Basic ECG Interpretation Module Notebook

Basic ECG Interpretation

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Basic ECG Interpretation
Module Objectives

At the completion of this module you will be able to:

1. List the key parts of the heart and their role in the circulatory system.
2. Describe the coronary artery circulation.
3. List the 4 characteristics of cardiac muscle fibers.
4. Briefly explain the nerve supply to the heart.
5. Briefly describe depolarization and repolarization of cardiac cells.
6. State the normal conduction flow of the heart.
7. State the equipment needed for ECG monitoring.
8. Identify proper ECG lead placement for a 5-lead system.
9. Define the meaning of retrograde and antegrade conduction.
10. Identify the timing and voltage criteria for the ECG graph paper.
11. Define the ECG isoelectric line.
12. Name the components of a normal ECG complex.
13. Correctly identify and measure the PR, PRS, and QT intervals.
14. Correlate each component of the ECG complex with the cardiac contraction
15. Measure the atrial rate (AR) and ventricular rate (VR) by 2 methods.
16. Describe the difference between regular and irregular rhythms.
17. Identify the site in the conduction system where the sinus rhythms originate.
18. List the intrinsic rate of the SA node.
19. State the ECG criteria for normal sinus rhythm.

20. State the ECG criteria for sinus rhythm.

21. Differentiate between normal sinus rhythm, sinus bradycardia, sinus tachycardia and sinus arrhythmia.

22. Define the ECG characteristics for interventricular conduction defect.

23. Identify the ECG characteristics for 1st degree AV block.

24. Describe the differences between sinus pause, sinus exit block, and sinus arrest.

25. Define atrial ectopy.

26. Define supraventricular and identify the criteria for a supraventricular rhythm

27. List the criteria for a premature atrial contraction and correctly identify on an ECG rhythm recording strip.

28. Identify blocked premature atrial contraction on an ECG rhythm recording strip.

29. List the criteria for atrial fibrillation and correctly identify on an ECG rhythm recording strip.

30. Identify the site in the conduction system where the junctional rhythms originate.

31. List the intrinsic rate of the AV junction.

32. Identify the ECG criteria for and accurately identify junctional rhythm on a rhythm strip recording.

33. Define and state the significance of a junctional escape rhythm or beats.

34. Identify the 3 potential locations on the ECG complex for the P wave in junctional rhythm.

35. State the ECG criteria for and accurately identify accelerated junctional rhythm on a rhythm strip recording.

36. State the ECG criteria for and accurately identify junctional tachycardia on a rhythm strip recording.

37. State the ECG criteria for and accurately identify premature junctional contraction on a rhythm strip recording.

38. Describe the morphology of a QRS complex initiated in the ventricular.

39. Identify the site in the conduction system where the ventricular rhythms originate.

40. Identify the ECG criteria for and correctly idioventricular rhythm.

41. Identify the ECG criteria for and correctly identify Accelerated Idioventricular.

42. Describe the difference between a ventricular dysrhythmia and an intraventricular conduction defect.

43. Identify the ECG criteria for and correctly identify a Ventricular Escape Beat.

44. Describe and correctly identify ECG criteria on a rhythm strip recording of First Degree Heart Block.

45. Describe and correctly identify ECG criteria on a rhythm strip recording of Second Degree Heart Block type I, Mobitz I or Wenckebach.

46. Describe and correctly identify ECG criteria on a rhythm strip recording of Second Degree Heart Block type II or Mobitz II.

47. Describe and correctly identify ECG criteria on a rhythm strip recording of Complete or Third Degree Heart Block.

48. State the primary indication for insertion of a temporary transvenous cardiac pacemaker.

Basic ECG Interpretation
Module Outline

Lesson I

Introduction to ECG Cardiac Anatomy and Physiology

A. Heart and Circulatory System
   a. Layer of the heart
      i. epicardium – thin outer layer
      ii. myocardium – thick muscle layer contains contractile and conductive tissue
      iii. endocardium – thin smooth inner layer
      iv. pericardium – surrounds heart and great vessels forms a sac with small amount of fluid to cushion heart and decrease friction

B. Cardiac Chambers
   a. 4 chambers
   b. 2 atria – right and left, receive blood from veins. Deliver blood to ventricles. 70 - 80% of blood flows passively to the ventricles remaining 20 – 30% flows as a result of atrial contraction. Low pressure chambers
   c. 2 ventricles – right and left, receive blood from the atria. Right ventricle is low pressure chamber. Left ventricle is high pressure chamber and 3 – 4 times thicker than right ventricle.

C. Heart Valve
   a. AV valves separate atria from ventricles
   b. Semilunar valves separate ventricles from receiving vessels

D. Circulation

E. Coronary Artery Circulation
   a. Right coronary artery (RCA)– supplies blood to the right atrium and the right ventricle and to the upper part of the conduction system: SA node in 55 – 60% of the population and to the AV node in 90% of the population
   b. Left coronary artery (LCA) divides into left anterior decending (LAD) and circumflex artery. LAD supplies blood to the left ventricle and the lower part of the conduction system: bundle of His and left and right bundle branches.

F. Nerve Function
   a. Sympathetic nervous system – causes release of epinephrine and norepinephrine which results in increase heart rate and increase in contractility
   b. Parasympathetic nervous system – mediated by vagus nerve which results in decrease in heart rate.

G. Muscle Cells
   a. Electrical cells or pacemaker cells have following properties
      i. Automaticity – initiate an impulse
      ii. Excitability – respond to an impulse
      iii. Conductivity – transmit an impulse
   b. Myocardial cells have following properties

i. Contractility – contract as a result of the impulse

H. Electrophysiology
   a. Pacemaker cells have the ability to initiate there own depolarization-repolarization cycle which is dependent on movement of electrical charges inside and outside of the cell. Major electrolytes involved: Na, K, Ca, and Mg.
      i. Depolarization: Na moves into the cell and K moves out producing a current this is transmitted from cell to cell. The depolarization of the cells is followed by muscle contraction.
      ii. Repolarization: process of the cell returning to its resting state.

I. Conduction System
   a. Specialized track of tissue capable of initiating and conducting rhythmic electrical impulses faster than other cardiac tissue
      i. all cardiac tissue is capable of initiating an electrical impulse
   b. Cardiac conduction system starts in Right atrium and extends to the ventricles
      i. SA node – primary pacemaker of the heart. Generates impulses at 60 – 100 times per minute. Located in the upper right of the right atrium. Internodal pathways carry impulses through right atrium and Bachman's bundle carry impulses through the left atrium for atrial depolarization.
      ii. AV node – secondary pacemaker of the heart. Generates impulses at 40 – 60 times per minute. Takes over if SA node fails. Slows the impulse before transmitting to bundle of His.
      iii. Bundle of His, left & right bundle branches & Purkinje fibers carry impulse to ventricle for ventricular depolarization

Lesson II

ECG Interpretation Basics

A. Monitoring Basics
   a. Equipment: monitor, electrodes, wires convert electrical impulses and cardiac depolarization and repolarization into a wave form called the ECG complex
   b. Electrical flow pattern can be looked at in different views called leads
      i. Bipolar leads look at electrical flow pattern of the heart in relationship to between a negative (-) and positive (+) lead
         1. Lead I right shoulder (-) to left shoulder (+)
         2. Lead II right shoulder (-) to left leg (+)
         3. Lead III left shoulder (-) to left leg (+)
      ii. Unipolar leads look at electrical flow pattern of the heart in relationship to one positive (+) electrode
         1. aVR (+) right arm
         2. aVF (+) left foot
         3. aVL (+) left arm
         4. V1 – V6 or precordial leads
      iii. Monitoring system allows lead selection – 2 types of systems available
         1. 5 Lead system – 4 limb leads and a percordial or chest lead
            a. allows monitoring of 2 leads simultaneously
         2. 3 Lead system – uses 3 leads – electrodes placed on right and left arm and left leg.
            a. Allows for monitoring of only 1 lead.
            b. Electrode wires must be moved to monitor different leads
         3. Lead selection based on patient condition but Lead II and V1 are the 2 leads most commonly monitored

   c. Electrical flow pattern
      i. Normal electrical flow pattern is right to left from the right shoulder to the left leg.
      ii. Electrical flow toward the positive electrode the ECG complex will be positive
      iii. Electrical flow away from the positive electrode the ECG complex will be negative
      iv. Lead II – positive electrode on the left leg, with normal electrical flow moving toward the left leg
         1. ECG complex in Lead II is mostly positive
      v. V1 – positive electrode in located 4th ICS to the right of the sternum with normal electrical flow moving toward the left leg and away from the electrode
         1. ECG complex in V1 is mostly negative
   d. Graph recording paper
      i. ECG complex can be recorded on graph paper that measures speed and voltage
      ii. Horizontal boxes measure time.
         1. 1 small box = 0.04 seconds and 1 large box = 0.20 seconds
         2. 15 large boxes = 3 seconds and 30 larges boxes = 6 seconds

3. TIC marks at top of ECG graph recording paper occur at 3 second intervals
iii. Vertical boxes measure voltage or amplitude
1. 1 small box = 1mm or 0.1 mV and 1 large box = 5 mm
iv. Isoelectric line or baseline is the straight line appears when the monitor is turned on.
1. Absence of or equal positive and negative forces appear as a flat line or straight line
2. Electrical activity of the heart is recorded on the graph paper as positive or negative waves in relation to the isoelectric line.
a. Positive above the isoelectric line
b. Negative below the isoelectric line

B. ECG Waveform Components
a. ECG complex is recording of cardiac depolarization and repolarization.
b. Waveforms are named
c. P wave
i. Graphic representation of atrial depolarization
d. QRS wave or complex
i. Graphic representation of ventricular depolarization
ii. Q wave 1st negative deflection after the P wave
iii. R wave 1st positive deflection after the P wave
iv. S wave 1st negative deflection after the R wave
v. QRS can have different shapes depending on lead monitored but is always referred to as the QRS complex. (see work sheets)
vi. Normal QRS interval or duration 0.04 – 0.10 seconds
e. T wave
i. Graphic representation of ventricular repolarization
ii. Represents the refractory period of the heart
1. absolute refractory period cells represented by the 1st half of the T wave.
2. relative refractory period also called vulnerable period cells represented by 2nd half of T wave
iii. Atrial repolarization occurs during ventricular depolarization and is not visible on the ECG recording
f. PR interval
i. Beginning of the P wave to beginning of the QRS complex
ii. PR interval 0.12 – 0.20 seconds
g. ST segment
i. Not measure but shape and location evaluated.
h. QT interval
i. Beginning of the QRS complex to the end of the T wave
ii. Normal 0.33 – 0.44 seconds but must be adjusted for heart rate.

C. Cardiac Cycle
a. Cardiac depolarization normally results in cardiac muscle contraction
i. Systole refers to muscle contraction

        ii. Diastole refers to muscle relaxation

D. Measuring heart rates
   a. Heart rates (atrial and ventricular) can be determined from the ECG graph paper
   b. Six second strip method
      i. Provides estimated heart rate to + or - 10
      ii. Count number of QRS complexes in a 6 second strip and multiply by 10
      iii. Can be used with rhythms that are regular and irregular
   c. Calculation by division method
      i. Provides exact heart rates
      ii. Count number of large boxes and portion of large boxes between 2 QRS complexes and divide into 300.
         1. Determine portion of a large box: 1 small box = 0.2 so multiply number small boxes by 0.2
            a. 2 large boxes and 2 small boxes between QRS complex then divide 300 by 2.4 to obtain heart rate.
               i. 300/2.4 = 125
      iii. Can only be used if rhythm is regular

Lesson III

Sinus Rhythms

A. Steps for ECG rhythm analysis
B. Normal sinus rhythm meets all criteria
C. Sinus rhythm meets criteria for P waves and QRS complexes but may not meet 1 or more of the other criteria (PR interval, QRS interval, rhythm or rate)
D. Intraventricular conduction defect indicates QRS interval is > 0.10 seconds in limb leads and >0.12 seconds in any lead.
    a. Can occur with any rhythm that will be discussed

NORMAL SINUS RHYTHM (NSR)

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Present, look the same & followed by QRS	Present, look the same & preceded by one P wave	0.12 -0.20 seconds and consistent	0.04 – 0.10 seconds and consistent	Regular P-P regular R-R regular	60 – 100

SINUS BRADYCARDIA

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Present & followed by QRS	Present & preceded by one P wave	0.12 -0.20 seconds and consistent	0.04 – 0.10 seconds and consistent	Regular P-P regular R-R regular	< 60
Meets all criteria for NSR except rate is slow. Rate might be too slow to maintain cardiac output.					

SINUS TACHYCARDIA

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Present, look the same & followed by QRS	Present, look the same & preceded by one P wave	0.12 -0.20 seconds and consistent	0.04 – 0.10 seconds and consistent	Regular P-P regular R-R regular	> 100
Meets all criteria for NSR except rate is fast. Rate usually > 100 – 150. Rate might be so fast that the decrease in ventricular diastolic filling time leads to a decrease in stroke volume and decrease in cardiac output.					

1st Degree AV Block

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Present, look the same & followed by QRS	Present, look the same & preceded by one P wave	> 0.20 seconds and consistent	0.04 – 0.10 seconds and consistent	Regular P-P regular R-R regular	variable
Meets all criteria for NSR except PR interval is > 0.20 and rate can be variable. Can only occur with sinus rhythms and usually occurs with rates < 100.					

SINUS ARRHYTHMIA

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Present, look the same & followed by QRS	Present, look the same & preceded by one P wave	0.12 -0.20 seconds and consistent	0.04 – 0.10 seconds and consistent	Irregular	variable
Meets all criteria for NSR except rhythm is irregular and rate can be variable.					

SINUS PAUSE

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Present, look the same & followed by QRS	Present , look the same & preceded by one P wave	0.12 -0.20 seconds and consistent	0.04 – 0.10 seconds and consistent	Irregular around the pause	variable
Meets all criteria for NSR except rate slows because SA node fails to fire. Pause is less than 2 cardiac cycles					

SINUS EXIT BLOCK

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Present, look the same & followed by QRS	Present, look the same & preceded by one P wave	0.12 -0.20 seconds and consistent	0.04 – 0.10 seconds and consistent	Irregular around the pause	variable

Meets all criteria for NSR except rate slows because SA node impulse not conducted. Pause is equal to 2 cardiac cycles

SINUS ARREST

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Present, look the same & followed by QRS	Present, look the same & preceded by one P wave	0.12 -0.20 seconds and consistent	0.04 – 0.10 seconds and consistent	Irregular around the pause	Variable but usually slow
Meets all criteria for NSR except rate slows because SA does not fire. Pause is > 2 cardiac cycles					

RHYTHM	TREATMENT
Normal Sinus Rhythm	No treatment
Sinus Bradycardia	No treatment unless slow rate results in decrease in cardiac output. Adjust medications that might be slowing rate. Cardiac pacemaker
Sinus Tachycardia	No treatment unless rapid rate causes decrease in cardiac output. Treat cause of tachycardia.
Intraventricular Conduction Defect	Treatment if needed is directed at the associated rhythm.
1st Degree AV Block	No treatment unless slow rate causes decrease in cardiac output. Adjust medications that might be slowing rate. Cardiac pacemaker.
Sinus Arrhythmia	No treatment
Sinus Exit Block, Sinus Arrest, Sinus Pause	No treatment unless pauses cause slow rate resulting in decrease in cardiac output. Cardiac pacemaker

Lesson IV

Atrial Rhythms

A. Impulse for depolarization occurs outside of the SA node in the atrial tissue
   a. Impulses can occur at rates of 400/minute
   b. P waves look different and might not be identifiable
   c. Conduction through the ventricle is normal so QRS complex looks normal but ventricular rate is usually variable and the rhythm irregular.

PREMATURE ATRIAL CONTRACTION (PAC)

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Early and looks different from the other P waves	Present and follows the premature P wave	0.12 -0.20 seconds but may not be the same as underlying rhythm	0.04 – 0.10 seconds	Irregular around the PAC	variable
P wave occurs earlier than expected and can be hidden in the T wave of the preceding beat. PACs may be isolated or occur frequently. The more frequent the PAC the more irritable the ectopic focus. PACs are interspersed in another rhythm (underlying rhythm). Evaluate the underlying rhythm first.					

BLOCKED PREMATURE ATRIAL CONTRACTION (PAC)

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Early and looks different from the other P waves	Premature P not followed by a QRS complex	0.12 -0.20 seconds but may not be the same as underlying rhythm	0.04 – 0.10 seconds	Irregular around the blocked PAC	variable
P wave occurs earlier than expected and can be hidden in the T wave of the preceding beat. Blocked PACs are not followed by a QRS complex and look like a missed or dropped beat. Blocked PACs are the most common cause of dropped or missed QRS complexes.					

PREMATURE ATRIAL CONTRACTION (PAC)

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Early and looks different from the other P waves	Present and follows the premature P wave	0.12 -0.20 seconds but may not be the same as underlying rhythm	0.04 – 0.10 seconds	Irregular around the PAC	variable
P wave occurs earlier than expected and can be hidden in the T wave of the preceding beat. PACs may be isolated or occur frequently. The more frequent the PAC the more irritable the ectopic focus. PACs are interspersed in another rhythm (underlying rhythm). Evaluate the underlying rhythm first.					

MULTIFOCAL ATRIAL RHYTHM (MAR)

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
P waves have 3 or more different shapes	Present preceded by one P wave	0.12 -0.20 seconds but might not be consistent	0.04 – 0.10 seconds	Irregular	Variable but ≤ 100
MAR also called wandering atrial pacemaker. Impulse for depolarization comes from at least 3 different areas in the atrium which causes the P wave to have different configurations.					

MULTIFOCAL ATRIAL TACHYCARDIA (MAT)

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
P waves have 3 or more different shapes	Present preceded by one P wave	0.12 -0.20 seconds but might not be consistent	0.04 – 0.10 seconds	Irregular	Variable but > 100
Impulse for depolarization comes from at least 3 different areas in the atrium which causes the P wave to have different configurations. Rapid rate can result in decreased ventricular filling time leading to a decrease in ventricular stroke volume and fall in cardiac output.					

ATRIAL TACHYCARDIA

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Present and followed by QRS complex	Present preceded by one P wave	0.12 -0.20 seconds but might not be consistent	0.04 – 0.10 seconds	Regular	150-250
Atrial tachycardia requires an atrial rate of 150 - 250. If P waves cannot be identified the rhythm will be call Supraventricular Tachycardia (SVT). Is usually is initiated by a PAC. If rhythm starts and stops suddenly it is call Paroxysmal Atrial Tachycardia (PAT)					

ATRIAL TACHYCARDIA with BLOCK

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Present not all followed by a QRS complex	Present preceded by one or more P waves	0.12 -0.20 seconds but might not be consistent	0.04 – 0.10 seconds	Atrial rhythm is regular Ventricular rhythm regular or irregular dependent on degree of block	Atrial rate 150-250 Ventricular rate variable
Atrial tachycardia with block the atrial rate is 150- 250 but not all of the atrial impulse are conducted through the AV node so ventricular rate is variable. Most common cause of atrial tachycardia with block is digitalis toxicity.					

ATRIAL FLUTTER

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
None Atrial waves called flutter waves. Impulses originate from the same ectopic site.	Present QRS may appear distorted and look different due to flutter waves.	None	0.04 – 0.10 seconds	Flutter waves are regular Ventricular rhythm is regular or irregular dependent on degree of block	Atrial rate 250-350 and not counted Ventricular rate variable

Atria beating so fast P waves cannot be identified and take on a saw-toothed jagged appearance. Atrial impulses blocked at the AV node so that not all are conducted. Ventricular rate and rhythm are dependent on the conduction rate of the atrial impulses. Loss of atrial kick and if rate uncontrolled (>100) causes a decrease in ventricular diastolic filling time leading to decrease in stroke volume and decrease in cardiac output.

ATRIAL FIBRILLATION

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
None Impulses originate from multiple ectopic sites.	Present	None	0.04 – 0.10 seconds	Ventricular rhythm irregular.	Ventricular rate variable Atrial rate over 350 time/min. and not counted
Atria beating so fast P waves cannot be identified and isoelectric line appears wavy with small undulations or can be flat. Ventricular rate and rhythm are dependent on the conduction rate of the atrial impulses but **ventricular rhythm is irregular**. Loss of atrial kick and if rate uncontrolled (>100) causes a decrease in ventricular diastolic filling time and leads to a decrease in stroke volume and decrease in cardiac output.					

RHYTHM	TREATMENT
Premature Atrial Contraction (PAC)	Not usually treated monitor for increasing frequency can lead to MAT or Atrial Fibrillation
Multifocal Atrial Rhythm/Tachycardia	Urgency of treatment based on ventricular rate. Digoxin, Calcium Channel Blocker, Beta Blockers
Atrial Tachycardia/ Atrial Tachycardia with block	Usually caused by digotalsis toxicity, Check drug level. Depending on severity of block may require temporary pacemaker
Atrial Flutter	Urgency of treatment based on ventricular rate. Digoxin, Calcium Channel Blocker, Beta Blockers, Amiodarone, Anticoagulation
Atrial Fibrillation	Urgency of treatment based on ventricular rate. Digoxin, Calcium Channel Blocker, Beta Blockers, Amiodarone, Anticoagulation

Lesson V

AV Junctional Rhythms

A. AV junction comprised of the AV node, tissue immediately surrounding the AV node and the upper portion of the bundle of His.
    a. Receives impulses from the SA node and/or the atria and delays transmission of the impulse.
        i. Allows for contraction of the atria before ventricles depolarized
        ii. Gatekeeper or filter to protect the ventricles from rapid impulses from the atria
    b. Secondary pacemaker of the heart. Takes over if the SA node fails
        i. Rate 40-60 beats/minute
B. P waves in junctional rhythms can be have different configuration and ECG location depending on where in junction impulse arises
    a. PR interval is <0.12
    b. P wave inverted in Lead II
    c. P wave can be before the QRS, after the QRS or not visible (buried in the QRS)
    d. P waves can be buried in the T waves following the QRS complex
C. Conduction through the ventricle is normal so QRS should appear normal

JUNCTIONAL RHYTHM

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Inverted in Lead II. Located before, after or within the QRS	Present	< 0.12 seconds	0.04 – 0.10 seconds	Regular	40 – 60 bpm
Junctional rhythm is regular. Sinus rhythm that slows so that the junction takes over as the pacemaker is called junctional escape rhythm; it can be a single beat (junctional escape beat) or a sustained rhythm. Junctional rhythms are protective but might result in the loss of atrial kick and be too slow to maintain cardiac output. Evaluate the patient.					

ACCELERATED JUNCTIONAL RHYTHM

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Inverted in Lead II. Located before, after or within the QRS	Present	< 0.12 seconds	0.04 – 0.10 seconds	Regular	60 – 100 bpm

JUNCTIONAL TACHYCARDIA

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Inverted in Lead II. Located before, after or within the QRS	Present	< 0.12 seconds	0.04 – 0.10 seconds	Regular	> 100 bpm

PREMATURE JUNCTIONAL CONTRACTION (PJC)

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Earlier than expected in the rhythm. Inverted in Lead II. Located before, after or within the QRS	Present	< 0.12 seconds if measurable	0.04 – 0.10 seconds	Irregular around the PJC	variable
P wave occurs earlier than expected and can be hidden in the QRS or the T wave following the premature beat. PJCs may be isolated or occur frequently. PJCs are interspersed in another					

rhythm (underlying rhythm). Evaluate the underlying rhythm first.

RHYTHM	TREATMENT
Junctional Rhythm	Not usually treated unless ventricular rate is slow and cardiac output affected. Monitor patient and treat cause of SA node dysfunction.
Accelerated Junctional Rhythm	
Junctional Tachycardia	
Premature Junctional Contractions (PJC)	

Lesson VI

Ventricular Rhythms

A. Impulse arises from the ventricle causing a delay in depolarization.
   a. Secondary pacemaker of the heart and takes over if SA node or AV junction fail.
      i. Intrinsic rate 20 – 40 bpm
   b. Conductions does not follow the normal pattern through the ventricle
      i. QRS is wide and bizarre looking
      ii. QRS interval is always > 0.10 and usually >0.12 seconds
   c. Atria may or may not be depolarized
      i. If depolarized and P wave present the P is not associated with ventricular depolarization (QRS complex)
B. Any ventricular dysrhythmia should be considered lethal.
   a. Depolarization can be disorganized and the resulting muscle contraction weak resulting in decrease stroke volume and decrease in cardiac output
   b. Rhythm may be rapid or beats early decreasing diastolic filling time resulting in decrease in stroke volume and decrease in cardiac output
   c. Rate may be too slow to maintain cardiac output

IDIOVENTRICULAR RHYTHM

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
None	Present with wide and bizarre shape	None	> 0.10 and usually > 0.12 seconds	Regular	20 – 40 bpm
Idioventricular rhythm is considered an escape rhythm. Elimination of rhythm might result in asystole but rate and force of ventricular contraction might not maintain cardiac output. Requires immediate evaluation.					

ACCELERATED IDIOVENTRICULAR RHYTHM

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
None	Present with wide and bizarre shape	None	> 0.10 and usually > 0.12 seconds	Regular	40 - 100 bpm
Accelerated Idioventricular rhythm is considered an escape rhythm. Elimination of rhythm might result in asystole but rate and force of ventricular contraction might not maintain cardiac output. Requires immediate evaluation.					

PREMATURE VENTRICULAR CONTRACTION (PVC)

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
None	Present and earlier than expected	None	> 0.10 usually > 0.12 seconds	Irregular around the PVC	variable
No P wave and QRS occurs earlier than expected. PACs may be isolated or occur frequently. PJCs are interspersed in another rhythm (underlying rhythm). Evaluate the underlying rhythm first. Frequency of PVC might affect ventricular stroke volume and cardiac output. Evaluate the patient.					

VENTRICULAR TACHYCARDIA (V Tach)

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
None but if seen are not associated with QRS	Present with wide and bizarre shape	None	> 0.10 and usually > 0.12 seconds	Regular	> 100 bpm
Ventricular tachycardia is considered a lethal dysrhythmia and requires immediate evaluation and possible intervention. Rapid rate and force of ventricular contraction might not maintain cardiac output. Requires immediate evaluation.					

VENTRICULAR FIBRILLATION (V Fib)

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
None	No identifiable form	None	None	Irregular	None
Ventricular fibrillation is a lethal dysrhythmia and requires immediate intervention. No ventricular contraction present. Patient will have no cardiac output.					

ASYSTOLE

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
None	None	None	None	None	None
No electrical activity present. Requires immediate intervention with CPR and ACLS.					

RHYTHM	TREATMENT
Idioventricular	Not usually treated unless ventricular rate is slow and cardiac output affected
Accelerated Idioventricular	Not usually treated unless ventricular rate is slow and cardiac output affected. Monitor for progression the Mobitz II
PVC	Might require temporary or permanent pacemaker dependent on ventricular rate. Monitor for progression to complete heart block
Ventricular Tachy	Usually require temporary and or permanent pacemaker

Lesson VII

AV HEART BLOCKS

A. AV Heart blocks develop because of delay or complete block of the conduction system at the AV junction
    a. Some or all of atrial impulses (P waves) are blocked at the AV junction.

1st Degree AV Block

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Present, look the same & followed by QRS	Present, look the same & preceded by one P wave	> 0.20 seconds and consistent	0.04 – 0.10 seconds and consistent	Regular P-P regular R-R regular	variable
Meets all criteria for NSR except PR interval is > 0.20 and rate can be variable. Can only occur with sinus rhythms and usually occurs with rates < 100.					

2nd DEGREE AV BLOCK TYPE I/MOBITZ I/WENCKEBACH

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Present, look the same not all followed by QRS complex	Present, look the same & preceded by one P wave	Becomes progressively longer until the P wave is not conducted	0.04 – 0.10 seconds and consistent	Regular P-P regular R-R irregular	variable
Mobitz I in ratio P: QRS the will be 1 less QRS complex than P wave. PR interval gets progressive longer. The shortest PR interval is immediately following the dropped QRS. The longest PR interval is immediately before the nonconducted P wave.					

2nd DEGREE AV BLOCK TYPE I/MOBITZ II

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Present, look the same not all followed by QRS complex	Present, look the same & preceded by more than 1 P wave	0.12 – 0.20 for the P waves that conduct. PR intervals are	0.04 – 0.10 seconds and consistent	Regular P-P regular R-R irregular	variable

		consistent for the P waves that are conducted			
Mobitz II can lead to complete heart block. Ventricular rate is variable and might be slow enough to cause drop in cardiac output. Evaluate patient.					

3rd DEGREE AV BLOCK/COMPLETE HEART BLOCK

P waves	QRS complex	PR interval	QRS interval	Rhythm	Rate
Present, look the same not followed by QRS complex	Present, look the same & not preceded by QRS complex	None	Usually > 0.10	P-P regular R-R regular	Variable with atrial rate (P waves) faster than ventricular rate (QRS complexes)
Complete heart block there is no communication between the atria and the ventricles. They beat independently of one another. If a P wave precedes a QRS complex it is coincidental and not consistent. Cardiac output is dependent on ventricular rate. Might require emergency transvenous or transcutaneous pacemaker					

RHYTHM	TREATMENT
1ST degree Block	Not usually treated unless ventricular rate is slow and cardiac output affected
Mobitz I	Not usually treated unless ventricular rate is slow and cardiac output affected. Monitor for progression the Mobitz II
Mobitz II	Might require temporary or permanent pacemaker dependent on ventricular rate. Monitor for progression to complete heart block
3rd Degree Heart Block/Complete Heart Block	Usually require temporary and or permanent pacemaker

Basic ECG Interpretation
Module Glossary

A

Absolute Refractory Period (ARP)	Period of time where the heart cannot be depolarized no matter how strong the stimulus.
Accelerated	When referring to ECG rhythms any rate that is faster than the intrinsic rate of the cell but not greater than 100 bpm.
Agonal Rhythm	See idioventricular rhythm.
Antegrade Conduction	In cardiac conduction referrs to the electrical impulse following the normal flow pattern.
Aorta (A)	1st artery that comes off of the left ventricle. Receive blood from the left ventricle for distribution to systemic circulation.
Aortic Valve	Valve that is located between the aorta and left ventricle. One way valve that allow blood to flow from the left ventricle to the aorta during ventricular systole and prevent back flow of blood from the aorta to the left ventricle during ventricular diastole.
Asystole	Absence of electrical activity in the heart. Also called ventricular standstill.
Atrial Depolarization	See cardiac depolarization.
Atrial Dysrhythmia	ECG rhythms initiated from impulses originating in the atrium.
Atrial Fibrillation	An atrial rhythm or atrial dysrhythmia caused by multiple chaotic asynchronous electrical impulses in the atria. The atria beat at > 400 bpm and have no sustained contraction. The atria appear to quiver. ECG is characterized by a wavy chaotic baseline with irregular ventricular conduction.
Atrial Flutter	An atrial rhythm or atrial dyrhythmia caused by rapid atrial impulses originating from the same focus at a rate of 250-350 bpm. Atrial activity appears as saw-tooth waves or flutter waves on the ECG rhythm strip. Ventricular response can be regular or irregular.
Atrial Kick	The amount of blood delivered to the ventricle during atrial systole/contraction. Comprises 20-30% of the ventricular stroke volume.
Atrial Rate (AR)	The number of times the atria beat in one minute. Determined by counting the P waves.
Atrial Tachycardia	An atrial rhythm or atrial dysrhythmia caused by an atrial rate of >150-250 bpm. All of the atrial impulses might or might not be conducted through the AV node.

