropine 0.5 mg IV repeat every 3-5 min, max 3mg
  - If atropine is ineffective
    - Dopamine 2-10 mcg/kg/minute OR
    - Epinephrine infusion: 2 – 10 mcg per minute
    - Prepare and provide external transcutaneous pacing

Tachycardias

- Stable & Narrow complex:
  - Vagal maneuvers
  - Adenosine (if regular)
    - First dose of 6 mg rapid IV push: follow by NS flush
    - Second dose: 12 mg if required
  - B-blocker or calcium channel blocker
  - Expert consultation
- Stable & Wide complex:
  - Adenosine only if regular and monomorphic
    - First dose of 6 mg rapid IV push: follow by NS flush
    - Second dose: 12 mg if required
  - Antiarrhythmic infusion
    - Amiodarone 150mg over 10 min, repeat if needed and maintenance infusion
  - Expert consultation
- Unstable (symptomatic):
  - Synchronized cardioversion
    - Narrow regular: 50 – 100 J
    - Narrow irregular: 120-200J
    - Wide regular: 100 J

Atrial Flutter/Atrial Fibrillation

- Stable (asymptomatic)
  - If rhythm is less than 48 hours old cardioversion or an antiarrhythmic, such as amiodarone, to restore sinus rhythm.
  - If rhythm is greater than 48 hours patient must be adequately anticoagulated before attempts are made to restore sinus rhythm.
  - Control heart rate using a calcium channel blocker, such as diltiazem, or a beta-blocker using caution in individuals with impaired LV function.
- Unstable
  - Immediate cardioversion regardless of the duration of the arrhythmia.

Second Degree AV-Block Type II (Mobitz II)

- This is a serious rhythm and can progress to third-degree AV block or ventricular standstill without warning.
- Close monitoring is required.
  - Treatment involves pacemaker therapy. Transvenous can be initiated until a pacemaker can be place.

Third Degree AV-Block (Complete Heart Block)

- Serious and potentially life threatening arrhythmia.
- Represents complete absence of conduction between the atria and the ventricles.
- The atria and the ventricles beat independently of each other.
- There is no relationship between the P waves or QRS complexes.
- This is a serious and potentially life threatening arrhythmia which can progress to ventricular standstill with little to no warning.
- Treatment for this rhythm is external pacing until transvenous pacing can be initiated.

Monomorphic Ventricular Tachycardia (Sustained VT) – Rapid Wide Complex Tachycardia

- ♥ STABLE with a PULSE:
  - Treat patient with Amiodarone only if regular and monomorphic.
  - Consider antiarrhythmic infusion i.e. Procainamide or Amiodarone IV drip.

- ♥ UNSTABLE with a PULSE: (low b/p, weak, clammy, cold, ashen, unresponsive or lethargic)
  - Deliver immediate synchronized cardioversion at 100J.
  - Evaluate the rhythm post cardioversion and consider a second attempt at a higher energy level if needed.
  -

- If the patient has **NO PULSE**

- ♥ Call for help
- ♥ Immediately begin CPR
- ♥ Apply defibrillator (hands-free) pads to patient clear your co-workers from touching the patient or the bed and deliver shock per AHA and equipment manufacturer guidelines.
- ♥ Immediately after the shock is delivered, resume compressions and bag mask ventilations. (CPR should not stop for more than 10 seconds.)
- ♥ You will continue CPR for 2 minutes (make sure your timer/recorder is tracking this for you) and prepare your first drug – your first medication will be Epinephrine 1mg, but do not administer it yet. This is also a good time to get IV or IO access if not already established.
- ♥ At 2 minutes clear to reevaluate your rhythm- if VF persists charge and defibrillate a second time per AHA and equipment manufacturer guidelines, clear the patient and deliver the shock. Immediately resume compressions (make sure to rotate compressor and person bagging every 2 minutes for optimal compressions - you will get tired quickly)
- ♥ During this 2 minute cycle administer the Epinephrine and prepare the second medication - Amiodarone 300mg.
- ♥ At the 2 minute mark clear to reevaluate your rhythm - if VF persist, charge and defibrillate per AHA and equipment manufacturer guidelines. Immediately resume compressions after the shock is delivered.
- ♥ During this 2 minute cycle, administer Amiodarone 300mg and prepare your next dose of Epinephrine 1 mg.
- ♥ These 2 minute cycles of rhythm check- shock if indicated- CPR- medication administration will continue as long as VF or pulseless VT persists.

Torsade de Pointes/Polymorphic Ventricular Tachycardia (VT)

- Examples: Arrhythmias with a polymorphic QRS appearance, torsade de pointes
- Usually these arrhythmias do not permit synchronization.
- The patient will have to be treated as VF: defibrillate per AHA and equipment manufacturer guidelines.
- Pharmacological treatment is magnesium in patients with a normal QT interval

- If there is doubt about whether an unstable patient has monomorphic or polymorphic VT, do not delay treatment for further rhythm interpretation. Provide defibrillation (not synchronized cardioversion) per AHA and equipment manufacturer guidelines.