Atrial Tachycardia with Block	Atrial tachycardia where some of the atrial impulses are blocked at the AV node causing the ventricular rate to be less than the atrial rate.
Atrioventricular or AV Valves	The one way valves in the heart that separate the atria from the ventricles. They allow blood to move from the atria to the ventricles during ventricular diastole and prevent blood from flowing back into the atria during ventricular systole. There are 2 AV valves the tricuspid and the mitral valve.
AV Junctional Rhythms or Junctional Rhythms	Rhythms initiated from impulses that originate from the AV junction. Intrinsic rate of the AV junction is 40-60 bpm.
AV Node	Part of the electrical conduction system of the heart responsible for slowing impulse conduction from the SA node or atria to the ventricles.
B	
Bachman's Bundle.	Part of the electrical conductions system that transmits electrical impulse to the left atrium.
Baseline	In reference to ECG indicates the flat line between the P wave and the QRS complex, the QRS complex and the T wave and the T wave and P wave. It is also called the isoelectric line and indicates the absence of electrical activity or equal amounts of positive and negative electrical activity.
Biphasic	In reference to ECG, indicates that a wave or complex has positive and negative components, that is, it will be above and below the isoelectric line.
Bundle Branches	Part of the cardiac conduction system that is responsible for ventricular depolarization and contraction. Consists of 2 branches the right bundle branch that conducts impulses to the right ventricle and the left bundle branch that conducts impulses to the left ventricle. The left bundle further divides into two sub-branches called the anterior fascicle and posterior fascicle which each help to distribute or spread the impulse throughout the larger left ventricle.
Bundle of His	Part of the cardiac conduction system responsible for conducting impulses from the AV node to the bundle branches. With the AV node and tissue surrounding the AV node it makes up the AV junction.
C	
Calculation of rate: Calculation By Division	Accurate method of determining atrial and ventricular rates for rhythms that are regular. Count the number of large boxes and portion of large boxes between P waves (atrial rate) or QRS complexes (ventricular rate) and divide into 300. Each small square is given a value of 0.2 and each large square is given a value of 1.
Calculation of rate: 6-Second Rhythm Strip Method	Method of determining atrial and or ventricular rates. Count the number of P waves (atrial rate) or QRS complexes (ventricular rate) in a 6 second ECG rhythm strip and multiply by 10. This will give an estimated number of beats in one minute (bpm).

Calipers	Tool used to assist in determining ECG rhythms, rates and intervals.
Cardiac Depolarization	The process by which the resting electrical forces of the cardiac cells are changed and an electrical impulse produced. Depolarization is normally followed by myocardial muscle contraction and is represented by the ECG complex. The P wave represents atrial depolarization and the QRS represent ventricular depolarization.
Cardiac Output	The amount of blood ejected by the heart in one minute. Expressing in liters per minute. Normal cardiac output is 4-8 liters per minute.
Cardiac Tamponade	Constriction of the heart that prevent filling of the ventricles. It is usually caused by fluid or blood accumulating in the pericardial sac.
Catecholamines	The neurotransmitter epinephrine and norepinephrine.
Chest Leads	In reference to standard 12 lead ECG the 6 unipolar leads located on the chest. The leads are V1 – V6 and look at the electrical conduction of the heart in relationship to the lead placement. Conduction toward the electrode results in positive complex conduction away from the electrode results in a negative complex.
Chordae Tendineae	These are strong fibrous cords that connect the valve leaflet to the papillary muscles.
Chronotropic Effect	Chronotropy refers to rate. A positive chronotropic effect would result in an increase in rate. A negative chronotropic effect results in a decrease in rate.
Circumflex Artery	One of the 3 major coronary arteries that deliver oxygenated blood to the heart. The circumflex artery provides blood to the posterior left ventricle and to the SA node in 45% of the population.
Coronary Sinus	Part of the venous drainage system of the heart. Returns de-oxygenated blood from the heart to the right atrium.
D	
Depolarization	The process where there is a change in the membrane potential of a cell allowing sodium to move in and potassium to move out of the cell, resulting in the cell becoming more positively charged.
Diastole	In reference to the heart it is the relaxation of the atriums or ventricles also know as the filling stage. It usually refers to the ventricles.
Dysrhythmias	Any ECG rhythm that is not normal sinus rhythm.
E	
ECG Complex	Graphic representation of one complete depolarization-repolarization cycle of the heart. Normally consists of the P wave, QRS complex, and the T wave.

ECG Rhythm	A group of ECG complexes.
Electrical Vector	The flow of the electrical forces in the heart.
Electrode System	The equipment needed to successfully monitor the ECG; includes electrodes, electrode wires, cable and transmitter box or bedside monitor.
Electrode Wire	Insulated wires that connect to the electrode and into the cable attached to the transmitter box or bedside monitor.
Electrodes	Self adhesive gel filled patches that attach to the chest and conduct electrical current produced from depolarization-repolarization cycle to the monitor.
Electrophysiology	The heart has a track of specialized tissue capable of rhythmic electrical impulses; this track can conduct impulses much more rapidly than normal cardiac tissue. The tracks are responsible for the generation and orderly spread of electrical impulses through the heart to produce a coordinated atrial and ventricular contraction at a normal rate and regular rhythm.
Endocardium	The inner surface of the heart.
Epicardium	The outer surface of the heart.
F	
First Degree Block	Sinus rhythm with a PR interval greater than 0.20.
Flutter Waves	Representation of atrial activity in atrial flutter. See atrial flutter.
I	
Idioventricular Rhythm	Cardiac rhythm that originates in the ventricle. Rate is 20-40 bpm.
Inferior Vena Cava (IVC)	Large vein that carries deoxygenated blood from the lower venous circulation (below the neck) and empties into the right atrium.
Inotropic Effect	Increases force of muscle contraction.
Internodal Pathways	Part of the cardiac conduction system. Transmits impulse from SA node through the right atrium.
Interpolated PVC	Premature ventricular contraction that falls between 2 complexes with no change in rhythm.
Intraventricular Conduction Defect (ICD)	A conduction through the ventricles that results in increase time for ventricular depolarization resulting in a prolonged QRS interval >0.10 in most leads and >0.12 in all leads.
Intrinsic Rate	The normal rate for a given pacemaker cells.
Isoelectric Line	In reference to ECG indicates the flat line between the P wave and the QRS

	complex, the QRS complex and the T wave and the T wave and P wave. It is also called the baseline and indicates the absence of electrical activity or equal amounts of positive and negative electrical activity.
J	
J-Point	Point at which the QRS Complex meets the ST Wave or an angle change occurs at this juncture
Junctional Escape Beat/Rhythm	Complex or rhythm that takes over if SA node fails. Beats or rhythm occur after a pause and later than expected.
Junctional Rhythms	Rhythms initiated from impulses that originate from the AV junction. Intrinsic rate of the AV junction is 40-60 bpm.
Junctional Tachycardia	Junction rhythm with a rate > 100 bpm
L	
Left Anterior Descending Artery (LAD)	Coronary artery that supplies oxygenated blood to the anterior surface of the left ventricle, the ventricular septum, the papillary muscles of the mitral valve and the bundle of His.
Left Atrium (LA)	Low pressure chamber that receives oxygenated blood from the pulmonary system via the pulmonary veins.
Left Coronary Artery	Coronary artery that delivers oxygenated blood to the left side of the heart. Divides into the left anterior descending artery and the circumflex artery.
Left Ventricle (LV)	High pressure chamber of the heart responsible for pumping oxygenated blood to the systemic circulation.
Limb Leads	In reference to standard 12 lead ECG the 6 limb that look at the electrical conduction of the heart in relationship to the lead placement. There are 3 bipolar leads, Lead I, II, & III and 3 unipolar leads, aVR, aVL, and aVF.
M	
Mitral Valve	One wave valve that allow blood flow from the left atrium to the left ventricle and prevents blood from flowing back to the left atrium during ventricular systole.
Multifocal Atrial Rhythm	Atrial dysrhythmia (atrial rhythm) that impulse for depolarization originates in 3 or more different foci in the atrium. ECG characterized by 3 or more different shaped P waves.
Multifocal PVCs	Premature ventricular contraction that originate from more than one focus.
Myocardium	Muscle layer of the heart.
N	
Negative Deflection	In reference to ECG any wave complex below the baseline (isoelectric line).

Nonconducted Premature Atrial Contraction (PAC)	Premature atrial contraction that is not conducted to the ventricles so no QRS is seen after the P wave.
Normal Sinus Rhythm (NSR)	ECG rhythm that meets normal criteria: P wave followed by QRS complex, QRS preceded by P wave, PR interval 0.12-0.20 seconds, QRS interval 0.06-0.10 seconds, P-P and R-R intervals regular and atrial and ventricular rate 60-100 bpm.
P	
P Wave	Part of the ECG complex that reflects atrial depolarization.
Pacemaker	Cells within the heart that can initiate depolarization. External mechanical device that initiates cardiac depolarization.
Papillary Muscles	Muscles that are attached to the chordae tendinae and to the ventricular wall. The papillary muscles and chordae tendinae work together to prevent valve leaflets from turning inside out. The valves open and close in response to pressure changes within the chambers.
Parasympathetic Nervous System (PNS)	Originates in the medulla and is mediated by the vagus nerve. Most of the fibers are cholinergic and secrete acetylcholine, which tends to be inhibitory in its actions. The cardiac effects of parasympathetic stimulation include slowing the heart rate, decreasing the speed of the conduction through the AV node, and slight depression in contractility.
Paroxysmal Atrial Tachycardia (PAT)	Atrial tachycardia that starts and stops suddenly.
Pericardial Effusion	An accumulation of fluid in the pericardial sac.
Polymorphic Ventricular Tachycardia	Ventricular tachycardia that has wide, bizarre and different shaped QRS complexes.
Positive Deflection	In reference to the ECG any complex that is above the baseline (isoelectric line).
PR Interval	Measured from where the P wave starts to where the QRS first leaves the isoelectric line. Represents atrial depolarization and the delay in the AV node.
Precordial	Over the heart in ECG refers the chest leads also call precordial leads.
Premature Atrial Contractions (PACs)	An ECG complex that appears earlier than expected that originates from an ectopic focus in the atrium.
Premature Junctional Contraction (PJCs)	An ECG complex that appears earlier than expected that originates from an ectopic focus in the AV junction.
Premature Ventricular Contractions (PVCs)	An ECG complex that appears earlier than expected that originates from an ectopic focus in the ventricle.

Pulmonary Artery	Vessel that delivers blood from the left ventricle to the pulmonary veins.
Pulmonary Valve	One way valve located between the low pressure right ventricle and the low pressure pulmonary artery. One wave valve that allow blood flow from the right ventricle to the pulmonary artery and prevents blood from flowing back to the right ventricle during ventricular diastole.
Pulmonary Veins	Vessels in the lung that receive oxygenated blood from the pulmonary capillary system and deliver it to the left atrium.
Purkinje Fibers	Final part of the conduction system that initiates ventricular depolarization.

Q

Q Wave	First negative deflection following the P wave.
QRS Complex	ECG representation of ventricular depolarization.
QRS Duration	The amount of time it takes for ventricular depolarization. Measured from when the QRS first leaves the isoelectric line to where the ST segment begins.

R

R On T PVC	Premature ventricular contraction that falls on or very near to the T wave.
R Wave	The first positive deflection following the P wave.
Relative Refractory Period (RRP).	Period of time before the cell is fully repolarized when it can respond to a stimulus.
Repolarization	The return of the membrane potential to it's resting state. Potassium move into the cell and sodium moves out of the cell.
Retrograde Conduction	Electrical impulse conduction in the opposite direction of the normal electrical flow.
Right Atrium (RA)	Low pressure cardiac chamber that receives deoxygenated blood from the systemic venous circulation via the inferior vena cava and the superior vena cava.
Right Coronary Artery	Coronary artery that delivers blood to the right ventricle, AV junction and the SA node in 55% of the population.
Right Ventricle (RV)	Low pressure cardiac chamber that receives blood from the right atrium and pumps it into the pulmonary artery.

S

SA Node	Primary pacemaker of the heart. The intrinsic rate of the SA node is 60-100 bpm.

Second Degree AV Heart Block Type II (Mobitz II)	Type of heart block where some P waves are not conducted through the AV node to the ventricle. Characterized by some P waves not followed by QRS complexes. P waves that are followed by QRS complexes have consistent PR intervals.
Second Degree Heart Block Type I (Mobitz I Or Wenckebach)	Type of heart block where the PR interval becomes progressively longer until the P wave is not conducted through the ventricle and a QRS complex it dropped.
Semilunar Valves	One way valves in the heart that separate the ventricles from the vessel that receives the blood. There are 2 semilunar valves the pulmonary valve and the aortic valve.
Sinus Arrest	Rhythm characterized by a pause caused by the SA node not firing. Characterized by a pause in the regular rhythm that measures more than 2 R-R intervals.
Sinus Arrhythmia	Rhythm that meets criteria for normal sinus rhythm except the rhythm is irregular.
Sinus Bradycardia	Rhythm that meets criteria for normal sinus rhythm except the rate is < 60 bpm.
Sinus Dysrhythmias	Any sinus rhythm that is not normal sinus rhythm
Sinus Exit Block	Rhythm characterized by a pause caused by the impulse initiated by the SA node not being conducted out of the node. Characterized by a pause in the regular rhythm of exactly 2 R-R intervals.
Sinus Pause	Rhythm characterized by a pause caused by the delay in impulse being initiated in the SA node. Characterized by a pause in the regular rhythm of less than 2 R-R intervals.
Superior Vena Cava (SVC)	Large vein that delivers deoxygenated blood from above the shoulders to the right atrium.
Supraventricular Impulse	Impulse that originates above the ventricle.
Supraventricular Tachycardia (SVT)	Tachycardia with a rate > 150 bpm that is initiated from an impulse originating above the ventricle where no P wave can be identified.
Sustained Ventricular Tachycardia.	A run of ventricular tachycardia of 5 or beats in a row.
Sympathetic Nervous System	The sympathetic nervous system innervates all parts of the heart, including the atria, ventricles, the SA and AV nodes, and all of the blood vessels. The sympathetic fibers are adrenergic and tend to be excitatory through the release of norepinephrine. There are 3 types of sympathetic receptors: alpha-adrenergic, beta-adrenergic, and dopaminergic.
Systole	Refers to the atrial or ventricular contraction. Normally follows cardiac depolarization.

T

T Wave	ECG representation of ventricular repolarization. It follows the QRS complex.
Third Degree Heart Block Or Complete Heart Block	Type of heart block characterized by independent activity of the atria and the ventricles. Impulses originating the SA node are not conducted to the ventricle so the impulse for ventricular depolarization originates from below the AV junction.
Torsade de Pointes	A form of polymorphic ventricular tachycardia characterized by QRS complexes that change directions.
Trabeculae	Smooth ridges on the walls of the heart.
Tricuspid Valve	One wave valve that allow blood flow from the right atrium to the right ventricle and prevents blood from flowing back to the right atrium during ventricular systole.
Trigeminy	Premature ventricular contractions occurring every third beat.
Tropomyosin/ Troponin	Around the actin fibril are interwoven protein rods of troponin and tropomyosin. They inhibit the ability of actin to connect with myosin. At the beginning of a contraction, calcium is released and attaches to troponin, allowing cross bridges on the myosin to attach to the actin.

U

Underlying Rhythm	Refers to the predominate rhythm on an ECG strip recording. Usually identified first when there are ectopic beats.
Unifocal Pvcs	Premature ventricular contractions that originated from one focus in the ventricle.
Unipolar Leads	ECG leads where the positive and negative electrode are located in the same spot. There are 6 unipolar leads, V 1-6, aVR, aVL, and aVF.

V

Vasovagal Response	Caused by stimulation of the parasympathethic nervous system and results in slowing of the heart rate. Can be initiated intentionally with carotid massage or valsalva maneuver (done by inhaling and tightening the diaphragm and chest muscles while bearing down as if to try to have a bowel movement) or unintentionally as a result of vomiting or bearing down with a bowel movement.
Ventricular Bigeminy	Premature ventricular contractions that occur with every other beat.
Ventricular Escape Beats/Rhythm	Complex or rhythm that takes over if SA node and AV junction fails to fire. Beats or rhythm occur after a pause and later than expected.

Ventricular Fibrillation	Impulse for ventricular depolarization originates from multiple sites in the ventricle. Results in weak disorganized quivering of the ventricle with no identified QRS complex that results in no cardiac output.
Ventricular Rate (VR),	Number of time the ventricle depolarizes in one minute which is determined by counting the number of QRS. Ventricular rate is what is measured when the pulse is assessed and counted.
Ventricular Stroke Volume	Amount of blood ejected with each ventricular contraction. Also called stroke volume with heart rate it determines cardiac output. Cardiac Output = Stroke Volume X Heart Rate.
Ventricular Tachycardia (VT)	Impulse for ventricular contraction originated from ventricle with a rate > 100 bpm.

W

Wandering Atrial Pacemaker	See multifocal atrial rhythm.

Basic ECG Interpretation

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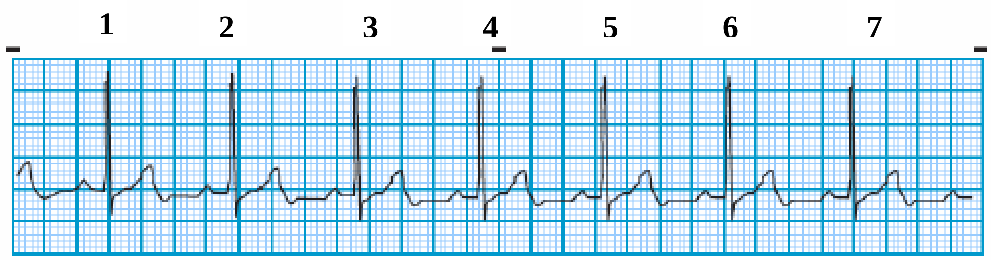
Appendix I: Calculating Heart Rate

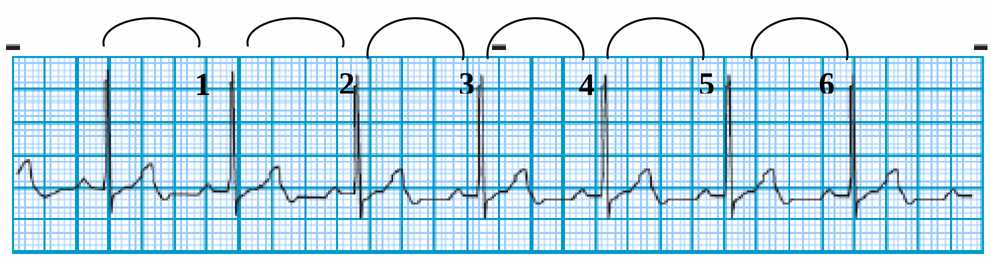
There are a number of different ways to calculate heart rates from a 6 second ECG strip recording. In the ECG Basic Dysrhythmia Interpretation e-learning module AACN chose to teach 2 of the methods. In practice you will encounter other methods of calculating heart rates. A description of some of the other methods is provided below. Remember that heart rate is only number and it is the patient's physiologic response to their hear rate and rhythm that is most important.

On the work sheets in the ECG Basic Dyrhythmia Interpretation module the six second strip method 1 and the calculation by division method 3 are used to determine the heart rates.

Six Second Strip
Method 1
Identify the number of QRS complexes in a 6 second strip and multiply by 10. This is similar to taking the patient's pulse for 6 seconds and multiplying that number by 10. Six seconds times 10 equals 60seconds or beats/minute. In the example below the estimated ventricular rate is 70 bpm. This method can be used for rhythms that are regular or irregular and might result in an over estimation of the heart rate.



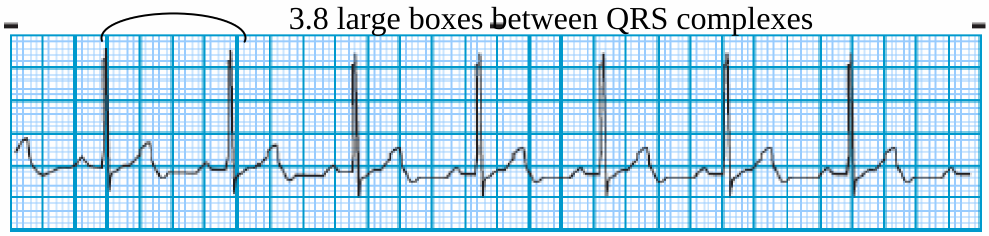
Six Second Strip
Method 2
Identify the number of QRS intervals in a 6 second strip beginning with the second complex and multiply by 10. This is similar to the calculation by division method where the In the example below the estimated ventricular rate is 60 bpm. This method can be used for rhythms that are regular or irregular and might result in an under estimation of the heart rate.



Calculation by division is based on the timed segments of the ECG graph paper. Each large box is 0.20 seconds; 300 times 0.20 equals 60 seconds or 1 minute. Each small box is 0.04 seconds; 1500 times 0.04 seconds equal 60 seconds or 1 minute.

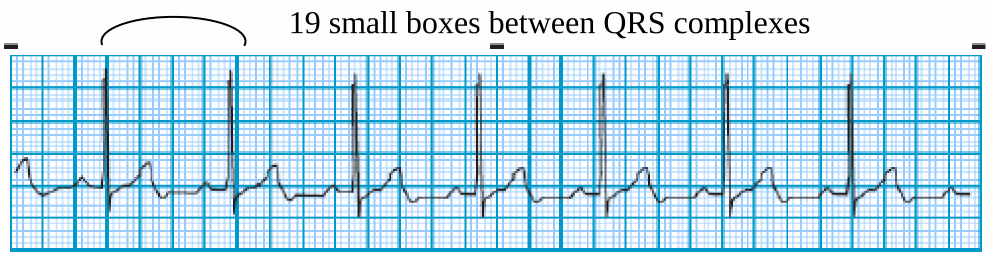
Calculation by Division
Method 3

Count the number of large boxes and portion of small boxes between 2 QRS intervals and divide into 300. Each large box is comprised of 5 small boxes or 0.2 of a large box. 1 divided by 5 = 0.2. This method should only be used if the rhythm is regular. In the example below there are 3.8 large boxes between the QRS intervals; 300/3.8 = 78.9 or rounding up a heart rate of 79 bpm.



Calculation by Division
Method 4

Count the number of small boxes between 2 QRS intervals and divide into 1500. This method should only be used if the rhythm is regular. In the example below there are 19 small boxes between the QRS intervals; 1500/19 = 78.9 or rounding up a heart rate of 79 bpm.



Appendix II: Corrections

The following areas were identified in beta testing and require clarification.

Lesson II: ECG Basic Interpretation

Over all there were questions regarding heart rate calculations. A handout has been created that illustrates the 2 methods of calculating heart rate that are taught in the module and 2 other methods that the learner may encounter in the clinical setting. In the module AACN attempts to place emphasis on the patient's hemodynamic response the heart rate and rhythm and not the number. For the purposes of testing and rhythm strip interpretation the six second strip method of counting the number of QRS complexes in a 6 second strip and calculation by division method of dividing the number of large boxes between 2 QRS complexes into 300 was used.

Slide 13:
On the graphic the J point is identified. The J point is not discussed in the module, however it is defined in the glossary.

Slide 28:
There is a misprint in the text and voice over. In the last paragraph 0.02 should read and state 0.2. Further explanation on why each small box is equal to 0.2 for rate calculation is included in the Calculating Heart Rate sheet.

Lesson III: Sinus Rhythms

Slide 39:
The complex is identified as QS and should be QR. In the text and voice over the complex is identified as both QS and QR. The correct identification is QR.

Lesson IV: Atrial Rhythms

Slide 6:
The rate of the rhythm strip is 60 bpm. The text and voice over incorrectly state that the rate is 70 bpm. The rate is actually 60 bpm.

Slide 7:
Voice over omitted the phrase "check the T wave of the preceding complex" in the 1st paragraph. Please read the text box.

Slide 19:
The last sentence of the text should read: "Treatment for patients in atrial fibrillation include anticoagulants, amiodarone, calcium channel blockers, digoxin and beta blockers."

Lesson V: AV Junctional Rhythms

Slide 30
This slide may be confusing. Please replace this slide with the attached PDF.

Lesson VI: Ventricular Rhythms

Slide 9:
The 3rd paragraph 3rd sentence should read: "The 1st, 5th and 6th complexes are upright so start with these." The voice over states 300/4.2 but should state 300/4.8. The text is correct.

Slide 13:
The 4th paragraph the following sentences were omitted: "However, because of the premature ventricular contractions calculation by division is not an accurate method of determining atrial and ventricular rate. There are no P waves present before the PVCs so the atrial rate in this rhythm strip is 60 bpm and the ventricular rhythm is irregular."

Appendix III: Slides & PDF Downloads

Lesson 1: Cardiac Anatomy & Physiology

Slide #	Content	PDF
1	Lesson I: Cardiac Anatomy & Physiology	
2	Objectives	
3	The Heart and Circulatory System	
4	Layers of the Heart	
5	Heart Chambers	
6	Heart Valves	
7	Circulation - Venous	
8	Circulation - Arterial	
9	Coronary Artery Circulation	
10	Nerve Functions - Sympathetic	X
11	Nerve Functions - Parasympathetic	
12	Cardiac Muscle Cell	
13	Structure of Myocardial Cells	
14	Electrophysiology	
15	Conduction System – SA Node	
16	Conduction System – AV	
17	Conduction System – Bundle of His	
18	Conduction System – Bundle Branches	
19	Conduction System – Purkinje Fibers	
20	Conduction System – Electrical Conduction Pathway	
21	Cardiac Cycle	
22	Self Assessment Questions	

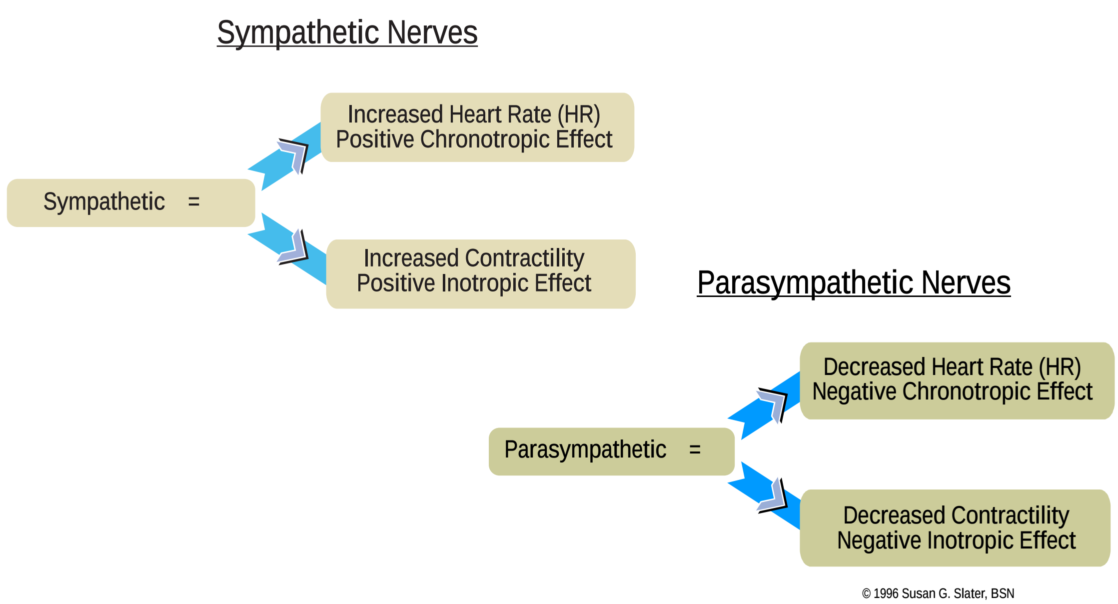
Module: ECG Module

Lesson: Introduction to ECG Cardio A&P

Section:

Slide: 10

Sympathetic/Parasympathetic Nervous System



Effects of the Sympathetic & Parasympathetic Nervous System on the Heart		
Function	Parasympathetic	Sympathetic
Automaticity (chronotropy or rate)	Decrease	Increase
Excitability	Decrease	Increase
Conduction	Decrease	Increase
Contractility (inotropy)	Decrease	Increase

Lesson 2: Cardiac Anatomy & Physiology

Slide #	Content	PDF
1	Lesson II: Basic ECG Interpretation	
2	Objectives	
3	Objectives	
4	Monitoring Basics	
5	Monitoring Basics: Einthoven's Triangle	
6	Monitoring Basics: Lead Placement	X
7	Retrograde & Antegrade Conduction	X
8	ECG Graph Paper: Isoelectric Line	
9	ECG Graph Paper: Timing & Voltage	
10	ECG Complex: P wave	
11	ECG Complex: QRS complex	
12	ECG Complex: QRS complex 1 & 2	
13	ECG Complex: QRS complex 3& 4	
14	ECG Complex: QRS complex 5 & 6	
15	ECG Complex: T wave	
16	ECG Complex: PR interval	
17	ECG Complex: ST segment	
18	ECG Complex: QT interval	
19	ECG Complex Review	
20	Diastolic Phase	
21	Systolic Phase	
22	Cardiac Cycle	
23	Measuring Heart Rates	
24	Measuring Heart Rates: Timing & Voltage	
25	Measuring Heart Rates: 6 second method - VR	
26	Measuring Heart Rates: 6 second method - AR	
27	Measuring Heart Rates: 6 second method - Review	
28	Heart Rates: Calculation by Division	
29	Measuring Heart Rates: Calculation by Division - VR	
30	Measuring Heart Rates: Calculation by Division - VR	
31	Measuring Heart Rates: Calculation by Division - AR	
32	Measuring Heart Rates: Calculation by Division - AR	X
33	Measuring intervals: PR	
34	Measuring Intervals: PR	
35	Measuring Intervals: QRS	
36	Measuring Intervals: QRS	X
37	Measuring Intervals: QT	
38	Measuring intervals: QT	
39	Caliper	
40	Caliper Use	
41	Self Assessment Questions	

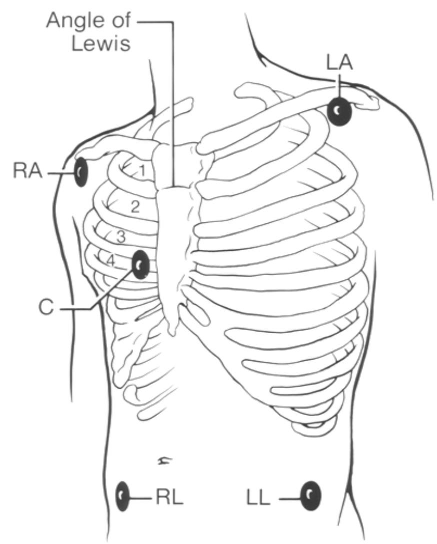
Module: ECG Module

Lesson: ECG Interpretation Basics

Section:

Slide: 6

5 Lead Placement



5 lead systems allow for the recording of any of the six limb leads plus one precordial (V) lead. Shown is lead placement for recording V1. 5 Lead monitoring systems are recommended over 3 lead systems for monitoring QRS morphology.