Ventricular Fibrillation

VF is a chaotic and disorganized rhythm that generates absolutely no perfusion! The heart is quivering as it is dying and requires **IMMEDIATE** defibrillation, **DO NOT DELAY**! The sooner the heart in VF can be defibrillated, the higher the chances of successfully converting to an organized rhythm.

- Call for help
- Immediately begin CPR
- Apply defibrillator (hands-free) pads to patient clear your co-workers from touching the patient or the bed and deliver shock per AHA and equipment manufacturer guidelines.
- Immediately after the shock is delivered, resume compressions and bag mask ventilations. (CPR should not stop for more than 10 seconds.)
- You will continue CPR for 2 minutes (make sure your timer/recorder is tracking this for you) and prepare your first drug – your first medication will be Epinephrine 1mg, but do not administer it yet. This is also a good time to get IV or IO access if not already established.
- At 2 minutes clear to reevaluate your rhythm- if VF persists charge and defibrillate a second time per AHA and equipment manufacturer guidelines, clear the patient and deliver the shock. Immediately resume compressions (make sure to rotate compressor and person bagging every 2 minutes for optimal compressions - you will get tired quickly)
- During this 2 minute cycle administer the Epinephrine and prepare the second medication - Amiodarone 300mg.
- Again at the 2 minute mark clear to reevaluate your rhythm - if VF persist, charge and defibrillate per AHA and equipment manufacturer guidelines, again resume compressions immediately after the shock is delivered.
- During this 2 minute cycle administer the Amiodarone 300mg and prepare your next dose of Epinephrine, 1 mg.
- These 2 minute cycles of rhythm check- shock if indicated- CPR- administer med will continue as long as VF or pulseless VT persists.

Asystole / Ventricular Standstill

- Immediately begin CPR
- Administer Epinephrine 1mg IVP as soon as possible and may repeat every 3-5 minutes. There is no maximum dose.
- A critical step to restore a perfusing rhythm is to quickly identify one of the underlying/reversible causes that most frequently leads to PEA. The most common are known as the H's & T's
  - H's: Hypoxia, Hypothermia, Hypo/Hyperkalemia, Hydrogen Ion (acidosis), Hypovolemia
  - T's: Toxins, Tension Pneumothorax, Tamponade, Thrombus (coronary or pulmonary)

Pulseless Electrical Activity (PEA)

- If you are in a code and you find an organized rhythm on the monitor:
  - ♥ CHECK FOR A PULSE!
    - If you have a rhythm and no pulse you are in PEA
  - ♥ Immediately begin CPR
  - ♥ Administer Epinephrine 1:10,000 1mg IVP
  - ♥ A critical step to restore a perfusing rhythm is to quickly identify one of the underlying/reversible causes that most frequently leads to PEA. The most common are known as the H's & T's
    - H's: Hypoxia, Hypothermia, Hypo/Hyperkalemia, Hydrogen Ion (acidosis), Hypovolemia
    - T's: Toxins, Tension Pneumothorax, Tamponade, Thrombus (coronary or pulmonary)
  - ♥ PEA is any organized rhythm without a pulse.

FOR ADDITIONAL TRAINING VISIT THE FOLLOWING WEB SITES

http://highered.mcgraw-hill.com/sites/0073520713/student_view0/ecg_exercises.html

http://www.youtube.com/watch?v=UfAz8-WC7G8

https://www.practicalclinicalskills.com/ekg

https://ekg.academy/

https://lms.rn.com/courses/2076/page4265.html

REFERENCES

Huff, Jane. (2017). *ECG workout exercises in arrhythmia interpretation.* (7th Ed). Ambler, PA: Lippincott Williams & Wilkins.

Sinz, E. & Navarro, K. (Eds) Advanced Cardiovascular Life Support Provider Manual. Dallas, TX: American heart Association, © 2016

Hazinski, M., Field, J, et al. (2010). 2010 American Heart association Guidelines for Cardiopulmonary Resuscitation and emergency Cardiovascular care Science. Circulation. 2010; 122 (suppl 3)

BASIC ARRHYTHMIA SAMPLE TEST

1. Which of the following measurements would be considered normal for the P-R interval?

   A. 0.06 seconds
   B. 0.16 seconds
   C. 0.24 seconds
   D. 0.32 seconds

2. The monitor shows regular QRS complexes with a constant QRS width of 0.08 second, the ventricular rate is 68/minute, and no P waves are visible. This rhythm is:

   A. Idioventricular rhythm
   B. Atrial fibrillation
   C. Accelerated junctional rhythm
   D. Junctional tachycardia

3. When treating a patient who is unresponsive with no pulse, no blood pressure, and no spontaneous respirations, the nurse should:

   A. Prepare the patient for defibrillation
   B. Connect the patient to the transcutaneous pacer
   C. Administer Lidocaine intravenous as primary intervention
   D. Begin CPR according to American Heart Association guidelines

STRIP IDENTIFICATION

INSTRUCTIONS: Read carefully

Each strip is a 6-second strip.