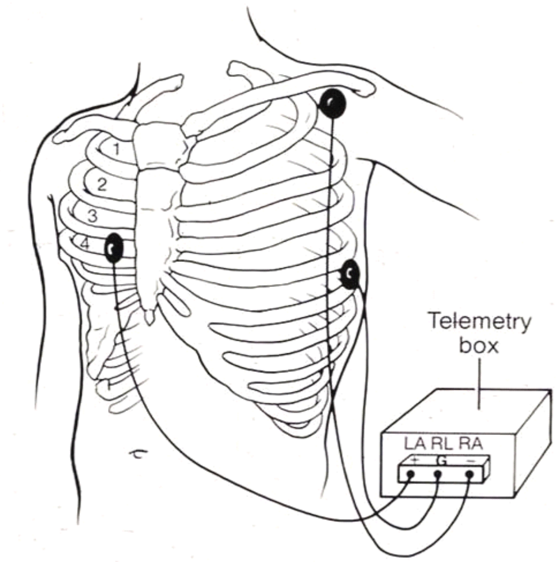
Module: ECG Module

Lesson: ECG Interpretation Basics

Section:

Slide: 6

3 Lead Placement



Simple 3-electrode lead system. Shown is electrode placement for MCL1 or V1. Monitoring MCL 1 is recommended if a 3 lead system is used.

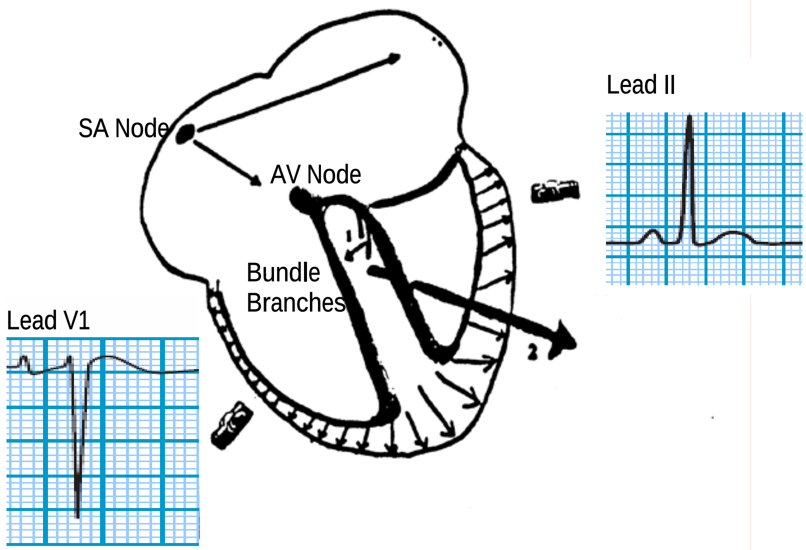
Module: ECG Module

Lesson: ECG Interpretation Basics

Section:

Slide: 7

Monitoring Basics



ECG leads give real time representation of the electrical flow of the heart in relationship to the placement of the electrode. Electrical flow moving towards the positive electrode will have complexes that are mostly positive or above the isoelectric line. Electrical flow moving away from the positive electrode will have complexes that are mostly negative or below the isoelectric line. Electrical flow that moves toward and away from the positive electrode will have parts of the complex above the isoelectric line and parts of the complex below the isoelectic line.

Lead II and Lead V1 are frequently monitored in the hospital setting. Lead II monitors flow between the right arm (negative electrode) and the left leg (positive electrode). As shown in the diagram this is the predominant electrical conduction pattern of the heart. Normal Lead II complexes are expected to be mostly positive.

Lead V1 monitors flow that is directed toward the 4th intercostal space to the right of the sternum. This is on the right side of the heart at the level of the AV node. As shown in the diagram, the predominate electrical flow pattern of the heart is away from the electrode. Normal V1 complexes are expected to be mostly negative.

Module: ECG Module

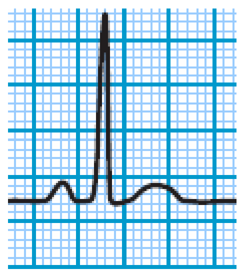
Lesson: ECG Interpretation Basics

Section:

Slide: 7

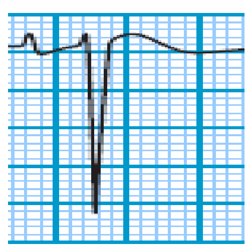
Monitoring Basics

Lead II is a bipolar lead and monitors the electrical flow of the heart between a negative electrode on the right arm and a positive electrode on the left leg. Normal electrical conduction is from the SA node to the Purkinge fibers or from right to left.



Lead II normal configuration is mostly positive

V1 is a unipolar lead. The electrode is placed at the 4th intercostals space to the right of the sternum. Normal electrical conduction is from the right shoulder to the left leg. The flow is away from the unipolar electrode so the ECG complex in V1 is mostly negative or below the isoelectric line.



Lead VI normal configuration is mostly negative

Module: ECG Module

Lesson: ECG Interpretation Basics

Section:

Slide: 32

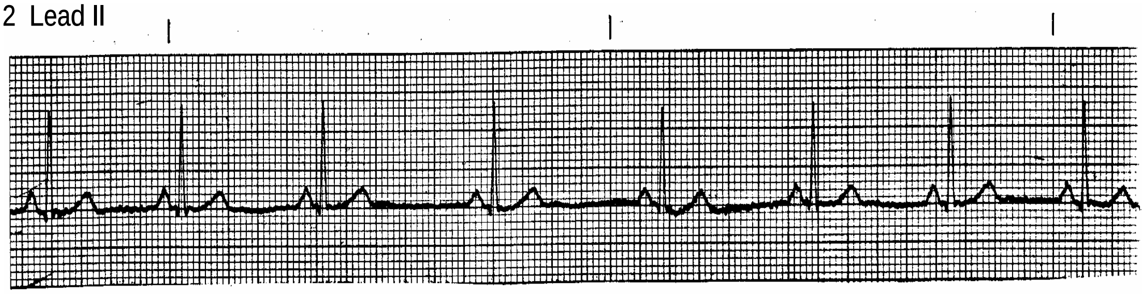
Calculating Heart Rate

1 Lead V1

6-second method

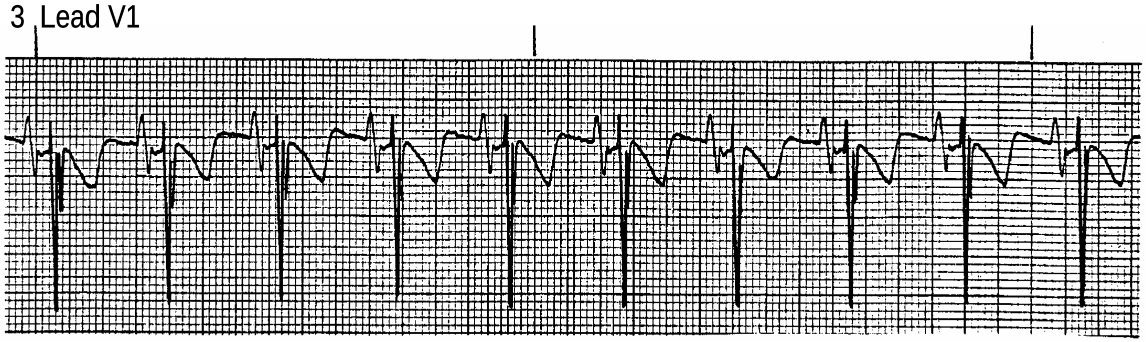
Calculation by Division

2 Lead II



6-second method

3 Lead V1



6-second method Calculation by Division

Module: ECG Module

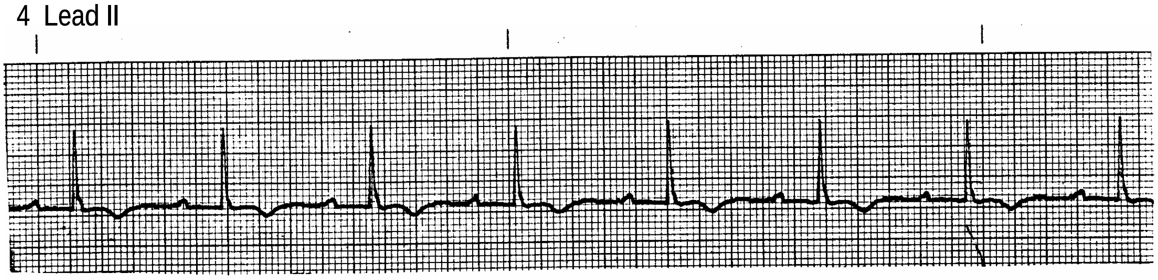
Lesson: ECG Interpretation Basics

Section:

Slide: 32

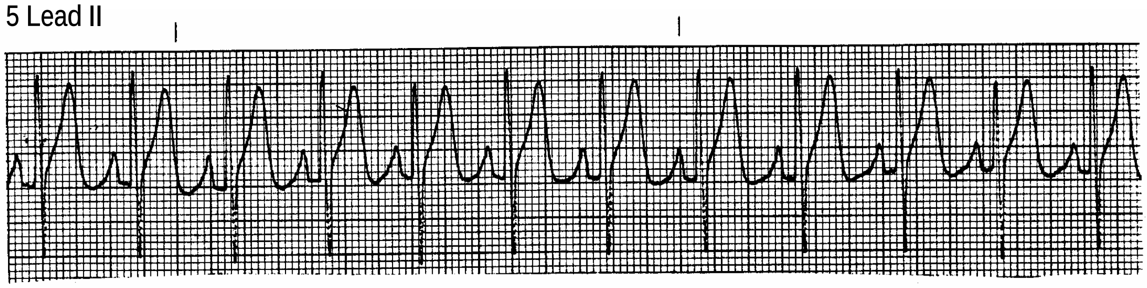
Calculating Heart Rate

4 Lead II



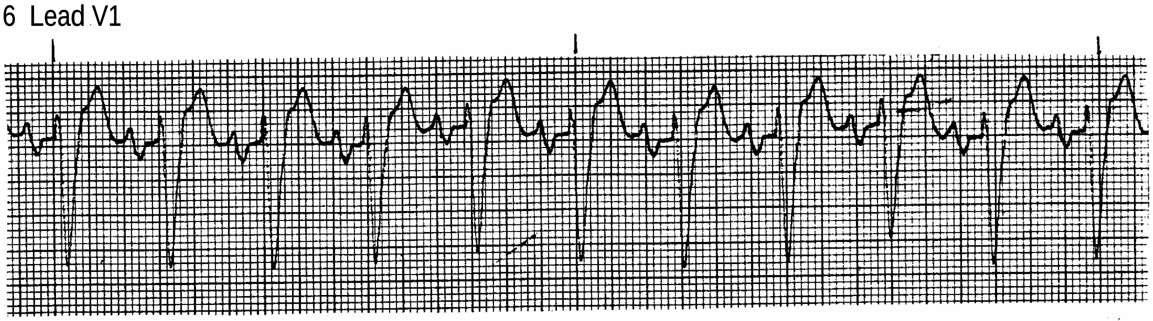
6-second method Calculation by Division

5 Lead II



6-second method Calculation by Division

6 Lead V1



6-second method Calculation by Division

Module: ECG Module

Lesson: ECG Interpretation Basics

Section:

Slide: 32

Calculating Heart Rate

Work Sheet Answers

1. 6-second method	60 bpm	Calculation by Division	63 bpm 300/4.8
2. 6-second method	60 bpm	Calculation by Division	rhythm is irregular
3. 6-second method	90 bpm	Calculation by Division	88 bpm 300/3.4
4. 6-second method	70 bpm	Calculation by Division	63 bpm 300/4.8
5. 6-second method	110 bpm	Calculation by Division	107 bpm 300/2.8
6. 6-second method	100 bpm	Calculation by Division	100 bpm 300/3

Module: ECG Module

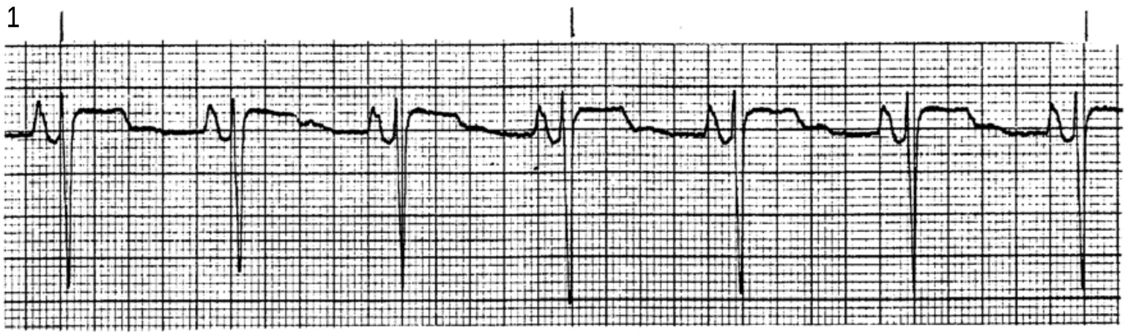
Lesson: ECG Interpretation Basics

Section:

Slide: 36

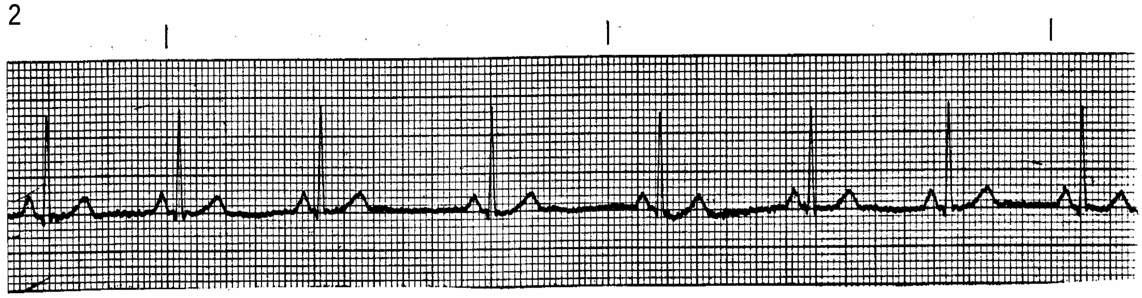
Interval Measurements

1



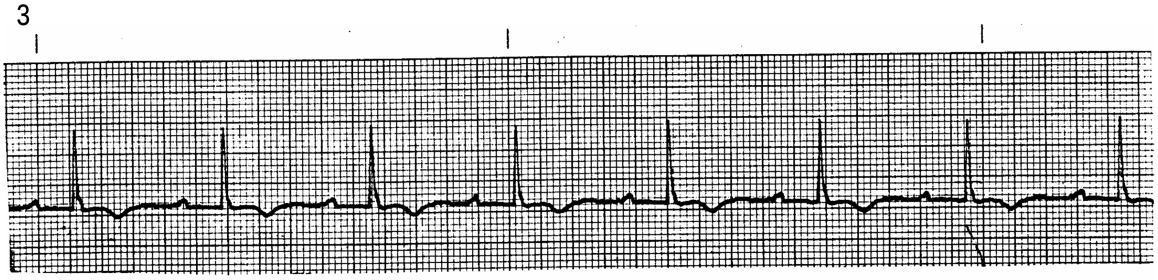
PR interval QRS interval

2



PR interval QRS interval

3



PR interval QRS interval

Module: ECG Module

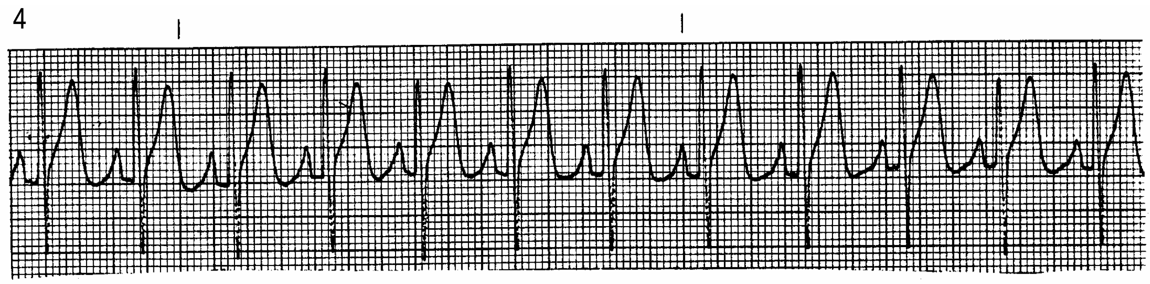
Lesson: ECG Interpretation Basics

Section:

Slide: 36

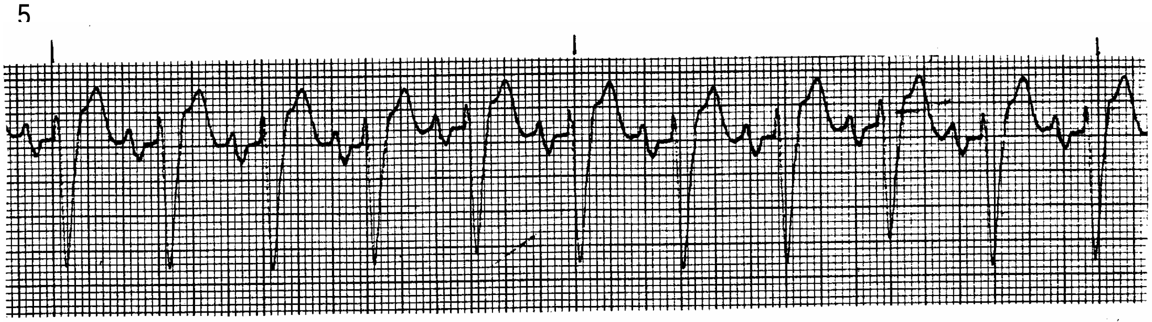
Interval Measurements

4



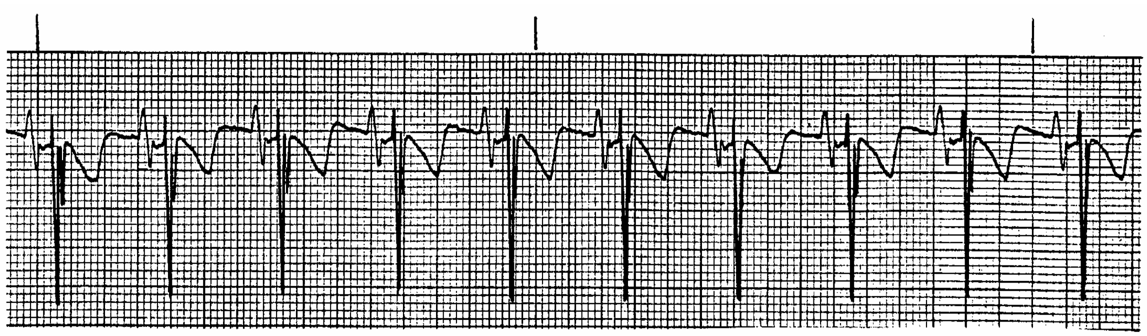
PR interval QRS interval

5



PR interval QRS interval

6



PR interval QRS interval

Module: ECG Module

Lesson: ECG Interpretation Basics

Section:

Slide: 36

Interval Measurements

Work Sheet Answers

1. PR Interval 0.16 seconds QRS Interval 0.08 seconds
2. PR Interval 0.16 seconds QRS Interval 0.06 seconds
3. PR Interval 0.28 seconds QRS Interval 0.06 seconds
4. PR Interval 0.20 seconds QRS Interval 0.08 seconds
5. PR Interval 0.22 seconds QRS Interval 0.16 seconds
6. PR Interval 0.18 seconds QRS Interval 0.14 seconds

Lesson 3: Sinus Rhythms

Slide #	Content	PDF
1	Lesson III: Sinus Rhythms	
2	Objectives	
3	Lesson Rhythms	
4	Steps of ECG Rhythm Analysis	X
5	Sinus Rhythm	
6	Normal Sinus Rhythm	
7	Normal Sinus Rhythm Elements	
8	Measuring Normal Sinus Rhythms – QRS Interval	
9	Measuring Normal Sinus Rhythms – PR Interval	
10	Normal Sinus Rhythm Elements – Caliper Animation	
11	Measuring Normal Sinus Rhythms – 6 second method - VR	
12	Measuring Normal Sinus Rhythms – Calculation by division - VR	
13	Measuring Normal Sinus Rhythms – 6 second method - AR	
14	Measuring Normal Sinus Rhythms – Calculation by division - AR	
15	Normal Sinus Rhythm Summary	X
16	Sinus Dysrhythmias	
17	Sinus Bradycardia	
18	Sinus Bradycardia - Wave Elements	
19	Sinus Bradycardia – QRS	
20	Sinus Bradycardia - PR	
21	Sinus Bradycardia - Regularity	
22	Sinus Bradycardia – 6 second method - VR	
23	Sinus Bradycardia – Calculation by division - VR	
24	Sinus Bradycardia - 6 Second Method - AR	
25	Sinus Bradycardia – Calculation by division - AR	
26	Sinus Bradycardia - Summary	
27	Sinus Tachycardia	
28	Sinus Tachycardia - Wave Elements	
29	Sinus Tachycardia - PR	
30	Sinus Tachycardia - QRS	
31	Sinus Tachycardia - Regularity	
32	Sinus Tachycardia – 6 second method - VR	
33	Sinus Tachycardia – Calculation by division - VR	
34	Sinus Tachycardia - 6 Second Method - AR	
35	Sinus Tachycardia – Calculation by division - AR	
36	Sinus Tachycardia Summary	
37	Intraventricular Conduction Defect - Wave Elements	
38	Intraventricular Conduction Defect - PR	
39	Intraventricular Conduction Defect - QRS	
40	Intraventricular Conduction Defect – 6 second method – VR	
41	Intraventricular Conduction Defect – Calculation by division - VR	
42	Intraventricular Conduction Defect - 6 Second Method - AR	
43	Intraventricular Conduction Defect – Calculation by division - AR	

44	Intraventricular Conduction Defect - Regularity	
45	Intraventricular Conduction Defect - Summary	
46	1st Degree AV Block	X
47	Intraventricular Conduction Defect	
48	Sinus Arrhythmia	
49	Sinus Arrhythmia - PR	
50	Sinus Arrhythmia - QRS	
51	Sinus Arrhythmia - Regularity	
52	Sinus Arrhythmia – 6 second method - VR	
53	Sinus Arrhythmia – 6 Second Method - AR	
54	Sinus Pauses	
55	Sinus Pause - Wave Elements	
56	Sinus Pause - Regularity	
57	Sinus Pause – Cardiac Cycles	
58	Sinus Pause – Cardiac Cycles - Evaluation	
59	Sinus Exit Block	
60	Sinus Arrest	
61	Sinus Dysrhythmia	X
62	Self Assessment Questions	

Module: ECG Module

Lesson: Sinus Rhythms

Section:

Slide: 4

ECG Rhythm Analysis

1. Identify P waves
   a. Are P waves present?
   b. Do the P waves all look the same (have the same shape)?
   c. Is every P wave followed by a QRS complex?
2. Identify the QRS complex
   a. Are QRS complexes present?
   b. Do the QRS complexes look the same (have the same shape)?
   c. Is there one and only one P wave before each QRS complex?
3. Measure the PR interval
   a. Is the PR interval within normal limits (0.12 – 0.20 seconds)?
   b. Is the PR interval the same for every ECG complex?
4. Measure the QRS interval
   a. Is the QRS interval within normal limits (0.04 – 0.10 seconds)?
   b. Is the QRS interval the same for every complex?
5. Determine the atrial and ventricular rhythm
   a. Is the P-P interval consistent (is the distance between the P waves the same)?
   b. Is the R-R interval consistent (is the distance between the QRS complexes the same)?
6. Determine the atrial and ventricular rate

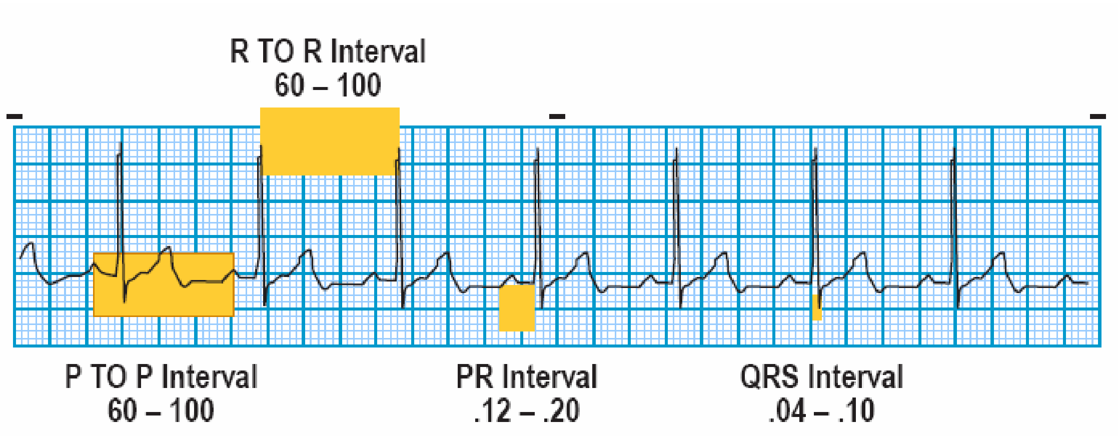
Module: ECG Module

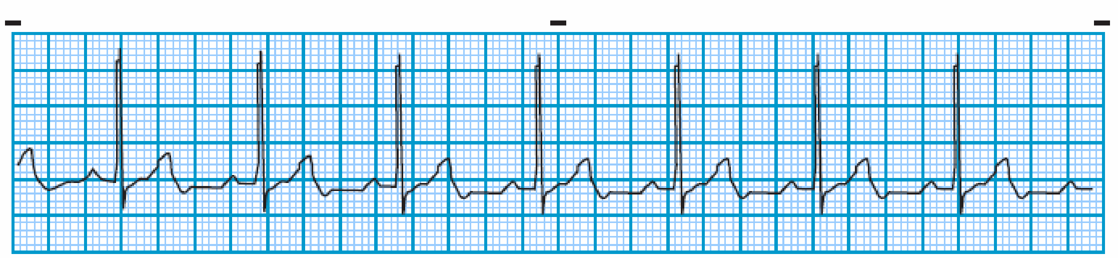
Lesson: Sinus Rhythms

Section:

Slide: 15

NSR Criteria





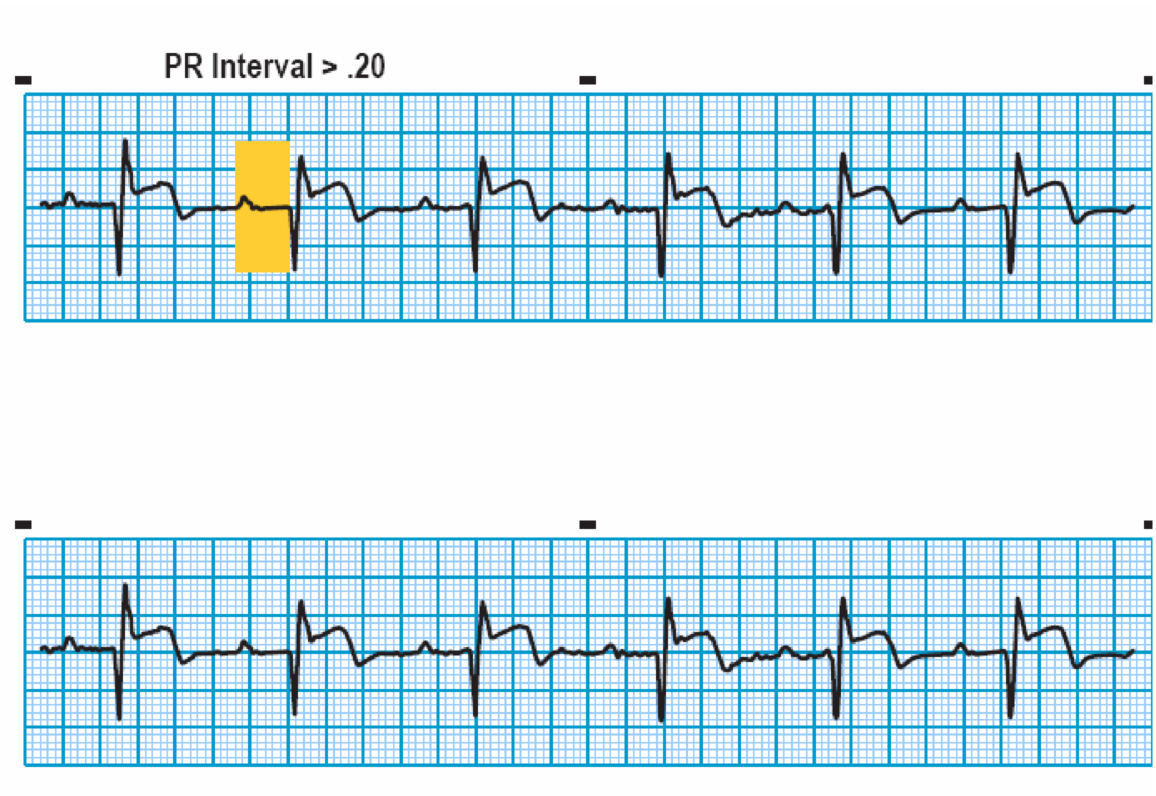
Module: ECG Module

Lesson: Sinus Rhythms

Section:

Slide: 46

1st Degree AV Block



Module: ECG Module

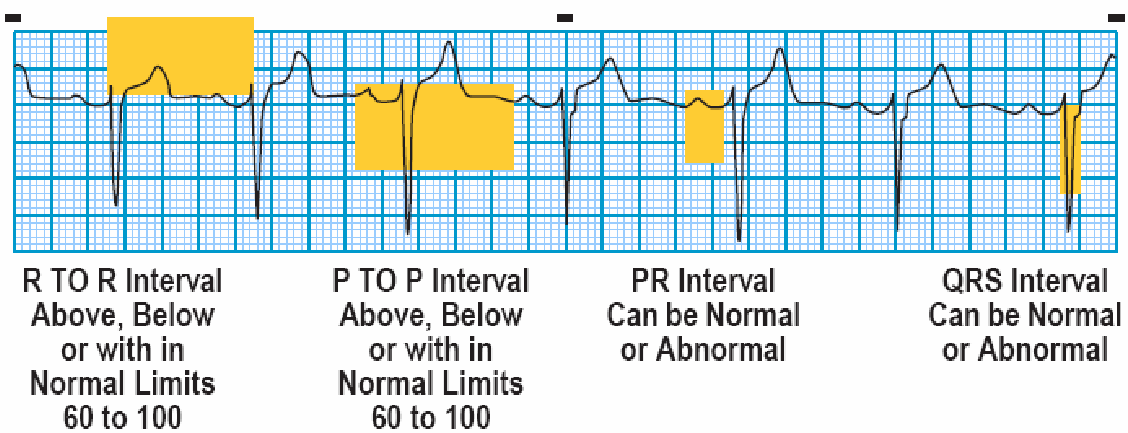
Lesson: Sinus Rhythms

Section:

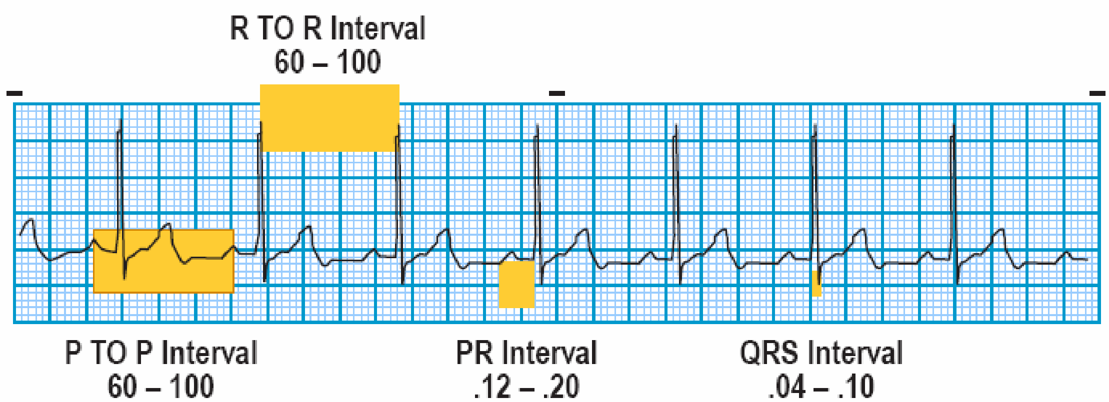
Slide: 61

Sinus Rhythm verses Normal Sinus Rhythm Criteria

Sinus Rhythm Criteria

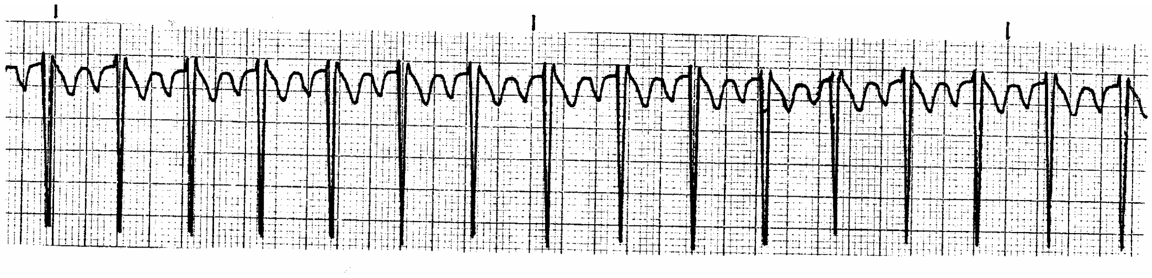


Normal Sinus Rhythm Criteria



Sinus Rhythm Work Sheets

1 Lead V1



P waves ______

PR interval _____

QRS _____

QRS interval _____

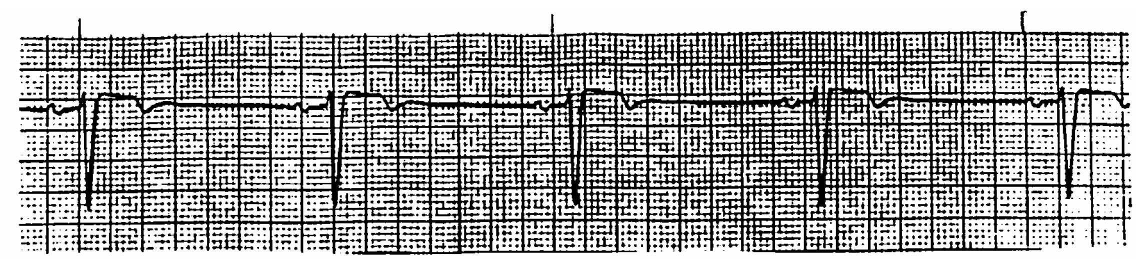
Vent. Rate ________

Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

2 Lead V1



P waves ______

PR interval _____

QRS _____

QRS interval _____

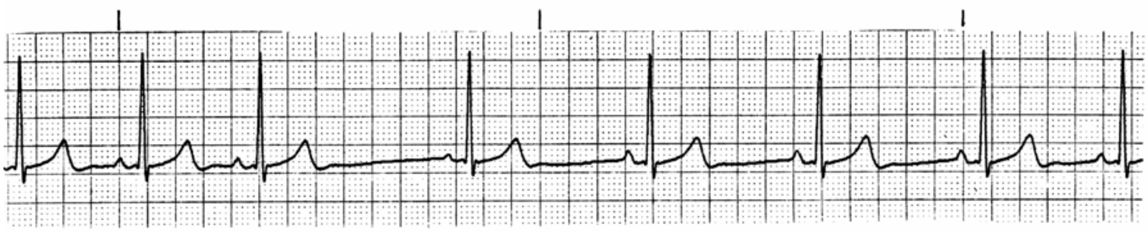
Vent. Rate ________

Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

3 Lead II



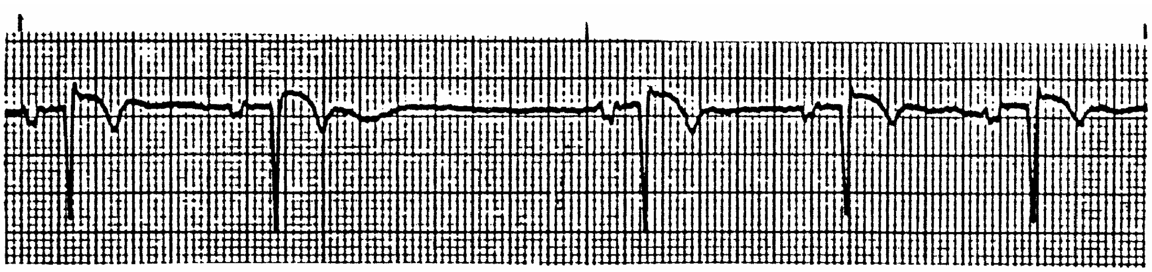
P waves ______ Vent. Rate ________

PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation ____________________

4 Lead V1



P waves ______ Vent. Rate ________

PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation ____________________

5 Lead II

P waves ______

PR interval _____

QRS _____

QRS interval _____

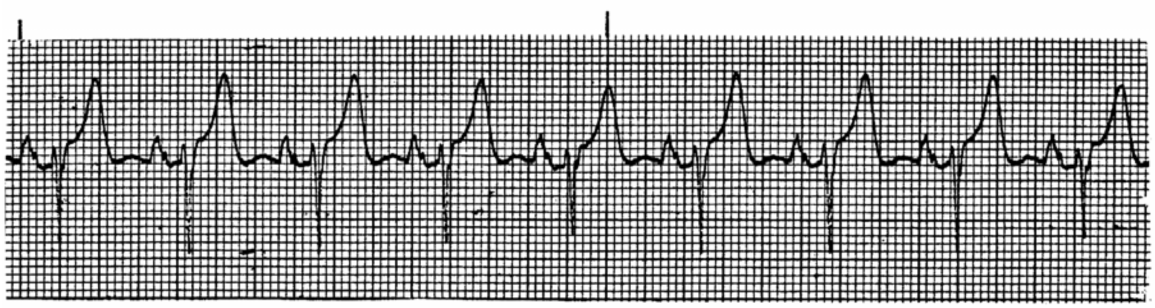
Vent. Rate ________

Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

6 Lead V1



P waves ______

PR interval _____

QRS _____

QRS interval _____

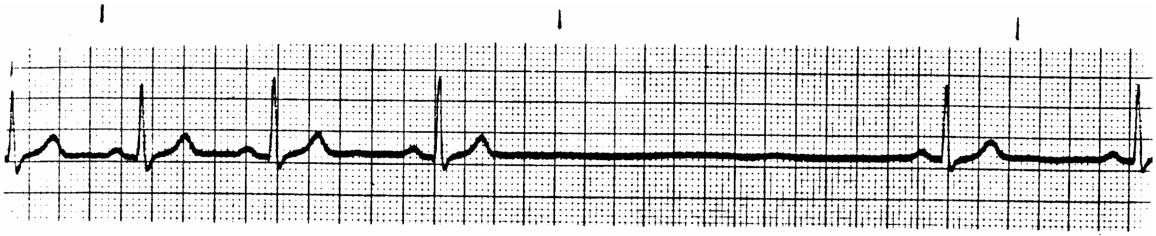
Vent. Rate ________

Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

7 Lead II



P waves ______

PR interval _____

QRS _____

QRS interval _____

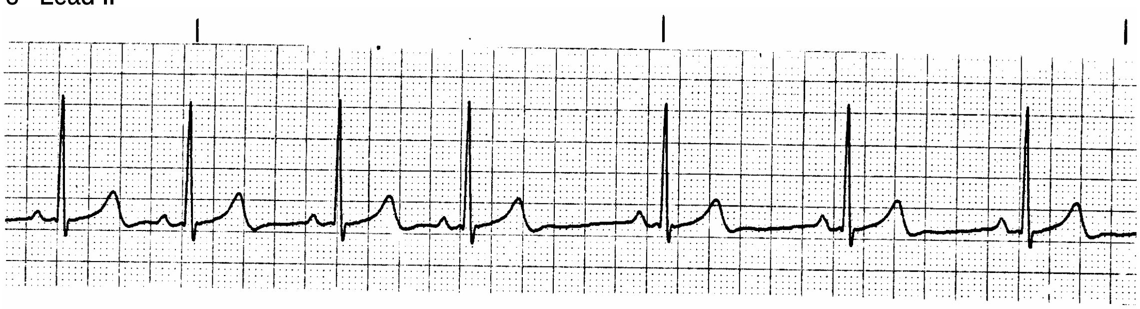
Vent. Rate ________

Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

8 Lead II



P waves ______

PR interval _____

QRS _____

QRS interval _____

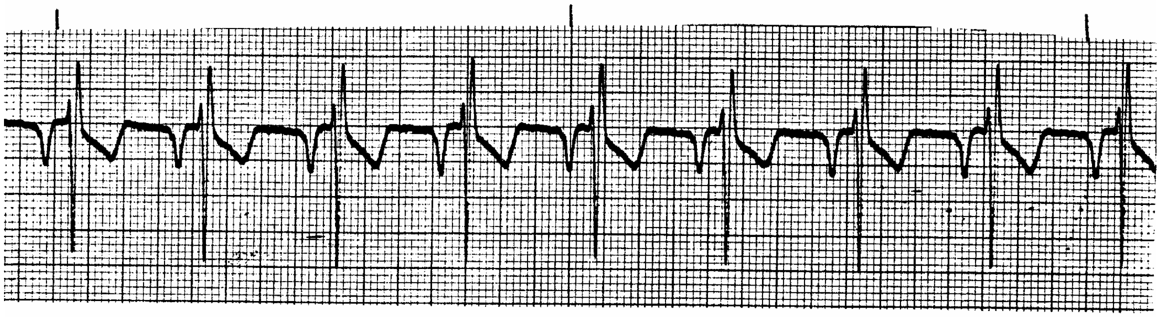
Vent. Rate ________

Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

9 Lead V1



P waves ______

PR interval _____

QRS _____

QRS interval _____

Vent. Rate ________

Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

Sinus Rhythm Work Sheet Answers

1.

P waves	present	Ventricular Rhythm	regular
PR interval	0.16	Atrial Rhythm	regular
QRS	present	Ventricular Rate	125 bpm
QRS interval	0.08		

Interpretation: Sinus tachycardia

Discussion: In Lead V1 the ECG electrode is located at the 4th intercostal space to the right of the sternum therefore the normal electrical flow of the heart is away from the electrode making the ECG complex mostly negative or below the isoelectric line. The P wave can be positive, negative or biphasic (above and below the isoelectric line) in Lead V1. In this rhythm strip P waves are present and they are negative. Each P wave is followed by a QRS complex. QRS complexes are present and each QRS is preceded by one P wave. The PR interval is 0.16 and the QRS interval is 0.08. The P-P and R-R intervals are regular. The ventricular rate, determined using calculation by division (300/2.4), is 125 bpm. Except for the rate this rhythm meets the criteria for normal sinus rhythm. Because the rate is > 100 bpm it is interpreted as sinus tachycardia. Cardiac output and systemic perfusion might or might not be affected by this rate. The patient should be assessed and the underlying reason for the tachycardia determined. Causes of sinus tachycardia include pain, anxiety, fever, infection, and hypovolemia.

2.

P waves	present	Ventricular Rhythm	regular
PR interval	0.20	Atrial Rhythm	regular
QRS	present	Ventricular Rate	39 bpm
QRS interval	0.10		

Interpretation: Sinus bradycardia

Discussion: This is Lead V1 the complex should be predominately negative. There are P waves present. In this strip the P waves are biphasic and each P wave is followed by a QRS complex. QRS complexes are present and each is preceded by one P wave. The PR interval is 0.20 and the QRS interval is 0.10. The P-P interval and R-R interval is regular. The rate, determined using calculation by division (300/7.6) is 39 bpm. The rhythm meets criteria for normal sinus rhythm except for the rate which is < 60. This rhythm is interpreted as sinus bradycardia. The rate is very slow and it is very likely that cardiac output and systemic perfusion might be compromised. Causes for sinus bradycardia include beta blockers, calcium channel blockers, digitalis and sick sinus syndrome. Sinus bradycardia can be normal in highly trained athletes.

3.

P waves	present	Ventricular Rhythm	irregular
PR interval	0.18	Atrial Rhythm	irregular
QRS	present	Ventricular Rate	50 bpm
QRS interval	0.08		

Interpretation: Sinus arrhythmia with bradycardia
Discussion: In Lead II the electric flow of the heart is toward the positive electrode on the left leg. In Lead II the ECG complex should be predominately positive and the P wave should be positive. In this strip P waves are present, upright and followed by a QRS complex. QRS complexes are present and each is preceded by one P wave. The PR interval and the QRS interval are normal. The P-P interval and the R-R interval are irregular throughout the strip. The ventricular rate, using the 6-second strip method, is 50 bpm. This rhythm is interpreted as sinus arrhythmia with a bradycardia.

4.

P waves	present	**Ventricular Rhythm**	irregular
PR interval	0.20-0.22	**Atrial Rhythm**	irregular
QRS	present	**Ventricular Rate**	50 bpm
QRS interval	0.08		

Interpretation: Sinus pause
Discussion: This is Lead V1 so the complex is predominately negative. In this strip the P waves are mostly negative. P waves are present and followed by QRS complexes. QRS complexes are present and preceded by one P wave. The PR interval and QRS interval are within normal limits. The P-P interval and R-R interval are irregular. The ventricular rate is 50 bpm. The rhythm slows after the 2nd ECG complex and then resumes at the rate and rhythm. The pause is less than 2 cardiac cycles making this a sinus pause. The rate is < 60 bpm so this is also a bradycardia.

5.

P waves	present	**Ventricular Rhythm**	irregular
PR interval	0.18	**Atrial Rhythm**	irregular
QRS	present	**Ventricular Rate**	60 bpm
QRS interval	0.06		

Interpretation: Sinus arrhythmia
Discussion: See discussion for rhythm strip 3

6.

P waves	present	**Ventricular Rhythm**	regular
PR interval	0.16	**Atrial Rhythm**	regular
QRS	present	**Ventricular Rate**	93 bpm
QRS interval	0.08		

Interpretation: Normal sinus rhythm (NSR)
Discussion: This is Lead V1 so the complex is predominately negative. In this strip the P waves are positive. P waves are present and followed by QRS complexes. QRS complexes are present and preceded by one P wave. The PR interval and QRS interval are within normal limits. The P-P interval and R-R interval are regular. The ventricular rate is 93 bpm. The rhythm meets the criteria for normal sinus rhythm and is interpreted as NSR.

7.

P waves	present	Ventricular Rhythm	irregular
PR interval	0.20	Atrial Rhythm	irregular
QRS	present	Ventricular Rate	40 bpm
QRS interval	0.08		

Interpretation: Sinus arrest with bradycardia

Discussion: This is Lead II so the complex is predominately positive. P waves are present and followed by QRS complexes. QRS complexes are present and preceded by one P wave. The PR interval and QRS interval are within normal limits. The P-P interval and R-R interval are irregular. The ventricular rate, determined using the 6-second strip method, is 40 bpm. The rhythm slows after the 3rd ECG complex. The pause is greater than 2 cardiac cycles making this a sinus arrest. The rate is < 60 bpm so this is also a bradycardia.

8.

P waves	present	Ventricular Rhythm	regular
PR interval	0.16	Atrial Rhythm	regular
QRS	present	Ventricular Rate	60 bpm
QRS interval	0.10		

Interpretation: Sinus arrhythmia
Discussion: See previous discussion for rhythm strip 3

9.

P waves	present	Ventricular Rhythm	regular
PR interval	0.20	Atrial Rhythm	regular
QRS	present	Ventricular Rate	79 bpm
QRS interval	0.10		

Interpretation: Normal sinus rhythm
Discussion: This is Lead V1 so the complex is predominately negative. In this strip the P waves are positive. P waves are present and followed by QRS complexes. QRS complexes are present and preceded by one P wave. The PR interval and QRS interval are within normal limits. The P-P interval and R-R interval are regular. The ventricular rate is 79 bpm. The rhythm meets the criteria for normal sinus rhythm and is interpreted as NSR.

Lesson 4: Atrial Rhythms

Slide #	Content	PDF
1	Lesson IV: Atrial Rhythms	
2	Objectives	
3	Objectives cont.	
4	Atrial Rhythms	
5	Atrial Conduction	
6	Premature Atrial Contraction - Steps of Rhythm Analysis	
7	Premature Atrial Contraction – Premature beat	
8	Premature Atrial Contraction – Non-conducted PAC	
9	Premature Atrial Contraction - Summary	X
10	Multifocal Atrial Rhythm	
11	Multifocal Atrial Tachycardia	X
12	Atrial Tachycardia	
13	Atrial Tachycardia – Supraventricular tachycardia	
14	Paroxysmal Atrial Tachycardia	
15	Atrial Tachycardia	
16	Atrial Flutter	
17	Atrial Flutter – Lead II	X
18	Atrial Fibrillation	
19	Atrial Fibrillation – 6 second method - VR	X
20	Atrial Fibrillation – Differentiation	X
21	Self Assessment Questions	

Module: ECG Module

Lesson: Atrial Rhythms

Section:

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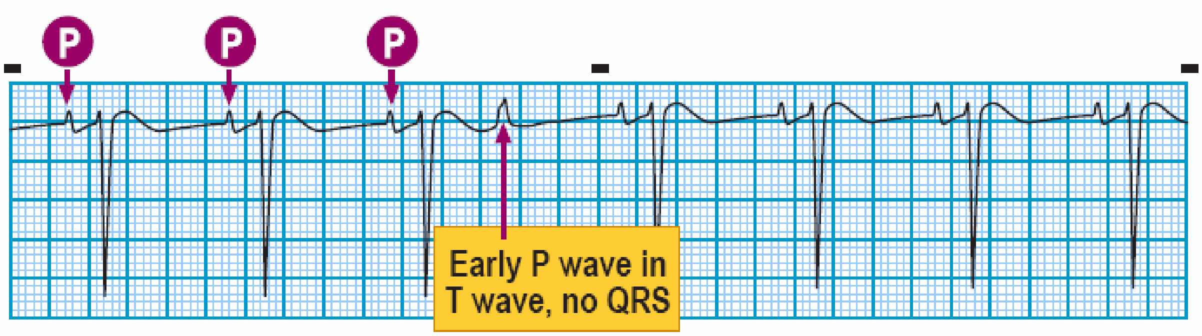
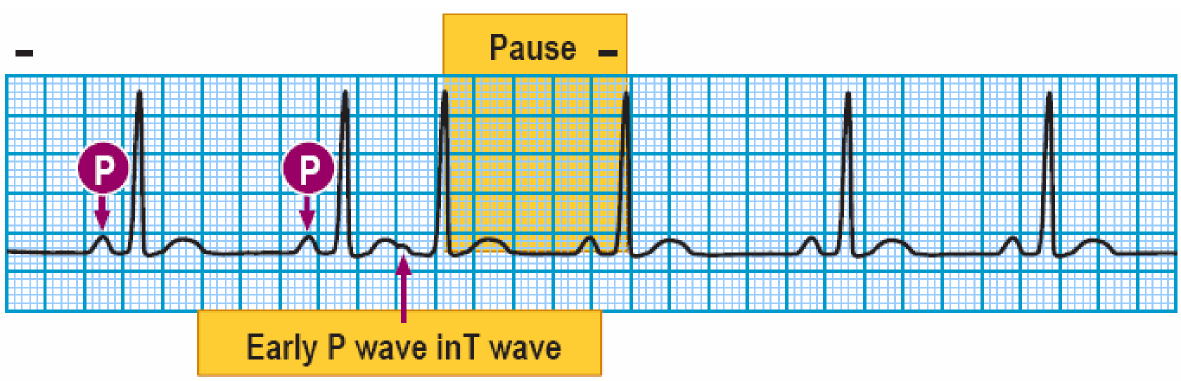
Premature Atrial Contraction (PAC)

- P wave different configuration than sinus P wave.
- P wave early, easily identified and followed by normal ventricular depolarization.
- P wave early, hidden in the T wave and followed by normal ventricular depolarization.
- P wave early, conduction blocked at the AV node so no ventricular depolarization occurs.





Module: ECG Module

Lesson: Atrial Rhythms

Section:

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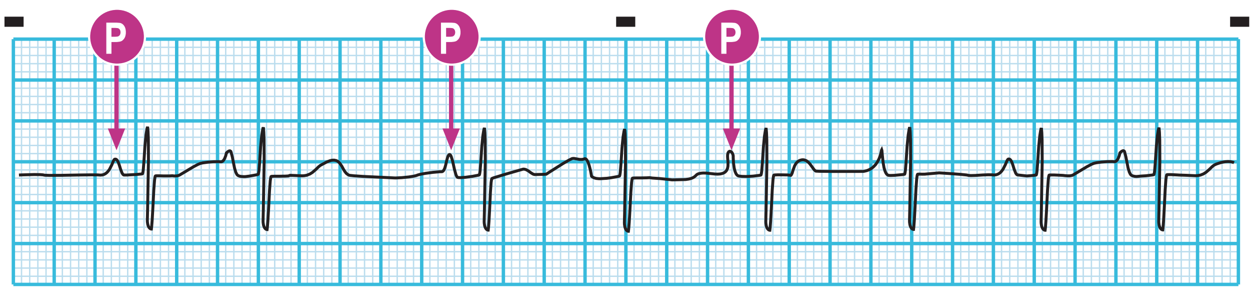
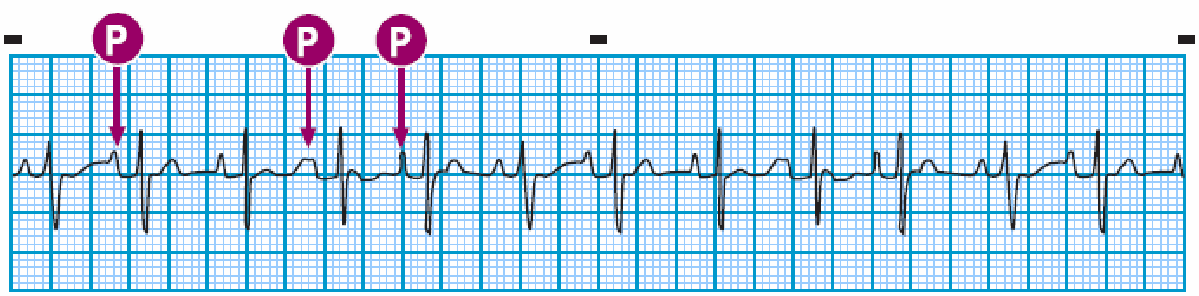
Multifocal Atrial Rhythm (MAR)/Wandering Atrial Pacemaker



Multifocal Atrial Tachycardia (MAT)



Module: ECG Module

Lesson: Atrial Rhythms

Section:

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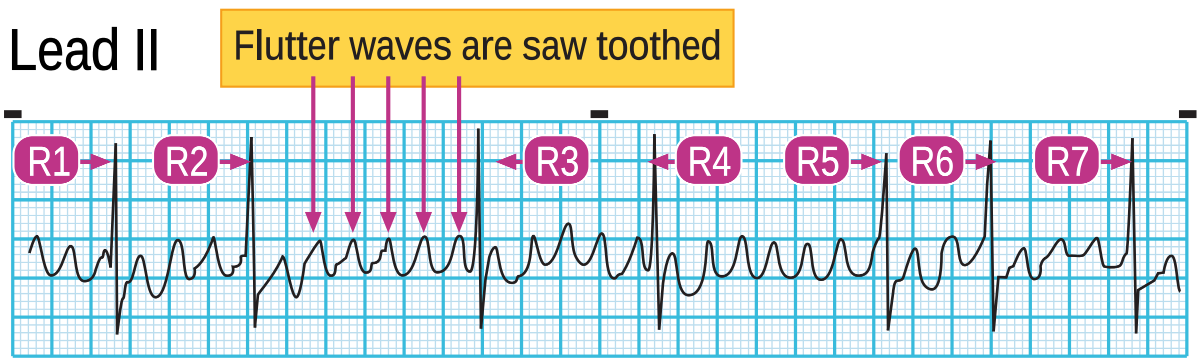
Atrial Flutter



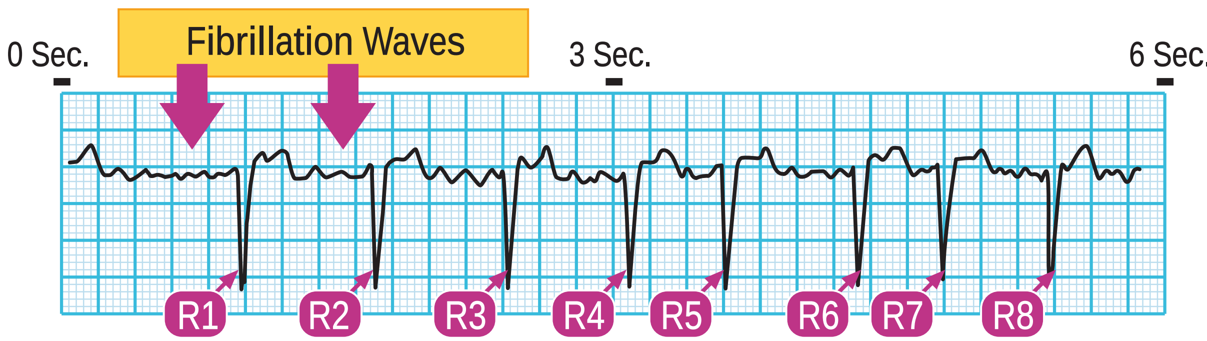
Module: ECG Module

Lesson: Atrial Rhythms

Section:

Slide: 19

Atrial Fibrillation



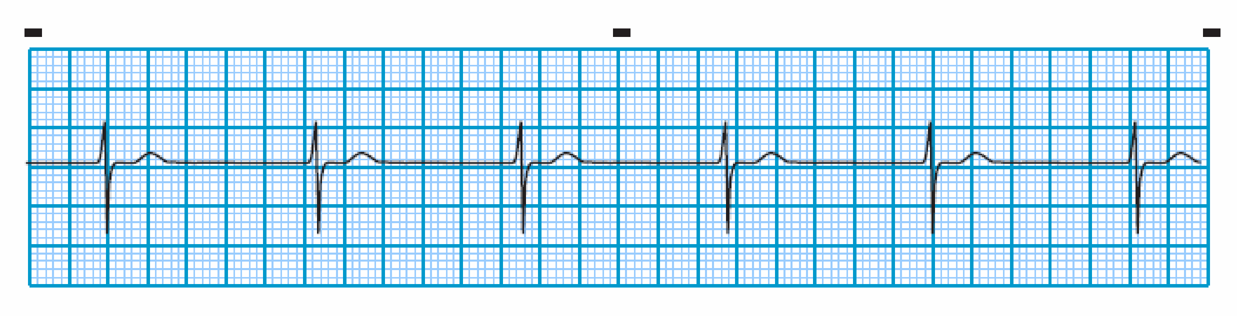
Module: ECG Module

Lesson: Atrial Rhythms

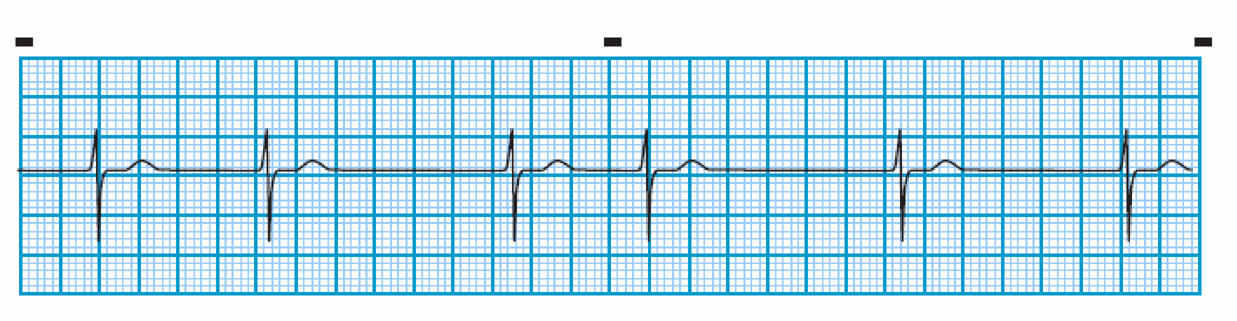
Section:

Slide: 20

Junctional Rhythm R-R regular



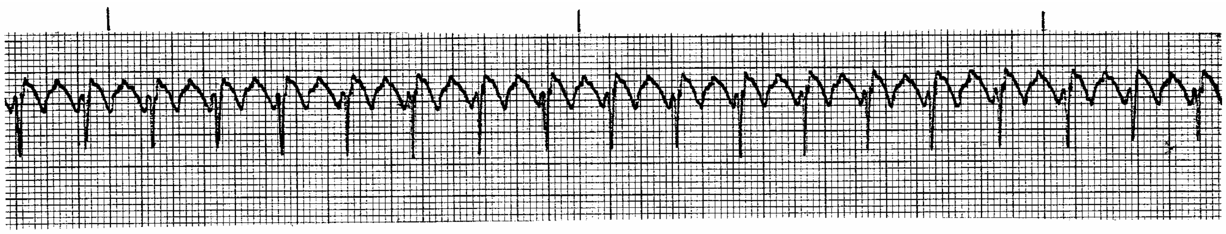
Atrial Fibrillation: R-R irregular



Atrial Rhythm Work Sheets

Unless indicated the rhythm strips are Lead V 1

1



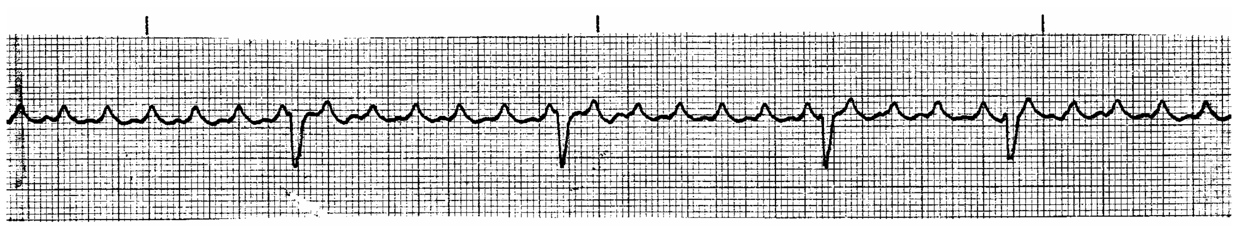
P waves ______ Vent. Rate ________

PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation ____________________

2



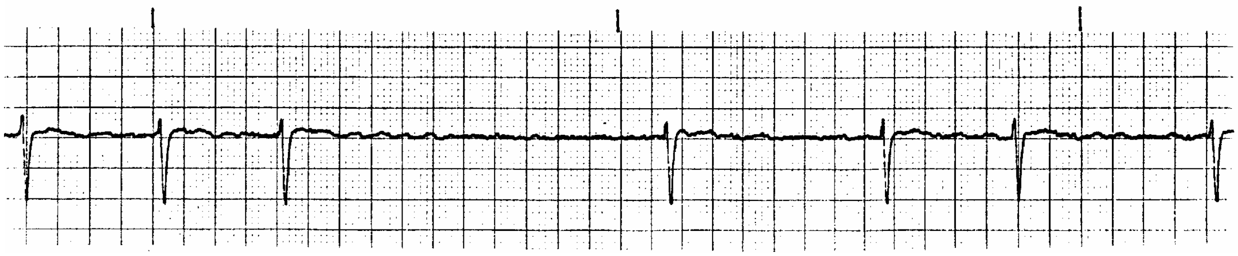
P waves ______ Vent. Rate ________

PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation ____________________

3



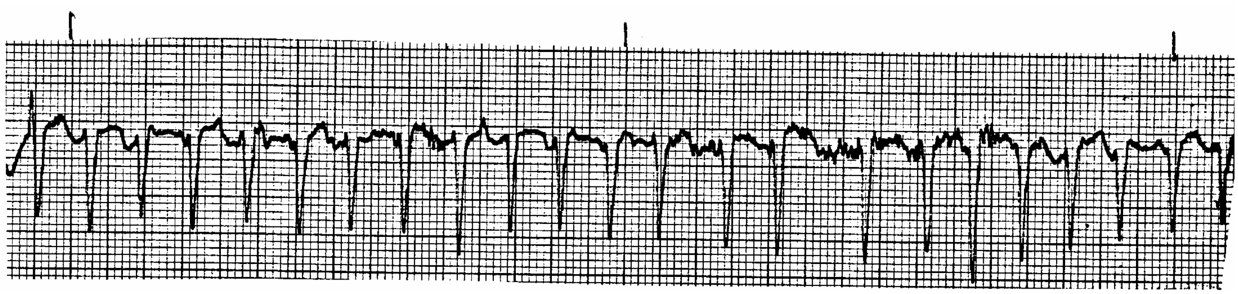
P waves ______ Vent. Rate ________

PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation ____________________

4



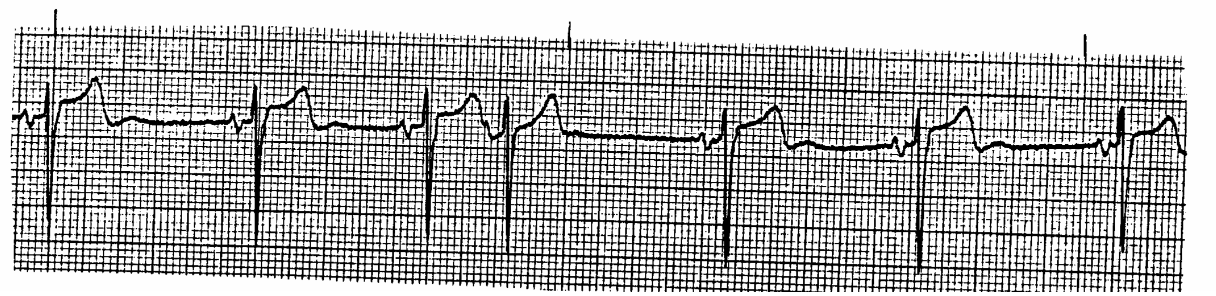
P waves ______ Vent. Rate ________

PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation ____________________

5



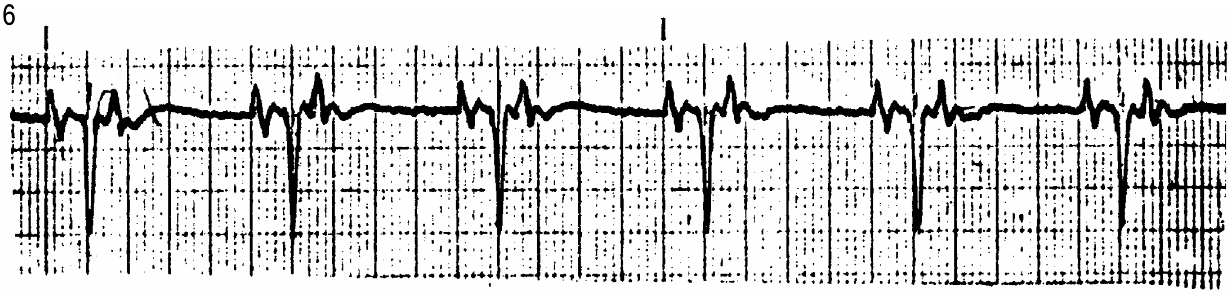
P waves ______ Vent. Rate ________

PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation ____________________

6



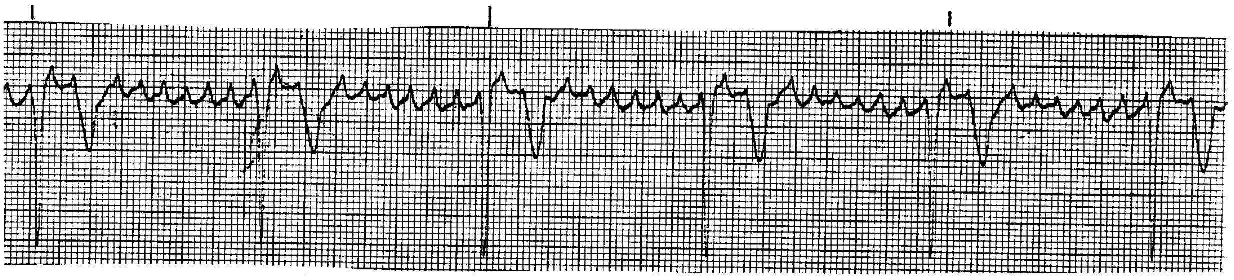
P waves ______ Vent. Rate ________

PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation ____________________

7



P waves ______

PR interval _____

QRS _____

QRS interval _____

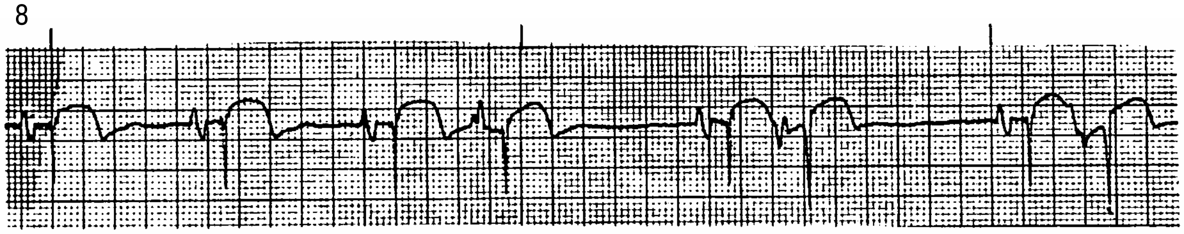
Vent. Rate ________

Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

8



P waves ______

PR interval _____

QRS _____

QRS interval _____

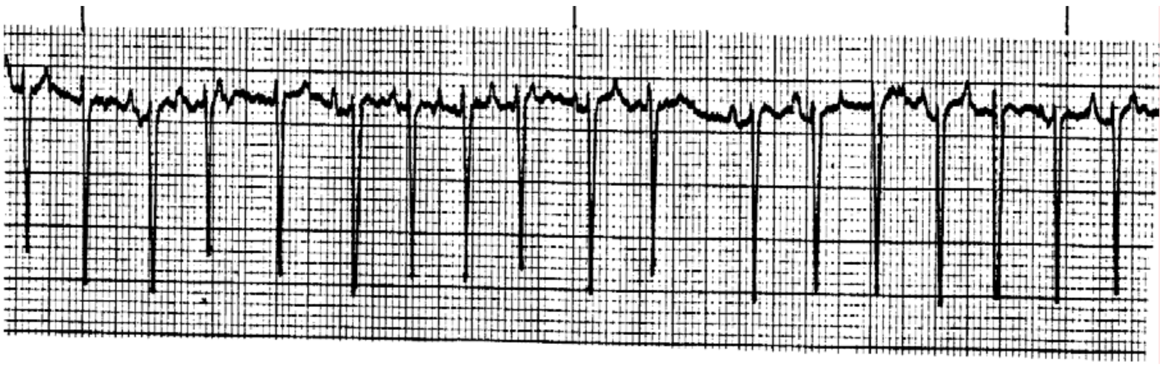
Vent. Rate ________

Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

9



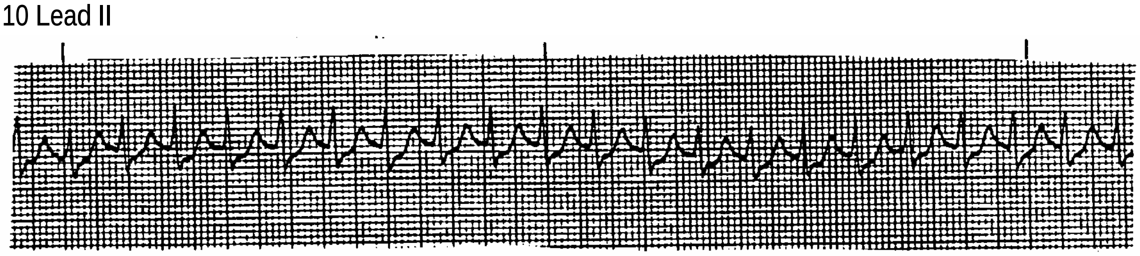
P waves ______ Vent. Rate ________

PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation ____________________

10 Lead II



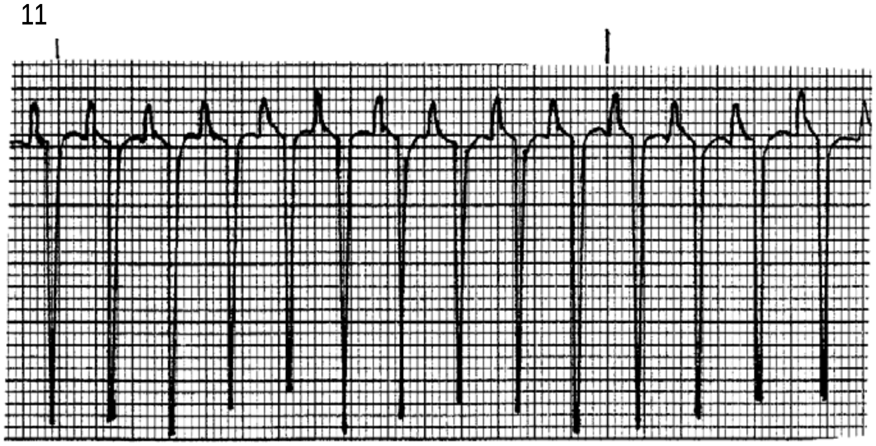
P waves ______ Vent. Rate ________

PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation ____________________

11



P waves ______

PR interval _____

QRS _____

QRS interval _____

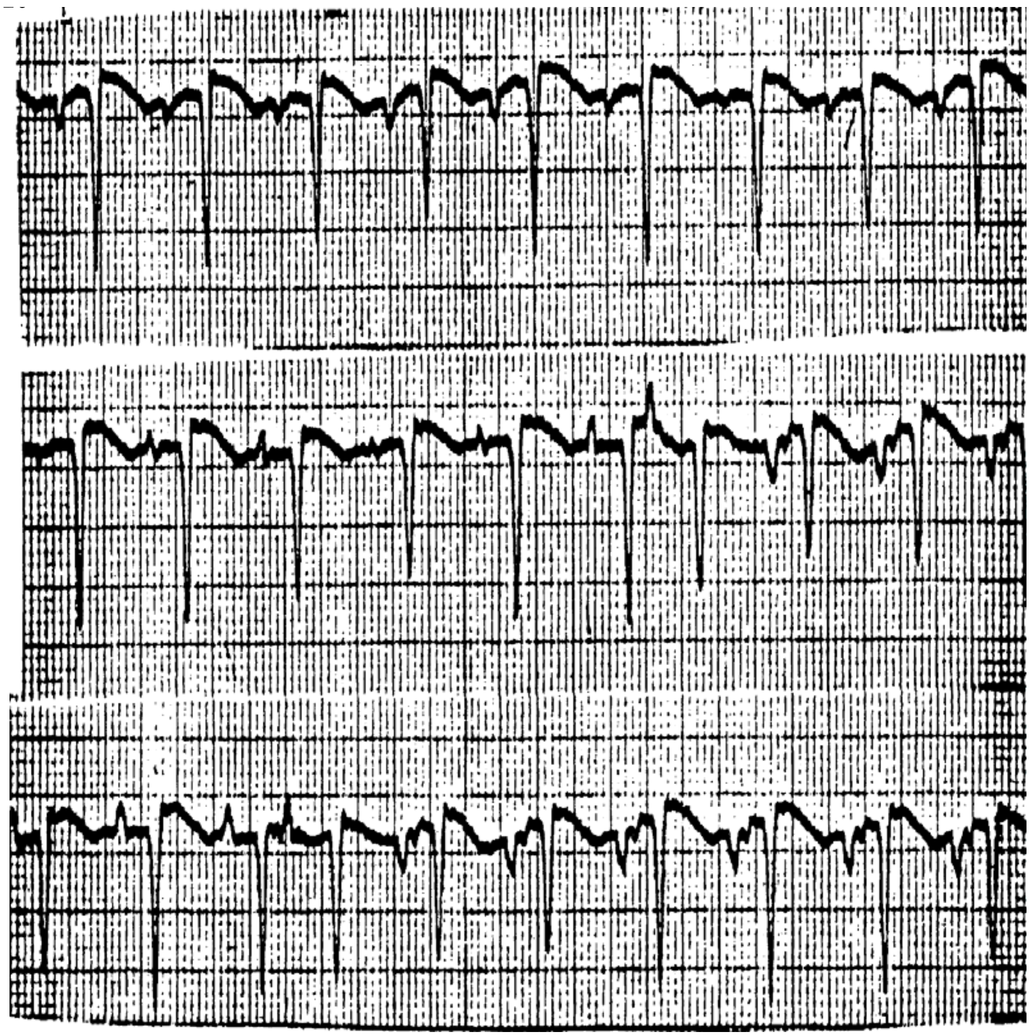
Vent. Rate ________

Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

12 Lead V1 continuous recording



P waves ______

PR interval _____

QRS _____

QRS interval _____

Vent. Rate ________

Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

____

Atrial Rhythm Work Sheet Answers

1.

P waves	flutter waves	Ventricular Rhythm	regular
PR interval	none	Atrial Rhythm	flutter wave regular
QRS	present	Ventricular Rate	137 bpm
QRS interval	0.06		

Interpretation: Atrial flutter uncontrolled ventricular response
Discussion: The flutter waves in this rhythm strip have the distinctive saw-tooth pattern. The ventricular rhythm is regular because the ratio of flutter waves to QRS complexes is 2:1 and regular. Atrial flutter can be regular or irregular depending on the ratio of flutter waves to QRS complexes.

2.

P waves	flutter waves	Ventricular Rhythm	irregular
PR interval	none	Atrial Rhythm	flutter waves regular
QRS	present	Ventricular Rate	30 bpm
QRS interval	0.10		

Interpretation: Atrial flutter controlled and very slow
Discussion: The flutter waves in this strip do not have the characteristic saw-tooth pattern that was seen in the 1st rhythm strip. The flutter waves resemble P waves and the rhythm could be mistaken for atrial tachycardia with block. To differentiate between the two rhythms look at the flutter waves. Flutter wave move through the QRS complex and may cause the QRS complexes to look different. A consistent PR interval can't be identified because there is no PR interval in atrial flutter. In this strip the flutter waves move through the QRS and a flutter wave is seen on the tip of the QRS in the 1st two complexes. The flutter waves are regular. In atrial tachycardia with block the P waves will conduct the QRS complex and there will be a PR interval. You could also look in a different lead to better identify the flutter waves. Atrial flutter can have a rapid or very slow ventricular response and demonstrated in the first 2 rhythm strips and require immediate assessment and intervention.

3.

P waves	none	Ventricular Rhythm	irregular
PR interval	none	Atrial Rhythm	none
QRS	present	Ventricular Rate	50 bpm
QRS interval	0.10		

Interpretation: Atrial fibrillation with a controlled ventricular response
Discussion: Fine fibrillation waves can be seen on the isoelectric line.

4.

P waves	none	Ventricular Rhythm	irregular

PR interval	none	**Atrial Rhythm**	none
QRS	present	**Ventricular Rate**	210 QRS interval 0.10

Interpretation: Atrial fibrillation with an uncontrolled ventricular response
Discussion: At the beginning of the rhythm strip the R-R interval appears regular but as it continues just past the 2nd tic mark it become irregular. The distinct erratic isoelectric line associated with atrial fibrillation can be seen when the R-R interval rate falls below 300. It is important to measure the entire rhythm strip. Rhythms tend to be less irregular as ventricular rates increase. This rate requires immediate patient assessment and intervention.

5.

P waves	present	**Ventricular Rhythm**	irregular
PR interval	0.16	**Atrial Rhythm**	irregular
QRS	present	**Ventricular Rate**	60 bpm
QRS interval	0.08		

Interpretation: Sinus rhythm with a PAC
Discussion: The 4th complex is early. The P wave is hidden in the T wave of the previous complex. The rhythm is irregular before the PAC but becomes regular after the premature beat.

6.

P waves	present	**Ventricular Rhythm**	regular
PR interval	0.16	**Atrial Rhythm**	irregular
QRS	present	**Ventricular Rate**	60 bpm
QRS interval	0.08		

Interpretation: Sinus rhythm with blocked premature atrial contractions (PACs)
Discussion: The ventricular rhythm because the blocked PACs fall in an every other beat pattern. Premature P waves occur just after the QRS complex at the beginning of the T wave. The P waves are not conducted so the QRS is not present. Blocked PACs are the most common cause of a missed or dropped QRS complex.

7.

P waves	flutter waves	**Ventricular Rhythm**	regular
PR interval	none	**Atrial Rhythm**	flutter waves regular
QRS	present	**Ventricular Rate**	50 bpm
QRS interval	0.10 but varies because of flutter waves		

Interpretation: Atrial flutter
Discussion: The flutter waves in this strip do not have the characteristic saw-tooth pattern that was seen in the 1st rhythm strip. The flutter waves resemble P waves and the rhythm could be mistaken for atrial tachycardia with block. To differentiate between the two rhythms look at the flutter waves. Flutter wave move through the QRS complex and T waves causing them to look different. A consistent PR interval can't be identified because there is no PR interval in atrial flutter.

In this strip the flutter waves move through the QRS and a flutter wave is seen on the tip of the QRS in the 1st two complexes. The flutter waves are regular and the rate of the flutter waves is 375 bpm which helps to differentiate from atrial tachycardia.

8.

P waves	present	Ventricular Rhythm	irregular
PR interval	0.20	Atrial Rhythm	irregular
QRS	present	Ventricular Rate	60 bpm
QRS interval	0.04		

Interpretation: Sinus rhythm with premature atrial contractions (PACs)
Discussion: The ventricular rhythm for the 1st three complexes is regular. PACs occur after the 3rd, 5th, and 7th complexes. The P waves of the 1st two PACs are easily seen. The P wave of the 3rd PAC is hidden in the T wave of the previous QRS complex (complex 7). The T wave does not look the same as the other T waves and a P wave can be identified on the downward slope of the T wave.

9.

P waves	none/fibrillation waves	Ventricular Rhythm	irregular
PR interval	none	Atrial Rhythm	none
QRS	present	Ventricular Rate	160 bpm
QRS interval	0.06		

Interpretation: Atrial fibrillation with an uncontrolled response
Discussion: In a few of the complexes there appears to be a P wave (3, 6, 8,12, 13) but there is no consistency and the isoelectric line is erratic and the ventricular rhythm irregular. This rhythm is sometimes also described as coarse atrial fibrillation. It is differentiated from atrial tachycardia and multifocal atrial tachycardia because P waves cannot be consistently identified. With this and other atrial rhythms the ventricular response rate and assessment of the patient's hemodynamic status is the primary concern.

10.

P waves	present/none	Ventricular Rhythm	regular
PR interval	0.12/none	Atrial Rhythm	regular/none
QRS	present	Ventricular Rate	188 bpm (calculation by division)
QRS interval	0.06		

Interpretation: Atrial tachycardia/Supraventricular tachycardia (SVT)
Discussion: P waves are located at the end of the T wave as the isoelectric line begins. The P wave is best identified beginning with the 6th complete complex. If the P waves are not identified this rhythm would be interpreted as supraventricular tachycardia because the ventricular rhythm is regular and ventricular conduction is normal. Either answer is correct. Again the first priority with this rhythm, because of the uncontrolled rate, is to assess the patient to evaluate his/her hemodynamic status.

11.

P waves	none	Ventricular Rhythm	regular
PR interval	none	Atrial Rhythm	none
QRS	present	Ventricular Rate	167 bpm
QRS interval	0.08		

Interpretation: SVT
Discussion: No P waves with a rapid regular ventricular response and normal conduction through the ventricle. Refer to 9 & 10.

12.

P waves	present	Ventricular Rhythm	regular/irregular
PR interval	varies	Atrial Rhythm	regular/irregular
QRS	present	Ventricular Rate	100 bpm
QRS interval	0.08		

Interpretation: Multifocal atrial rhythm with 2 PACs.
Discussion: P waves are present and are followed by QRS complexes, however, the P waves do not all look the same. There are at least 4 different looking P waves in this continuous strip. The PR intervals are within normal limits but vary slightly. The underlying rhythm is regular except around the PACs that occur at the 7th complex on the 2nd strip and the 4^{th} complex of the 3^{rd} strip. The different shaped P waves indicate that the impulse originates in 4 distinct foci in the atrium making this a multifocal atrial rhythm (MAR).

Essentials of Critical Care Orientation ECCO®

Lesson 5: Junctional Rhythms

Slide #	Content	PDF
1	Lesson V: Junctional Rhythms	
2	Objectives	
3	Junctional Rhythms	
4	Junctional Rhythms – AV Junction	
5	Retrograde & Antegrade Conduction	
6	Junctional Rhythm	
7	Junctional Rhythm: P wave location	X
8	Junctional Rhythm - ECG Criteria	X
9	Junctional Rhythm: P wave location – Before QRS	
10	Junctional Rhythm: P wave location – After QRS	
11	Junctional Rhythm: P wave location - Inverted	X
12	Junctional Rhythm: P wave location - Hidden	
13	Junctional Rhythm: P wave location - Summary	X
14	Junctional Rhythm – Differentiation Atrial Fibrillation	X
15	Junctional Rhythm – Lead II	
16	Junctional Rhythm – PR interval	
17	Junctional Rhythm – QRS interval	
18	Junctional Rhythm – Regularity Animation	
19	Junctional Rhythm – Calculation by division - VR	X
20	Junctional Escape Rhythm	X
21	Junctional Escape Rhythm - Steps of Rhythm Analysis	
22	Junctional Escape Rhythm - Regularity	
23	Junctional Escape Rhythm – 6 second method	
24	Junctional Escape Rhythm - Summary	
25	Accelerated Junctional Rhythm	X
26	Accelerated Junctional Rhythm – Calculation by division	
27	Junctional Tachycardia	X
28	Junctional Tachycardia - Calculation by division	
29	Premature Junctional Contraction (PJC)	
30	Premature Junctional Contraction (PJC) - Calculation by division	X
31	Premature Junctional Contraction (PJC) - Summary	
32	Junctional Rhythm Review	X
33	Self Assessment Test	

Module: ECG Module

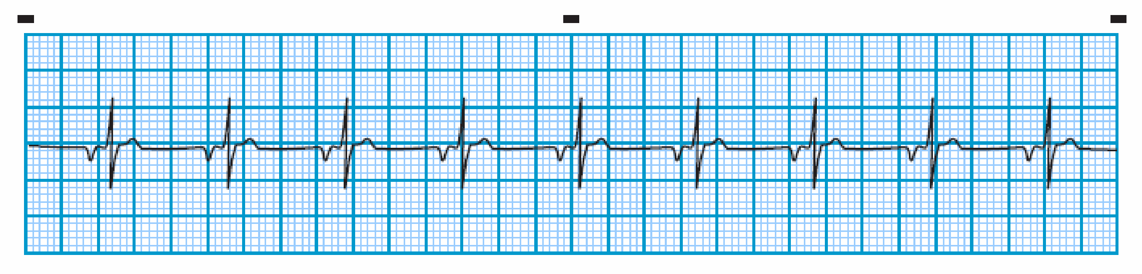
Lesson: Junctional Rhythms

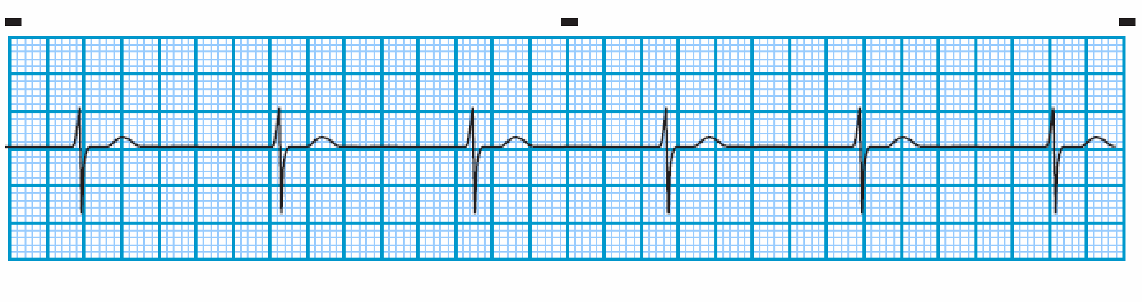
Section:

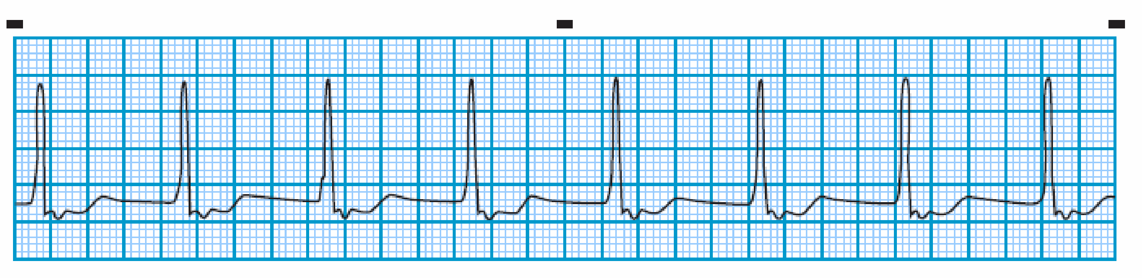
Slide: 7

American Association of Critical-Care Nurses

P wave locations







Module: ECG Module

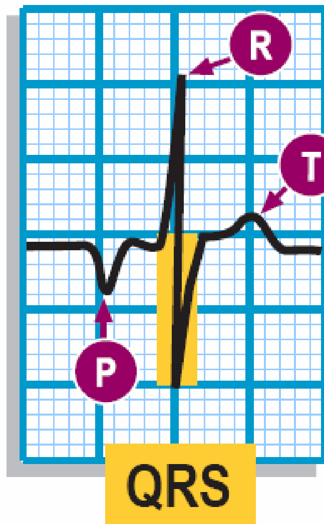
Lesson: Junctional Rhythms

Section:

Slide: 8

ECG Criteria:

P wave:	Before QRS, after QRS, not visible
PR interval:	< 0.12 if P wave present and before QRS
QRS:	Normal
Rhythm:	Regular
Rate:	40 – 60 beats per minute



Module: ECG Module

Lesson: Ventricular Rhythms

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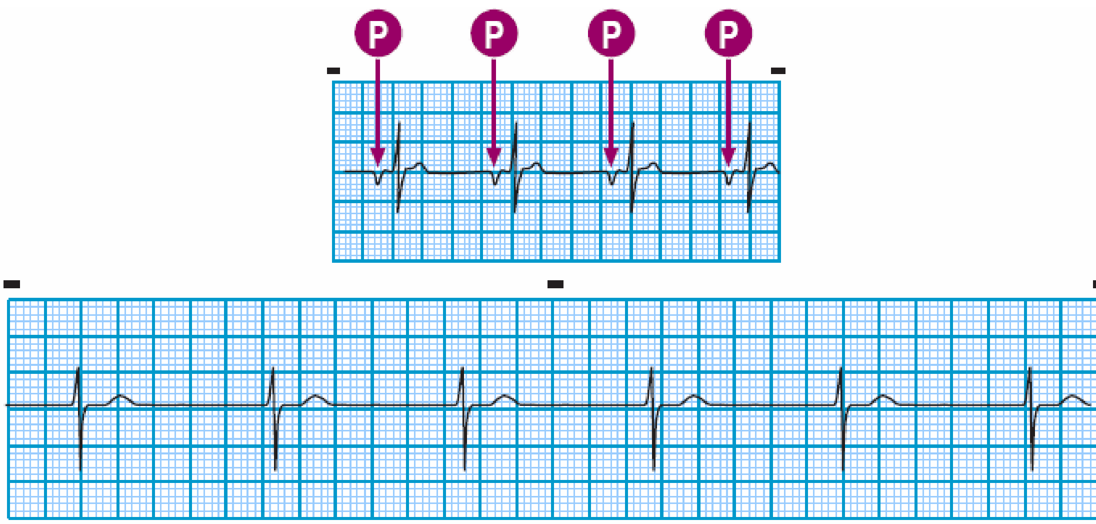
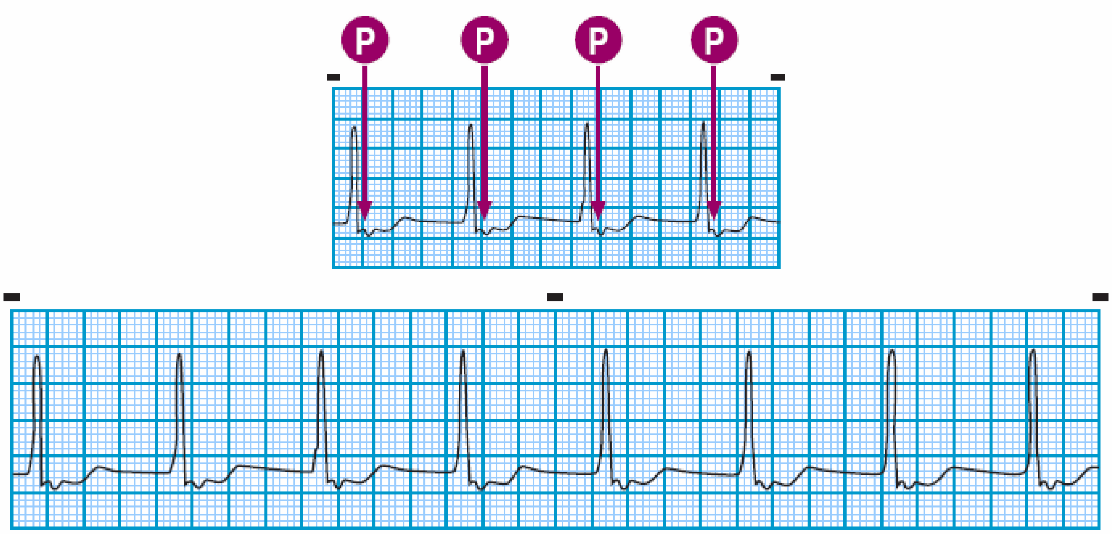
P wave location