Rhythm: Please identify rhythm regularity. Write if it is regular or irregular

Rate: Calculate the ventricular HR in the most precise manner.

P wave: Please identify if normal, inverted, flat, small, sawtooth, wavy or none.

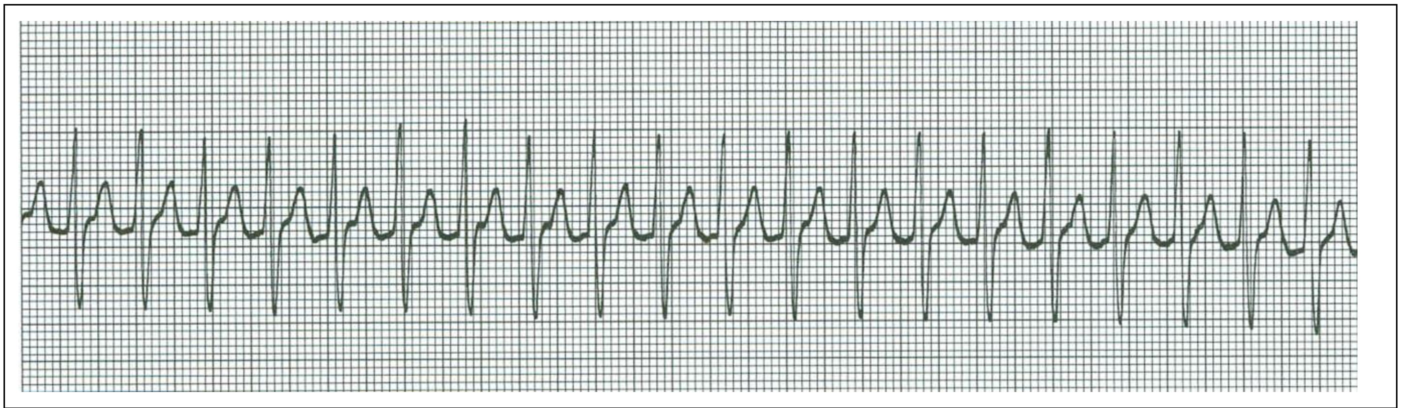
PR Interval: Measure the PR Interval using calipers. If unable to measure, write not measurable. If there is none, write absent

QRS: Measure the QRS complex using calipers. If unable to measure, write not measurable. If there is none, write absent.

Rhythm Interpretation: Identify the rhythm

DO NOT LEAVE ANY ITEM BLANK OR IT WILL BE MARKED WRONG

4.

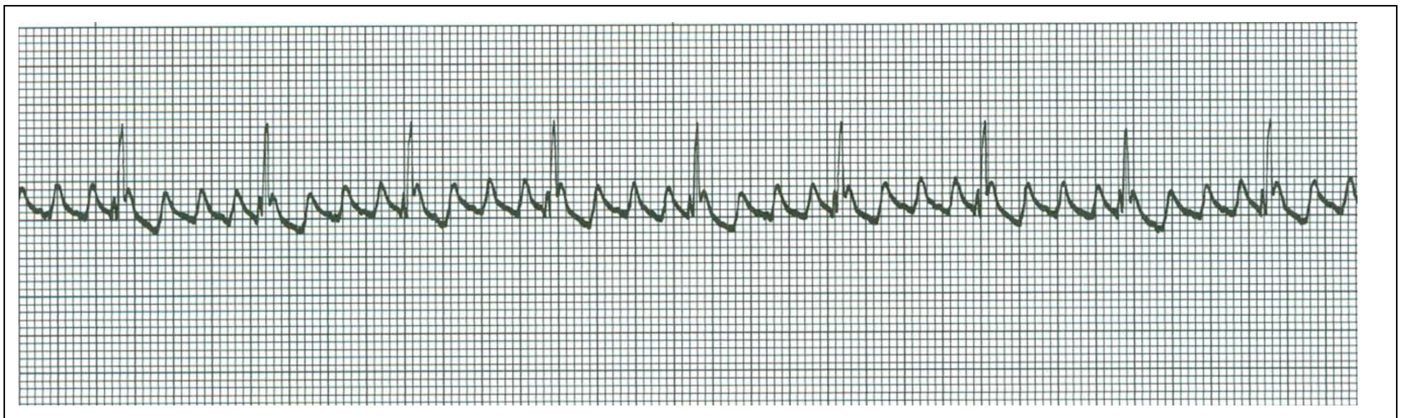


Rhythm | Rate | P wave

PR interval | QRS complex

Rhythm Interpretation:

5.



Rhythm | Rate | P wave

PR interval | QRS complex

Rhythm Interpretation:

Answers: 1. B, 2. C, 3. D, 4. Rhythm: SVT, Rate: 180 , P wave: hidden, PRI: unmeasurable, QRS: 0.12s
5. Rhythm: Atrial Flutter, Rate: 80, P wave: saw-tooth, PRI: unmeasurable, QRS: 0.06s