Module: ECG Module

Lesson: Junctional Rhythms

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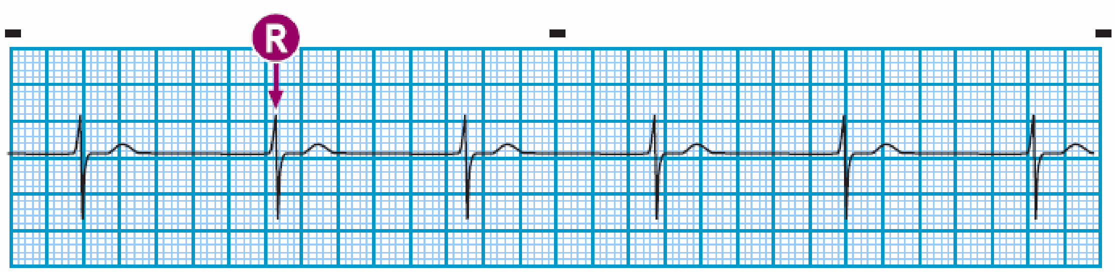

Module: ECG Module

Lesson: Junctional Rhythms

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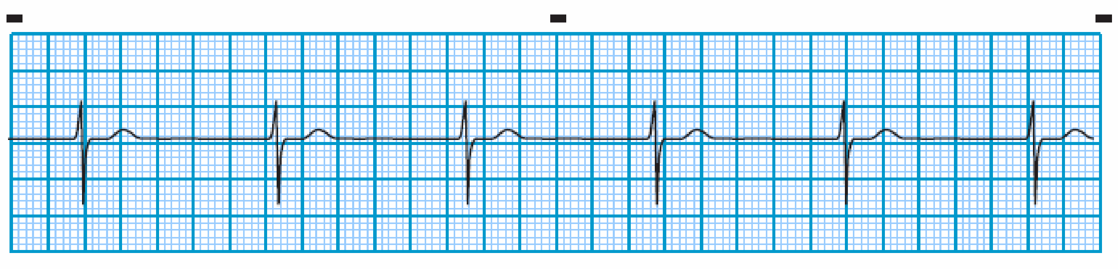
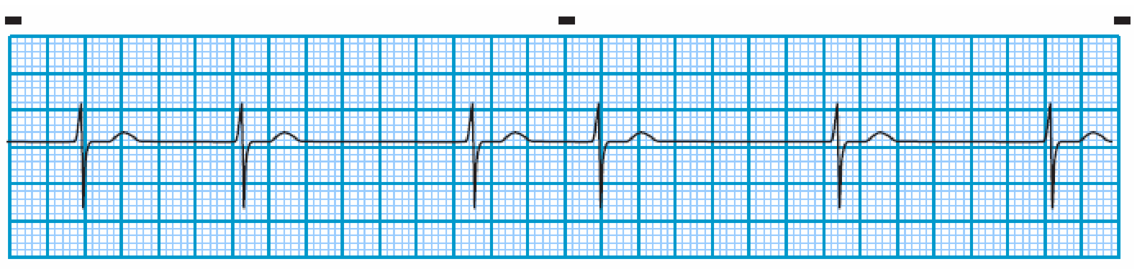
Junctional Rhythm: R-R regular



Atrial Fibrillation: R-R irregular



Module: ECG Module

Lesson: Junctional Rhythms

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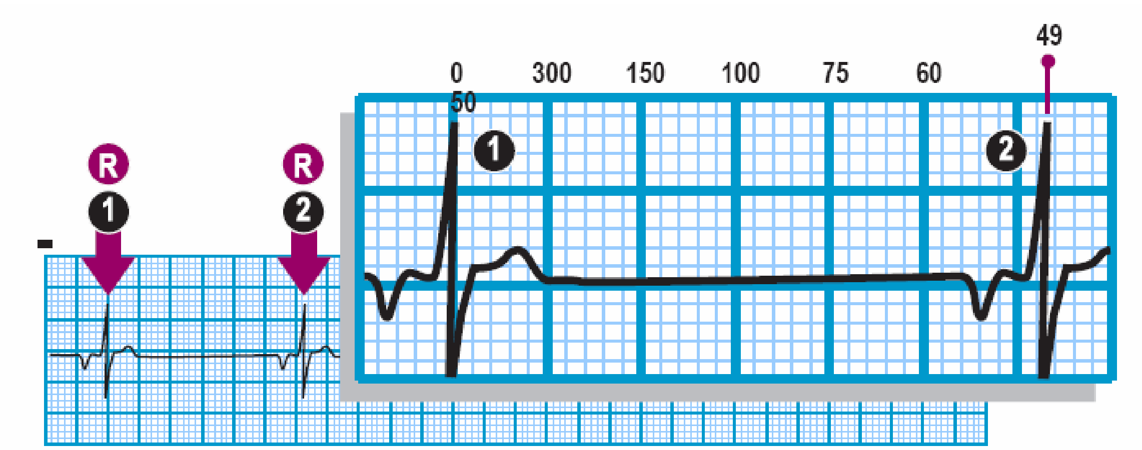

Module: ECG Module

Lesson: Junctional Rhythms

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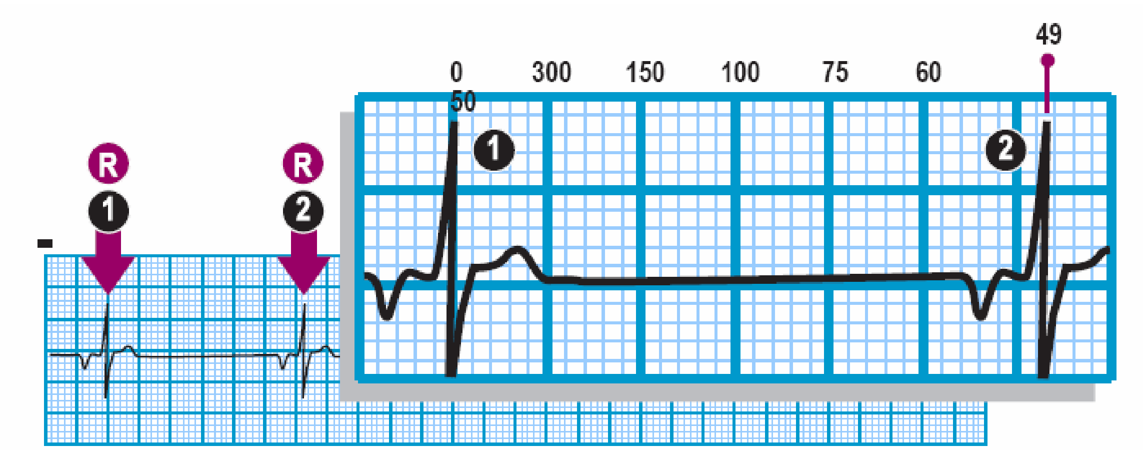

Module: ECG Module

Lesson: Junctional Rhythms

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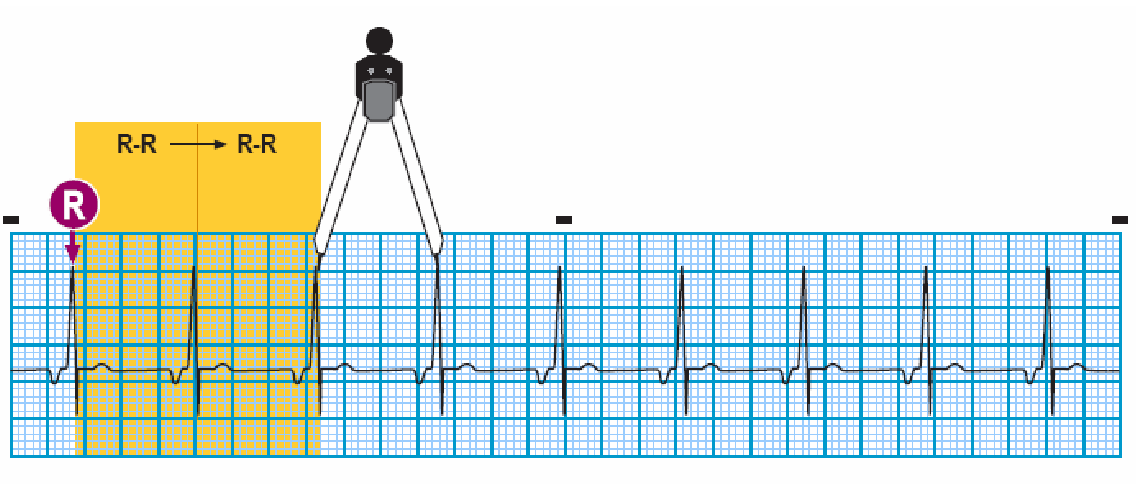
ECG Criteria



- P wave before or after QRS or not visible
- PR interval < 0.12 seconds
- QRS normal
- Rhythm regular
- Rate 60-100 bpm

Module: ECG Module

Lesson: Junctional Rhythms

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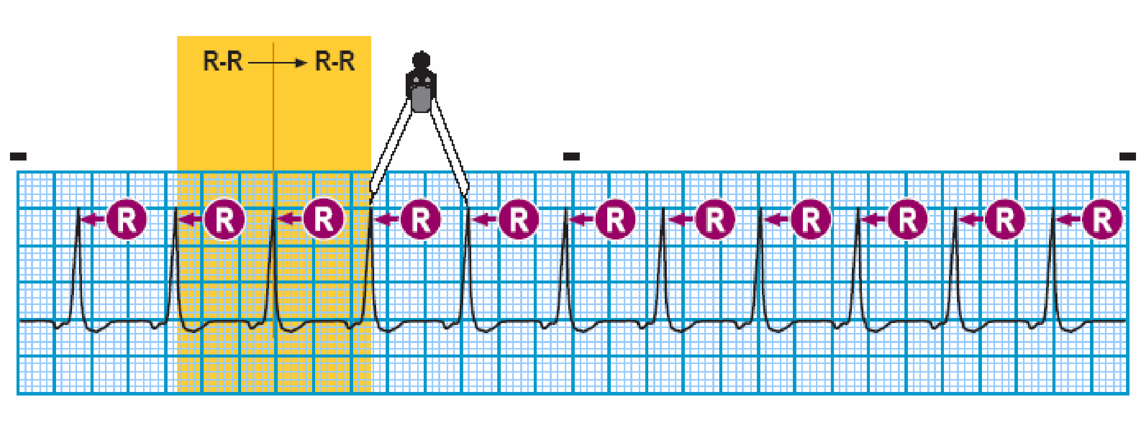
Junctional Tachycardia



Module: ECG Module

Lesson: Junctional Rhythms

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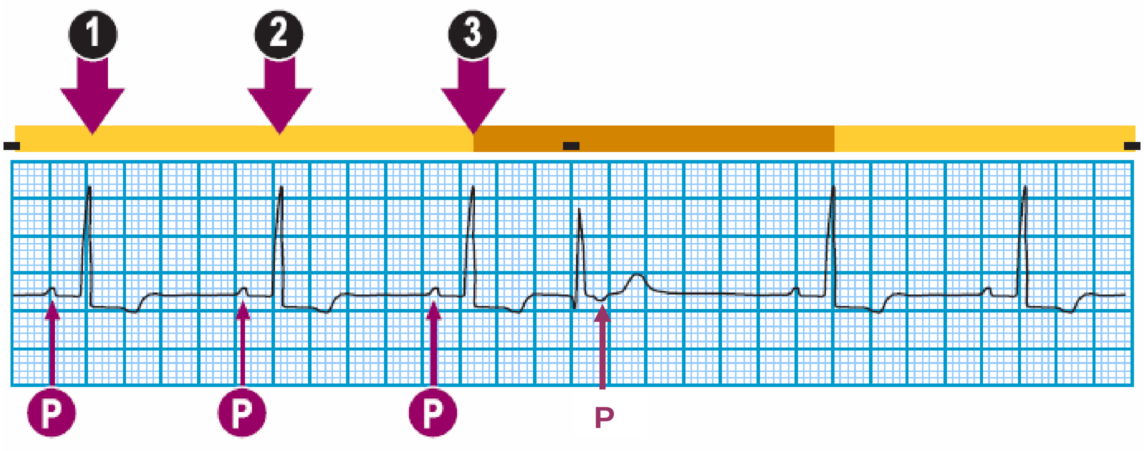
Premature Junctional Contraction (PJC)



Analyze the example:

-P waves are present do not look the same. The P wave in the 4th complex is inverted.
-P waves followed by QRS complexes have a PR interval of 0.20. The P wave in 4th complex follows the QRS.
-QRS complexes are present and they look the same but there is not a P wave before each QRS complex.
-There is an inverted P wave after the QRS in the 4th complex.
-The QRS interval is 0.10

You can see that the 4th complex on this recording is early or premature. The premature beat causes the R-R intervals just before the premature complex and just after the premature complex to be irregular. However, the rhythm leading into the premature complex is regular.

Calculate the rate of the rhythm leading into the premature junctional rhythm contraction. There are 5.2 large boxes between the QRS complexes. 300/5.2 =57; 6 or a ventricular rate of 58 bpm.

Except for the premature beat this rhythm meets the criteria for sinus bradycardia and can be interpreted as sinus bradycardia with a premature junctional contraction.

Because PJC makes the rhythm irregular the 6 second strip method for determining ventricular can also be used. Using this method the ventricular rate is 60.

Module: ECG Module

Lesson: Junctional Rhythms

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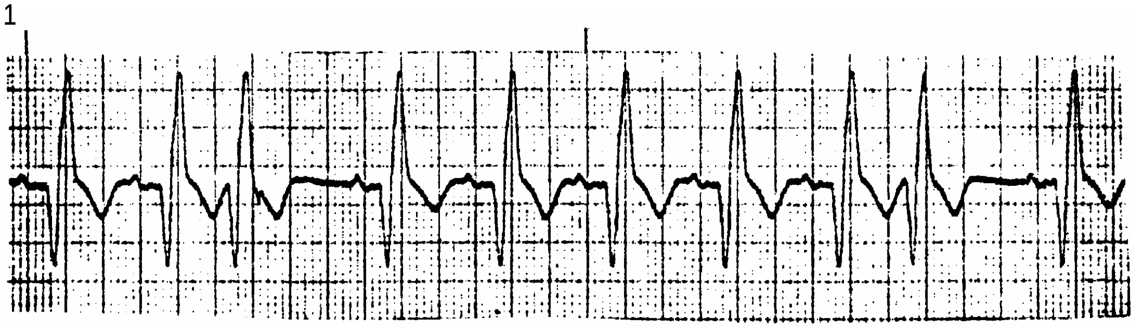
P wave inverted in Lead II:	Seen before or after QRS or is not visible
QRS complex:	Follows normal ventricular conduction pathway
Junctional Rhythm :	VR 40 - 60
Accelerated Junctional Rhythm:	VR 60 - 100
Junctional Tachycardia	VR > 100

Junctional Rhythm Work Sheets

Unless otherwise indicated the rhythm strips are Lead II.

1



P waves ______

PR interval _____

QRS _____

QRS interval _____

Vent. Rate ________

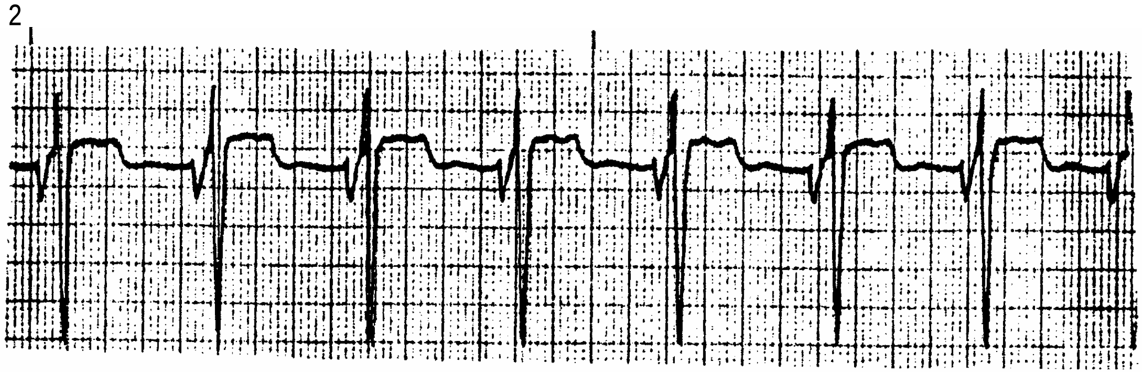
Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

____

2



P waves ______

PR interval _____

QRS _____

QRS interval _____

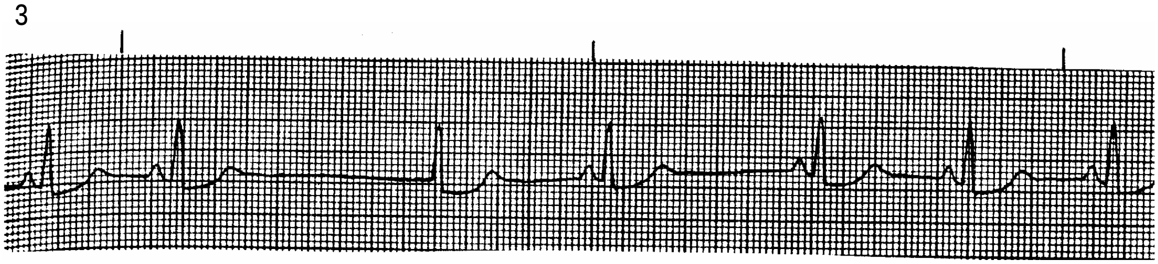
Vent. Rate ________

Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

3



P waves ______ Vent. Rate ________

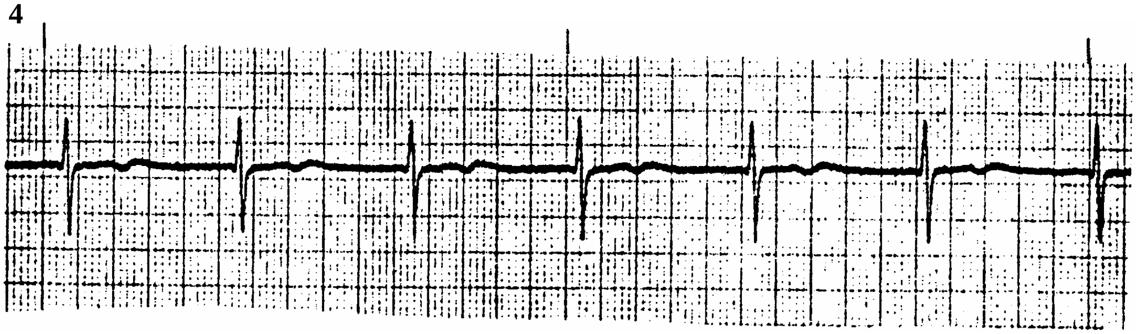
PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation ____________________

____

4



P waves ______ Vent. Rate ________

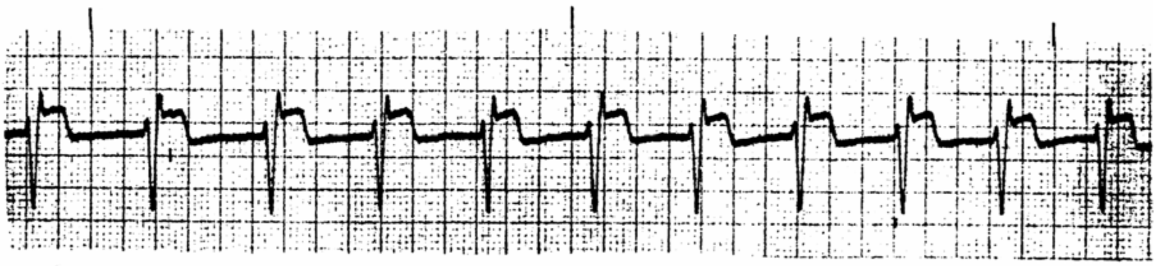
PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation ____________________

____

5 Lead V1



P waves ______

PR interval _____

QRS _____

QRS interval _____

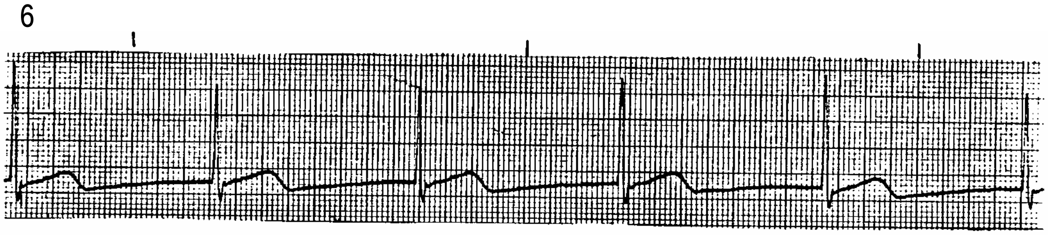
Vent. Rate ________

Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

6



P waves ______

PR interval _____

QRS _____

QRS interval _____

Vent. Rate ________

Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

Junctional Rhythm Work Sheet Answers

1.

P waves	present	Ventricular Rhythm	irregular
PR interval	0.20	Atrial Rhythm	irregular
QRS	present	Ventricular Rate	100 bpm
QRS interval	0.14		

Interpretation: Sinus rhythm with an intraventricular conduction defect and 2 premature junctional contractions
Discussion: There are 2 premature junctional contractions (PJC); the 3rd beat and the 9th beat. The PJCs are early which makes the rhythm around the beats irregular however; the underlying atrial and ventricular rhythms are regular. The QRS interval is prolonged. In the clinical area this rhythm would be identified as sinus rhythm with PJCs and the term intraventricular conduction defect would not be included.

2.

P waves	present & inverted	Ventricular Rhythm	regular
PR interval	0.11	Atrial Rhythm	regular
QRS	present	Ventricular Rate	75 bpm
QRS interval	0.10		

Interpretation: Junctional rhythm
Discussion: P waves are present, inverted in Lead II and the PR interval is < 0.12.

3.

P waves	present	Ventricular Rhythm	irregular
PR interval	0.14	Atrial Rhythm	irregular
QRS	present	Ventricular Rate	50 bpm
QRS interval	0.06		

Interpretation: Sinus bradycardia with junctional escape beat
Discussion: The underlying rhythm in this strip is sinus bradycardia. After the 2nd complex the rate slows to about 40 and the AV junction takes over. The SA node picks up again with the 4th complex and the ventricular rate gradually increases. The R-R interval of the last 3 complexes is regular.

4.

P waves	present & follows QRS	Ventricular Rhythm	regular
PR interval	none	Atrial Rhythm	regular
QRS	present	Ventricular Rate	62 bpm
QRS interval	0.06		

Interpretation: Accelerated junctional rhythm

Discussion: The P waves in this rhythm are present. They follow the QRS complex, are inverted and located in the T wave. The rate, determined by calculation by division is 62 making this an accelerated junctional rhythm. Using the 6-second strip method the ventricular rate is 60 which would make this a junctional rhythm.

5.

P waves	none	Ventricular Rhythm	regular
PR interval	none	Atrial Rhythm	none
QRS	present	Ventricular Rate	79 bpm
QRS interval	0.10		

Interpretation: Accelerated junctional rhythm
Discussion: P waves are not visible. The QRS interval is normal and the R-R interval is regular. The ventricular rate is fast enough that cardiac output should be adequate but with no visible P wave atrial kick is lost so the patient should be assessed.

6.

P waves	none	Ventricular Rhythm	regular
PR interval	none	Atrial Rhythm	none
QRS	present	Ventricular Rate	40 bpm
QRS interval			

Interpretation: Junctional rhythm
Discussion: No P waves are visible. The ventricular rate is the lower limit for a junctional rhythm. The patient's cardiac output might be compromised because of the slow ventricular rate and the loss of atrial kick.

Lesson 6: Ventricular Rhythms

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1	Lesson VI: Ventricular Rhythms	
2	Objectives	
3	Objectives – cont.	
4	Ventricular Rhythms	
5	Ventricular Morphology	
6	Ventricular Conduction	
7	Idioventricular	X
8	Idioventricular – Agonal rhythm	
9	Accelerated Idioventricular Rhythm	X
10	Ventricular Escape Beat	
11	Differential Diagnosis	
12	Differential Diagnosis	
13	Premature Ventricular Contraction - Unifocal	X
14	PVCs - Premature Ventricular Contraction - Multifocal	
15	Premature Ventricular Contraction – R on T	X
16	Premature Ventricular Contraction – Interpolated PVC	
17	Premature Ventricular Contraction – Ventricular Bigeminy	X
18	Premature Ventricular Contraction - Ventricular Trigenimy	X
19	Premature Ventricular Contraction - Pairs	
20	Ventricular Tachycardia (VT)	X
21	Ventricular Tachycardia (VT) – No P waves visible	
22	Ventricular Tachycardia (VT) – Calculation by division	
23	Ventricular Tachycardia (VT) - Differential Diagnosis	X
24	Ventricular Tachycardia (VT) - Summary	
25	Torsade de Pointes	
26	Ventricular Fibrillation (V fib)	
27	Asystole	X
28	Self Assessment Questions	

Module: ECG Module

Lesson: Ventricular Rhythms

Section:

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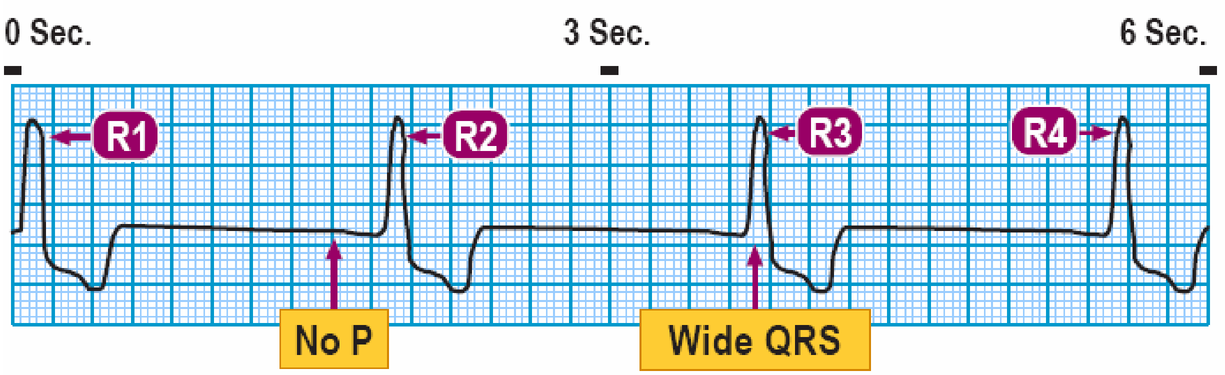
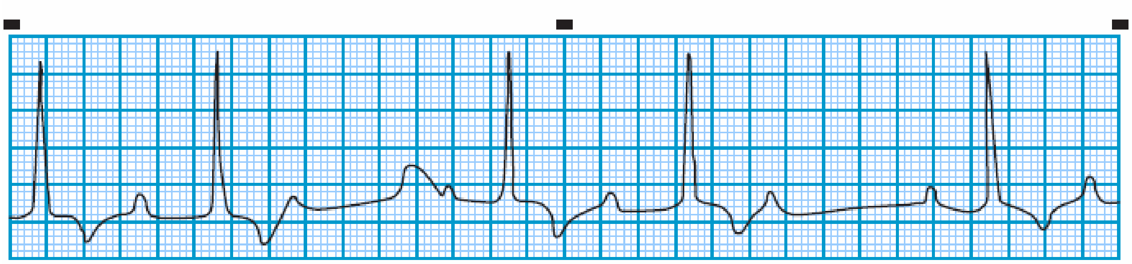
Idioventricular Rhythm Criteria





Module: ECG Module

Lesson: Ventricular Rhythms

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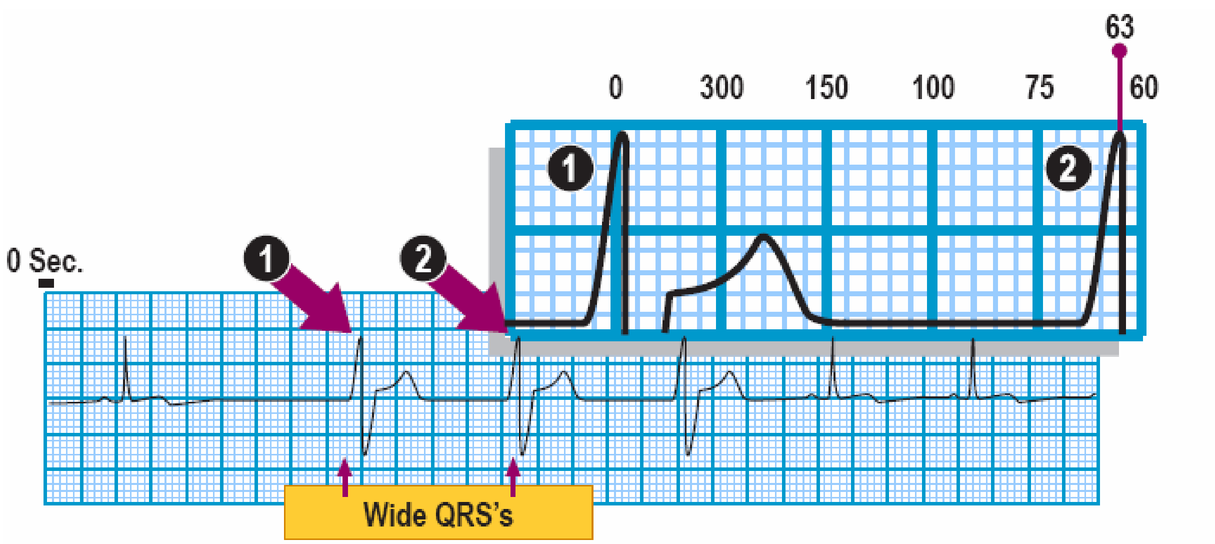
Accelerated Idioventricular Rhythm Criteria



Module: ECG Module

Lesson: Ventricular Rhythms

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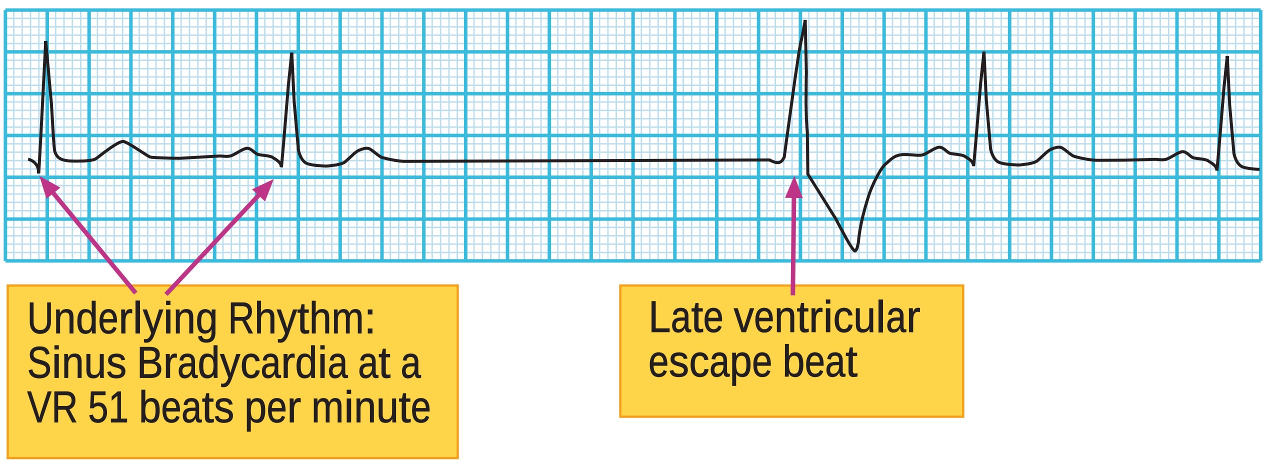
Ventricular Escape Beat

Underlying Rhythm slow and secondary pacemaker generates impulse



Module: ECG Module

Lesson: Ventricular Rhythms

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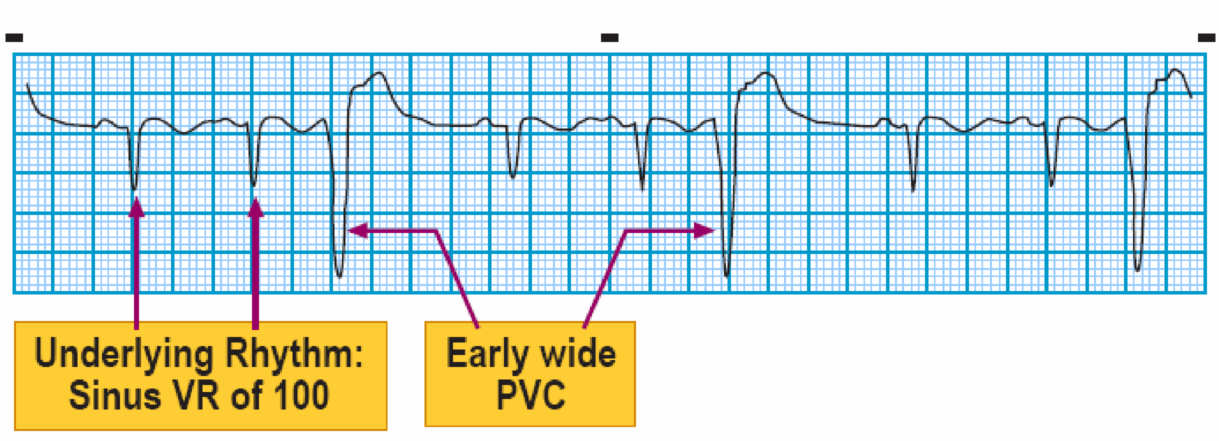
PVC Criteria

- PVCs originate below the bundle of His from an irritable focus in the ventricle.
- PVCs occur earlier than the next expected beat.
- PVCs are not preceded by P waves.
- QRS wide and bizarre looking >0.12 seconds.
- T waves are often large and often opposite direction of
  - QRS.
- PVCs often have a compensatory pause, while the underlying rhythm resets.



Module: ECG Module

Lesson: Ventricular Rhythms

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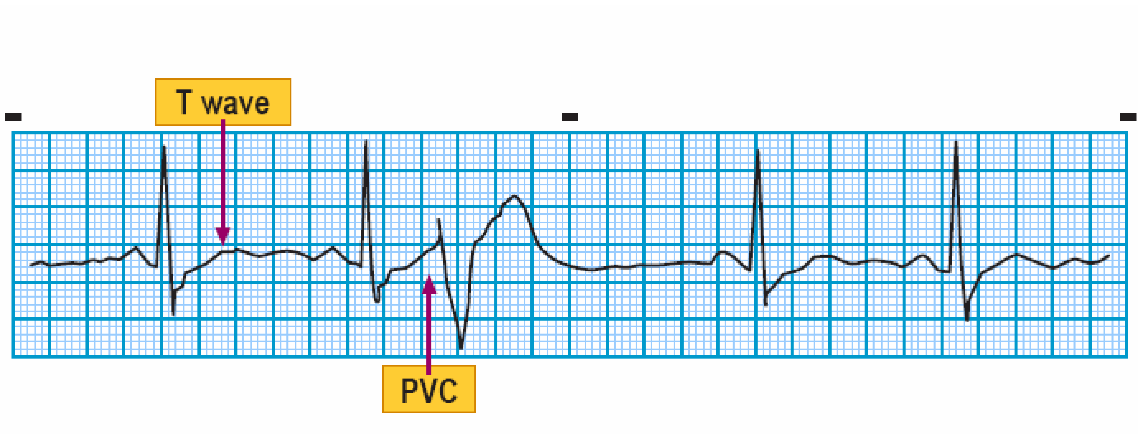
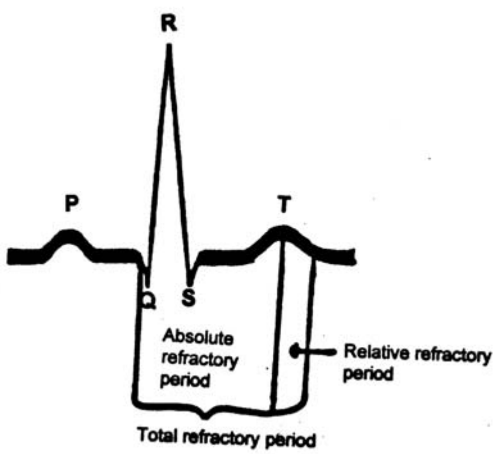
PVC – R on T





Electrical impulse occurring during the relative refractory period can result in lethal ventricular dysrhythmias.

Module: ECG Module

Lesson: Ventricular Rhythms

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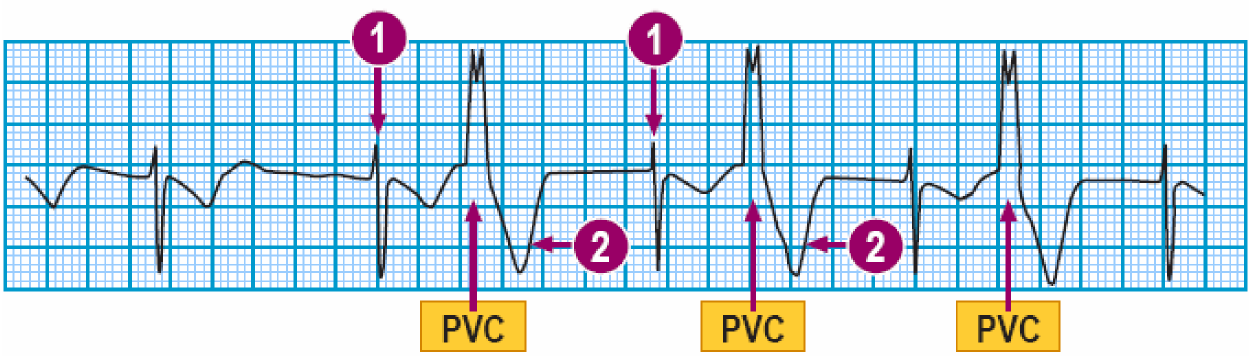
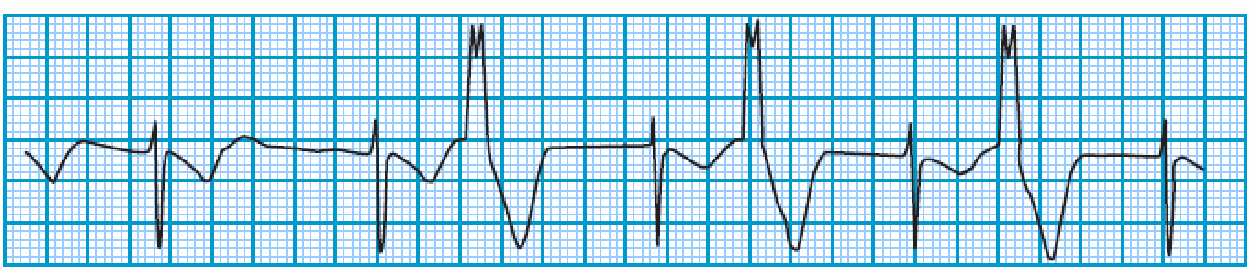
PVC -- Bigeminy





Module: ECG Module

Lesson: Ventricular Rhythms

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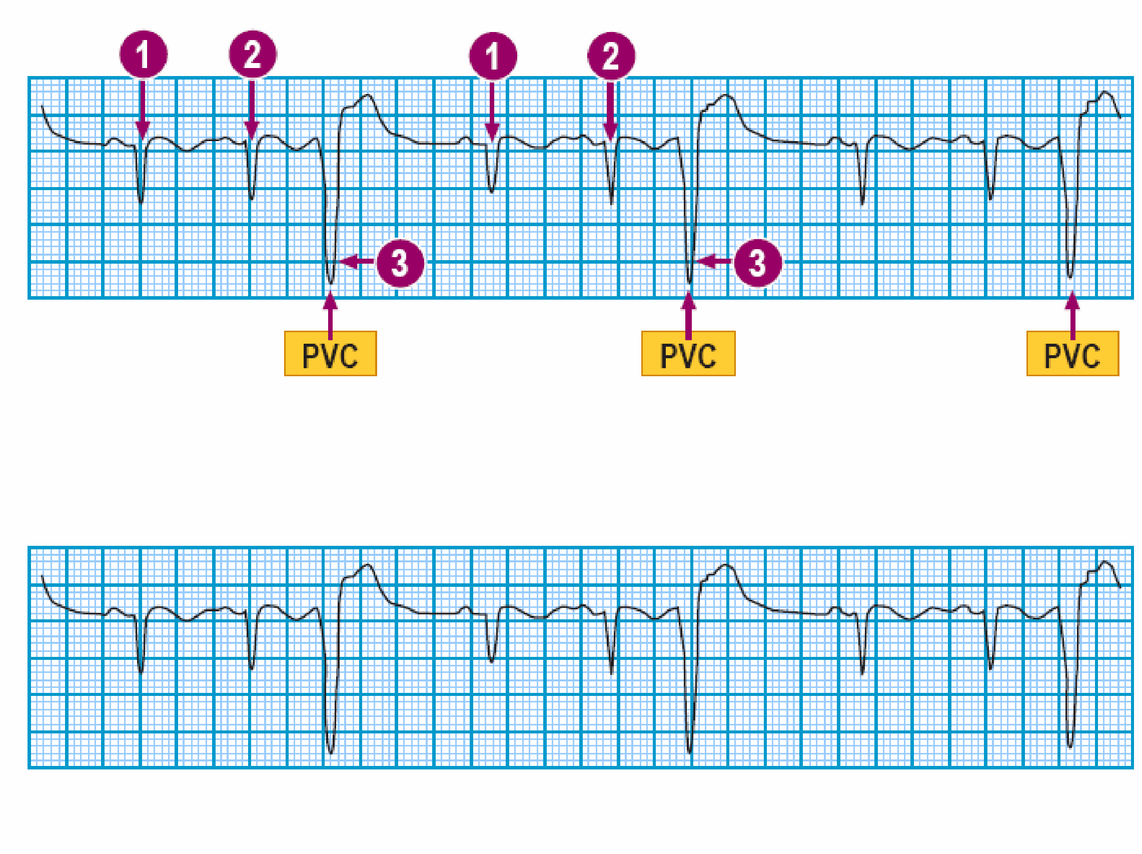
PVC -- Trigeminy



Module: ECG Module

Lesson: Ventricular Rhythms

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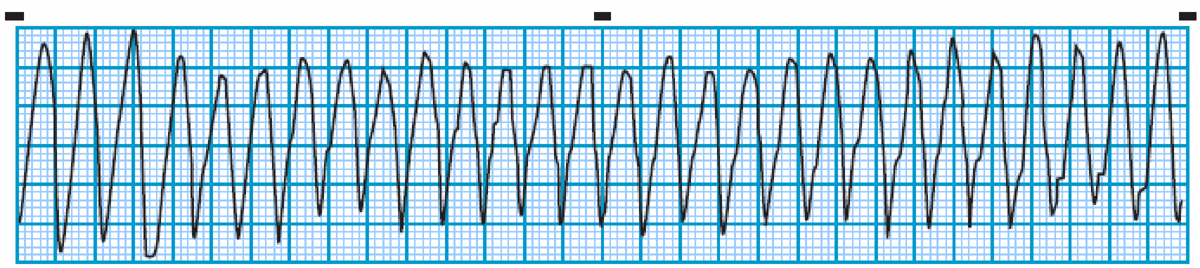
Ventricular Tachycardia



Rhythm Summary	Rate
Idioventricular (intrinsic)	20 - 40 bpm
Accelerated Idioventricular	41 - 100 bpm
Ventricular Tachycardia	> 100 bpm

Module: ECG Module

Lesson: Ventricular Rhythms

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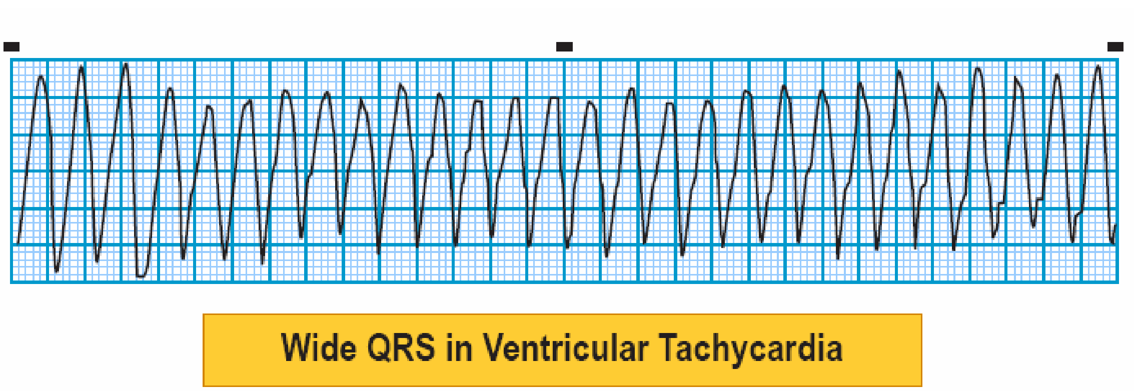
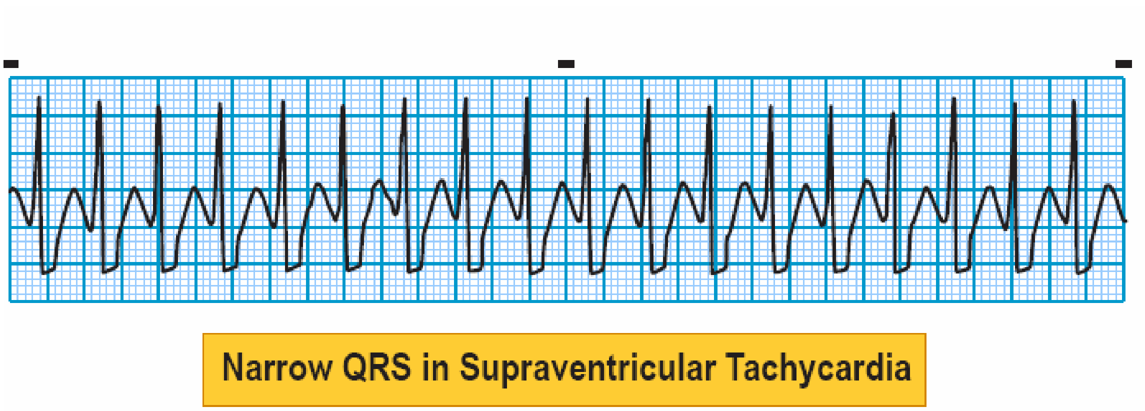
Ventricular Tachycardia verses Supraventricular Tachycardia Differential Characteristics





Module: ECG Module

Lesson: Ventricular Rhythms

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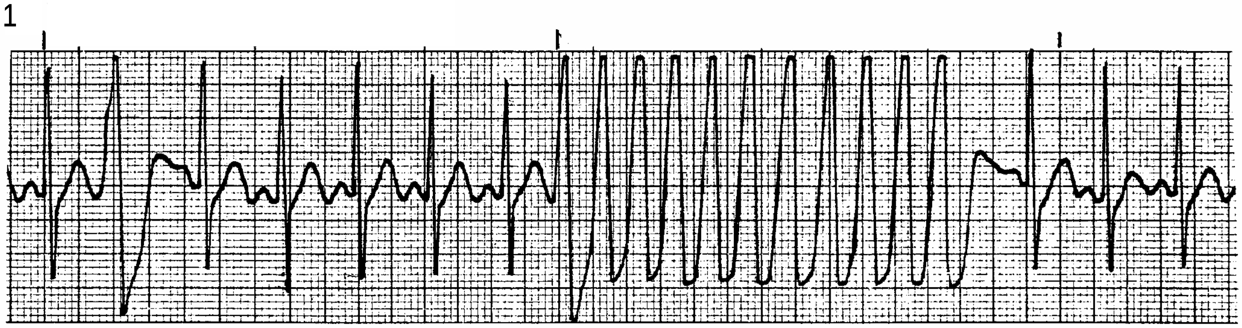
Ventricular Rhythms Work Sheets

Unless otherwise indicated the rhythms strips are Lead II.

1



P waves ______ Vent. Rate ________

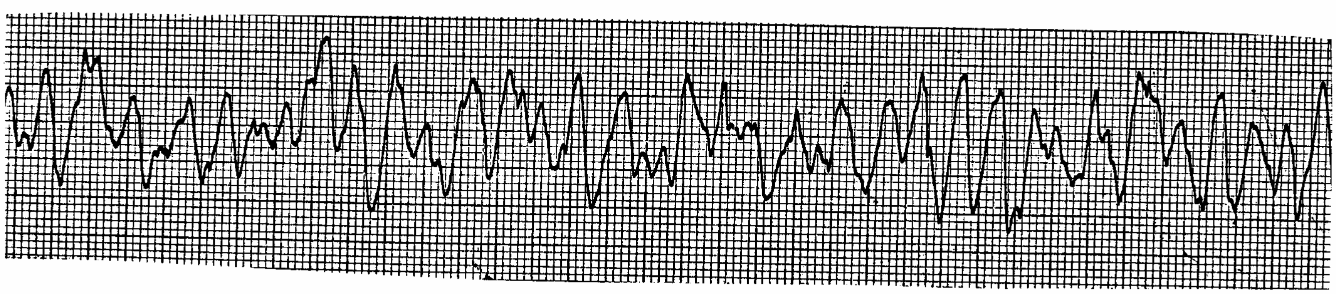
PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation ____________________

____

2



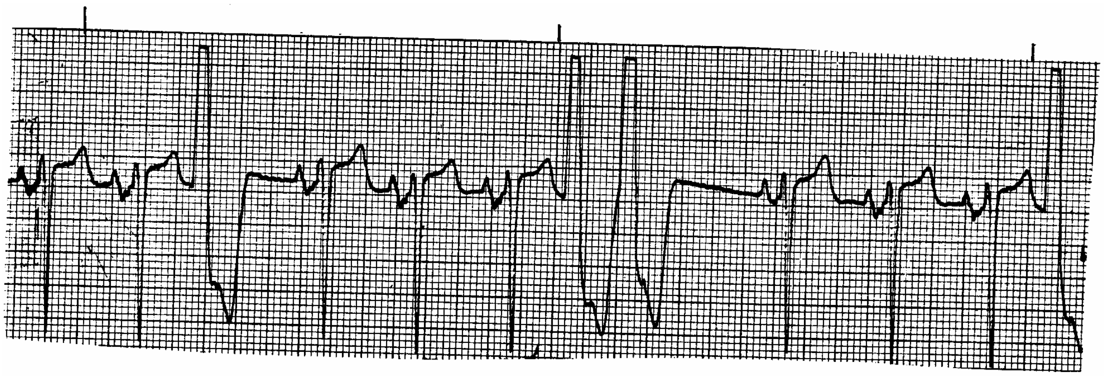
P waves ______ Vent. Rate ________

PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation _____________________

3 Lead V1



P waves ______ Vent. Rate ________

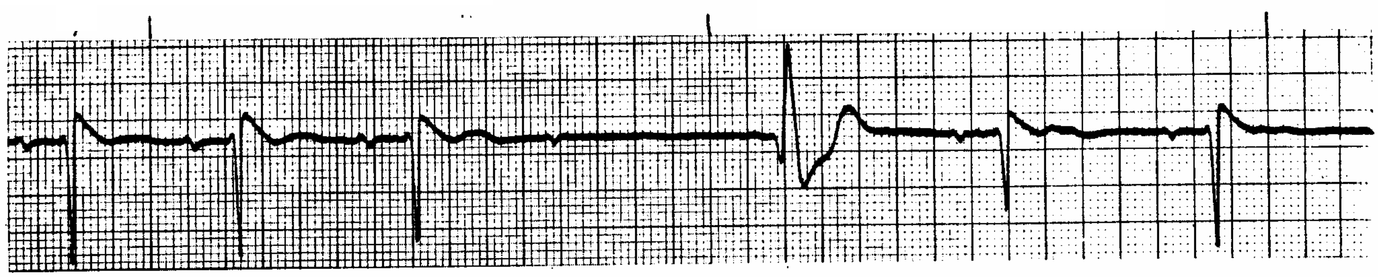
PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation ___________________

____

4 Lead V1



P waves ______ Vent. Rate ________

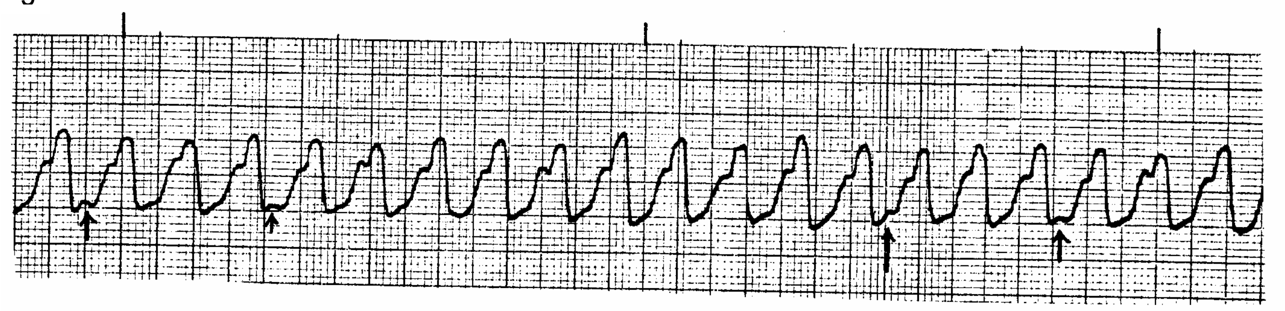
PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation ___________________

____

5



P waves ______ Vent. Rate ________

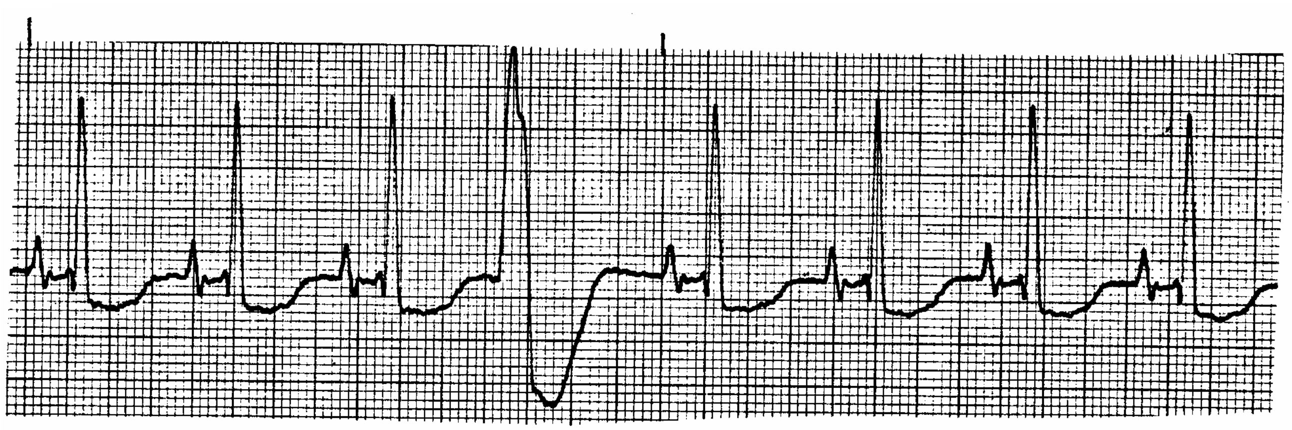
PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation ____________________

____

6



P waves ______ Vent. Rate ________

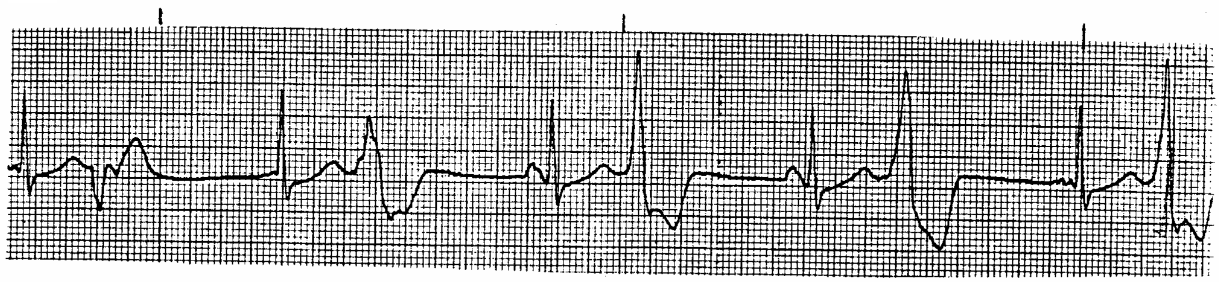
PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation ____________________

____

7



P waves ______

PR interval _____

QRS _____

QRS interval _____

Vent. Rate ________

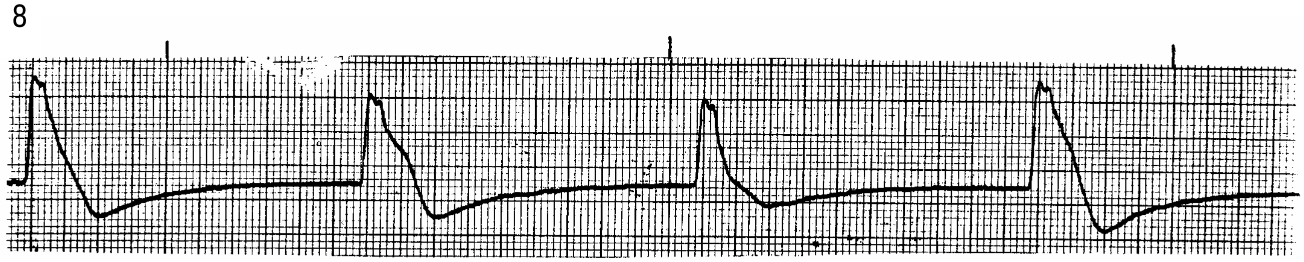
Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

____

8



P waves ______

PR interval _____

QRS _____

QRS interval _____

Vent. Rate ________

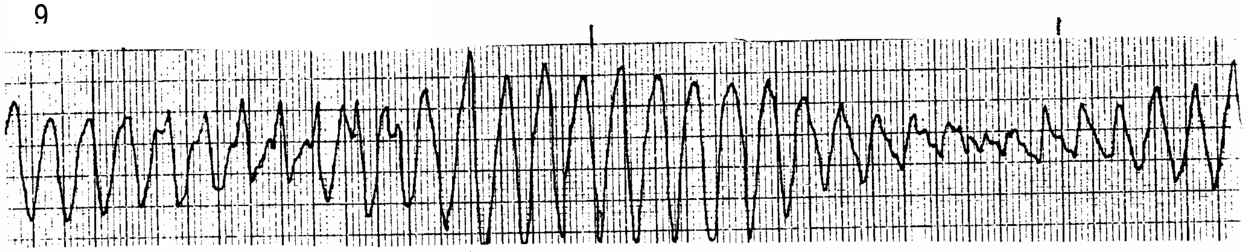
Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

____

9



P waves ______

PR interval _____

QRS _____

QRS interval _____

Vent. Rate ________

Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

Ventricular Rhythms Work Sheet Answers

1.

P waves	present	**Ventricular Rhythm**	irregular
PR interval	0.16	**Atrial Rhythm**	irregular
QRS	present	**Ventricular Rate**	190 bpm
QRS interval	0.08		

Interpretation: Sinus Tachycardia with PVC at 2nd complex and run of Ventricular Tachycardia
Discussion: Interpret the underlying rhythm before the abnormal complexes. The underlying rhythm is Sinus tachycardia with a rate of 125. There is a run of ventricular tachycardia beginning at complex 8 with a rate of 250 and a single PVC following the 2nd complex. Interpret the underlying rhythm first then the abnormal rhythm. Ventricular complexes are wide and bizarre and usually > 0.12 seconds in duration, however the QRS interval of the ventricular complex is usually not measured.

2.

P waves	none	**Ventricular Rhythm**	irregular
PR interval	none	**Atrial Rhythm**	none
QRS	none	**Ventricular Rate**	not measurable
QRS interval	not measured		

Interpretation: Ventricular fibrillation
Discussion: This rhythm is also called coarse V Fib because the isoelectric line has so much movement. It is V Fib because no distinct complexes can be identified. There will be no cardiac output or pulse with this rhythm. The patient will require immediate intervention with defibrillation and support medications per ACLS or hospital specific guidelines.

3.

P waves	present	**Ventricular Rhythm**	irregular around premature beats
PR interval	0.16	**Atrial Rhythm**	irregular around premature beats
QRS	present	**Ventricular Rate**	100 bpm
QRS interval	0.10		

Interpretation: NSR with unifocal PVC and 1 set of paired PVCs or couplets
Discussion: The rhythm between the PVCs is regular.

4.

P waves	present	**Ventricular Rhythm**	irregular
PR interval	0.28	**Atrial Rhythm**	irregular
QRS	present	**Ventricular Rate**	50 bpm
QRS interval	0.08 w/ complex		

Interpretation: 1st degree AV block w/ escape beats ventricular 4 wide
Discussion: The rate slows to 30 bpm after the 3rd complex and the ventricular escape beat occurs. The other 4 complexes are sinus beats but the PR interval is prolonged making this a 1st degree AV block.

5.

P waves	none	**Ventricular Rhythm**	regular
PR interval	none	**Atrial Rhythm**	none
QRS	present	**Ventricular Rate**	167 bpm
QRS interval	wide not measurable		

Interpretation: Ventricular Tachycardia
Discussion: Some P waves can be identified in this rhythm strip (see arrows) but they are not associated with the QRS complexes and may be difficult for the novice to see. The QRS complex is wide and it is difficult to differentiate the QRS from the T wave. This is often the case with ventricular rhythms and is why the QRS interval is usually not measured. This rhythm requires immediate patient evaluation and usually defibrillation with initiation of ACLS or hospital specific guidelines.

6.

P waves	present	**Ventricular Rhythm**	irregular around premature beat
PR interval	0.20	**Atrial Rhythm**	irregular around premature beat
QRS	present	**Rate**	80 bpm
QRS interval	0.10 w/ one wide complex		

Interpretation: NSR w/ 1 PVC following the 3rd complex
Discussion:

7.

P waves	present	**Ventricular Rhythm**	irregular
PR interval	varies 0.10 – 0.16	**Atrial Rhythm**	irregular
QRS	present	**Rate**	70 bpm
QRS interval	0.12		

Interpretation: Sinus beats, Junctional beats & Multifocal PVCs in a bigeminy pattern (every other beat). The QRS complexes are > 0.10 so there is an intraventricular conduction defect present in the underlying rhythm.

Discussion: Three different rhythms or complexes can be identified in this rhythm strip. The premature beats are wide, bizarre looking and the T wave (repolarization) is in the opposite direction of the QRS complex. The wide premature beats have 4 different shapes (6 & 10 look the same) and fall in an every other beat or bigeminy pattern.

Counting left to right on the rhythm strip complexes 3 & 9 are junctional and complexes 5 & 7 are sinus beats. The QRS complex for both the sinus and junctional beats look the same but are >0.10

so the is some delay in ventricular conduction. This rhythm requires immediate evaluation of the patient's hemodynamic status.

8.

8.	P waves	none	Ventricular Rhythm	regular
	PR interval	none	Atrial Rhythm	none
	QRS	present	Ventricular Rate	31 (calculation by division)
	QRS interval	wide and bizarre		

Interpretation: idioventricular or agonal
Discussion: This rhythm is also called an agonal rhythm or dying heart. It is frequently seen before asystole occurs. There will be no cardiac output or pulse and would require immediate evaluation and intervention i.e. CPR with supportive medication per ACLS or hospital specific guidelines.

9.	P waves	present at end	Ventricular Rhythm	irregular becoming regular
	PR interval	0.20	Atrial Rhythm	irregular becoming regular
	QRS	present	Rate	75 at end (calculation by division)
	QRS interval	0.10 at end		

Interpretation: Torsade de pointes converting to NSR
Discussion: Examine the rhythm strip and look at how the QRS complexes change direction.

Lesson 7: Heart Block Rhythms

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1	Lesson VII: Heart Block Rhythms	
2	Objectives	
3	AV Heart Block Rhythms	
4	1st Degree AV Block	X
5	2nd Degree AV Heart Block Type I	
6	Heart Block: Mobitz I	
7	Heart Block: Mobitz I – P waves	X
8	Heart Block: Mobitz II	
9	Heart Block: Mobitz II – P waves	X
10	Heart Block: Mobitz II - Summary	
11	(3rd) Heart Block: Complete Heart Block	
12	Complete Heart Block	X
13	Cardiac Pacemaker - Ventricular	
14	Cardiac Pacemaker - Placement	
15	Temporary Pacemaker Generator	
16	(Permanant) Cardiac Pacemaker	
17	Ventricular Paced Rhythm	X
18	Ventricular Paced Rhythm - Summary	X
19	Self Assessment Questions	

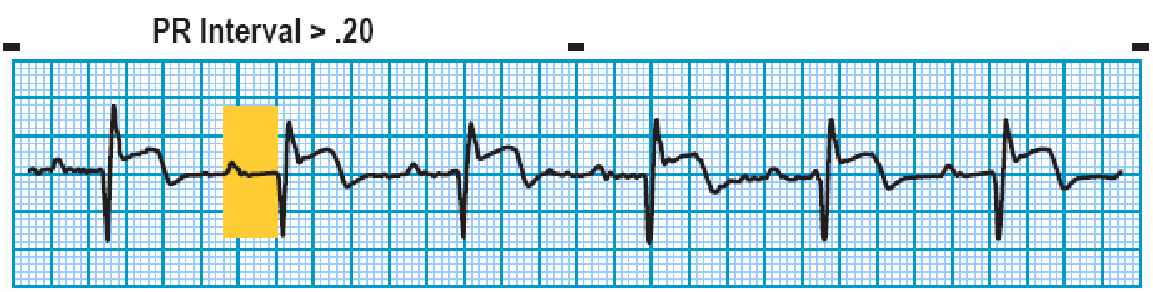
Module: ECG Module

Lesson: Heart Block

Section:

Slide: 4

1st Degree AV Block



This rhythm strip also shows ST segment elevation. The ST segment elevation does not affect the rhythm interpretation. The movement in the isoelectric line (baseline) is caused by patient movement.

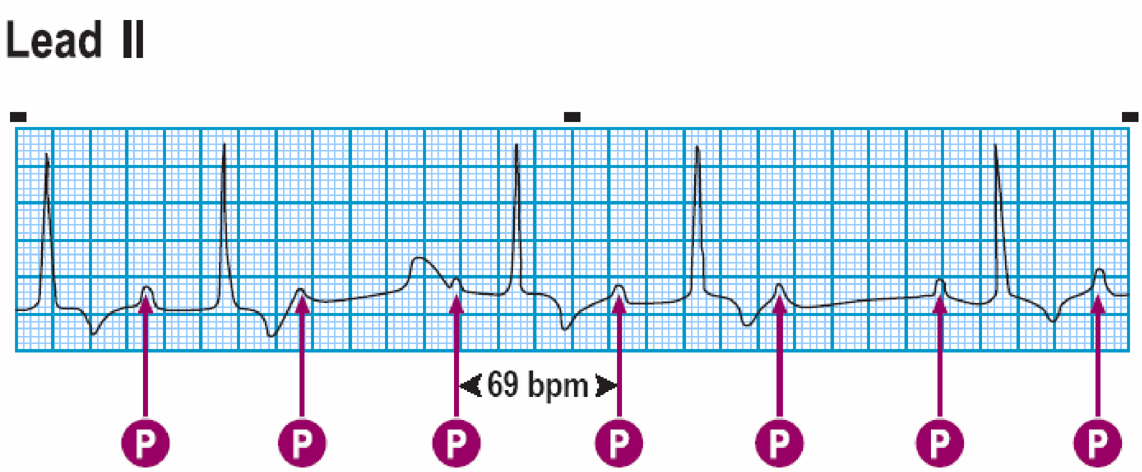
Module: ECG Module

Lesson: Heart Block

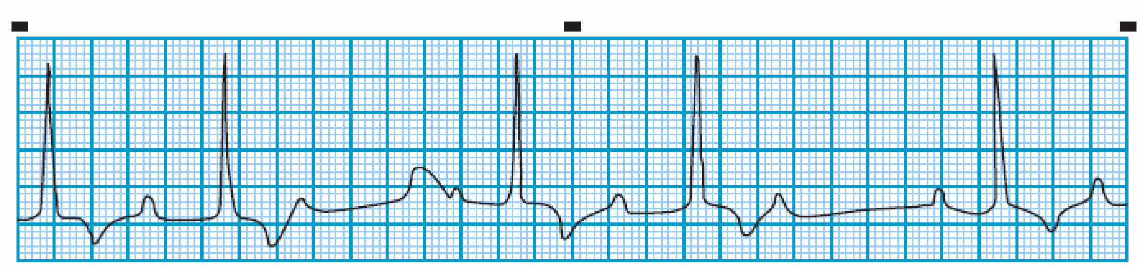
Section:

Slide: 7

2nd Degree Heart Block Type I, Mobitz I or Wenekebach



The distortion of the isoelectric line just before the 3rd P wave is called artifact and can be caused by patient movement.



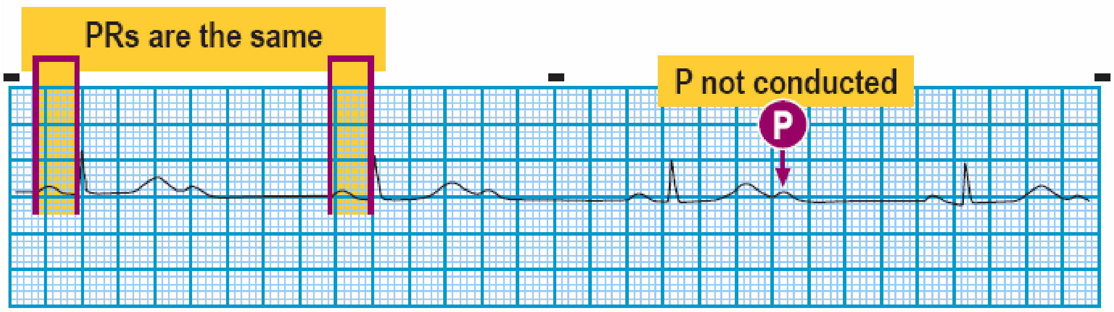
Module: ECG Module

Lesson: Heart Block

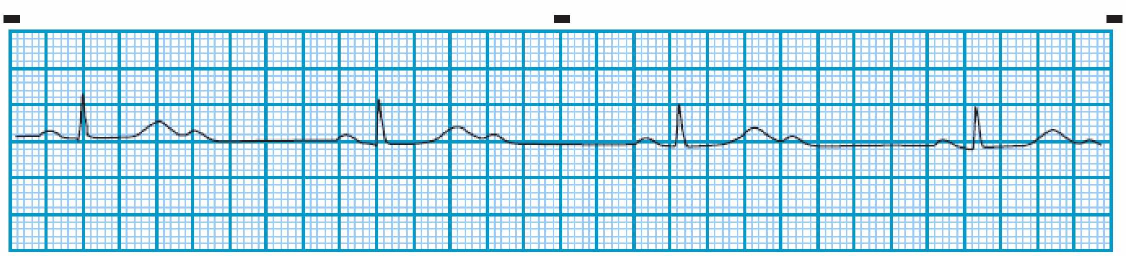
Section:

Slide: 9

2nd Degree Heart Block Type II or Mobitz II



In this strip the R-R interval is irregular because every other P wave is not conducted. In Mobitz II the ventricular rhythm will be irregular unless the P to R ratio is 2:1.



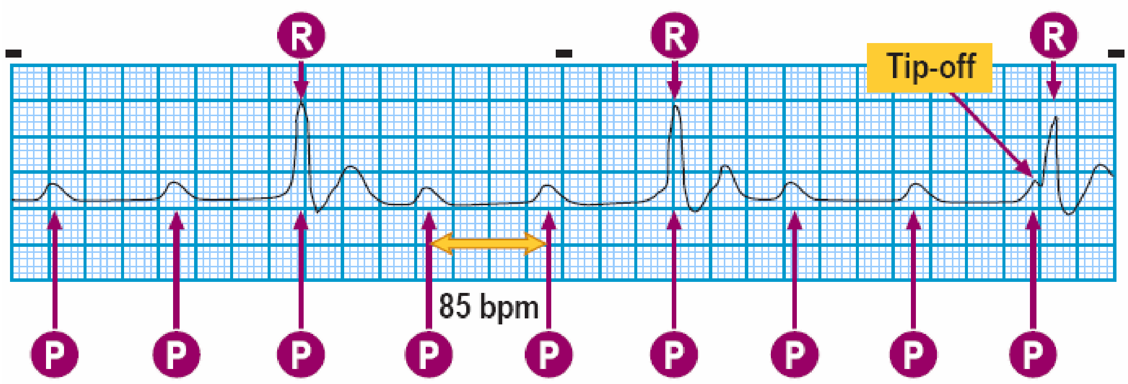
Module: ECG Module

Lesson: Heart Block

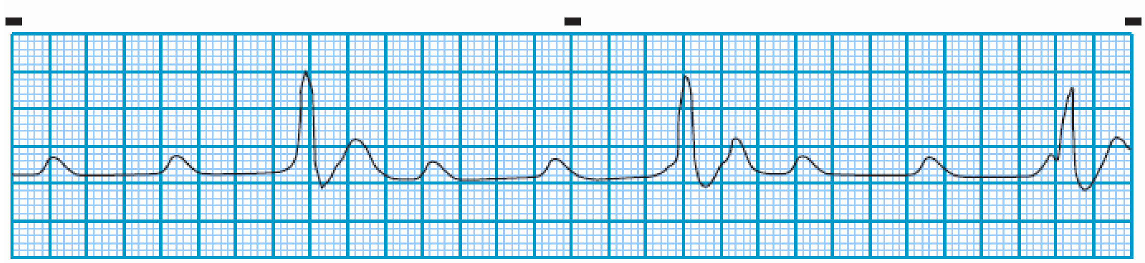
Section:

Slide: 12

3rd Degree Heart Block or Complete Heart Block



In 3rd degree heart block the P-P interval is regular. P waves can be hidden in the QRS complex or the T wave, they can also be found at the beginning or end of the QRS or T wave making it look distorted. This P wave can be differentiated from movement artifact because it will fall in the correct P-P rhythm.



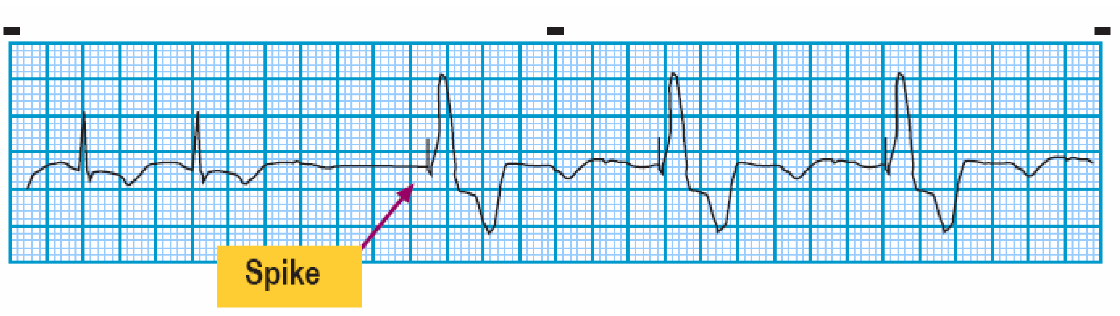
Module: ECG Module

Lesson: Heart Block

Section:

Slide: 17

Ventricular Paced Rhythms



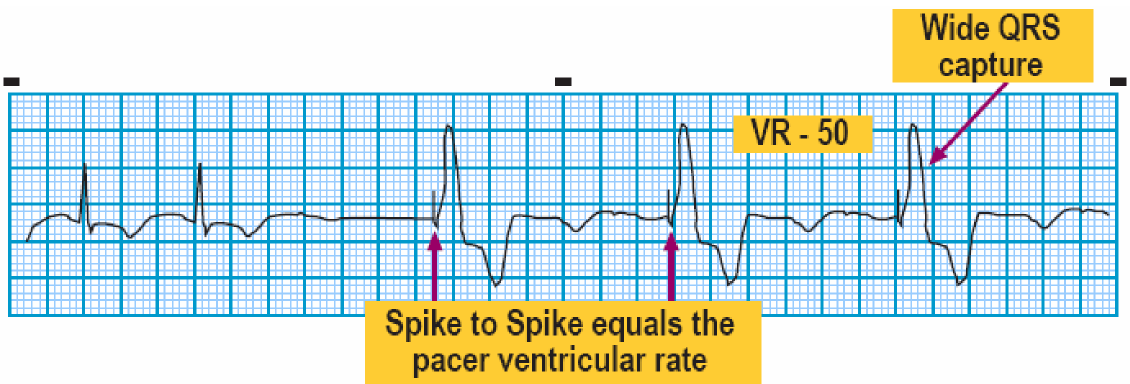
Module: ECG Module

Lesson: Heart Block

Section:

Slide: 18

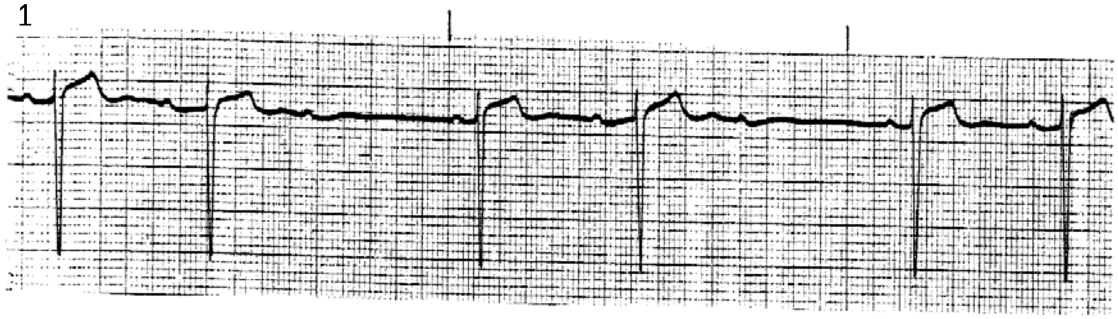
Ventricular Paced Rhythm



Heart Block Work Sheet

Unless otherwise indicated the rhythm strips are Lead V1.

1



P waves ______

PR interval _____

QRS _____

QRS interval _____

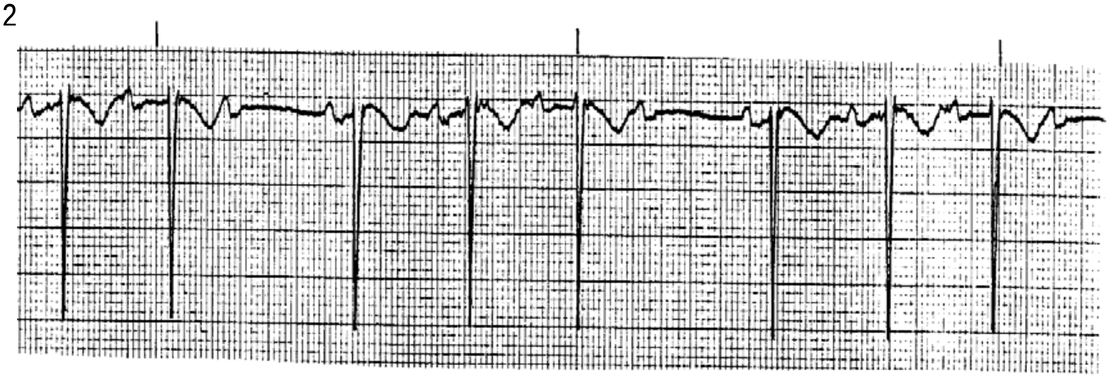
Vent. Rate ________

Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

2



P waves ______

PR interval _____

QRS _____

QRS interval _____

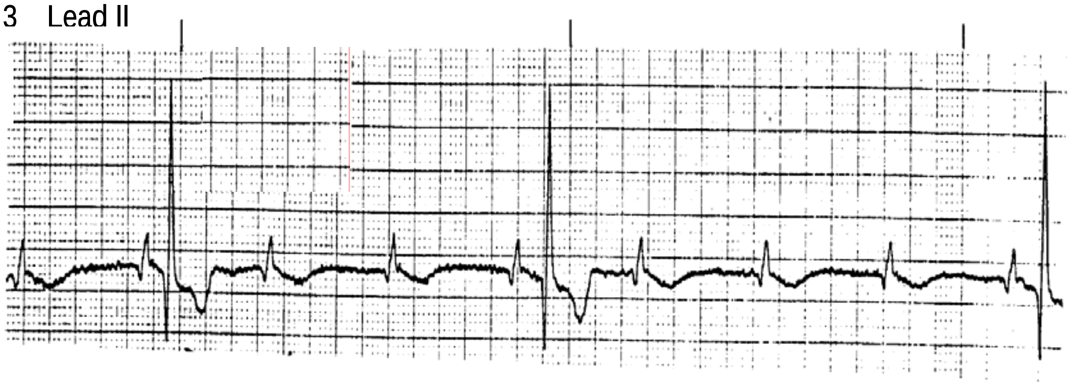
Vent. Rate ________

Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

3 Lead II



P waves ______

PR interval _____

QRS _____

QRS interval _____

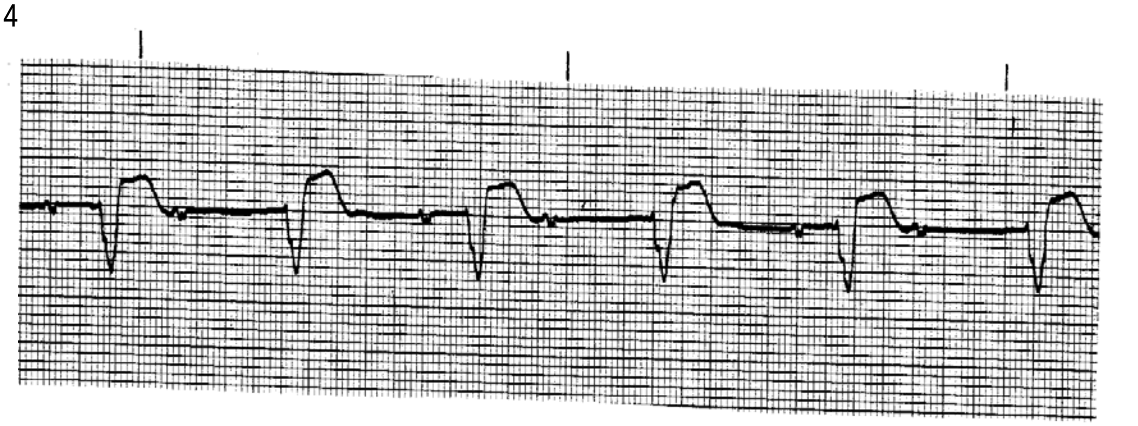
Vent. Rate ________

Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

4



P waves ______

PR interval _____

QRS _____

QRS interval _____

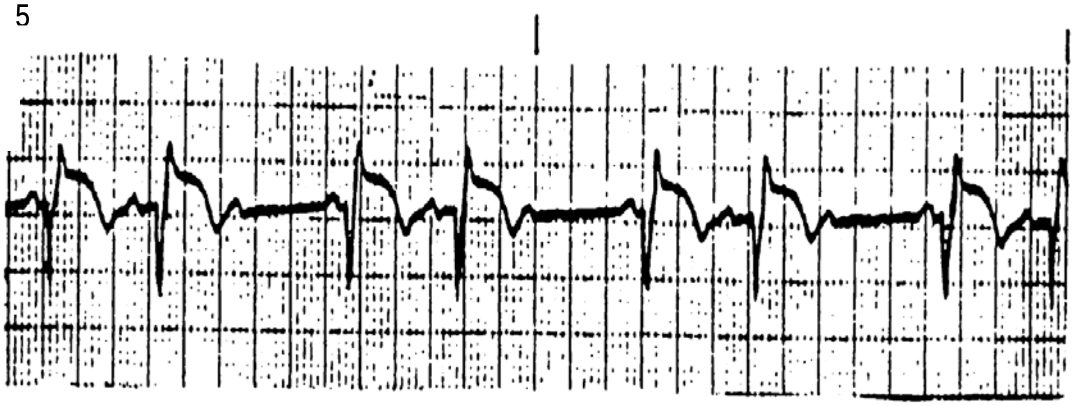
Vent. Rate ________

Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

5



P waves ______

PR interval _____

QRS _____

QRS interval _____

Vent. Rate ________

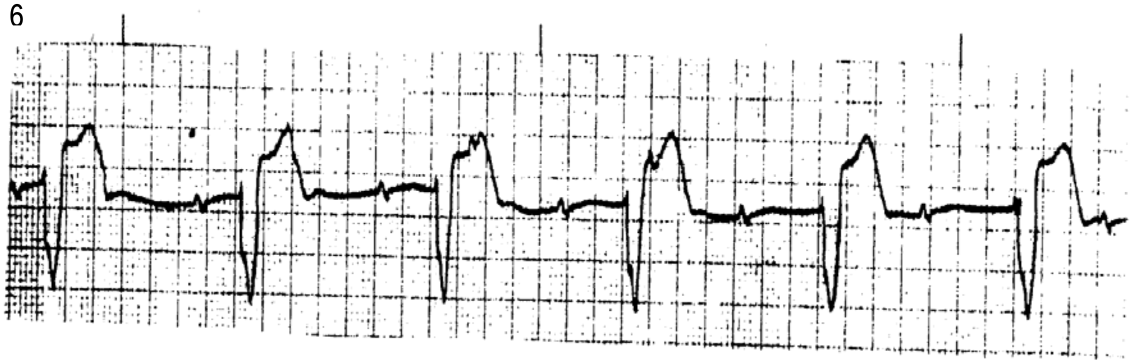
Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

____

6



P waves ______

PR interval _____

QRS _____

QRS interval _____

Vent. Rate ________

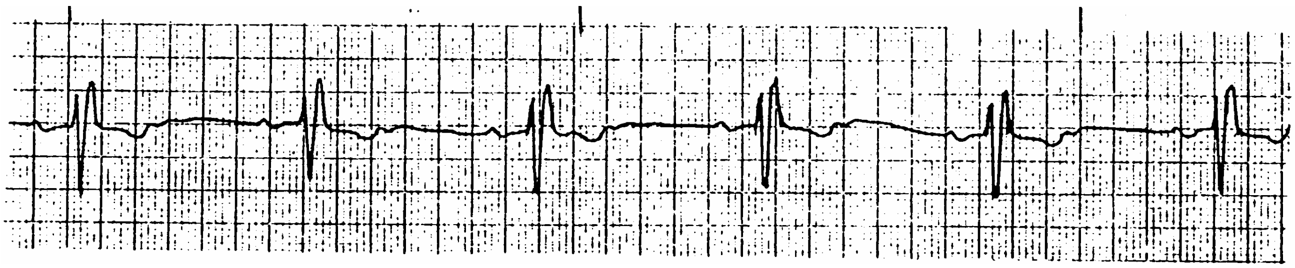
Vent. Rhythm _______

Atrial Rhythm ________

Interpretation ____________________

____

7



P waves ______ Vent. Rate ________

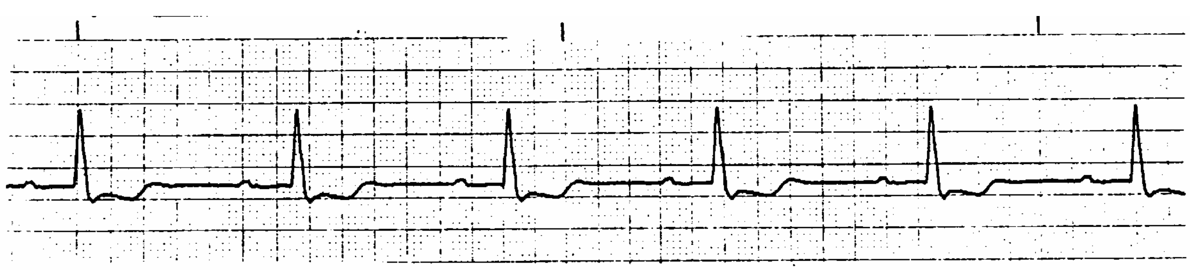
PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation ____________________

____

8 Lead II



P waves ______ Vent. Rate ________

PR interval _____ Vent. Rhythm _______

QRS _____ Atrial Rhythm ________

QRS interval _____ Interpretation ____________________

____

Heart Block Work Sheet Answers

1. | | | | |
   |---|---|---|---|
   | P waves | present | Atrial Rhythm | regular |
   | PR interval | 0.26 – 0.32 | Ventricular Rhythm | irregular |
   | QRS | present | Ventricular Rate | 40 bpm |
   | QRS interval | 0.06 | | |

   Interpretation: Mobitz I
   Discussion: The P-P interval is regular and PR interval gets progressively longer until one P wave is not conducted. The ventricular rate is slow and cardiac output might be compromised.

2. | | | | |
   |---|---|---|---|
   | P waves | present | Atrial Rhythm | regular |
   | PR interval | 0.16, 0.24, 0.28 | Ventricular Rhythm | irregular |
   | QRS | present | Ventricular Rate | 70 bpm |
   | QRS interval | 0.04 | | |

   Interpretation: Mobitz I
   Discussion: The ventricular rate is faster in this rhythm strip so the cardiac output is probably adequate. Treatment of Mobitz I will be rate dependent.

3. | | | | |
   |---|---|---|---|
   | P waves | present | Atrial Rhythm | regular |
   | PR interval | 0.20 | Ventricular Rhythm | irregular |
   | QRS | present | Ventricular Rate | 10 bpm |
   | QRS interval | 0.14 | | |

   Interpretation: Mobitz II
   Discussion: In Mobitz II the P-P intervals are regular and when the P is followed by a QRS complex the PR intervals are the same. In this rhythm strip the P waves are not conducted in a regular pattern so the ventricular rhythm is irregular. The ventricular rhythm will be regular in Mobitz II if the P to QRS ratio is consistent (2:1, 3:1 4:1) etc. In this rhythm the ventricular rate is not fast enough to sustain cardiac output and the patient would require immediate intervention. The QRS interval is wider than 0.10 so there is an intraventricular conduction defect present.

4. | | | | |
   |---|---|---|---|
   | P waves | present | Atrial Rhythm | regular |
   | PR interval | none | Ventricular Rhythm | regular |
   | QRS | present | Ventricular Rate | 46 (calculation by division) |
   | QRS interval | 0.18 | | |

   Interpretation: Complete heart block
   Discussion: The P- P rhythm is regular. Start measuring at the first 2 P waves. The third P wave is hidden in the QRS complex and cannot be visualized but if you mark the spot where the P wave should be and continue with the measurement the 4th P wave falls in the correct pattern or

sequence. In complete heart block P waves are often hidden in the QRS complexes. The P waves are not connected to the QRS complex. The PR intervals are not the same and do not follow any pattern like is seen in Mobitz I.

5.

P waves	present	Atrial Rhythm	regular
PR interval	0.12 – 0.20	Ventricular Rhythm	irregular
QRS	present	Ventricular Rate	70 bpm
QRS interval	0.10		

Interpretation: Mobitz I
Discussion: The P-P interval is regular and PR interval gets progressively longer until one P wave is not conducted. The ventricular rate is within normal limits so unless there are other factors cardiac output and systemic perfusion should not be compromised.

6.

P waves	present	Atrial Rhythm	regular
PR interval	0.32-0.72	Ventricular Rhythm	irregular
QRS	present	Ventricular Rate	40 bpm
QRS interval	.016		

Interpretation: Mobitz I
Discussion: This example of Mobitz I has progressively longer PR interval but in the six second strip you are not able to see the nonconducted P wave which probably occurs following the last complex on the rhythm strip. There is no set pattern in Mobitz I for the nonconducted P wave. If the PR interval gets progressive longer continue to run the rhythm strip. There is an intraventricular conduction defect present.

7.

P waves	present	Atrial Rhythm	regular
PR interval	0.24	Ventricular Rhythm	regular
QRS	present	Ventricular Rate	44 (calculation by division)
QRS interval	0.16		

Interpretation: Mobitz II
Discussion: In this example the R – R are regular because the conducted P wave are at a consistent ratio of 2:1. The nonconducted P waves are at the end of the T wave of the QRS complex and are best seen in complexes 1, 4 & 5. There is also an intraventricular conduction defect present.

8.

P waves	present	Atrial Rhythm	regular
PR interval	0.36	Ventricular Rhythm	regular
QRS	present	Ventricular Rate	46 (calculation by division)

QRS interval 0.10

Interpretation: Sinus bradycardia with 1st degree block

Discussion: P-P and R-R intervals are regular and the PR interval is prolonged but consistent. The ventricular rate is slow so cardiac output and systemic perfusion might be compromised.